Sistem nauke-faktor poticaja ili ograničavanja razvoja: Science system-a Factor of Stimulation or Limitation in Development

Trifković, Miloš

2021-10-27

Academy of Sciences and Arts of Bosnia and Herzegovina

https://bastina.anubih.ba/items/fe55fd34-af42-4399-8913-79b68cd89f42

Sistem nauke

70 GODINA

SISTEM NAUKE – FAKTOR POTICAJA
ILI OGRANIČAVANJA RAZVOJA

70 GODINA

AKADEMIJA NAUKA I UMJETNOSTI BOSNE I HERCEGOVINE
АКАДЕМИЈА НАУКА И УМЈЕТНОСТИ БОСНЕ И ХЕРЦЕГОВИНЕ
ACADEMY OF SCIENCES AND ARTS OF BOSNIA AND HERZEGOVINA

Special Editions
Volume CC

Department of Social Sciences
Volume 18

International Scientific Conference "Science system – a Factor of Stimulation or Limitation in Development"

Sarajevo, 5th of November, 2021

Proceedings

Editor
Academician Miloš Trifković

SARAJEVO 2021

DOI: 10.5644/PI2021.200.00

70 GODINA

AKADEMIJA NAUKA I UMJETNOSTI BOSNE I HERCEGOVINE
АКАДЕМИЈА НАУКА И УМЈЕТНОСТИ БОСНЕ И ХЕРЦЕГОВИНЕ
ACADEMY OF SCIENCES AND ARTS OF BOSNIA AND HERZEGOVINA

Posebna izdanja
Knjiga CC

Odjeljenje društvenih nauka
Knjiga 18

Međunarodna naučna konferencija “Sistem nauke – faktor poticaja ili ograničavanja razvoja”

Sarajevo, 5. novembra 2021. godine

Zbornik radova

Urednik
Akademik Miloš Trifković

SARAJEVO, 2021.

Sistem nauke – faktor poticaja ili ograničavanja razvoja
Sarajevo, 5. novembra 2021.

Izdavač
Akademija nauka i umjetnosti Bosne i Hercegovine

Za izdavača
Akademik Muris Čičić

Urednik
Akademik Miloš Trifković

Redakcioni odbor
Dopisni član Fikret Čaušević, akademik Muris Čičić i akademik Miloš Trifković

Recenzenti:
Prof. dr. Elvis Ahmetović, prof. dr. Ivica Aviani, prof. dr. Zoltan Baracskai, dopisni član Fikret Čaušević, prof. dr. Elvir Čizmić, prof. dr. Slobodan Ćamilović, doc. dr. Bernard Harbaš, prof. dr. jur. Rudolf Krasser, akademik Slavo Kukić, prof. dr. Asim Kurjak, prof. dr. Slobodan Marković, prof. dr. Najla Podrug, prof. dr. Slavo Radošević, prof. dr. Željko Senković, prof. dr. Željko Šain

Prevod i lektura na engleski i B/H/S jezik
Adnan Arnautlija

Lektorica za B/H/S jezik
Irma Grebović-Muratović

Korektura
Sabina Vejzagić i Belinda Milanović

DTP
Narcis Pozderac

Štampa
Dobra knjiga d.o.o. Sarajevo

Tiraž
300

Sarajevo, 2021.

CEEOL
EBSCO

ISBN 978-9926-410-72-8

SADRŽAJ

PREDGOVOR

Akademija nauka i umjetnosti Bosne i Hercegovine (ANUBiH) kontinuirano prati i izučava razvoj nauke i stanje inovacionog sistema u državi. Najnoviji doprinos ovome procesu je međunarodno savjetovanje „Sistem nauke – faktor poticaja ili ograničavanja razvoja„ u organizaciji Odjeljenja društvenih nauka.

Podaci statističkih zavoda u Bosni i Hercegovini, sve dostupne međunarodne studije i analize, odgovori Bosne i Hercegovine na primarna i dopunska pitanja o nauci iz Poglavalja 25. Evropske komisije, srednjoročni razvojni planovi različitih nivoa državne organizacije i rezultati istraživanja ANUBiH, uključujući i posljednje „Harmonizacija sistema nauke u Bosni i Hercegovini“, pokazuju da naučnoistraživački i tehnološko-razvojni rad u Bosni i Hercegovini u apsolutnom smislu stagniraju, dok u relativnom nazaduju. Na ovom zaključku je zasnovan i naziv konferencije. Naše studije potvrđuju da su glavni razlozi nezadovoljavajućeg stanja nauke i tehnološkog razvoja u Bosni i Hercegovini apsolutno nedovoljno finansiranje, te policentričan i atrofirani inovacioni sistem. U skladu s tim je određen profil ove pozivne konferencije. Ona nije usmjerena na opis stanja, nego na politiku i instrumente njegovog mijenjanja.

Prilozi su orijentisani na najvažnije i najkritičnije strukturalne i funkcionalne elemente inovacionog sistema, one koji bitno utiču na razvoj društva i ekonomije znanja. Ovi faktori su ispitani s ciljem utvrđivanja ključnih poveznica globalnog i domaćeg razvoja inovacionog sistema i poruka koje Bosna i Hercegovina može izvući iz svjetskih kretanja. Da bi se to postiglo, izabrani aspekti inovacionog sistema su osvijetljeni naročito iz uglova ekonomske politike i planiranja, organizacije, finansiranja, prava, etike i scienciometrije. Ovakav postupak je u fokus konferencije stavio tri grupe subjekata: državu, univerzitete i privredna društva. Time je ukazano na nužnost sistematske primjene *Triple Helix* pristupa i u našoj državi.

Organizatori konferencije se nadaju da će naučna i stručna javnost posebnu korist imati iz ogromnog znanja i iskustva koje autori sažeto prezentiraju u svojim člancima. Da bi to bogatstvo, koje nam je stavljeno na raspolaganje bez naknade, bilo što bolje iskorišteno, u programu konferencije je ostavljeno dovoljno vremena za diskusiju. S istim ciljem će izlaganja, diskusije i zaključci konferencije biti postavljeni na internet stranici ANUBiH. Ukoliko to bude inspiracija za nova istraživanja i konkretne promjene u ovoj oblasti, konferencija će u cjelini ispuniti svoju misiju.

Akademija nauka i umjetnosti Bosne i Hercegovine izražava zahvalnost Federalnom ministarstvu obrazovanja i nauke, posebno gospodinu mr. sc. Jasminu Brankoviću, pomoćniku ministra za nauku i tehnologije ne samo za finansiranje konferencije i štampanje Zbornika radova, nego i za razumijevanje poteškoća koje je pandemija COVID-19 prouzrokovala organizatorima ovog skupa.

U ime radnih tijela koja su organizovala konferenciju i izdavanje Zbornika radova zahvaljujem se svim uposlenicama i uposlenicima ANUBiH na nesebičnom zalaganju za uspjeh ovoga projekta.

Sarajevo, oktobra 2021. godine.

Akademik Miloš Trifković, urednik
Akademija nauka i umjetnosti Bosne i Hercegovine

DOI: 10.5644/PI2021.200.01

Ograničenja naučnog konsenzusa

Uvodno obraćanje

Dražen Prelec[*]

Zadovoljstvo mi je i čast doprinijeti konferenciji na temu "Sistem nauke - faktor stimulacije ili ograničenja u razvoju", koju organizuje Akademija nauka i umjetnosti Bosne i Hercegovine. Nemoguće je precijeniti važnost i pravovremenost teme ove konferencije, koja postavlja najmanje dva različita pitanja. Prvo, "vanjsko" pitanje je: kako mjeriti utjecaj naučnih istraživanja na društvo u cjelini. Drugo, "interno" pitanje je kako bi naučni sistem trebao biti organiziran kako bi se povećala produkcija istinskog znanja. Iz programa je evidentno da će se o oba pitanja govoriti tokom konferencije.

Trebao bih obznaniti već na početku da se moje istraživanje ne bavi proučavanjem nauke same po sebi. Radio sam na pitanjima donošenja odluka, bihevioralnoj ekonomiji i, što je ovdje relevantno, na razvoju mehanizama za iznošenje i objedinjavanje stručnih procjena, što me u smislu ove konferencije čini "meta stručnjakom" ako ne "stručnjakom za domen". Stručno ili specijalizirano prosuđivanje je, naravno, u srži nauke i doprinosi napetosti između naučnika i opće javnosti, od koje se traži da prihvati sudove naučne zajednice bez nužnog razumijevanja popratnih razloga ili dokaza. Od laika se jednostavno traži da vjeruju nauci.

Fokus mog govora bit će na metodama za postizanje konsenzusne prosudbe u situacijama u kojima se stručnjaci ne slažu. Takvo neslaganje rutinski se javlja u svakoj disciplini i instituciji, i endemično je u donošenju pravnih odluka, umjetničkih sudova, te u nekim područjima medicine, posebno psihijatriji. Unutar prirodnih nauka navedeno neslaganje ima i unutrašnji i vanjski aspekt. Na svakodnevnom nivou u okviru uobičajenog funkcioniranja nauke,

[*] Profesor na Sloan School of Management, na Odsjeku za ekonomiju i Odsjeku za mozak i kognitivne nauke, Massachusetts Institute of Technology. E-mail: dprelec@mit.edu.

postoje odluke o prihvatanju članaka za objavljivanje i odluke o finansiranju prijedloga grantova ili zapošljavanju i unapređivanju pojedinačnih kandidata. U takvim slučajevima, jednako kvalificirane sudije ili članovi vijeća mogu donijeti različite zaključke. Kako onda treba donositi odluke? Treba li ih povjeriti jednom "diktatoru", kao što je urednik časopisa ili predsjednik univerziteta, ili nekom stručnom panelu, kao što je tipično u odlukama o finansiranju grantova? Izazov postizanja konsenzusne prosudbe pojavljuje se i na vanjskom nivou, kada neka disciplina govori o društvenim problemima i politici. Postavlja se, dakle, pitanje u šta disciplina zapravo vjeruje, naprimjer o klimatskim promjenama ili ekonomskoj politici? Treba li to kolektivno uvjerenje izračunati nekom vrstom prosjeka vjerovanja profesionalaca u ovoj disciplini?

Ovdje se susrećemo s drevnim problemom demokratskog glasanja i njemu srodnih pitanja o tome ko je kompetentan glasati o nekom određenom pitanju i kako glasove kombinirati u cilju donošenja odluke. Moglo bi se početi sa starim Grcima. Primijetit ću samo dva važna novija rezultata, jedan matematički i jedan empirijski.

Matematički rezultat je Condorcetov 'teorem porote' (Condorcet, 1785). Condorcet je razmatrao tačnost mišljenja većine o nekom binarnom pitanju, poput pitanja da li je neki prijedlog 'tačan' ili 'netačan'. Pretpostavlja se da pitanje ima objektivno tačan odgovor, koji ne mora znati niti jedna osoba. Condorcet je dokazao da ako svaki pojedinac koji glasa ima više od 50% šansi biti u pravu, tada mišljenje većine postaje sve vjerovatniji pokazatelj istine kako se povećava broj glasača, i postaje nepogrešivo kako se taj broj približava beskonačnosti. Ovo je bio rani dokaz zakona velikih brojeva.

Više od jednog stoljeća kasnije, engleski učenjak Francis Galton, pružio je malu, ali elegantnu empirijsku demonstraciju, koja se pokazala još utjecajnijom (Galton 1907). Galton je proveo eksperiment prosuđivanja u prirodnom okruženju seoskog sajma, gdje su se kupovale i prodavale životinje. Zatražio je od prisutnih ljudi da procijene težinu jednog vola ili, preciznije, težinu mesa koje će životinja proizvesti nakon što je zaklana. Galton je obrazložio da bi tačnost srednje procjene predstavljala validan test demokratskog odlučivanja:

> "Prema demokratskom principu 'jedan glas jedna vrijednost', gdje srednja [prosječna] procjena izražava *vox populi*, svaka druga procjena se odbacuje ili kao preniska ili kao previsoka od strane većine ispitanika..."

Galton nije provjeravao stručnost ispitanika, a grupa ljudi koja je davala procjene bila je raznolika, neki su imali iskustva s procjenom vrijednosti životinja ponuđenih na prodaju, a drugi su bili puki prolaznici. Eksperiment bi se stoga mogao predstaviti kao test demokratskog principa 'jedna osoba jedan glas'. Rezultat eksperimenta bio je izvanredan i možda razočaravajući za Galtona koji je bio politički konzervativan. Prosječna procjena gotovo se savršeno podudarala sa stvarnom težinom.

Galtonov rad postao je poticaj za ono što je danas poznato kao filozofija 'mudrosti gomile', koja smatra da je algoritamska agregacija mišljenja superiornija od akreditiranih stručnjaka te da bi ih trebala zamijeniti. Utopijske tvrdnje povezane s ovom filozofijom dobro su sažete u bestseleru "Mudrost gomile", novinara Jamesa Surowieckog:

> "Velike grupe ljudi pametnije su od elitne manjine, bez obzira koliko oni genijalni bili – bolje su u rješavanju problema, podsticanju inovacija, donošenju mudrih odluka, čak i u predskazivanju budućnosti (Surowiecki, 2005)."

Pokret iza filozofije mudrosti gomile crpi snagu iz dva trenda – jednog tehnološkog i jednog društveno-političkog. Rasprostranjeno usvajanje elektroničkih komunikacijskih uređaja učinilo je istraživanje velikog broja raštrkanih pojedinaca mnogo lakšim i, ako je potrebno, njihovo plaćanje za iznošenje mišljenja. To vidimo u sve većem broju online sistema ocjenjivanja i besplatno datih ocjena. Svi možemo bez mnogo napora glasati o raznim vrstama pitanja. Galtonov *vox populi* sada se čuje posvuda, sve vrijeme. Ovo je praćeno povećanim nepovjerenjem u stručnost općenito, a posebno u naučnu ekspertizu.

Međutim, tehnološki napredak u komuniciranju mišljenja nije učinio ništa za rješavanje temeljnog teorijskog problema: iako je očito istina da velika skupina ljudi ima više informacija od bilo kojeg pojedinca, nije očito tačno da će nefiltrirano mišljenje većine ispravno odražavati te informacije. Mišljenje većine definitivno može proizvesti pogrešan rezultat ako su najkvalitetnije informacije koncentrirane kod malog broja pojedinaca, dok većina ima pogrešna uvjerenja. To vrijedi i u nauci, jer se novi naučni razvoji često dočekuju sa skepsom čak i unutar same naučne zajednice.

Prije nego razmotrimo alternative mišljenju većine kao definiciji istine, trebali bismo napomenuti da naša kultura posjeduje još jedan moćan mehanizam za izazivanje i kombiniranje mišljenja mnogih pojedinaca: tržišta i tržišne institucije. Na tržištima se ovakva mišljenja ne izražavaju eksplicitno, već samo implicitno kroz trgovačke aktivnosti. Odnosno, ulaganjem u tržište, ulagači izjavljuju da imaju određene informacije ili uvide koji se ne odražavaju na trenutnu tržišnu cijenu, ali će se kasnije odraziti, što će rezultirati profitom.

Tržišta, koja se smatraju instrumentom kolektivnog odlučivanja, imaju tri zanimljive karakteristike. Prvo, tržišta su proceduralno demokratska: svi mogu učestvovati; osobi nije potrebna diploma ili položen test da bi mogla "glasati" na tržištu. Međutim, za razliku od glasanja, sud tržišta nije algoritamski demokratski, jer cijena ne odražava prosječno mišljenje, već prosjek ponderiran visinom uloga koji su različiti učesnici na tržištu spremni uložiti. Oni s dubljim džepovima imaju veći utjecaj. Bar u teoriji, tržišni instrument trebao bi biti izuzetno osjetljiv na stručnost, jer će pojedinci s vrhunskim informacijama uložiti relativno više i imati veći utjecaj na cijenu. Treće, tržišta rješavaju ono što ekonomisti nazivaju "problemom kompatibilnosti poticaja", tj. tržišta pružaju poticaje pojedincima da otkriju svoje iskreno mišljenje o budućim cijenama. To nije slučaj s glasanjem ili ocjenjivanjem, gdje ljudi mogu dati glas ili ocjenu nepošteno, bez ikakve kazne.

S obzirom na ove prednosti, moglo bi se postaviti pitanje mogu li tržišta imati ulogu u raspodjeli sredstava za naučne projekte, evaluaciji prijedloga grantova ili uredničkim odlukama u časopisima? Doista, nedavni rad pokazao je da je određena vrsta "tržišta predviđanja" sposobna predvidjeti ponovljivost naučnih nalaza (Dreber et al., 2015). Učesnici na tržištu mogu donekle naslutiti da li je objavljeni rezultat krhak ili nevjerodostojan.

Ostaje da se vidi da li tržišta mogu igrati veću ulogu u donošenju naučnih odluka. Ključno ograničenje tržišta je da se tržišne vrijednosnice moraju definirati uzimajući u obzir provjerljivu, javnu metriku ili događaj. Spomenuti rad definira, provjerljivi događaj kao rezultat pokušaja reprodukcije eksperimentalnog nalaza. Rezultat će biti poznat: ili će eksperimentalni rezultat biti reproduciran ili neće biti reproduciran. No, mnoga, ako ne i najzanimljivija znanstvena pitanja nisu lako provjerljiva. To svakako vrijedi za društvene znanosti, gdje, naprimjer, 'istina' kejnzijanskog pristupa makroekonomiji nikada neće biti riješena, na zadovoljstvo svih.

Sličan problem pojavljuje se ako pokušate koristiti tržišta za donošenje odluke o finansiranju grantova. Može se zamisliti tržište na kojem bi pojedinci ulagali u prijedloge koji se natječu za sredstva. Međutim, čak i ako bi se mogao definirati provjerljiv indeks za ocjenu krajnjeg učinka istraživačkog projekta, takav bi se indeks mogao izračunati samo za prijedloge koji su zaista i finansirani, prijedlozi bez sredstava neće imati određenu tržišnu vrijednost.

Iz ovih razloga, neka vrsta glasanja ostaje preferirani instrument za usaglašavanje mišljenja u nauci. Kao što je već napomenuto, veliko ograničenje glasanja je njegova neosetljivost na relativnu stručnost. Ovaj se problem ne rješava traženjem od pojedinaca da iznesu nivo svog samopouzdanja, a zatim procjenjivanjem njihovih odgovora u odnosu na njihovo subjektivno iskazano samopouzdanje. Ljudi jednostavno nisu dobri u komuniciranju uvjerenosti i lako je zamisliti scenarije u kojima su stručnjaci upravo ljudi koji imaju relativno manje samopouzdanja (to bi bio slučaj kada informacije dostupne stručnjacima ruše uvjerenost u široko rasprostranjeno konsenzusno mišljenje).

U nedavnom radu kolege i ja predložili smo rješenje ovog problema, zasnovano na traženju od stručnjaka ne samo da daju svoj lični sud, već i predviđanje prosudbi koje će dati drugi stručnjaci, tj. njihovi "kolege" (Prelec, Seung i McCoy, 2017). Ovdje opisani princip glasanja ne predstavlja standardni demokratski princip odabira alternative koja će dobiti najviše glasova, odnosno najpopularnije alternative, već različit princip odabira alternative koja dobije najviše glasova u odnosu na predviđanja. To se zove princip "iznenađujuće popularnog". Tvrdnje koje stoje iza ove teorije zasnovane su na matematičkom modelu, ali se osnovna intuicija može predstaviti jednostavnim primjerima.[1]

Kao elementarnu demonstraciju ili "dokaz koncepta" razmotrimo jednostavno činjenično pitanje na koje većina ljudi daje pogrešan odgovor. Ovo je primjer takvog pitanja: "Je li grad Philadelphia glavni grad američke savezne države Pennsylvania?" Budući da je Philadelphia poznat veliki grad, a također igra važnu ulogu u američkoj povijesti, čini se da je prirodni kandidat da bude glavni grad države, te većina ljudi u SAD-u i vjeruje da je to glavni grad ove države. Međutim, glavni grad je relativno nepoznati Harrisburg. Stoga Condorcetova pretpostavka pada, jer svaki glasač ima manje od 50% šansi tačno presudi po ovom pitanju. Mišljenje većine obično je pogrešno i, zaista, garantovano će biti pogrešno kod velikog broja uzoraka.

Evo kako se ovaj problem može riješiti. Princip 'iznenađujuće popularnog' ne podržava mišljenje većine, već upoređuje glasove za svaki mogući odgovor s predviđenim glasovima za taj odgovor. U slučaju Philadelphije, iako samo manji broj ljudi (oko 35%) daje tačan odgovor, "Ne", to je više od predviđenih glasova za "Ne" koji čine oko 25%. Stoga će se odgovor "Ne" proglasiti tačnim odgovorom prema metodi, budući da je 35% veće od 25%.

Vrijedi zastati kako bi se razmotrilo zašto je broj predviđenih "Ne" glasova manji od stvarnih glasova. To je zato što pojedinci koji znaju da je tačan odgovor "Ne" također znaju da većina ljudi ne zna tačan odgovor. Drugi način izražavanja ove intuicije je: da je Philadelphia zaista glavni grad, gotovo svi bi vjerovali da je to slučaj, a ne samo 65%. Ako je očigledan odgovor istinit,

[1] Princip 'iznenađujuće popularnog', također, se može koristiti za pružanje podsticaja za iskrene prosudbe, u situacijama gdje se iskrenost ne može neovisno potvrditi (Prelec, 2004).

onda bi ga trebali podržati gotovo svi; ako se značajna manjina ne slaže s očiglednim odgovorom, onda je taj odgovor najvjerojatnije lažan. U osnovi, princip iznenađujuće popularnog implementira sistem hendikepa, gdje se različiti odgovori procjenjuju upoređujući koliko podrške dobijaju u odnosu na predviđeni hendikep.

Kako bismo pružili demonstraciju sa značajnijim interesom, koja uključuje istinsku stručnost u određenom domenu, testirali smo metodu sa stručnjacima za umjetnost procjenjujući tržišnu vrijednost savremenih umjetničkih djela (Prelec, Seung & McCoy, 2017). Sa stanovišta metode, izazov ovdje sličan je izazovu sa kojim se suočava naučni panel stručnjaka sa zadatkom da ocijeni različite prijedloge grantova za istraživanje. U oba okruženja, panel će biti sastavljen od ljudi s različitim ukusima i različitim nivoom znanja o pojedinim umjetničkim djelima ili prijedlozima podnijetim na ocjenjivanje. U našem istraživanju s modernom umjetnošću predvidjeli smo i uočili specifičnu vrstu greške demokratskog algoritma glasanja, naime, da je previše konzervativan. Čak i ako nekoliko stručnjaka ipak prepozna izvanredan talent, njihova će mišljenja općenito nadglasati njihove kolege koje ga ne prepoznaju. Važno je shvatiti da ovo nije problem individualnog neznanja, već problem načina glasanja. Izuzetno umjetničko djelo ima veće šanse da ga prepozna jedan nasumično odabran član panela, nego mišljenje većine cijelog panela. (Moglo bi se reći da ovi nalazi pružaju neku vrstu podrške praksi pokroviteljstva u umjetnosti, gdje se odluke u osnovi delegiraju jednom aristokratskom ili bogatom pojedincu).

Moguće je da se isti problem javlja u okviru naučnih panela ili odbora, jer su u strukturnom smislu postavka i dileme u odlučivanju slični. Među pojedincima koji čine takve panele postojat će razlike u stručnosti u vezi s konkretnim prijedlozima. Oni koji su relativno manje upoznati s prijedlogom vjerovatno će dati sigurnu, 'prosječnu' ocjenu, što je ispravan odgovor na ličnom nivou. Ovo stvara pristrasnost prema zaista originalnim prijedlozima, čiji merit prepoznaje relativno mali broj njih. U teoriji, 'iznenađujuće popularni' princip glasanja uklonit će pristranost i pružiti više mogućnosti da nove ideje dobiju sredstva.

Takav eksperiment još nije proveden, pa ovi prijedlozi ostaju spekulativni. Izazovi u implementaciji ove metode i ocjenjivanju njenog učinka u odnosu na tradicionalnu alternativu mišljenja većine nisu trivijalni. Ipak, znamo dovoljno o individualnim i kolektivnim pristranostima u donošenju odluka da možemo preporučiti promjenu načina na koji se stvari rade, u nadi da ćemo promovirati ideje i projekte koji inače ne bi opstali.

Do sada smo se bavili "unutrašnjim" pitanjem poboljšanja raspodjele resursa u okviru nauke, ali iste zabrinutosti i mogući lijekovi primjenjuju se na "vanjsko" pitanje identifikacije i prenošenja najboljeg odgovora na pitanja koja bi društvo moglo postaviti naučnoj zajednici. Samo naučni konsenzus nije pouzdan pokazatelj najboljeg odgovora u svjetlu svih naučnih dokaza, jer dokazi nisu demokratski raspoređeni unutar naučne zajednice koja je, kao i sve ljudske zajednice, podložna konvencijama, modi i predrasudama.

Do sada smo se bavili "unutrašnjim" pitanjem poboljšanja raspodjele resursa u okviru nauke, ali isti izazovi i potencijalna rješenja važe i za "vanjsko" pitanje identifikacije i komuniciranja najboljeg odgovora na pitanja koja bi društvo moglo postaviti naučnoj zajednici. Sam naučni konsenzus nije pouzdan pokazatelj najboljeg odgovora u svjetlu svih naučnih dokaza, jer dokazi nisu demokratski raspoređeni unutar naučne zajednice koja je, kao i sve ljudske zajednice, podložna konvencijama, modi i predrasudama.

Reference

Condorcet, J.-A.-N. de Caritat, marquis de. *Essai sur l'application de l'analyse à la probabilité des décisions rendues à la pluralité des voix*. Paris: Imprimerie Royale, 1785.

Dreber, A., Pfeiffer, T., Almenberg, J., Isaksson, S., Wilson, B., Chen, Y., Nosek, B.A., & Johannesson, M. Using prediction markets to estimate the reproducibility of scientific research. *Proceedings of the National Academy of Sciences*, 2015, *112*(50), 15343-15347.

Galton, F. Vox populi (the wisdom of crowds). *Nature*, 1907, *75*(7), 450-451.

Prelec, D., Seung, H. S., & J. McCoy. A solution to the single-question crowd wisdom problem. *Nature*, 2017, *541*(7638), 532-535.

Prelec, D. "A Bayesian truth serum for subjective data." *Science*, 2004, 306, 462-466.

Surowiecki, J. *The wisdom of crowds*. Anchor, 2005.

DOI: 10.5644/PI2021.200.02

Javno istraživanje i razvoj i nauka – privredne veze u ekonomskom razvoju: Implikacije za Bosnu i Hercegovinu

Slavo Radošević[*]

Sažetak: Ovaj rad predstavlja trenutno razumijevanje uloge javnog istraživanja i razvoja (I&R) u ekonomskom rastu i veze nauke i privrede u ekonomijama srednjeg nivoa dohotka, poput Bosne i Hercegovine (BiH). U drugom dijelu predstavljamo konvencionalno viđenje veza nauke i privrede koje te veze razmatra prvenstveno u smislu jednosmjernog prijenosa znanja ili njegove komercijalizacije iz istraživanja i razvoja u sektor poslovnih preduzeća. Na osnovu uporednih podataka, koji uključuju i BiH, pokazujemo alternativni pristup i raspravljamo o njegovoj relevantnosti u kontekstu BiH. Naš zaključak je da bi veze nauke i privrede (VNP) trebale podržati ukupno unaprijeđenje tehnologija, a ne (tj. ne samo) rast zasnovan na istraživanju i razvoju. U sljedećem dijelu predstavljamo trenutno razumijevanje uloge javnog istraživanja i razvoja u ekonomskom rastu. Drugi dio istražuje ulogu javnog istraživanja i razvoja u kontekstu konvergencije, dok treći dio posebno istražuje ulogu veza nauke i privrede u kontekstu konvergencije. Četvrti dio predlaže "*triple helix*" pristup vezama nauke i privrede za konvergencijske ekonomije. Njegove karakteristike ilustrujemo kroz podatke za ekonomije centralne i istočne Europe. Konačno, peti dio daje zaključak sa implikacijama za BiH.

Ključne riječi: Istraživaje i razvoj, nauka - privrede veze, *triple helix*, tehnološka nadogradnja

1. Uloga javnog istraživanja i razvoja u ekonomskom rastu[1]

Konvencionalni argument za javna ulaganja u I&R, a posebno za javnu podršku privatnom I&R, temelji se na pretpostavci da firme ne ulažu u istraživanje i razvoj zbog mogućeg "curenja znanja". Kao rezultat toga, kompanije imaju poteškoća u preuzimanju svih prednosti istraživanja i razvoja i, kao rezultat toga, premalo ulažu u I&R, što opravdava javnu podršku privatnom I&R.

Primarni analitički dokaz za ulogu javnog istraživanja i razvoja u ekonomskom rastu predstavlja ekonometrijska literatura o povratu od I&R. Ova literatura može se razdvojiti na:

[*] Prof. dr., Univerzitetski koledž u Londonu. E-mail: s.radosevic@ucl.ac.uk

[1] Ovaj dio se djelimično oslanja na rad Radošević S (2016) "The role of public research in economic development, Chapter II.1 in EC, Science, Research and Innovation performance of the EU. A contribution to the Open Innovation, Open Science, Open to the World agenda, DG for Research and Innovation", Europska komisija, str. 119-139.

- procjene privatnih stopa povrata na I&R,
- procjene društvenih stopa povrata na I&R, te
- procjene povrata od javnog I&R.

1.1. Procjene privatnih i društvenih stopa povrata

Mjerenje stopa povrata na I&R temelji se na logici proizvodne funkcije, gdje se I&R tretira kao jedan od inputa pored kapitala i rada. Ovaj pristup dominira jer može dati kvantitativne procjene koliko I&R doprinosi rastu ili koliki su povrati ulaganja u I&R.

Procjene društvenih stopa povrata na I&R temelje se na pretpostavci da se prihodi od istraživanja i razvoja ne odnose samo na pronalazača, već i druge kompanije u istoj industriji. To je zato što su ove kompanije ili povezane lancima vrijednosti (dobavljači i kupci) ili sa konkurentima koji mogu slobodno učiti na osnovu grešaka lidera ili ih mogu oponašati. Društvena stopa povrata se potom procjenjuje dodavanjem privatne stope povrata (koristi za firmu koja vrši I&R) zbroju prinosa od istraživanja i razvoja koje provode vanjski elementi, bilo da se radi o drugim kompanijama ili industrijama ili zemljama.

Postoji saglasnost da su stope privatnog i društvenog povrata na privatno finansirani I&R značajne i pozitivne u mnogim zemljama. Većina njih spada u raspon između (10%)20% i (30%)50%. Društveni povrat na I&R je značajan i znatno premašuje privatne prinose.[2] On premašuje privatni povrat za 50 do 100 posto. Sveikauskas (2007) sugerira da je privatni povrat na I&R oko 25 posto, dok je društveni povrat 65 posto.

Na makro nivou, studija OECD -a (2003) pokazuje jasnu pozitivnu vezu između intenziteta I&R-a privatnog sektora i rasta bruto domaćeg proizvoda (BDP-a) po glavi stanovnika za ekonomije OECD -a. Međutim, ne postoji jasna veza između javnog I&R i rasta, barem kratkoročno (ibid). Autori ističu da je to posljedica "*važnih interakcija između javnih i privatnih I&R aktivnosti, kao i teško mjerljivih koristi od javnog istraživanja i razvoja (npr. istraživanja u sektorima odbrane, energetike, zdravstva i univerzitetska istraživanja)*

[2] Za listu referenci na ove izvore vidi Radošević (2016) "The role of public research in economic development, Chapter II.1 in EC, Science, Research and Innovation performance of the EU. A contribution to the Open Innovation, Open Science, Open to the World agenda, DG for Research and Innovation", Europska komisija, str. 119-139.

i od generiranja osnovnog znanja koje pruža dugoročno prelijevanje tehnologija" (OECD, 2003)[3]

1.2. Procjene povrata na javna I&R

Procjene povrata na javno finansirani I&R opterećene su sa nekoliko metodoloških složenosti. Prvo, direktni efekti istraživanja i razvoja manje su važni od njegovih indirektnih efekata, koji se javljaju kada ulaganja u privatnom sektoru nadopunjuju rezultate javnog I&R-a. Drugo, ne treba sav javni I&R računati kao ulaganja, jer za značajan dio javnog I&R nije lako pripisati stopu povrata. Dakle, samo mali dio javnog istraživanja i razvoja treba klasificirati kao ulaganje (Sveiruskas, 2007). Treće, javni I&R omogućava ili otvara dalja ulaganja u I&R od strane privatnog sektora. U tom smislu, prilično je dvosmisleno odvojiti privatna od javnih ulaganja kao da su ona neovisna jedna od drugih ako javno istraživanje uspostavi osnovno razumijevanje i koncepte dok ih privatna istraživanja i razvoj implementiraju. Dakle, ova dualna priroda javnog istraživanja i razvoja, gdje jedan njegov dio nema komercijalne ciljeve, dok drugi dijelovi stvaraju osnovu za buduća komercijalna kretanja, čini prilično nezgodnim tumačenje procjena povrata javno finansiranih ulaganja u I&R.

Stilizirana činjenica ekonometrijskog istraživanja je da su stope povrata na javna istraživanja i razvoj niže ili manje značajne od onih iz privatnih I&R. Na primjer, vidi Griliches, 1986; Levy i Terleckyj, 1989; Lichtenberg i Siegel, 1991; Mansfield, 1980; Nadiri i Mamuneas, 1994. te reference citirane u Hall et al. 2010, Sveiruskas, 2007. i Kokko et al. (2015).[4] Objašnjenja ovih rezultata su različita. Prvo, konvencionalno objašnjenje je da privatne kompanije mogu biti manje efikasne kada koriste javno finansiranje za I&R, ili ovo finansiranje može biti udaljeno od tržišta. Drugo, vladini projekti istraživanja i razvoja se nalaze u područjima koja su ili udaljena od tržišta (odbrana) ili se provode u mješovitom polju poput zdravstvenog sektora. Treće, javna istraživanja i razvoj ne stvaraju direktne koristi, već indirektne, razvijanjem osnova za I&R aktivnosti preduzeća i javnih organizacija (univerziteti, bolnice itd.). Četvrto, često se navodi da je javno istraživanje i razvoj usmjereno prema rizičnijim područjima, što bi trebalo smanjiti stopu povrata. Međutim, kada su

[3] Park (1995.) je također otkrio da je I&R privatnog sektora važnije od javnog I&R u regresijama rasta u državama OECD-a. Vidi PARK, W.G. (1995), "International R&D Spillovers and OECD Economic Growth", Economic Inquiry, Vol. 33, str. 571-91.
[4] Za kompletnu listu referenci vidi Radošević (2016.) op. Cit.

uspješna, povrati na osnovna istraživanja i razvoj veći su u odnosu na povrate na primijenjena ili razvojna istraživanja i razvoj (Griliches, 1986; Link, 1981; Mansfield, 1980). Peto, vlade mogu pretjerano ulagati u naučno-tehnološka područja koja su ‘pretrpana’ i gdje su povrati niski. Također, trebamo imati na umu da postoje značajne razlike u tome koliko se industrije oslanjaju na javnu nauku. Na primjer, Marsili (2001) pokazuje da doprinos akademskog istraživanja industriji mjeren citatima naučnih radova u patentima može biti vrlo visok, npr u industrijama farmaceutskih proizvoda i računara. U drugim industrijama, ova vrsta doprinosa je niska, ali postojana, uglavnom kroz protok studenata.

1.3. Klasifikacija benefita javnog istraživanja

Iako ekonometrijski pristup dominira u procjeni učinaka istraživanja i razvoja, uključujući javno finansirani I&R, evidentno je da složenost odnosa između javnog istraživanja i razvoja i rasta zahtijeva alternativne pristupe. Znamo da su veze između javno finansiranog istraživanja i razvoja i privrede raznolike i indirektne. Na temelju ovih pretpostavki Martin et al. (1996) i Martin i Salter (2001) (vidi također Martin i Tang, 2006) razvili su klasifikaciju koristi javnog istraživanja, koja pokazuje raznolikost i složenost njegovih utjecaja. Ove koristi mogu nastati i iz privatnih istraživanja, iako vjerovatno u donekle izmijenjenom obliku i razmjeru. Oni razlikuju sljedeće vrste koristi (str. 520):

1. Povećanje količine korisnog znanja;
2. Obuka kvalifikovanih diplomaca;
3. Kreiranje novih naučnih instrumenata i metodologija;
4. Umrežavanje i stimulisanje društvene interakcije;
5. Jačanje kapaciteta za naučno i tehnološko rješavanje problema;
6. Stvaranje novih firmi.

Povećanje količine znanja

Javno istraživanje i razvoj povećava količine znanja koje je dostupno kompanijama. Publikacije predstavljaju bitan izvor učenja za kompanije u sektorima poput farmacije, ali zapravo je znanje, a ne samo informacije, ono što je kompanijama najvrednije. S obzirom da je javno istraživanje udaljeno od tržišta, ono stimulira i omogućava firmama da se usredsrede na istraživanja bliska tržištu, pa stoga predstavlja dopunu, a ne zamjenu. To zahtijeva poznavanje publikacija i neformalne kontakte, zajednički I&R i umrežavanje (Arundel et al., 1995).

Kvalifikovani diplomci

Kvalifikovani diplomci se u mnogim industrijama smatraju primarnom koristi za kompanije. Oni donose složene vještine rješavanja problema, nove metodologije i kapacitete za izvođenje istraživanja i razvoja. Naravno, ovaj prijenos varira od područja do područja i ovisi o tome gdje se nalaze kritične kompetencije u određenim tehnološkim područjima.

Novi instrumenti i metodologije

Instrumentacija ili naucna oprema aktivno pokreće naučni napredak (De Sola Price i Bedini, 1967). Stoga su razvoj novih instrumenata i metodologija bitan rezultat javnog istraživanja i razvoja, posebno u nekim sektorima.

Umrežavanje i društvene interakcije

Industrije su također društvene zajednice unutar kojih akademske mreže mogu odigrati vitalnu ulogu i bitan su dio tehnološkog umrežavanja. Veze sa akademskom zajednicom neophodne su u industrijama koje su direktno zavisne od nauke. U drugim slučajevima, gdje su diplomirani studenti važan izvor novih znanja, umrežavanje je više neformalnog tipa putem bivših učenika. U drugim sektorima mreže se održavaju uglavnom putem izložbi i konferencija. Martin i Salter (2001) daju pregled literature koja pokazuje intenzivnu lokaliziranu prirodu saradnje na istraživanju i razvoju, koja je odraz geografske, kulturne ili institucionalne blizine.

Tehnološko rješavanje problema

Kapaciteti istraživanja i razvoja javnog sektora u rješavanju problema nadopunjuju njegovu ulogu pružatelja opšteg naučnog znanja. Ova stručnost utjelovljena je u pojedinačnim ugovorima i saradnji sa univerzitetima i javnim službama za istraživanje sa pojedinim firmama i vrlo je česta u primijenjenim područjima istraživanja i razvoja.

Stvaranje novih firmi

Stvaranje novih firmi povezanih sa istraživanjem smatra se jednom od značajnih ili poželjnih prednosti javnog istraživanja i razvoja. Uprkos svim političkim hvalospjevima, čini se da je ovo mnogo manje značajna korist javnog istraživanja i razvoja (Brown i Mason, 2014).

Postoje potpuno nerealna očekivanja u pogledu sposobnosti javnog istraživanja i razvoja da generira patente, prihode od licenciranja i povezana istraživanja zasnovana na patentu. Samo nekolicina univerziteta u svijetu uspješno je pretvorila istraživanje u inovacije, a većina prihoda od ovih aktivnosti potječe od vrlo malog broja univerziteta.[5]

2. Uloga javnog istraživanja i razvoja u kontekstu konvergencije

U ovom odjeljku bavimo se pitanjem: koja je relevantnost literature o stopama povrata na I&R za konvergencijske zemlje čije kompanije uglavnom djeluju "iza tehnološke granice"?

Prvo, istraživanje o procijenjenim stopama povrata implicitno pretpostavlja da sposobnosti preduzeća za I&R nisu problem. Međutim, to nije slučaj u konvergencijskim ekonomijama gdje je postotak kompanija koje su stalno aktivne u polju istraživanja i razvoja značajno manji. Drugo, podjednako se pretpostavlja da sposobnosti u akademskom sektoru omogućuju redovnu interakciju s poslovnim sektorom i da se te interakcije mogu mjeriti putem budžeta za I&R. Međutim, akademski sektor možda nije u mogućnosti da uđe u interakciju s poslovnim sektorom iz različitih razloga, uključujući jaz između baza znanja javnih organizacija za I&R i preduzeća. Stoga se apsorpcijski kapacitet poslovnog sektora ne može uzeti zdravo za gotovo.

Naša prva polazna tačka za razumijevanje uloge javnog istraživanja i razvoja u kontekstu konvergencije je ta da njegovu ulogu treba sagledati u tri izvora istraživanja i razvoja: privatnom istraživanju i razvoju, javnom istraživanju i razvoju i istraživanju i razvoju iz inostranstva. Relativna važnost ovih izvora varira u zavisnosti od razvoja. U fazi konvergencije strane veze su ključne, ali u post-konvergencijskoj fazi one nisu dovoljne jer ih je potrebno zamijeniti raznim lokalnim vezama (Albuquerque et al., 2015).

Druga polazna tačka je da se uloga javnog istraživanja i razvoja može shvatiti samo ako se razmatra u odnosu na nivo sposobnosti kompanija (Albuquerque et al., 2015). Dakle, moramo uzeti u obzir evoluciju kako

[5] Npr. na samo 10% univerziteta u Europi odnosi se 85% ukupnih prihoda generiranih kroz izume. Univerziteti Ujedinjenog Kraljevstva stvaraju tek 2–4% svojih ukupnih prihoda kroz patentiranje i licenciranje, dok mnogo značajnija sredstva dolaze iz ugovorenih istraživanja, saradničkih istraživanja i profesionalnog obrazovanja. U SAD-u, MIT generira 22 spin off kompanije godišnje, dok je prosjek među 157 univerziteta tek 4. Izvor: OECD (2013), "Commercialising Public Research. New trends and strategies", Pariz

lokalnog javnog istraživanja i razvoja, tako i lokalnih kompanija. Osim sposobnosti kompanija, trebali bismo uzeti u obzir i "sposobnosti univerziteta" (Eun et al. 2006) ili "akademske sposobnosti" (Liefner i Schiller, 2008) jer se i one razvijaju postajući sve raznovrsnije.[6]

Ključno je razmatrati odnos između javnog istraživanja i razvoja i poslovnog sektora u kontekstu evolucije. "*Kako se razvijaju sposobnosti kompanija, univerziteta i javnih istraživačkih instituta, mijenjaju se priroda, kanali i razlozi važnosti univerziteta za kompanije*" (Albuquerque et al., 2015).

Iz historijskih izvještaja o javnom istraživanju i razvoju saznajemo da kanali interakcije između javnog istraživanja i razvoja i poslovanja imaju historiju evolucije (Albuquerque et al., 2015). Daniel Schiller i Keun Lee (2015) ocrtavaju obrazac promjene odnosa između akademske zajednice i biznisa. U početku, univerziteti i javne istraživačke organizacije pružaju ljudske resurse, testiranje i jednostavno rješavanje problema (npr. savjetovanje i tehnička pomoć). Kasnije, univerziteti i javne istraživačke organizacije postaju bolje opremljeni, a lokalne kompanije mogu koristiti njihove laboratorije. Konačno, oni poduzimaju istraživačke aktivnosti koje zamjenjuju i nadopunjuju I&R od strane kompanija. Sličan proces se odvija i na strani kompanija. "*U početku, kompanije mogu koristiti samo univerzitetski obrazovane ljudske resurse, kasnije će moći tražiti od univerziteta i javnih istraživačkih organizacija rješavanje tehničkih problema, a kako ti problemi postaju složeniji, mogu se pojaviti pitanja za istraživanje, te zajednički projekti istraživanja i razvoja mogu postati dio agende*" (str. 21), (Kruss et al., 2015).

Historijske cinjenice pokazuju da je istraživanje na univerzitetima i u javnim laboratorijama u interakciji sa sposobnostima kompanija jedan od značajnih pokretača procesa konvergencije (Mazzoleni i Nelson, 2007). Međutim, programi istraživanja i razvoja koji su efektivno doprinijeli konvergenciji nisu djelovali unutar "izoliranih akademskih krugova", već su bili usmjereni da pomognu u rješavanju problema i unaprijeđenju tehnologije relevantne za određeni ekonomski sektor. Uglavnom su to bile nauke i inženjerske discipline orijentirane na primjenu, gdje je nauka mogla biti u direktnoj interakciji sa problemima i mogućnostima u poljoprivredi, medicini i industriji. Konačno, osim univerziteta, važnu ulogu imale su i javne istraživačke organizacije

[6] Liefner i Schiller (2008) definiraju akademske sposobnosti kao *"set funkcionalnih vještina i organizacijskih sposobnosti institucija visokog obrazovanja neke zemlje da provode svoju proširenu ulogu u procesu tehnološke nadogradnje i učenja"* (str. 281). Akademske sposobnosti čine dio apsorpcijskih sposobnosti neke države ili eksternu dimenziju internih apsorpcijskih kapaciteta kompanija.

(JIO) smještene izvan glavne univerzitetske strukture, u namjenskim laboratorijama orijentiranim na aplikacije.

Unutar ove perspektive, koristi javnog istraživanja i razvoja imaju donekle različit slijed u kontekstu konvergencije u usporedbi sa ekonomijama koje su tehnološki lideri. Slijed predstavljen ispod odražava opadajuću važnost različitih tipova koristi u konvergentnim državama[7]:

1. **Obučavanje stručnih kadrova**; Obučavanje stručnih kadrova vjerovatno je najvažnija korist od javnog istraživanja i razvoja, posebno zato što kompanije nisu dovoljno razvijene da same ponude usvajanje neophodnih vještina[8].
2. **Povećavanje kapaciteta za naučno-tehnološko rješavanje problema**;[9]
3. **Formiranje mreža i stimulacija društvenih interakcija**[10];
4. **Kreiranje novih naučnih instrumenata i metodologija**[11];
5. **Povećanje količine korisnog znanja kroz ugovorena istraživanja**[12];
6. **Kreiranje novih kompanija**[13].

3. Veze između nauke i privrede u kontekstu konvergencije

Obično se pretpostavlja da su veze nauke i privrede prilično nerazvijene u konvergencijskim kontekstima kakav je u BiH. Međutim, istraživanje koje su proveli Albuquerque et al. (2015), i dokazi iz EU to opovrgavaju (vidi Radošević, 2016). Prvo, dokazi iz istraživanja o inovacijama u konvergentnim ekonomijama pokazuju da inovativne kompanije univerzitete smatraju vrlo važnim izvorima informacija u sličnoj ili čak većoj mjeri nego u razvijenim zemljama. Na primjer, u brazilskoj anketi o inovacijama iz 2008. godine, 6,8% inovativnih kompanija smatralo je univerzitete visoko važnim izvorom

[7] U fusnotama dajemo prijedloge mogućeg istraživačkog projekta koji bi mogao pokušati prikazati obim ovih poveznica kroz statističke indikatore. Naravno, prva opcija bi bila da se provede namjensko istraživanje o obimu ovih koristi.
[8] Ova dimenzija se može izmjeriti kroz WEF GCR podatke o kvalitetu obrazovanja, kao pokazatelju kvalitete obučenosti stručnih kadrova.
[9] Ova dimenzija mogla bi se izvesti iz podataka o finansiranju istraživanja i razvoja iz poslovnog sektora, sektora visokog obrazovanja i javnog sektora, iz podataka istraživanja inovacija o izvorima informacija za inovacije – univerziteta i javnih istraživačkih organizacija
[10] Ova dimenzija može se izvesti iz podataka inovacijskih istraživanja o izvorima informacija za inovacije
[11] Ova dimenzija može se izvesti iz podataka o investicijama u istraživanje i razvoj
[12] Ova dimenzija može se izvesti iz podataka o radovima i patentima iz sektora visokog obrazovanja i javnih istraživačkih organizacija, ukoliko su isti dostupni
[13] Ova dimenzija može se izvesti iz podataka o javno finansiranom rizičnom kapitalu

informacija. U Istraživanju inovacija EU koje je provela EK, ovaj omjer je bio 4,3% (Albuquerque et al., 2015). Takođe, nema značajne razlike između razvijenih zemalja i zemalja u razvoju u rangiranju kompanija po važnosti izvora inovacija. Na primjer, korelacija u važnosti izvora informacija za inovacije između SAD -a i Indije iznosi 0,886 (tablica 5.6 u Albuquerque et al., 2015).

Dokazi kao što je ovaj dovode u pitanje prevladavajuće mišljenje da su u konvergencijskim zemljama veze između javnog i poslovnog istraživanja i razvoja nepostojeće ili slabe. Smatramo da je ovaj mit raširen jer je odnos između javnog istraživanja i razvoja i poslovnog sektora umanjen zbog komercijalizacije istraživanja i razvoja. Zaista, iz te perspektive, veze između nauke i privrede slabe su u zemljama koje zaostaju za tehnološkom granicom. Međutim, ovo je prilično redukcionistički stav o ulozi javnog istraživanja i razvoja. Ovo gledište proizilazi iz situacije u razvijenim zemljama, što je dovelo do *Triple Helix* inicijative. Osnovna ideja je da se priroda znanja u novim industrijama promijenila tako da zahtijeva nove oblike interakcije između nauke i privrede, gdje se njihove uloge mnogo više preklapaju.[14] Međutim, kako su s pravom istaknuli Eun et al. (2006), ove industrije čine manjinu tehnološkog spektra u konvergentnim ekonomijama. Za dokaze o CEE regiji, vidi Radošević et al. (2010).

Dokazi dakle ukazuju na važnost inovacijskih aktivnosti koje nisu temeljene na istraživanju i razvoju, te da je inovacijska politika u mnogim zemljama Srednje i Istočne Europe izrazito pristrana prema promociji rasta zasnovanog samo na istraživanju i razvoju. Međutim, ulaganja u I&R sama po sebi ne moraju nužno dovesti do inovacija zbog različitih strukturnih faktora. Prvo, istraživanje i razvoj mogu biti udaljeni od tržišta, pa stoga, iako sistem istraživanja i razvoja može biti međunarodno odličan, lokalna industrija možda neće moći komercijalizirati rezultate tog istraživanja i razvoja. Drugdje je to opisano kao jaz između međunarodne izvrsnosti i lokalne relevantnosti (Radošević, 2011).[15] Drugo, I&R često nije primarni izvor inovacija, već se inovacije pojavljuju putem inovacijskih modusa koji nisu temeljeni na

[14] Vidi Etzkowitz, H., Leydesdorff, L. (Eds.), 1997. *Universities and the Global Knowledge Economy: A Triple Helix of University-Industry-Government Relations*. Pinter, London.; Etzkowitz, H., 1998. *The norms of entrepreneurial science: cognitive effects of the new university-industry linkages. Research Policy 27*, 823–833.; Etzkowitz, H., Leydesdorff, L., 1999. *The future location of research and technology transfer*. Journal of Technology Transfer 24, 111–123.

[15] Radošević 2011. op cit

istraživanju i razvoju. Slika 1 prikazuje privredu kao mjesto većeg broja široko definiranih modusa inovacija.

Inovacije se ne odvijaju samo na temelju istraživanja i razvoja, već postoje i različite vrste inovacija koje se temelje na iskustvu (rad-korištenje-interakcija) (Lorenz i Lundvall, 2006). Rast i produktivnost ekonomije mogu počivati na nizu drugih aktivnosti koje nisu inovacijske u užem smislu, ili su postepene inovacije (poboljšanja u inženjeringu proizvoda i procesa). Također, razne aktivnosti za povećanje produktivnosti, poput aktivnosti vezanih za kvalitet i druge aktivnosti poput praksi upravljanja usmjerenih na proizvodnju, mogu potaknuti rast dodane vrijednosti ili produktivnosti (Bloom i Van Reenen, 2010). Međutim, ove aktivnosti često mogu biti mnogo kritičnije za rast produktivnosti, konkurentnosti i zaposlenosti nego I&R. Umjesto toga, istraživanje i razvoj često su važni kao promotori apsorpcijskih kapaciteta, odnosno kao aktivnost koja pomaže kompanijama i sektoru istraživanja i razvoja da prate trendove u istraživanju i razvoju i povećaju kapacitete za prilagođavanje uvezenih tehnologija.

Slika 1. Privreda kao mjesto većeg broja modusa inovacija

Izvor: Dominique Foray, Kevin Morgan i Slavo Radošević (2018), The role of smart specialisation in the EU research and innovation policy landscape, EU Directorate-General for Regional and Urban Policy, Radni dokument, dostupan na: http://ec.europa.eu/regional_policy/sources/docgener/brochure/smart/role_smartspecialisation_ri.pdf

"Rad-korištenje-interakcija" modus inoviranja važan je kako u razvijenim tako i u manje razvijenim zemljama, a ipak je izrazito zanemaren.

Produktivnost ekonomija poput Bosne i Hercegovine mnogo je više vođena raznim aktivnostima koje nisu vezane za I&R. Tri najvažnije su: inženjering, proizvodne sposobnosti i prakse upravljanja. Nažalost, podaci o ovim aktivnostima su oskudni. Konačno, čak i kada kompanije inoviraju, većina njihovih rashoda odnosi se na nabavku mašina i opreme.

Važno je prepoznati da su ove aktivnosti međusobno komplementarne i kumulativne. Uspješne kompanije su one koje spajaju inovacije zasnovane na istraživanju i razvoju i modusu rada-korištenja-interakcije. Razvijene proizvodne sposobnosti i inženjerska poboljšanja (postupne inovacije) preduslovi su za ambicioznije inovacijske napore. Poboljšane prakse upravljanja takođe su snažno povezane sa nivoima produktivnosti kompanija i ekonomija. Dakle, inovacijska politika se ne može svesti na inovacije zasnovane na istraživanju i razvoju, već treba prepoznati i uzeti u obzir raznolikost inovacijskih modusa i aktivnosti za povećanje produktivnosti. Stoga, politiku istraživanja i razvoja treba nadopuniti mjerama koje se bave nizom drugih jednako važnih izvora inovacija i rasta produktivnosti.

Alternativni način da se ova pitanja konceptualiziraju je procijeniti u kojoj se mjeri politika bavi čitavim spektrom tehnoloških i proizvodnih sposobnosti kompanija kroz takozvano “stepenište kompetencija” ili “ljestvicu inovacija” (Slika 2). Možemo samo pretpostaviti da su u BiH ove stepenice prilično strme, odnosno da je udio istraživača u poslovnom sektoru vrlo ograničen, kao i da je udio kompanija sa tehnološkim kompetencijama također nizak.

Slika 2: Segmentiranje kompanija na ljestvici inovacija

Izvor: De Jager D. et al. (2002), Competence Centre Programme Estonia Feasibility Study, naručena od strane Odjela za tehnologiju i inovacije Ministarstva ekonomskih odnosa i komunikacija Republike Estonije, Tallinn.

Nije iznenađujuće da znamo mnogo više o istraživačko-razvojnom sistemu i pitanjima rasta zasnovanog na istraživanju i razvoju nego o inovacijskim aktivnostima koje se ne odnose na I&R. Stoga postoji snažna potreba za istraživanjem ovih aktivnosti, jer tek kada budu dostupni novi podaci o tim aktivnostima "skrivenih inovacija" moći ćemo legitimirati i podržati planske aktivnosti. Standardni model u ovoj oblasti koji povezuje I&R, inovacije i produktivnost je takozvani CDM model koji se može testirati na osnovu BEEPS podataka za BiH ili drugih podataka koji bi mogli kombinirati podatke iz istraživanja inovacija s drugim podacima na nivou kompanija (Okvir 1).[16] Ovo istraživanje bi pokazalo koja su ograničenja CDM modela u ekonomijama poput BiH. Je li inovacija jedini pokretač produktivnosti? Koje su druge odrednice produktivnosti? Ovo bi također bila prilika za pokušaj ekonometrijskog testiranja alternativa ili modifikacija ovog modela, koji se ne zasniva na istraživanju i razvoju kao značajnom inputu, već na varijablama poput ulaganja, i koji bi se zasnivao na sintetičkom pokazatelju nadogradnje tehnologije zasnovanom na kombinaciji pitanja iz istraživanja inovacija.[17] Rezultati ovog modela bacili bi mnogo više analitičkog svjetla na važnost istraživanja i razvoja za produktivnost nego što je to moguće u ovom opisnom istraživanju.

Druga linija istraživanja trebala bi se temeljiti na anketi na nivou kompanija i uzimala bi u obzir čitav niz njihovih inovacijskih aktivnosti prikazanih na slici 2.

Okvir 1: Šta je CDM model?

Tzv. CDM model je način na koji ekonomisti istražuju odnos između istraživanja i razvoja, inovacija i produktivnosti na nivou kompanije. CDM model se zasniva na nizu od tri koraka.

- U prvom koraku, kompanije odlučuju da li će, i koliko, investirati u I&R. Samo ukoliko je neto povrat na ovu investiciju pozitivan (sto analitičar ne može odrediti ali je poznato kompanijama) oni će imati pozitivno ulaganje u I&R.

---

[16] Naziv CDM predstavlja inicijale trojice autora ovog modela: Crépon, B., E. Duguet and J. Mairesse (1998), "Research, Innovation, and Productivity: An Econometric Analysis at the Firm Level", Economics of Innovation and New Technology, 7(3), str. 115–156.

[17] Za neke od ideja koje se mogu koristiti u razvoju alternativnih varijabli vidi tabelu 2.2, Golderbg et al. (2011), *Igniting Innovation. Rethinking the Role of Government in Emerging Europe and Central Asia*, World Bank, Washington

- U drugom koraku, model upoređuje zadane investicije u I&R sa inovacijskim outputima, definiranim ili kao inovativnom prodajom ili kao broj patenata, koristeći funkciju proizvodnje znanja.
- Konačno, u trećem koraku, CDM procjenjuje proizvodnu funkciju koja opisuje odnos između inovacijskih outputa i produktivnosti.

Za sažetak i aplikaciju CDM modela u kontekstu CEE/CIS regije, vidi EBRD *Transition Report 2014: Innovation in Transition*, poglavlje 2, str. 31-42.

4. '*Triple helix*' pristup vezama između nauke i privrede za konvergentne ekonomije

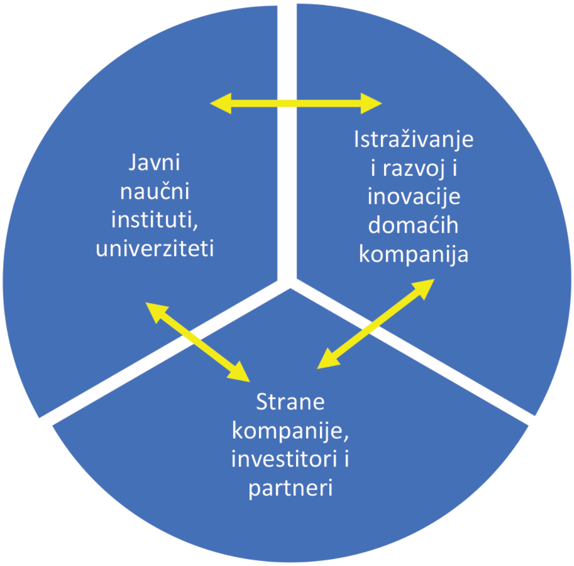
Konvencionalni pristup vezama između nauke i privrede, koji te veze svodi na komercijalizaciju javnog istraživanja i razvoja, previše je uzak i makroekonomski marginalan za konvergentne ekonomije. Kao što je ranije naglašeno, uloga javnih istraživačkih organizacija može se shvatiti samo u odnosu na sposobnosti kompanija za promjenu. To je potvrđeno širim ispitivanjem ovih veza u ekonomijama u razvoju (vidi Albuquerque et al., 2015). Kako se sposobnosti kompanija, univerziteta i istraživačkih instituta nadograđuju, priroda veza između univerziteta i kompanija se mijenja.

Takođe, pored veza između domaće privrede i nauke, moramo uzeti u obzir i veze između stranih direktnih investicija (SDI) i domaćih firmi i između SDI i domaćih univerziteta i istraživačkih instituta. Zašto? U konvergentnim ekonomijama, glavni priliv znanja dolazi kroz SDI i trgovinske odnose u lancima snabdijevanja (podugovaranje) i izvoz. Takođe, javne istraživačke organizacije mogu pristupiti međunarodnim mrežama znanja putem međunarodnih projekata, uključujući Horizon Europe ili Erasmus programe razmjene.

Domaće kompanije oslanjaju se na strane izvore znanja u licenciranju i 'obrnutom inženjeringu' ili u saradnji sa kupcima i matičnim kompanijama. Međutim, kako se zemlje razvijaju, važnost lokalnih izvora znanja, uključujući I&R, raste. U početku se lokalno znanje koristi kao nadopuna osnovnom tehnološkom znanju iz inostranstva. Kako se zemlje razvijaju, domaće veze postaju sve važnije.

Dakle, veze između nauke i privrede treba posmatrati u ovom kontekstu sposobnosti kompanija i I&R sistema za istraživanje i razvoj, i njihovog odnosa sa stranim partnerima. Slika 3 stilizovano prikazuje stvarni *triple helix* model u konvergentnim ekonomijama koji je od velike važnosti za zemlje poput BiH.

Slika 3: Triple helix model inovacija i veza između nauke i privrede u konvergentnim ekonomijama



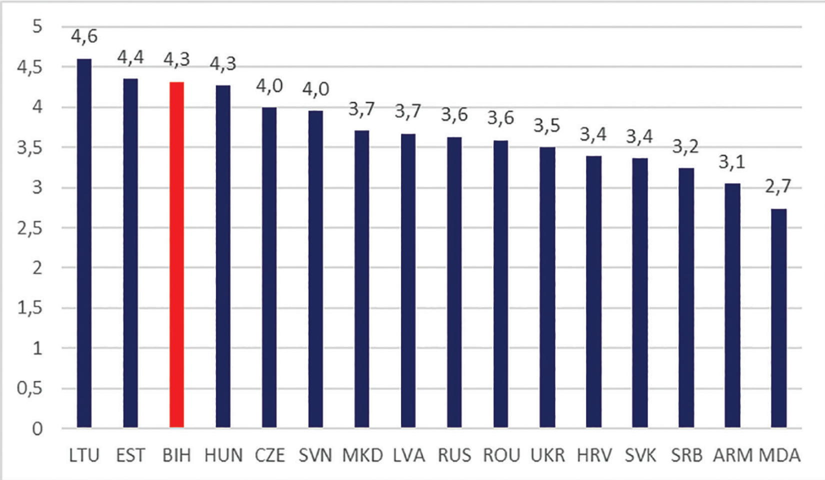
Izvor: Radošević, 2021, Science industry links chapter: UNECE Innovation for Sustainable Development (I4SD) Review of Moldova, forthcoming

Slika 3 sugerira da nisu važne samo veze između domaćih kompanija i javnih istraživačkih organizacija, već još više veze između domaćih i stranih kompanija i veze univerziteta sa stranim firmama i međunarodnim izvorima znanja. Kako se zemlje razvijaju, priroda odnosa između nauke i privrede se mijenja. U početnim fazama, veze sa SDI su ključne, ali kako se zemlje postupno tehnološki unapređuju, odnosi između domaćih kompanija i domaćih organizacija za I&R postaju sve važniji.

U nastavku ilustriramo snagu i intenzitet svakog od tri stuba spirale u slučaju ekonomija centralne i istočne Europe, uključujući Zapadni Balkan.

Subjektivna procjena intenziteta univerzitetsko-istraživačke saradnje u istraživanju i razvoju putem WEF-ovih globalnih izvještaja o konkurentnosti na skali od 1-7 (najbolje) pokazuje relativno visoku ocjenu saradnje univerziteta i privrede u BiH u poređenju sa drugim ekonomijama zapadnog Balkana, Srbijom i Hrvatskom. Kako tumačimo ovaj rezultat? Prvo, pojedinačni pokazatelj treba posmatrati u kontekstu drugih pokazatelja. Drugo, kao što je ranije istaknuto, stanje veza između nauke i privrede može se shvatiti samo u kontekstu sposobnosti kako kompanija tako i akademske zajednice.

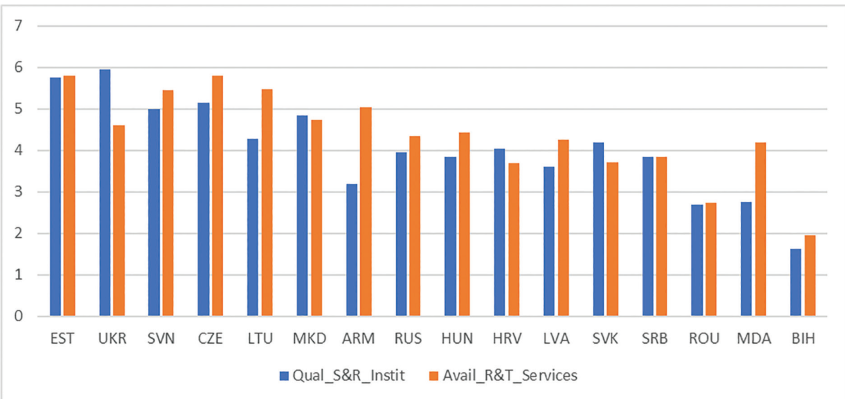
Slika 4: Procjena saradnje između univerziteta i privrede u istraživanju i razvoju za 2019. (skala 1-7)



Izvor: WEF GCR

Slika 5 pokazuje da je kvaliteta naučnih i istraživačkih usluga i njihova dostupnost relativno niska. Štaviše, čini se da je najlošija u poređenju sa svim uporednicima na slici 5. Ovo može sugerisati da je saradnja relativno bolja s obzirom na sposobnosti akademskog i poslovnog sektora nego u drugim ekonomijama zapadnog Balkana. Međutim, u ekonomskom žargonu, ova saradnja se može opisati kao saradnja "ravnoteže na niskom nivou". Drugim riječima, odvija se na vrlo niskim nivoima u istraživačko-razvojnim i inovacijskim aktivnostima akademskog i poslovnog sektora. Sljedeće dvije slike idu u prilog ovoj hipotezi.

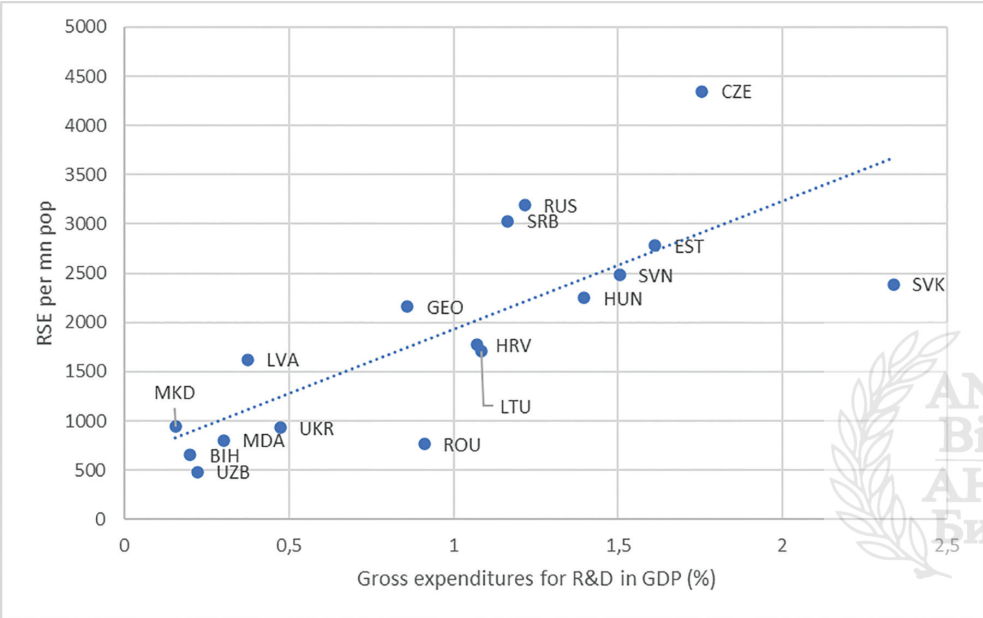
Slika 5: Kvalitet i dostupnost istraživačko-razvojnih usluga



Izvor: WEF GCR

Slika 6 pokazuje da je intenzitet istraživanja i razvoja BH ekonomije također najniži među uporednim ekonomijama. Njen prosječni intenzitet istraživanja i razvoja od samo 0,2% i 656 istraživača na 1 milion stanovnika ukazuju na minimalna ulaganja, koja su nedovoljna za adekvatno usvajanje stranog znanja, a kamoli za značajne aktivnosti stvaranja znanja.

Slika 6: Udio bruto ulaganja u I&R u GDP-u i broj istraživača na 1 milion stanovnika u 2019.

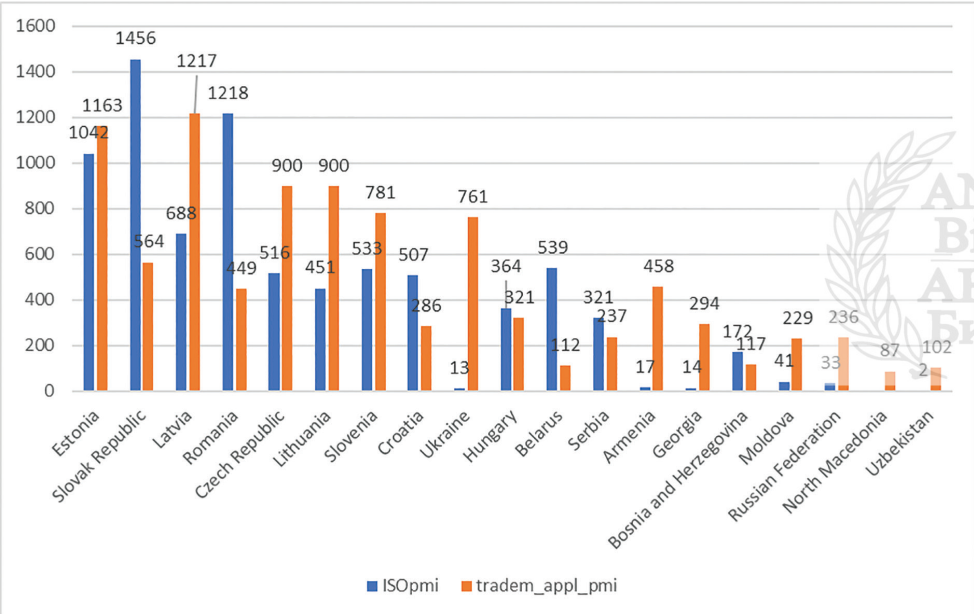


Izvor: World Bank Development indicators database

Drugi stub *triple helix* inovacijskog modela je sektor poslovnih kompanija. S obzirom na općenito vrlo niske rashode za I&R u BiH, pretpostavljamo da su ulaganja u poslovnom sektoru relativno marginalna. Ovo je dodatno otežano dominacijom malih preduzeća u ekonomskoj strukturi, koja po pravilu nemaju sopstvene kapacitete za I&R, te deindustrijalizacijom u postsocijalističkom periodu. Dakle, na ovoj osnovi, ne možemo očekivati "uzvodnu" potražnju za istraživanjem i razvojem bilo interno (unutar kompanije) ili eksterno (kroz vanjsko istraživanje i razvoj). Međutim, možemo očekivati mogući rast potražnje od "nizvodnih" aktivnosti u kompanijama, odnosno aktivnosti vezanih za poboljšanje proizvodnih sposobnosti, kvalitete i diferencijacije proizvoda.

ISO9000 certifikati i aplikacije za zaštitne žigove po milionu stanovnika su nesavršeno ali vrijedno mjerilo za ovu vrstu aktivnosti. Broj od 172 ISO9900 certifikata na 1 milion stanovnika u BiH spada u donju grupu uporednih ekonomija. Iznad je ekonomija CIS-a, koje su većinom izvan globalnih proizvodnih mreža, ali je znatno ispod susjednih i centralnoeuropskih ekonomija. Ovo odražava vrlo ograničenu integraciju BiH u lance vrijednosti EU gdje su standardi kvaliteta jedan od preduslova. Situacija je lošija u pogledu zaštitnih žigova, koji predstavljaju mjerilo za diferencijaciju proizvoda na domaćem i stranom tržištu. To također može odražavati njenu ekonomsku strukturu u kojoj postoji mali udio industrije robe široke potrošnje.

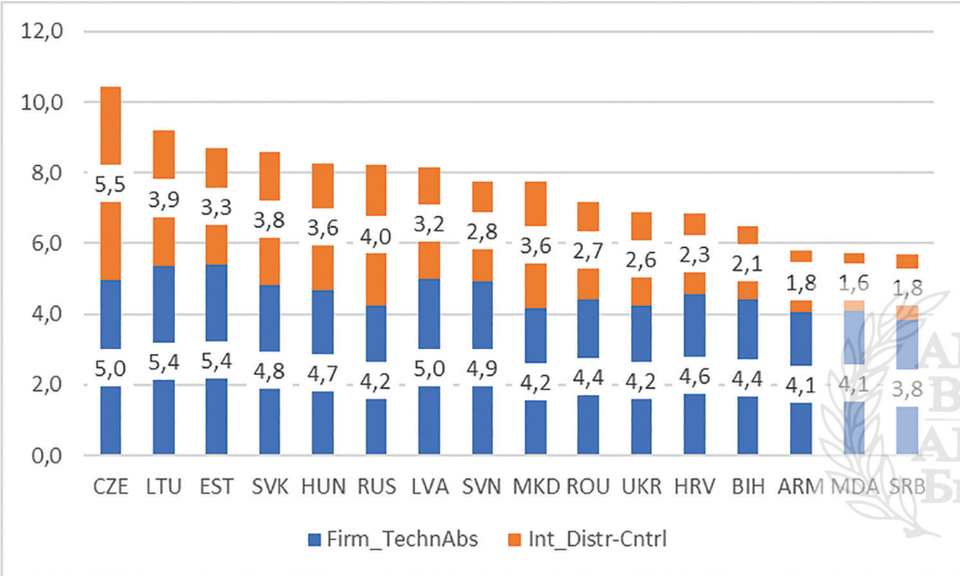
Slika 7: ISO900 certifikati i zaštitni žigovi na 1 milion stanovnika, prosjek za period 2015-19.



Izvor: ISO i WIPO baze podataka

Ključna karakteristika kompetentnih kompanija su njihove organizacione sposobnosti, pomoću kojih razumijemo kako se ljudi i resursi okupljaju kako bi obavili neki posao unutar kompanije. Organizacijske sposobnosti proizlaze iz niza povezanih aktivnosti unutar kompanije, a ne iz bilo koje pojedinačne aktivnosti. Ne postoje dogovorena mjerila organizacijskih sposobnosti. Kao nesavršene zamjene za iste, ovdje koristimo dvije komponente koje bi mogle baciti malo svjetla na njihov nivo razvoja: postojan kapacitet za apsorpciju tehnologija i kontrola međunarodne distribucije. Slika 8 prikazuje procjenu svake od ovih komponenti za BiH kao i za uporedne ekonomije. BiH je rangirana u grupi na začelju. Njene kompanije imaju niske sposobnosti usvajanja novih tehnologija i zavise od stranih partnera za pristup međunarodnim kanalima distribucije. Obje značajke snažno će oblikovati opseg i prirodu veza između nauke i privrede.

Slika 8: Procjena postojanih kapaciteta za apsorpciju tehnologija i kontrolu međunarodnih distribucijskih kanala (WEF GCR 2019).

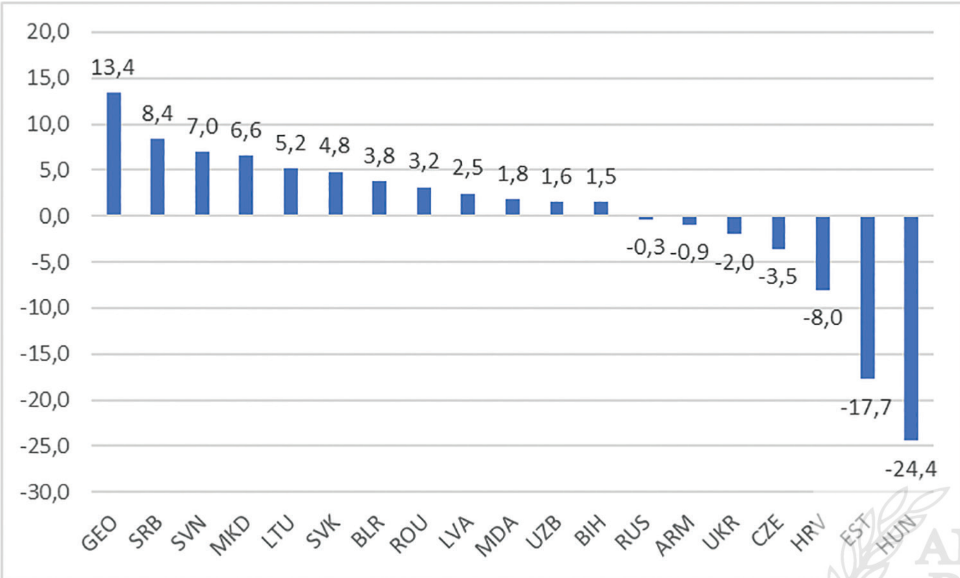


Izvor: WEF GCR

Treći stub veza između nauke i privrede u konvergentnim ekonomijama su SDI, koje predstavljaju primarni izvor novih tehnologija i srodnog znanja. U ekonomiji koja nema dovoljno kapitala i novih tehnologija i sa ograničenim pristupom stranim tržištima, direktne strane investicije (SDI), podugovaranje i drugi oblici znanja neophodni su za nadogradnju tehnologije, zapošljavanje i izvoz. Štoviše, BiH je pozicionirana blizu srednjoeuropskih ekonomija, što je izvrsna prilika da se pridruži njihovim industrijskim mrežama i integrira u lance snabdijevanja EU.

Ako kao kriterij koristimo udio neto priljeva u BDP-u, ovaj potencijal za brzu integraciju u industrijske mreže EU još nije iskorišten. U odnosu na uporedne ekonomije, BiH se nalazi u grupi ekonomija koje su strani investitori "otkrili" nakon 2008. godine. Međutim, ukupan udio priliva je i dalje oskudan (1,5% BDP-a u periodu 2015-19).

Slika 8[18]: Prosjek SDI neto priliva za period 2014-19 u % BDP-a



Izvor: World Bank Development Indicators database

Alternativni način sticanja stranog znanja je kupovina stranih prava intelektualnog vlasništva putem licenci i drugih elemenata intelektualne svojine (softver itd.). Ovaj kanal stjecanja znanja je prilično marginalan u BiH i nalazi se na nivou od 0,001% BDP -a

Ukratko, naši vrlo nesistematski i prilično nesavršeni pokazatelji o tri stuba *triple helix* metode sugeriraju da su sva tri prilično slaba, pogotovo ako ih posmatramo u konvencionalnom smislu veza nauke i privrede zasnovanih na istraživanju i razvoju. Postoje značajna ograničenja tradicionalnog pogleda na veze nauke i privrede, gdje sektor istraživanja i razvoja djeluje kao primarni izvor znanja, a sektor poslovnih preduzeća kao primalac. Ključni pokretač inovacijskog procesa su kompanije, a karakteristike njihovih inovacijskih procesa određuju obim i razinu saradnje sa sektorom za istraživanje i razvoj. Ovo nas ostavlja sa pitanjem: Koji je najproduktivniji okvir veza između nauke i privrede u konvergentnim ekonomijama poput BiH?

[18] SDI neto prilivi predstavljaju vrijednost dolaznih direktnih investicija od strane nerezidentnih investitora u posmatranoj ekonomiji.

5. Veze između nauke i privrede: implikacije za BiH

Naš zaključak o gornjem pitanju svodi se na jednu rečenicu: veze između nauke i privrede bi trebale podržavati nadogradnju tehnologija, a ne (ili ne samo) rast zasnovan na istraživanju i razvoju. Drugdje smo detaljnije razvili nadogradnju tehnologije kao odgovarajući okvir za mjerenje i konceptualiziranje razvoja tehnologije u konvergentnim ekonomijama (vidi Radošević i Yoruk, 2016, 2018, 2019; Radošević, 2017; Bruno et al., 2021).

Većina kompanija u novim državama članicama EU, kao i u zemljama Zapadnog Balkana, su “non-I&R inovatori” (Arundel et al., 2008). Stoga, kako bi se postigao rast i zaposlenost, politika se ne bi trebala fokusirati isključivo na poticanje ulaganja u I&R i podršku restrukturiranju prema industrijama koje su intenzivno aktivne u istraživanju i razvoju. Više od polovine kompanija u zemljama centralne i istočne Europe inovira bez ulaganja u I&R, a možemo pretpostaviti da je ovaj udio još veći u BiH. Umjesto toga, fokus politike trebao bi se baviti mnogo više faktorima proizvodnih sposobnosti (kvaliteta, produktivnost, vještine, inženjering, softver, usluge intenzivnog znanja itd.).

U skladu s tim, zemlje Zapadnog Balkana trebale bi težiti izgradnji politika koje će poticati ove procese. Pitanje je da li je ‘mainstream’ politika za nauku i tehnologije, ili inovacijska politika dovoljan i neophodan odgovor za poticanje razvoja industrije/tehnologije u regiji Zapadnog Balkana? Tvrdimo da je ‘mainstream’ politika inovacija neophodan, ali ne i dovoljan element za promicanje tehnološkog razvoja ekonomija Zapadnog Balkana. U ovim ekonomijama, I&R prvenstveno djeluju kao faktor apsorpcijske sposobnosti, a ne kao direktni izvor dodane vrijednosti i zapošljavanja.

Glavni izazov je kako započeti industrijsku i tehnološku nadogradnju, koja je specifična za određenu industriju. Čini se da baza znanja za takav proces na Zapadnom Balkanu nije glavno ograničenje. Njeni dijelovi već postoje ili su u procesu stvaranja putem opsežne strane tehničke pomoći. Na primjer, studija OECD -a (2010) o sektorskoj konkurentnosti nekoliko sektora Zapadnog Balkana ukazala je na puteve za razvoj u sektorima odjevnih predmeta, dobavljača u automobilskoj industriji i IT outsourcingu poslovnih procesa (vidi ispod). Izazov je kako promovisati veze između nauke i privrede koje mogu podržati ove procese?

Obrasci industrijskog razvoja na Zapadnom Balkanu u odabranim industrijama

Odjeća: od isključivo CTM (42%) usluga do postupnog uvođenja usluga dodane vrijednosti (OEM/OBM) + prevazilaženje imitacija (škole dizajna)
Dobavljači u automobilskoj industriji: izaći iz 'troškovne zamke' podugovaranja i krenuti prema unaprijeđenim standardima kvaliteta, dizajna i vještina upravljanja lancem opskrbe
BPIT Outsourcing: od fragmentiranih, raznolikih i kompanija orijentiranih na lokalno tržište ka fokusu na ključne kompetencije (specijalizacije) i kreiranje BPIT šampiona

Izvor: Author based on OECD (2010)

Reference

Albuquerque, Eduardo Wilson Suzigan, Glenda Kruss, Keun Lee (eds)(2015) Developing National Systems of Innovation: University–Industry Interactions in the Global South, Edward Elgar, Cheltenham.

Arundel, A., C. Bordoy and M. Kanerva (2008), 'Neglected innovators: how do innovative firms that do not perform R&D innovate? Results of an analysis of the Innobarometer 2007 survey No. 215', INNO-Metrics Thematic Paper

Arundel, A., Van de Paal, G., Soete, L., 1995. PACE Report: Innovation Strategies of Europe's Largest Firms: Results of the PACE Survey for Information Sources, Public Research, Protection of Innovations, and Government Programmes. Final Report, MERIT, University of Limburg, Maastricht

Bloom, N. and Van Reenen, J. (2010) Why Do Management Practices Differ across Firms and Countries? Journal of Economic Perspectives, Volume 24, Number 1, Winter 2010, p.203–224

Derek de Sola Price and Silvio A. Bedini, (1967) "Instrumentation," in Technology in Western Civilisation, ed.

Eduardo Albuquerque, Wilson Suzigan, Glenda Kruss, Keun Lee (eds)(2015) Developing National Systems of Innovation: University–Industry Interactions in the Global South, Edward Elgar, Cheltenham.

Glenda Kruss, Keun Lee, Wilson Suzigan, and Eduardo Albuquerque (2015) Introduction, In Albuquerque et al (2015) op cit

Griliches, Z. (1986). "Productivity, R&D, and basic research at the firm level in the 1970s". *American Economic Review* 76, 141–154.

Jong-Hak Eun, Keun Lee, Guisheng Wu (2006) Explaining the "University-run enterprises" in China: A theoretical framework for university–industry relationship in developing countries and its application to China, *Research Policy* 35 (2006) 1329–1346

Lee, Jong Dong Lee, Slavo Radosevic, Dirk Meissner, Nick Vonortas) (eds) Technology Upgrading and Economic Catch-up, Oxford University Press

Levy, D., Terleckyj, N. (1989). "Problems identifying returns to R&D in an industry". Managerial and Decision Economics 1–2, 43–49.

Lichtenberg, F.R., Siegel, D.S. (1991). "The impact of R&D investment on productivity-new evidence using linked R&D-LRD data". Economic Inquiry XXIX, 203–228.

Liefner, I., Schiller, D. (2008). Academic capabilities in developing countries – a conceptual framework with empirical illustrations from Thailand. *Research Policy*, 37, 276–293.

Lorenz , E. and Lundval, B. A. (2006)(eds) How European economies learn: coordinating competing models, Oxford University Press, Oxford.

Mansfield, E. (1980). "Basic research and productivity increase in manufacturing". American Economic Review 70, 863–873.

Mazzoleni Roberto and Richard R. Nelson (2007) Public research institutions and economic catch-up, *Research Policy* 36 (2007) 1512–1528

Melvin Kranzberg and Carroll W. Pursell, Jr. (Oxford: Oxford University Press).

Meyer-Krahmer, F., Schmoch, U., 1998. Science-based technologies: university–industry interactions in four fields. Research Policy 27, 835–851.

Nadiri, M.I., Mamuneas, T.P. (1994). "Effects of public infrastructure and R&D capital on the cost structure and performance of US manufacturing industries". *Review of Economics and Statistics* 76 (1), 22–37.

OECD 2003 The Sources of Economic Growth in OECD Countries, Paris

OECD 2003 The Sources of Economic Growth in OECD Countries, Paris

Radosevic S. (2017) Upgrading technology in Central and Eastern European economies. IZA World of Labor: 338 doi: 10.15185/izawol.338

Radosevic Slavo and Esin Yoruk (2016) Why Do We Need Theory and Metrics of Technology Upgrading?, Asian Journal of Technology Innovation, Volume 24, 2016 - Issue sup1, http://dx.doi.org/10.1080/19761597.2016.1207415

Radosevic Slavo and Esin Yoruk (2018) Technology upgrading of middle-income economies: A new approach and Results, Technological Forecasting & Social Change 129: pp. 56–75

Radosevic, S., M. Savic and R. Woodword (2010) *Knowledge based entrepreneurship in central and eastern Europe: results of a firm level based survey*, In Malerba, F. (ed) Knowledge-Intensive Entrepreneurship and Innovation Systems, Routledge, p.198-218

Radosevic, Slavo Deniz E. Yoruk and Esin Yoruk (2019) Technology Upgrading and Growth In Central and Eastern Europe, Chapter 8 in Social and Economic Development in Central and Eastern Europe. Stability and Change after 1990 Edited By Grzegorz Gorzelak, Routledge, London

Randolph Luca Bruno, Kirill Osaulenko and Slavo Radosevic (2021) Technology Upgrading in Emerging Economies: A New Approach to its Measurement, Results and Relationship to Mainstream Measures , In Lee et al, Oxford UNiversitry Press

Schmoch, U., 1997. Indicators of the relations between science and technology. *Scientometrics* 38: 1., 103–116.

Sveikauskas Leo 2007 R&D and Productivity Growth: A Review of the Literature, Bureau of Labor Statistics Working Paper 408

DOI: 10.5644/PI2021.200.03

Reforma evaluacije i finansiranja nauke prilikom kretanja sa razine niskog učinka

Uvodno obraćanje

*Štěpán Jurajda**[1]

Izazov

Mnoge postkomunističke zemlje u zadnje vrijeme uživaju brzu ekonomsku konvergenciju ka svojim zapadnoevropskim susjedima, ali s druge strane došlo je do iznenađujuće male konvergencije u smislu učinaka naučnog istraživanja. U 2015. godini tek oko 3% početnih grantova Evropskog istraživačkog vijeća (ERC) poticalo je od novih članica EU. Kao što su to pokazali, na primjer, Jurajda et al. (2016), postsovjetske zemlje Evrope još uvijek znatno zaostaju u pogledu visokokvalitetnih akademskih rezultata, posebno u društvenim i medicinskim naukama, koje su ključne za kvalitetu lokalne uprave na mnogim razinama. Izdavanje publikacija u postkomunističkim zemljama također je snažno fokusirano na kvantitetu, a ne na kvalitetu. Ukratko, bibliometrijski dokazi ukazuju na to da nekoliko naučnih područja u ovim zemljama dosljedno nisu u stanju dostići naučne standarde EU-15 (na svjetskom nivou).

Postoje li naučne politike koje bi se mogle usvojiti kako bi se prevazišao ovaj jaz? Nekoliko zemalja je u zadnje vrijeme eksperimentisalo sa sistemima evaluacije i finansiranja nauke koji se oslanjaju na kvantitativne mjere kao što su broj (kvalitativno cijenjenih) publikacija ili citata. Većina iskustava iz ovih

* CERGE-EI, a joint workplace of Charles University in Prague and the Economics Institute of the Czech Academy of Sciences. E-mail: stepan.jurajda@cerge-ei.cz

[1] Autor je profesor ekonomije na CERGE-EI-u, Prag, član Nacionalnog ekonomskog vijeća češke vlade, te član Vijeća za istraživanje, razvoj i inovacije češke vlade, gdje predsjedava Odborom za evaluaciju istraživačkih organizacija. Takođe je član Akademskog senata Češke akademije nauka i naučnih vijeća Češke naučne fondacije, Charles univerziteta i Univerziteta Masaryk, te predsjednik Odbora za evaluaciju Društvenih i humanističkih nauka na Univerzitetu Charles, predsjedavajući Odbora za evaluaciju istraživačkih instituta češkog Ministarstva rada i socijalnih pitanja, predsjednik Vijeća za diplomiranje CERGE-a i član Izvršnog i Nadzornog odbora CERGE-EI-a, gdje je prethodno bio direktor.

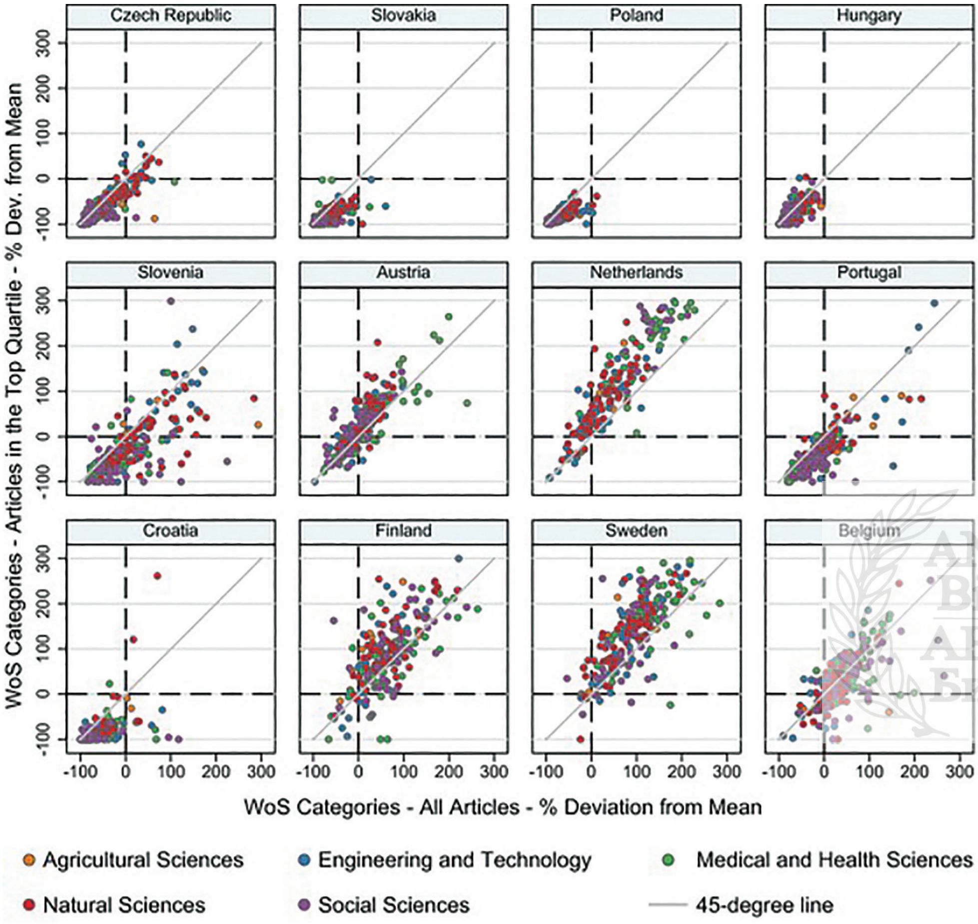
reformi bila je negativna jer kvantitativni indikatori često dovode do oportunističkog ponašanja usmjerenog na maksimiziranje indikatora, a ne kvalitete naučnih rezultata. Tipična lekcija iz ovih eksperimenata je oslanjanje na recenzije naučnih rezultata. Međutim, takvo stručno ocjenjivanje često se mora oslanjati na domaće naučnike i stoga je fundamentalno problematično u područjima nauke gdje određena zemlja daleko zaostaje za međunarodnim standardima. U širem smislu, teško pitanje je: kako se može reformirati finansiranje i evaluacija nauke kako bi se poboljšali rezultati kada čitava nacionalna područja nauke znatno zaostaju za međunarodnim standardima?

Ovo pitanje je dijelom otežano činjenicom da su niski nivoi učinka u cijelome polju obično u sprezi sa niskim nivoom finansiranja i sa unutrašnjim demokratskim procesima u akademskim krugovima, što otežava reforme i brze promjene. Ovaj rad pruža stilizirani opis nedavnih reformi finansiranja i evaluacije nauke u Češkoj Republici. Cilj mu je ilustrirati ove poteškoće i ponuditi neke prijedloge o tome kako se probiti kroz reformske blokade nudeći dvoslojne sheme finansiranja. Rasprava se djelomično temelji na opisnim dokazima iz Češke Republike i na relevantnoj naučnoj literaturi koja pokriva druge zemlje EU, ali većina ovdje ponuđenih stavova i preporuka pripada reformatoru uključenom u proces predlaganja, usvajanja i provedbe reforme finansiranja i evaluacije nauke, odnosno nisu naročito naučne prirode.

Uporno nizak relativni učinak u društvenim naukama

Sve je više dokaza da postkomunističke zemlje još nisu uspjele premostiti jaz u naučnim rezultatima u odnosu na zemlje EU-15. Slika 1 (preuzeto iz Jurajda et al., 2017) predstavlja bibliometrijsko poređenje za razdoblje 2010-2014, zasnovano na *Web of Science* (WoS), učinka izdavačkog rada u 226 naučnih disciplina za šest postkomunističkih država članica EU u odnosu na šest zemalja EU-15 uporedne veličine. Grafikon upoređuje svaku zemlju sa prosječnim učinkom cijelog uzorka u smislu broja članaka po glavi stanovnika na horizontalnoj osi i u smislu broja članaka po glavi stanovnika u najutjecajnijim časopisima, prema procjeni na osnovu časopisa koji pripada najboljoj četvrtini časopisi prema Article Influence Score (AIS), pokazatelju utjecaja citiranosti časopisa. Postkomunističke zemlje, s izuzetkom nekoliko naučnih disciplina uglavnom u Sloveniji, još uvijek znatno zaostaju za svojim kolegama iz EU. Iz ovih statistika također je jasno da istraživanja u postkomunističkim zemljama imaju tendenciju relativno više se fokusirati na kvantitet, a ne na kvalitet. Relativni učinak izdavačkog rada postkomunističkih zemalja u WoS-u posebno je slab u društvenim i medicinskim naukama, a relativno najsnažniji u prirodnim naukama i inženjerstvu.

Slika 1: Web-of-Science poređenje kvantiteta i kvaliteta objava



Izvor: Jurajda et al. (2017).

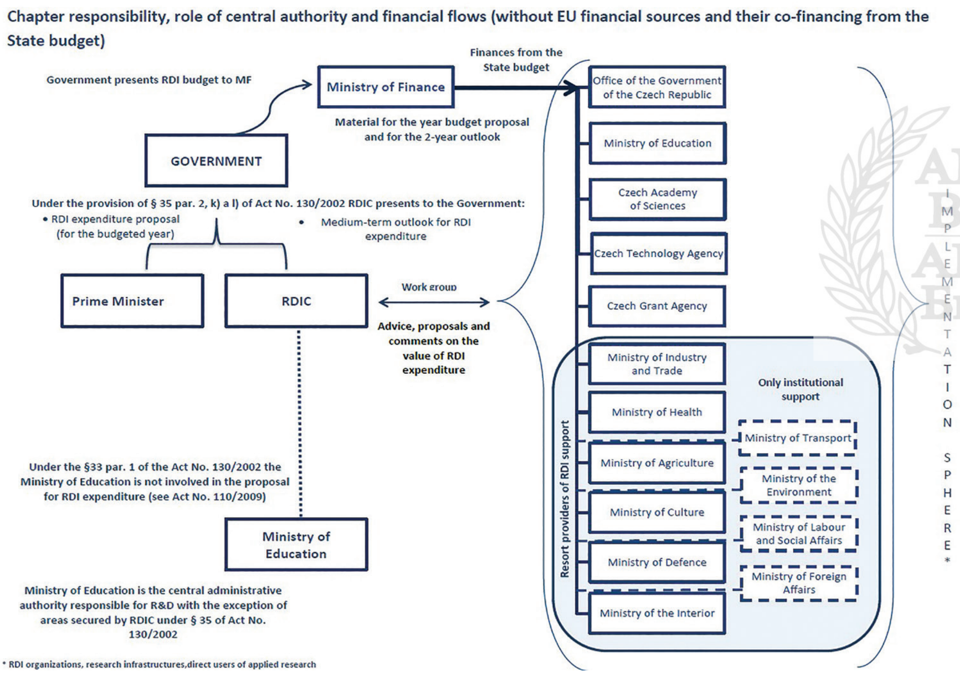
Finansiranje nauke u Republici Češkoj: osnovne činjenice

Kako je organizovana administracija nauke u Češkoj? Ne postoji ministarstvo za istraživanje, a cijeli sektor za istraživanje, razvoj i inovacije (I&R&I) koordinira hibridno izvršno-strateško vijeće za istraživanje i razvoj (RDIC) na čelu s premijerom. Radi se o savjetodavnom tijelu vlade, koje predlaže budžete i politike, uključujući raspodjelu sredstava takozvanim „pružateljima“ finansiranja.[2]

[2] Zemlja ima niz strateških planova i dokumenata o politici, gdje Nacionalna ekonomska strategija sadrži i Strategiju inovacija do 2030. godine, koja uključuje Nacionalnu politiku

U okviru osnovnih istraživanja, ključni pružaoci institucionalnog finansiranja (blok grantova) su Ministarstvo obrazovanja (koje obezbjeđuje finansiranje univerziteta) i Akademija nauka (koja pokriva njene institute). U sektoru institucionalnog finansiranja provedene su dvije reforme finansiranja, o kojima će biti riječi u nastavku. Među ključnim pružateljima finansiranja konkurentnih programa su Češka naučna fondacija („Agencija za grantove Češke Republike“), koja pokriva osnovne nauke, i Tehnološka agencija, koja pokriva primijenjena istraživanja i inovacije. Postoje i konkurentni programi finansiranja koji se pružaju kroz nekoliko ministarstava (industrije, zdravstva, kulture itd.). Konačno, postoji niz primjenjenih istraživačkih instituta pri određenim ministarstvima, npr. geološki institut pri Ministarstvu okoliša.

Slika 2: Javna administracija nauke u Češkoj



Izvor: RDIC Republike Češke

Kako se vrednuju ti kanali finansiranja? Sheme konkurentnog finansiranja zasnovane na programima kvalitativno ocjenjuju njihovi pružaoci, pri čemu se izvještaji o evaluaciji dostavljaju RDIC-u, koji odobrava produženja

istraživanja i razvoja i inovacija, koja zauzvrat uključuje Nacionalnu strategiju istraživanja i inovacija za Strategiju pametne specijalizacije (RIS3).

programa ili ne. Institucionalno finansiranje (finansiranje osnovnog istraživanja kroz blok grantove univerziteta i istraživačkih instituta) prošlo je kroz dvije velike reforme u posljednjoj deceniji. Ove reforme su se dogodile na leđima rasta ukupnog finansiranja. Rashodi Češke Republike za istraživanje i razvoj (GERD) značajno su porasli sa 1,3% BDP-a u 2010. na nešto manje od 2% u 2014. godini, s blagim padom nakon toga. Time je intenzitet finansiranja istraživanja Češke Republike blizu, ali i dalje ispod prosjeka EU-28. Kao što smo vidjeli na slici 1, Češka Republika znatno zaostaje za EU-15 u društvenim naukama. Prema statistikama OECD -a, Češka također ima posebno nizak udio (od 6% u 2017) GERD-a u društvenim i humanističkim naukama. Kombinacija niskog učinka i finansiranja tipična je za društvene nauke u regionu i može odražavati komunističko naslijeđe.[3] U Češkoj je to također posljedica nedavne reforme finansiranja i evaluacije, koja je nanijela trajnu štetu društvenim naukama.

Dvije reforme institucionalnog finansiranja u Češkoj

Nakon generalno kritikovane sheme finansiranja zasnovane na recenzijama koja je djelovala 2000-ih, a koja se za evaluaciju oslanjala na lokalne panele niske kvalitete, češki RDIC je 2008. uveo opsežnu reformu finansiranja zasnovanu na kvantitativnim bibliometrijskim pokazateljima. Dok su druge zemlje eksperimentisale sa šemama finansiranja zasnovanim na formulama, ovo je bila prva reforma u kojoj se svo institucionalno finansiranje zasnivalo na formulama, a ne na bilo kakvom odlučivanju stručnjaka/administratora.

Od 2009. češki su akademici počeli isporučivati sav svoj istraživački rezultat u vladin registar koji vodi RDIC, a koji je koristio bazu podataka o rezultatima za određivanje raspodjele oko milijardu eura finansiranja istraživanja svake godine, što je otprilike 50% ukupnih budžetskih sredstava za istraživanje češke vlade. Formula finansiranja temeljila se na broju radova u WoS-u koje je objavila određena istraživačka jedinica, s nešto višim 'bodovima' dodijeljenim publikacijama u časopisima s većim faktorom utjecaja (IF), te na broju knjiga i drugih vrsta publikacija, pri čemu se svakoj vrsti publikacije dodjeljuje određeni broj bodova finansiranja. Ukupni budžet je tada raspodijeljen proporcionalno raspodjeli ovih bodova na određene pružaoce finansiranja koji su koristili istu transparentnu shemu za raspodjelu sredstava univerzitetima, od kojih su mnogi koristili iste formule finansiranja

[3] Za povezanu raspravu vidi Kovač et al. (2018).

za dodjelu sredstava fakultetima, pa čak i pojedinim odjeljenjima. Ono što je najvažnije, „bodovi" po vrsti publikacije bili su isti u svim disciplinama i područjima znanosti.

U roku od tri godine, ovaj sistem je postigao masovnu preraspodjelu sredstava sa radnih mjesta sa niskom produktivnošću na radna mjesta sa visokim produktivnošću, i iz područja nauke u kojima čak i najbolji naučnici u svijetu objavljuju samo nekoliko radova godišnje (matematika, ekonomija) u područja nauke gdje prosječni naučnik objavljuje nekoliko radova godišnje (npr. hemijsko inženjerstvo). Neki prirodno-matematički fakulteti povećali su sveukupno finansiranje u kratkom vremenskom periodu, u značajnoj mjeri na štetu društvenih i humanističkih nauka.

Brzina preraspodjele i proizvoljna priroda međudisciplinarne preraspodjele sredstava za nauku bili su toliko dramatični da je do 2013. godine uvedena izmijenjena verzija sheme finansiranja koja je fiksirala ukupne budžetske udjele u glavnim područjima znanosti (na primjer u društvenim znanostima) i dovela do masovne i grozničave utrke u okviru svakog od budžeta za pojedine oblasti, zasnovane na produkciji velike količine outputa. Iako je učinak s višim IF-om dobio više „bodova" nego učinak manjeg kvaliteta, ovu razliku „bodovnom" nagrađivanju obesmislila je razlika u troškovima produkcije. S obzirom na to koliko je lako bilo generirati nove WoS časopise i povećati njihov IF,[4] masovna produkcija outputa niske kvalitete bila je jedini način na koji su radna mjesta mogla zadržati svoj dio budžeta za određenu oblast. Ta grozničava utrka u masovnoj produkciji nije dopuštala povećanje finansiranja za radna mjesta koja su se fokusirala na povećanje kvalitete svojih rezultata. Situacija u društvenim naukama bila je posebno teška zbog dva faktora. Prvo, ukupni budžet društvenih nauka se smanjio zbog proizvoljne preraspodjele sredstava u prve tri godine reforme, što je osnažilo grozničavu utrku za finansiranje. Drugo, mnogi istraživači društvenih nauka nikada prije ove reforme nisu objavljivali u visokokvalitetnim časopisima, što je značilo da je masovna produkcija nekvalitetnih publikacija jedini način da se natječu za sredstva.[5]

Reforma je rezultirala značajnom preraspodjelom prema kvalitetnijim radnim mjestima u prirodnim naukama i masovnom prekomjernom produkcijom

---

[4] Tri su se prakse uglavnom koristile za napuhavanje IF-ova časopisa: Prvo, WoS Zbornik radova povezan sa lokalnim konferencijama značajno je citirao lokalno objavljivane časopise. Drugo, neki časopisi povećali su stopu samocitata. Treće, „citatni konzorcijumi" polu-lažnih časopisa (nekoliko ekonomskih časopisa na Baltiku, na primjer) bili su uključeni u praksu snažnog citiranja jedni drugih unutar implicitnog citatnog konzorcija.

[5] Neki programi društvenih nauka upućivali su svoje studente da objavljuju svoje magistarske teze u skoro pa predatorskim izdavačkim kućama, poput Lambert Academic Publishing.

rezultata istraživanja niske ili nulte znanstvene vrijednosti u mnogim područjima - rezultata koji se ne bi proizveli da nije bilo moćnih transparentnih poticaja proisteklih iz finansiranja zasnovanog na formulama. U WoS kategorijama u kojima je takvo oportunističko ponašanje bilo posebno jako, uključujući nekoliko disciplina u tehničkim područjima i u društvenim naukama, Češka Republika sada proizvodi onoliko WoS članaka niske kvalitete (u najnižem, 4. kvartilu WoS AIS rangiranja) koliko bi odgovaralo jednoj petini takve proizvodnje u svim zemljama EU-15 zajedno. U posljednjih godinu dana, kao posljedica „bodovnih" poticaja, češki ekonomisti su proizveli više ISI zbornika od svih američkih ekonomista; jasno je da isti nisu sistematski povećali naučna znanja u ovoj oblasti.

Sastav RDIC-a promijenio se oko 2014. godine, a novo Vijeće je 2017. godine uvelo još jednu veliku reformu finansiranja i evaluacije. Ova druga reforma ukinula je formularnu shemu finansiranja i zamijenila je shemom koja se u velikoj mjeri oslanja na stručne recenzije, ali disciplinira recenziranje bibliometrijskim statistikama. Novi sistem uspoređuje samo ocijenjene jedinice unutar polja, a ne između polja, i funkcionira kroz 5 modula (dimenzija) evaluacije:

- M1 – Kvalitet odabranih 10% rezultata (stručne recenzije uz korištenje eksternih oponenata)
- M2 – Učinak istraživanja (bibliometrijska provjera kroz panele discipline)
- M3 – Društvena relevantnost (raportira se 'pružaocu')
- M4 – Održivost (raportira se 'pružaocu')
- M5 – Strategija (raportira se 'pružaocu')

Prvi modul fokusira se na stručno recenziranje publikacija koje spadaju izvan WoS-a (gdje mjerilo uticaja nije lako dostupno) i na evaluaciju WoS outputa koji se mogu izdvojiti po svom uticaju. Drugi modul fokusira se na dvije statistike za svaku ocijenjenu jedinicu unutar discipline: (a) njen profil kvalitete, gdje se veliki udio publikacija u najniže rangiranim časopisima smatra neprikladnim, i (b) njen udio u visokokvalitetnim outputima unutar discipline u odnosu na njen udio u finansiranju (kapacitet) unutar discipline. Korak normalizacije kapaciteta tek se treba u potpunosti provesti. Ponavljamo, poređenja unutar M1 i M2 vrše se samo unutar istoga polja. M1 i M2 se izvode godišnje na nacionalnom nivou (pod nadzorom RDIC-a), a zatim se ocjene sa terena agregiraju do nivoa istraživačke jedinice (univerzitet, institut) od strane 'pružatelja usluga' koji izvode vlastite korake ocjenjivanja unutar ostala tri modula, koji se rade u petogodišnjem ciklusu.

WoS dio bibliometrijskog modula M2 oslanja se na ocjenu utjecaja članka u procesu rangiranja časopisa u 6 polja i 42 kategorije FORD disciplina (na osnovu OECD klasifikacije). WoS časopisi segmentirani su prema AIS rangiranju časopisa u 1. decil i četiri kvalitativna kvartila. Paneli pišu izvještaj za cijelu disciplinu, a zatim komentarišu profile publikacija pojedinih univerziteta.

Preraspodjela sredstava postignuta na temelju nove sheme do sada je bila minimalna, ali je reforma uspjela u tome da svi pružatelji usluga sada prihvataju da njihove odluke o finansiranju trebaju odražavati princip „indeksnog finansiranja“, gdje bi istraživačke jedinice koje postižu veće ocjene u evaluacijama trebale ostvariti veće stope rasta njihovog institucionalnog finansiranja. Ovo je veliko poboljšanje u odnosu na prethodnu shemu, koja je svake godine (na osnovu pravila trojke) preraspoređivala sva sredstva proporcionalno „bodovima“ evaluacije zasnovanih na formuli finansiranja. To je rezultiralo velikim godišnjim povećanjima, ali i padovima finansiranja, što bi svaka shema finansiranja nauke trebala izbjegavati.

Naučene lekcije: prepreke i zamke reformi

Gore navedeni subjektivni pregled češkog iskustva u reformama dobro se uklapa u postojeću naučnu literaturu koja proučava podsticajne mjere u produkciji naučnog znanja.

Štamparski stroj podsticaja kvantitativnog izdavaštva

Postoji sve obimnija literatura o tome kako ekonomski podsticaji snažno utiču na ponašanje naučnika (Stephan, 2012). S ciljem pružanja poticaja visokokvalitetnoj nauci, reformatori često tvrde da stručno recenziranje kroz časopise i mjerenje kvaliteta časopisa (obično mjerenja broja citiranja) pružaju idealnu eksternu kvantitativnu strukturu koja se može koristiti za raspodjelu sredstava. Ova ideja dovela je do nekoliko nesretnih neželjenih posljedica u više zemalja.

Sve do gore opisane češke reforme iz 2009. godine, Australija je bila jedina zemlja koja je pokušala uvesti jednostavne bibliometrijske formule finansiranja u raspodjelu velikog dijela sredstava za istraživanje univerzitetima. Butler (2003) izvještava o efektima jednostavne formule finansiranja koja se koristi u Australiji za finansiranje univerzitetskih istraživanja, pri čemu nije učinjen nikakav pokušaj da se uzme u obzir kvalitet publikacija. Iako su se takve sheme finansiranja koristile od 1990. godine, njihovi budžetski udjeli bili su mali (na razini od oko 5%). U 2001. godini, međutim, udio ukupnih sredstava usmjerenih na istraživanje i povezanih formulom dramatično se povećao. Butler (2003) pokazuje da je uvođenjem formula za finansiranje publikacija, broj publikacija u donjoj polovini časopisa rangiranih prema utjecaju citiranosti rastao dvostruko brže od broja članaka u časopisima koji su rangirani u gornjoj polovici, da se takva „inflacija" nekvalitetnih istraživačkih outputa dogodila u gotovo svim poljima nauke, i da se to nije dogodilo izvan univerzitetskog sektora u Australiji, tj. tamo gdje nije primijenjena ova formula finansiranja. Iako češko iskustvo do sada nije sažeto u nekoj naučnoj procjeni ove vrste, stilizirani opis koji je gore naveden podudara se s iskustvom Australije.

Italija je još jedan primjer zemlje koja je uvela bibliometrijske procjene sa vjerovatno negativnim posljedicama u smislu strateškog ponašanja naučnika. Seeber et al. (2019) pokazuju da italijanski akademici reagiraju na kvantitativne metrike citiranja koje se koriste u promocijama tako što ubrzano povećavaju broj samocitacija, pri čemu je to povećanje najizraženije za društvene nauke. U skladu s ovim nalazom, Baccini et al. (2019) ističu da se omjer u kojem citati u italijanskim publikacijama dolaze iz same Italije također povećava nakon uvođenja metrike zasnovane na citatima u akademskim evaluacije, a Bagues et al. (2019) otkrili su da je oko 5% italijanskih istraživača, što je veliki udio, objavljivalo u časopisima koje je naučni bibliotekar Jeffrey Beall klasificirao kao „predatorske".

Poređenje krušaka i jabuka

Posebno nesretna karakteristika češke reforme 2008-2013 bila je dodjela istih sredstava po objavljenom članku u bilo kojoj oblasti nauke, uprkos ogromnim razlikama u praksi objavljivanja među naučnim disciplinama. Za slične neželjene posljedice plaćanja istih nivoa plaća svim istraživačima u svim disciplinama, vidi Boyle (2008).

Neprimjerene mjere vode do nesretnih podsticaja

Kada god zemlje povezuju finansiranje s faktorom utjecaja (IF) časopisa u kojima naučnici objavljuju, pojavljuju se novi časopisi koji omogućuju onim naučnicima koji ne mogu objavljivati u visokokvalitetnim publikacijama da pojačaju svoje 'računovodstvene' rezultate. Takvi časopisi mogu poboljšati svoj IF citatima u zbornicima lokalno organiziranih konferencija, i to često čine. Jedan od načina da se izbjegnu ovi poticaji „štamparskog stroja" je oslanjanje na ocjenu utjecaja članaka (Article Influence Score - AIS). AIS je također prosječna mjera uticaja po članku zasnovana na citatima u Web of Science (WoS), ali ima nekoliko važnih prednosti u odnosu na IF. Veću težinu stavlja na citate iz prestižnijih časopisa, a zanemaruje citiranje članaka iz istog časopisa, otežavajući manipulaciju. Takođe je važno izbjeći ugrožavanje humanističkih nauka na osnovu činjenice da takav eksterni indikator za kvalitet nije dostupan za knjige i časopise koji nisu dio WoS-a.

Dodatni problem pri restrukturiranju raspodjele sredstava je to što se žele izbjeći nepredvidive brze promjene u finansiranju. Osnovna karakteristika produkcije naučnog znanja je da izgradnja visokokvalitetnih timova (odjeljenja, škola) zahtijeva niz godina, ali se oni mogu brzo poremetiti privremenim nedostatkom odgovarajućih sredstava. To nalaže da sheme finansiranja ne uvode velike fluktuacije u finansiranju iz godine u godinu. Slično, iako konkurentno (tj. grantovsko) finansiranje daje poticaj za rast kvalitete, kada je udio konkurentnog finansiranja u odnosu na institucionalno (blok-grant) finansiranje previsok, i ovo stvara previše neizvjesnosti koja ograničava sposobnost ambicioznih radnih mjesta da održe uzlaznu putanju kvaliteta. U tipičnom okruženju, ovo nije obavezujuće pitanje jer se status quo obično održava internim akademskim demokratskim procesima, ali češka reforma 2009-2010 pokazuje da reformski napori mogu otići predaleko. To znači da bi preraspodjela sredstava prema radnim mjestima višeg kvaliteta ili pojedincima idealno trebala doći iz ukupnog povećanja dodatnih sredstava, a ne na štetu njihovih konkurenata u sistemu.

Zaključci i preporuke

Glavne lekcije iz češke reforme mogu se sažeti na sljedeći način: Rast ukupnog finansiranja otvara vrata reformama, ali bez evaluacija prema međunarodnim standardima, napredak je spor ili nikakav. Sve prakse evaluacije moraju se izvoditi strogo unutar disciplina. Formulativni „transparentni" poticaji mogu imati negativne efekte, pa je oslanjanje na stručne recenzije od kritičnog značaja, ali to otvara još jedno ključno pitanje ko određuje sastav panela za ocjenjivanje. Međunarodni savjetodavni odbori mogu biti od pomoći.[6]

[6] U kontekstu Češke Republike, Češka naučna fondacija podugovara neke od svojih evaluacija sa ESF-Science Connect-om. RDIC ima Međunarodni savjetodavni odbor, koji uključuje vrhunske češke naučnike koji rade u inostranstvu. Svi češki univerziteti i neki instituti Češke

Na osnovu ovih lekcija mogu se formulisati dvije preporuke: (i) Pokušati da se što više posveti eksternim evaluacijskim mjerilima koja nisu zasnovana na formulama, kao što je broj dodijeljenih ERC grantova po oblastima. Ako lokalni napori srednjeročno ne naprave razliku na osnovu takvih eksternih mjerila, na kraju će se ocijeniti da nisu uspješni. (ii) Kada god postoji mogućnost za rast javnog finansiranja, podijeliti finansiranje na glavni postojani dio, koji je dostupan postojećoj naučnoj zajednici sa visokim nivoom predvidljivosti i kontinuiteta, i strukturno odvojeni nivo finansiranja koji je fokusiran samo na visokokvalitetne učinke. Ovaj drugi nivo u idealnim prilikama se u raspodjeli sredstava može osloniti na evaluacione i savjetodavne odbore sastavljene od naučnika sa vodećih svjetskih istraživačkih institucija, uključujući i one iz dijaspore.

Vrlo ambiciozan projekt u okviru ove druge razine bio bi uspostavljanje velikog centra izvrsnosti poput austrijskog IST-a (vidi https://ist.ac.at/en/home/).[7] Možda je realnije uspostavljanje programa velikih grantova usmjerenih na osobu (slično kao i kod ERC natječaja, ali na nižem nivou očekivanja i finansiranja, primjeri uključuju EXPRO grantove Češke naučne fondacije, grantove *Lumina Quaeruntur* Češke akademije nauka ili Dioscuri centre MPG mreže), kao i sheme finansiranja na radnom mjestu. Jedan primjer, gdje je podrška međunarodno konkurentnim poduhvatima poželjna na nivou radnog mjesta (za razliku od nivoa osobe) su doktorske studije. Postoje primjeri dobre prakse koje treba slijediti pri kreiranju konkursa za najbolji doktorski program u zemlji u svim oblastima, i u velikodušnoj podršci tom programu (i njegovom fakultetu) (npr. LC centri češkog Ministarstva obrazovanja 2000-ih ili velika njemačka *Exzellenzinitiative*). Ako se takvi napori pokažu kao preambiciozni, svaka nacionalna evaluacija koja pruža veću stopu rasta finansiranja najbolje ocijenjenim institucijama na osnovu upoređivanja striktno unutar istog polja također će vjerovatno postupno napraviti razliku.

akademije nauka sada imaju Međunarodni savjetodavni odbor. Nekoliko nobelovaca je trenutno uključeno u neke od ovih odbora.

[7] Ovo ne mora zahtijevati nove građevine budući da može odgovarati distribuiranom centru sa svojim upravnim odborom. Općenito, iako su ulaganja u zgrade i laboratorije (opremu) često vrlo važna, kritični aspekt znanstvenog napretka je ljudski kapital i sposobnost privlačenja i zadržavanja perspektivnih istraživača koji tada mogu pomoći u prikupljanju sredstava za njihovu opremu.

Reference

Butler, L. (2003) “Modifying publication practices in response to funding formulas,” *Research Evaluation,* 12 (1), 39–46.

Baccini, A., De Nicolao, G., and E. Petrovich (2019) “Citation gaming induced by bibliometric evaluation: A country-level comparative analysis,” *PLOS ONE*, 14(9).

Bagues, M., Sylos-Labini, M., and N. Zinovyeva (2019) “A Walk on the Wild Side: ‘Predatory’ Journals and Information Asymmetries in Scientific Evaluations,” *Research Policy*, 48(2): 462–477.

Boyle, G. (2008) “Pay Peanuts and Get Monkeys? Evidence from Academia,” *The B.E. Journal of Economic Analysis & Policy*: 8(1), Article 21.

Jurajda, Š., Kozubek, S., Münich, D., and S. Škoda (2017) “Scientific publication performance in postcommunist countries: still lagging far behind.” *Scientometrics* 112, 315–328.

Kovač, D., Scrbec, N., and B. Podobnik (2018) “Does it Pay Off to Research Economics—A Tale of Citation, Knowledge and Economic growth in Transition Countries,” *Physica A: Statistical Mechanics and its Applications*, 505(1): 293-305.

Seeber, M., Cattaneo, M., Meoli, M., and P. Malighetti (2019) “Self-citations as Strategic Response to the Use of Metrics for Career Decisions,” *Research Policy*, 48(2): 478–491.

Stephan, P. (2012) *How Economics Shapes Science,* Harvard University Press.

DOI: 10.5644/PI2021.200.04

Uticaj prava intelektualnog vlasništva na nacionalne sisteme nauka

Joseph Straus[*]

"Nauka, više od bilo čega drugog među institucijama čovječanstva, raste poput korova iz godine u godinu. Umjetnost je podložna hirovima mode, religija je okrenuta ka unutra i vođena tako da održi samu sebe, a pravo se kreće između oslobađanja i porobljavanja."
K. B. Mullis (dobitnik Nobelove nagrade za hemiju 1993)

Sažetak: Nakon izlaganja o postupcima razvoja i korištenja vakcina protiv COVID-19 u 2020. godini, kao primjera uspješne saradnje između akademske zajednice, industrije i vlada u podršci istraživanju i pretvaranju njegovih rezultata u inovacije potpomognute patentima, ovaj rad se okreće nacionalnim naučnim sistemima. Prvo se bavi pionirskom ulogom izveštaja "Nauka, beskrajna granica" ("Science the Endless Frontier") iz 1945. godine, koji predstavlja Magna cartu američke nauke i njene politike patenata. Pomenuti su i kasniji razvoji u SAD-u koji otkrivaju postupni zaokret od poticanja prijenosa znanja i tehnologije sa institucija koje finansira država na industriju, dopuštajući to samo u obliku neekskluzivnih licenci, do nametanja obaveze komercijalizacije rezultata istraživanja javnom istraživačkom sektoru, dopuštajući ekskluzivne licence i prijenos prava intelektualnog vlasništva privatnim kompanijama, a sve uz prepoznavanje i očuvanje akademske slobode i istraživanja. Dalje, rad tematizira razvoj na razvoj događaja u zemljama u kojima su zakonodavci generalno slijedili američki model. Naposlijetku, ovaj prilog govori o sistemu prava intelektualnog vlasništva u svjetlu specifičnih potreba akademskih istraživača.

Ključne riječi: relacije Univerzitet-industrija-vlada, prava intelektualnog vlasništva, nacionalni sistemi nauke

I. Uvod

Rijetko su, ako ikada u doba mira, događaji poput onih koji su okarakterizirali 2020. godinu, na impresivniji način pokazali značaj takozvanog *Triple Helix* savezništva za dobrobit svjetskog društva. Pojam saveza "trostrukog heliksa"

[*] Prof. dr. jur. dres. jur. h.c., professor prava, Univerzitet u Minhenu i Univerzitet u Ljubljani, direktor emeritus na Max Planck institutu za inovacije i konkurenciju u Minhenu. Inostrani član Akademije nauka i umjetnosti Bosne i Hercegovine. E-mail: j.straus@ip.mpg.de

označava "spiralni model inovacija u smislu odnosa na relaciji univerziteti-industrije-vlade [potreban] da bi se uhvatio razvoj višestrukih veza u različitim fazama kapitalizacije znanja".[1] Samo zahvaljujući uspješnoj i intenzivnoj interakciji između univerziteta, industrija i vlada bilo je moguće, po prvi put u historiji, razviti i staviti na tržište nove vakcine za borbu protiv pandemije SARS 2 COVID-19. Naučne i tehnološke osnove za cjepiva BioNTech-Pfizer, Moderna i Oxford-AstraZeneca, koji su kao prvi dobili odobrenje i stupili na tržište, potječu iz kasnih 1980-ih i 1990-ih.

Prvo je uska međunarodna saradnja između javno finansiranih istraživačkih institucija i biotehnoloških kompanija, oslanjajući se na patente koji štite njihove osnovne istraživačke izume,[2] stvorila prve terapije zasnovane na rekombinantnoj DNK tehnologiji, poput humanog inzulina, eritropoetina (EPO), faktora koji stimulišu granulocitne kolonije (GCSF) i drugih. Zatim, desetak godina intenzivnih zajedničkih napora u okviru Projekta humanog genoma (HGP), međunarodno podržanog javnog projekta (paralelnog s Celera Genomics privatnim projektom), 2001. godine kulminiralo je dešifriranjem čitavog ljudskog genoma.[3] Dok su istraživači Oxford-AstraZeneca u svoju vakcinu uveli dvolančanu DNK S proteina Coronavirusa koristeći drugi virus (adenovirus) kao vektor, [4] što je dakle pristup razvijen 1990-ih, BioNTech i Moderna vakcine nose instrukcije za izgradnju S proteina u jednolančanoj RNK.

Da bi na kraju dobili BioNTech-Pfizer i Moderna vakcine koje koriste RNA nosilac kao "vektor", bila je potrebna promjena paradigme, potaknuta istraživačkim radom na mRNA s obje strane Atlantika. Međutim, dok su Katalin Karikó i Drew Weissman, istraživači koji su radili na mRNA na Univerzitetu

[1] Leydesdorff & Etzkowitz, Emergence of a Triple Helix of University-Industry-Government Relations, 1996:279-286, citirano iz Leydesdorff & Etzkowitz, The Future Location of Research: A Triple Helix of University-Industry-Government Relations II, 1996: 20-25. Za detaljnu raspravu Triple Helix-a kao modela za inovacijske studije, usp. Etzkowitz & Leydesdorff, Universities and the Global Knowledge Economy: A Triple Helix of University-Industry-Government Relations, 1997:1-8 i Viale & Etzkowitz, Third Academic Revolution: Polyvalent Knowledge; The "DNA" of the Triple Helix, 2005, dostupno na https://www.researchgate.net/publication/242406526_Third_academic_revolution_polyvalent_knowledge_theDNA_of_the_triple_helix (posljednji pristup 9. februara 2021). i Leydesdorff, The Triple Helix: An Evolutionary Model of Innovations, 2000:243–255.

[2] Usp. npr. Straus, Intellectual Property Rights and Bioeconomy, 2017:576-590 (str. 580-582).

[3] Fraser, Editorial: A Genome to Celebrate, 2021:545; Jones & Cook-Deegan, Complicated Legacies: The Human Genome at 20, 2021:564-569.

[4] Usp. Corum & Zimmer, How the Oxford-AstraZeneca Vaccine Works, The New York Times of February 8, 2021 (https://www.nytimes.com/interactive/2020/health/oxford-astrazeneca-covid-19-vaccine.html (posljednji pristup 9. februara 2021)).

u Pennsylvaniji tokom 1990-ih, hvaljeni kao ključni istraživači za razvoj terapija zasnovanih na mRNA[5] pošto su 2005. objavili svoj rad,[6] ime Ingmara Hoerra, jednog od ranih pionira Evrope u istraživanju mRNA, nigdje se ne spominje. Ingmar Hoerr koji je započeo svoj doktorski rad sredinom 1990-ih bio je uvjeren da RNA može biti platforma za razvoj mnoštva terapija, od profilaktičkih vakcina do imunoterapija. Za razliku od Karikó i Weissmana koji su modificiranim verzijama, nazvanim pseudouridin i 5-metiluridin, tj. nukleozidima, smanjili antivirusni odgovor mRNA uridina, i dobili patent za njihovu upotrebu 2012. godine,[7] Hoerr je stabilizirao mRNA modifikacijom sekvence. Od 1999. godine, Hoerr je podnio brojne prijave za patente, npr. 5. juna 2001., odnosno prije 20 godina, za "Farmaceutski sastav koji sadrži stabiliziranu mRNA optimiziranu za prevođenje u svojim regijama kodiranja".[8] Hoerr je svoja otkrića objavio 2000. godine u svojoj doktorskoj tezi pod nazivom "RNK vakcina za indukciju specifičnih citotoksičnih T-limfocita (CTL) i antitijela"[9] i zajedno sa svojom grupom u časopisu *European Journal of Immunology*.[10] Njegovo otkriće olakšalo je upotrebu ribonukleinske kiseline za razvoj vakcina i imunoterapija. RNK vakcine mogu se proizvoditi u velikim količinama i mogu postići isti napredak kao DNK vakcine, a nemaju potencijalno štetan učinak integracije DNK u genom. Međutim, Ingmar Hoerr nije samo "ključni rani pionir mRNA" koji je riješio problem stabiliziranja mRNA promjenom paradigme.[11] Dr. Hoerr također predstavlja poduzetnički duh i izvanrednu neposustajuću energiju potrebnu da se važno osnovno istraživačko otkriće pretvori u komercijalni proizvod koji koristi društvu, tj. vakcinu. Ingmar Hoerr osnovao je 2000. uspješnu biotehnološku kompaniju

[5] Usp. Keener, Just the Messenger: A New Class of Therapeutic Instruct the body to make its own drugs, 2018:1294-1300; Gaveria & Kilic, A Network Analysis of COVID-19 mRNA Vaccine Patents, 2021:546-549; Fauci, The Story Behind COVID-19 Vaccines, 2021; Kolata, Kati Kariko Helped Shield the World From the Coronavirus, 2021.

[6] Karikó & Buckstein & Ni & Weissman, Suppression of RNA Recognition by Toll-like Receptor: The Impact of Nucleoside Modification and the Evolution Origin of RNA, 2005:165-175, sa referencama na neke od njihovih ranijih publikacija.

[7] Prema Keener-u, *supra* br. 6, str. 1299.

[8] US Patent 10188748 B2 (A1) od 29. januara 2019, prioritetna prijava 5. juna 2001. (prijava objavljena 12. decembra 2002).

[9] Usp. Wikipedia pod Ingmar Hoerr.

[10] Usp. Hoerr & Obst & Rammensee & Jung, In Vivo Application of RNA Leads to Induction of Specific Cytotoxic T-Lymphocytes and Antibodies, 2000:1-7.

[11] Kuhn naglašava, "Naučna zajednica izuzetno je efikasan instrument za maksimiziranje broja i preciznosti problema riješenih promjenom paradigme." (Kuhn, The Structure of Scientific Revolutions, 1970 (str. 169).

CureVac sa sjedištem u Tübingenu, koja sada u saradnji s GlaxoSmithKline radi na vakcini efikasnoj i protiv brazilskih, britanskih i južnoafričkih mutacija COVID-19. U članku objavljenom 2017. godine, Hoerr je detaljno opisao ne samo izazovan temelj kompanije, borbu za nagovaranje i okupljanje javnih i privatnih investitora da osiguraju potrebna sredstva itd. već je naglasio i da su "valjani pretklinički podaci i idealno široki patenti" bili presudni za uspjeh kompanije.[12] Teško je razumjeti da radovi koji izvještavaju o CureVac-ovim programima za mRNA vakcine protiv gripe i malarije, podržanim od strane Bill & Melinda Gates fondacije, ili o prvim kliničkim ispitivanjima CureVac mRNA vakcine protiv raka prostate provedenim već 2008. godine,[13] niti ne spominju ime Ingmara Hoerra, osnivača CureVac-a, niti njegov ključni rad objavljen 2000. godine!

Kada je u pitanju razvoj i odobravanje za stavljanje u promet nove vakcine, što zahtijeva desetine hiljada kliničkih testova i košta stotine miliona ili više eura ili dolara, univerziteti, javne istraživačke institucije, pa čak i uspješne biotehnološke start-up kompanije trebaju jake privatne i javne saveznike. Finansijski rizici su takve magnitude da čak i velike farmaceutske kompanije u pravilu zaziru od takvih pothvata ako vlada ne signalizira svoju spremnost da finansijski podrži projekt. U slučaju razvoja vakcina protiv koronavirusa, čak je i farmaceutski gigant poput američke kompanije Merck&Co., unatoč već provedenom ulaganju, odustao od svojih napora zbog neuspjeha koje je doživio. Međunarodna federacija proizvođača farmaceutskih proizvoda (IFPMA) procjenjuje da će izdaci proizvođača lijekova, kada je u pitanju razvoj vakcina protiv koronavirusa i njihova proizvodnja, iz privatnih fondova do kraja 2021. godine iznositi više od 10 milijardi američkih dolara. Međutim, za razvoj vakcina protiv koronavirusa rano javno finansiranje također je bilo od ključne važnosti. Bez tog finansiranja kompanije nikada ne bi pokrenule tako široku inicijativu. Daleko najvažnije bilo je finansiranje koje je osigurao program vlade SAD-a, "Operacija Warp Speed", koji je generirao više od 12 milijardi američkih dolara. EU je bila mnogo skromnija. U tu će svrhu potrošiti ne više od nekoliko stotina miliona eura. Presudni za nevjerovatnu brzinu razvoja vakcina protiv koronavirusa nisu bili samo angažman najboljih istraživača i finansijska podrška vlada, već i mogućnost globalnog tržišta bez presedana. Prodaja predviđena za 2021. godinu je impresivna: Pfizer (~

[12] Usp. Hoerr, A Successful Founder off the Beaten Path, 2017:900-903 (str. 902, dodan naglasak).

[13] Usp. npr. Keener, *supra* br. 6, str. 1298, izvještaj o CureVacu koji u potpunosti ignoriše Hoerra.

15 milijardi američkih dolara), Moderna (~ 12 milijardi američkih dolara), BioNTech (~ 8 milijardi američkih dolara), CureVac (~ 5 milijardi američkih dolara) i AstraZeneca (~ 4 milijarde američkih dolara).[14]

Međutim, izuzetno cijenjeni i pozdravljeni uspjeh *Triple Helix* saveza, koji je isporučio nove vakcine za borbu protiv pandemije koronavirusa za nevjerovatnih godinu dana, već je zamagljen. Razlog tome je što proizvodni kapaciteti znatno zaostaju za hitnom potražnjom, ogromni ukupni troškovi vakcinacije cijele populacije koji su nedostižni mnogim, ako ne i većini zemalja, i perspektiva dobiti koju proizvođači vakcina, korisnici javnih finansiranja vrijednih više milijardi, mogu očekivati zahvaljujući njihovim patentima. Ne iznenađuje da su uslijedili pozivi za obavezno udruživanje patenata, prisilne licence itd., kako bi se prevazišli problemi, kao i prijedlozi za rješavanje problema slabljenjem zaštite patenata.[15] Iznenađujuća je pak bila odluka američkog predsjednika Joea Bidena od 5. maja 2021. godine da podrži privremeno odricanje patenata za vakcine protiv Covid-19,[16] što je izazvalo ne samo veliku zabrinutost farmaceutske industrije, već nije smatrano niti primjerenim niti produktivnim od strane evropskih lidera poput njemačke kancelarke Angele Merkel i francuskog predsjednika Emmanuela Macrona.[17]

II. Nacionalni sistemi nauka

(a) SAD – Pionir

2020. godine SAD su proslavile 75. godišnjicu onoga što se smatra “Magna cartom američke nauke”,[18] izvještaj *Science, the Endless Frontier*, koji je Vannevar Bush, direktor Ureda za naučno istraživanje i razvoj, predao predsjedniku Harryju Trumanu 25. jula 1945. (u daljem tekstu “Izvještaj”).[19] Ovaj

[14] Usp. Benz & Feldges, Ein Turbo für die Impfstoff-Hersteller: Lässt sich die Produktion von Corona-Vakzinen Beschleunigen?, 2021. (https://www.nzz.ch/wirtschaft/corona-impfung-moeglichkeiten-zur-beschleunigung-der-produktion-ld.1599788 (posljednji pristup 8. februara 2021).

[15] Usp. npr. Abbott & Reichman, Facilitating Access to Cross-Border Supplies of Patented Pharmaceuticals: The Case of the COVID-19 Pandemic, 2020:535-561.

[16] Usp. npr. Asgari & Mancini & Kuchler, Pharma Industry Fears Biden’s Patent Decision Sets Dangerous Precedent, Financial Times, 07. maja 2021., str. 3; Stacey & Williams, Biden‘s Diplomatic Victory Blunts Pharma Lobby, Financial Times od 10. maja 2021., str. 4.

[17] Usp. npr. Peel, EU Leaders. Confront US over Vaccine Patent Waiver Demands, Financial Times od 8. maja 2021, str. 2.

[18] Thorp, Editorial: Science has always been Political, 2020:227.

[19] https://www.nsf.gov/od/lpa/nsf50/vbush1945.htm (posljednji pristup 3. februara 2021).

izvještaj rezultat je zahtjeva predsjednika Franklina D. Roosevelta iz 1944. koji je tražio odgovore / ideje na četiri pitanja. Sva su bila fokusirana na to kako se najbolje rezultati istraživačkog rada koji je Bushov ured tako uspješno proveo "u najvećoj tajnosti, i bez ikakvog javnog priznanja; ali njegovi opipljivi rezultati mogu se naći u priopćenjima koja su dolazila s ratišta širom svijeta", mogu profitabilno koristiti u doba mira. Dakle, "za poboljšanje nacionalnog zdravlja, stvaranje novih preduzeća koja donose nova radna mjesta i poboljšanje nacionalnog životnog standarda."[20]

Kako podvlači glavni urednik revije *Science*, Holden Thorp, Bushov Izvještaj izložio je obrazloženje i strukturu sistema za finansiranje nauke u SAD-u. [21] Što se tiče obrazloženja, Izvještaj je naglasio da: "nauka može biti djelotvorna u nacionalnoj dobrobiti samo kao član tima, bilo to u uslovima mira ili rata. Ali, bez napretka nauke, niti jedno postignuće u drugim smjerovima ne može osigurati naše zdravlje, prosperitet i sigurnost kao nacije u modernom svijetu."[22] Dakle, vlada bi trebala prihvatiti nove odgovornosti za promociju protoka novih naučnih saznanja i razvoj naučnog talenta omladine.[23] Izvještaj preporučuje da se uspostavi nova agencija za te svrhe. Ta agencija "trebala bi prepoznati da se sloboda istraživanja mora očuvati i trebala bi prepustiti internu kontrolu politike, osoblja i metoda i opsega istraživanja institucijama u kojima se isto provodi. Trebala bi biti u potpunosti odgovorna predsjedniku i preko njega Kongresu za svoj program."[24] Kao rezultat ovog izvještaja, predsjednik Harry Truman 10. maja 1950. godine osnovao je Nacionalnu fondaciju za nauku, osmišljenu na principu da naučnici sami trebaju odrediti tok temeljnih istraživanja.[25]

U kontekstu ovog rada i s obzirom na tekuće rasprave o uticaju prava intelektualnog vlasništva, posebno patenata, na naučni napredak i prevođenje javno finansiranih rezultata istraživanja u inovativne proizvode i procese, sljedeće izjave iz izvještaja "Nauka, beskrajna granica" čine se od trajne važnosti.

> "Najvažniji načini na koje vlada može promovirati industrijsko istraživanje su povećavanje protoka novih naučnih saznanja kroz podršku osnovnim

[20] Predsjedničko pismo od 17. novembra 1944. (ibid. str. 3, 4).
[21] Thorp, *supra* br. 18.
[22] The Report, str. 5.
[23] Ibid str. 7.
[24] Ibid str. 8.
[25] Usp. Gibson, Overseeing Innovation: 75 Years after Vannevar Bush‘s Impactful Report, Debate Continuous About Directing Science, 2020:258-259 (str. 259).

istraživanjima i pomoć u razvoju naučnih talenata. Uz to, vlada bi trebala pružiti odgovarajuće poticaje industriji za provođenje istraživanja, (a) razjašnjavanjem sadašnjih nesigurnosti u Zakonu o unutrašnjim prihodima u pogledu odbitka troškova za istraživanje i razvoj kao tekućih troškova neto dobiti, i (b) jačanje patentnog sistema kako bi se eliminisale nesigurnosti koje sada opterećuju male industrije i kako bi se spriječile zloupotrebe koje odražavaju diskreditaciju sistema koji je u osnovi zdrav. Pored toga, trebalo bi pronaći načine kako da prednosti osnovnog istraživanja dođu do industrija koje trenutno ne koriste nova naučna saznanja".[26]

"V. Politika patenata. - Uspjeh Nacionalne istraživačke fondacije u promociji naučnog istraživanja u ovoj zemlji ovisit će u velikoj mjeri o saradnji organizacija izvan vlade. U sklapanju ugovora sa tim organizacijama ili davanjem bespovratnih sredstava za njih, Fondacija bi trebala adekvatno zaštititi javni interes i istovremeno ostaviti saradničkoj organizaciji dovoljnu slobodu i podsticaj za obavljanje naučnih istraživanja. Javni interes obično će biti adekvatno zaštićen ako vlada dobije licencu bez naknade za vladine svrhe prema bilo kojim patentima koji proizilaze iz rada koji finansira Fondacija. Istraživačka institucija ne bi trebala biti dužna patentirati otkrića nastala kao rezultat podrške Fondacije. Svakako ne bi trebao postojati apsolutni zahtjev da se sva prava na takva otkrića dodijele Vladi, već to treba biti prepušteno diskreciji direktora i zainteresiranog odjeljenja da li u posebnim slučajevima javni interes zahtijeva takvu dodjelu. Zakonodavstvo po ovom pitanju trebalo bi članovima Fondacije prepustiti diskreciju u pogledu njihove politike patenata kako bi se aranžmani patenata mogli prilagoditi prema okolnostima i javnom interesu."[27]

Kao rezultat politike patenata integrirane u izvještaj "Nauka, beskrajna granica", američki univerziteti i institucije koje se finansiraju iz javnog sektora aktivno su se angažirali u patentima. Dobili su brojne patente, međutim, vrlo rijetko komercijalno iskorištene. Budući da patenti izdani na javno finansiranim rezultatima istraživanja nisu mogli biti niti ekskluzivno licencirani niti transferirani privatnim preduzećima, nije došlo do njihovog prevođenja u inovativne proizvode i procese. Krajem 1970-ih, od 25.000 do 30.000 patenata u vlasništvu vlade, manje od 5% njih je licencirano.[28] Da bi prevazišle ovu ekonomski nepovoljnu situaciju, SAD su 1980-ih donijele nekoliko zakona čiji je cilj bio poticanje prenosa tehnologija koje su rezultirale iz federalno finansiranih istraživanja provođenih na univerzitetima i akademskim

[26] Ibid, Sažetak (str. 6).
[27] Ibid str. 30.
[28] Usp. Straus, *supra* br. 2 (str. 581).

istraživačkim institucijama. Godine 1980. Bayh-Doleov zakon[29] uveo je mogućnost da privatne stranke zadrže patentna prava putem "title in contractor" politike, tj. mogućnosti za mala preduzeća i neprofitne organizacije, uključujući univerzitete, da zadrže prava intelektualnog vlasništva nad rezultatima istraživanja koja se finansiraju iz federalnih izvora. Također 1980. godine, Stevenson-Wydlerov zakon[30] zahtijevao je od saveznih agencija koje upravljaju istraživanjem da uspostave Ured za istraživanje i tehnološke primjene (ORTA) u svim laboratorijama kojima upravlja država ili kooperanti sa godišnjim budžetom većim od 20 miliona američkih dolara. Godine 1986. Federalni zakon o prijenosu tehnologije (FTTA)[31] izmijenio je Stevenson-Wydlerov zakon premještanjem naglaska u saveznoj politici s one koja dopušta prijenos tehnologije na onu koja zahtijeva da agencije energično djeluju u saradnji s industrijom kako bi komercijalizirale istraživanja koja se finansiraju od strane države. U takozvanim ugovorima o kooperativnom istraživanju i razvoju (CRADA) dozvoljeni su i ekskluzivni uslovi licenciranja.

Ova intervencija američkog zakonodavstva imala je višestruke i dalekosežne posljedice. Otvorila je put za suštinsku promjenu pristupa javno finansiranim rezultatima istraživanja, jer je ne samo ohrabrila, već je zapravo i obvezala univerzitete i druge institucije koje se finansiraju iz javnih fondova da komercijaliziraju rezultate istraživanja postignute federalnim fondovima, tj. da ih učine vlasničkim što je više moguće a federalna vlada postala je treći igrač u igri. Iako su ukupan socijalni i ekonomski uticaj Bayh-Dole-ovog zakona i ostalih američkih zakonodavnih mjera često dovođeni u pitanje,[32] nepobitna je činjenica da su američki univerziteti i federalno finansirane istraživačke institucije od 1980-ih igrale ključnu ulogu kao generator novih znanja , kao i njihov prevodilac u inovacije. Godišnje statistike koje objavljuje Američko udruženje univerzitetskih tehnoloških menadžera (AUTM) to već dugo pokazuje. Njihovo Istraživanje o aktivnostima izdavanja dozvola iz 2018. godine otkriva da su članovi stvorili 825 novih proizvoda, osnovali 1.080 novoosnovanih preduzeća, podnijeli 17.087 novih prijava patenata,

[29] Public Law 96-517.
[30] Public Law 96-480.
[31] Public Law 99-502.
[32] Usp., npr. Mowery & Nelson & Sampath & Ziedonis, The Growth of Patenting and Licensing by US Universities: An Assessment of the Effect of the Bayh-Dole Act of 1980, 2001:99-119; a što se tiče kritičara Frangioni, The Impact of Greed on Academic Medicine and Patient Care, 2008:503-507.

izvršili 9.350 licenci i opcija i dobili 7.625 američkih patenata.[33] Ukupni prihodi američkih univerziteta od njihovih licenciranja u 2018. godini iznosili su 2,94 milijarde američkih dolara. Pod pretpostavkom prosječne stope tantjema po osnovu autorskih prava od 2%, akademska tehnologija bila je odgovorna za prodaju proizvoda u iznosu od oko 147 milijardi američkih dolara.[34] Statistika za period 2015–2019. otkriva da su univerziteti bili vrlo aktivni, ako ne i dominirali u biotehnološkim patentima. Među prvih 20 akademskih centara rangiranih po broju izdanih biotehnoloških patenata, svi osim jednog (Univerzitet u Tokiju koji je zauzeo 17. mjesto) bili su američki, pri čemu su University of California System (1.557 patenata), Stanford University (658 patenata), University of Texas System (531 patenata), Massachusetts Institute of Technology (519 patenata) i University of Pennsylvania (495 patenata) rangirani na prvih 5 mjesta.[35] Patentiranje je, međutim, skupo. Samo u 2018. godini američki univerziteti potrošili su više od 425 miliona američkih dolara na troškove vezane za patente.[36]

Međutim, same statistike patenata ne predstavljaju "opipljiv ishod" sve veće saradnje između federalno finansiranih istraživanja i industrije od usvajanja zakonodavnih mjera iz 1980-ih. U tom pogledu najupečatljiviji su zbirni podaci o broju lijekova razvijenih iz izuma koje su istraživačke institucije javnog sektora (PSRI) generirale samostalno ili zajednički, zaštićenih pravima intelektualnog vlasništva specifičnim za lijekove, a koji su zatim prebačeni na kompanije putem komercijalnih licenci.[37] Ovi podaci otkrivaju da su, između 1991. i 2006. godine, na osnovu rezultata istraživanja PSRI-a, razvijena 153 lijeka (tj. odobrila ih je i Federalna uprava za lijekove (FDA)), uključujući 22 koja su razvijena iz Intramuralnog programa istraživanja Nacionalnog

[33] AUTM 2018 Licensing Activity Survey: A Survey of Technology Licensing and Related Activity for US Academic and Nonprofit Research Institutions, str. 4 (https://autm.net/AUTM/media/SurveyReportsPDF/AUTM_FY2018_US_Licensing_Survey.pdf (posljednji pristup 18. februara 2021).

[34] Usp. Dipanjan & Gupta & Turo, The Evolution of University Technology Transfer: By the Numbers, 2020. (https://researchgate.net/publication/340766806 (posljednji pristup 20. februara 2021).

[35] Usp. za detalje Huggett & Paisner, Biotech Patenting 2019, 2020:921-922.

[36] Prema Dipanjan & Gupta & Turo, *supra* br. 26.

[37] Kako je definisano u Stevens & Jensen & Wyller & Kilgore & Chatterjee & Rohrbaugh, The Role of Public-Sector Research in the Discovery of Drugs and Vaccines, 2011:535-541, str. 537. Ovi autori naglašavaju da je u većini slučajeva intelektualno vlasništvo bilo patent ili patentna prijava, ali da je nekoliko proizvoda koristilo zaštićene biološke materijale koje je razvio i licencirao PSRI.

instituta za zdravlje (NIH-IRP)[38], za koje su patentne prijave podnesene oko 1985. (s jednim izuzetkom), a patenti su dodijeljeni između 1991. i 2007.[39] Terapijska područja za 153 lijeka bila su onkologija (40), zarazne bolesti (36), kardiologija (12), imunologija (6) i drugi (59).[40] Izuzetan uticaj koji su lijekovi i biološki lijekovi koje je razvio i patentirao samo NIH imali i još uvijek imaju na javno zdravstvo širom svijeta proizlazi iz činjenice da su lijekovi i biološki lijekovi koji još uvijek imaju dozvolu NIH-a ostvarili prodaju od 4,7 milijardi američkih dolara u 2010. Pored toga, prodaja za lijekove i biološke lijekove za koje su patenti istekli (koji nisu više pod licencom NIH) iznosila je oko 2,2 milijarde američkih dolara u 2010. Dakle, ukupna svjetska prodaja u 2010. godini samo za izume NIH Intramuralnog programa iznosila je najmanje 6,9 milijardi američkih dolara.[41] Instrumentalna uloga koju su patenti NIH-a odigrali u postizanju tako impresivnih i korisnih 'opipljivih' rezultata, trebala bi biti očigledna.

(b) Neki od sljedbenika

(i) Japan

Zakonodavni potezi SAD-a iz 1980-ih, koji su čvrsto integrirali javno finansirana akademska istraživanja u nacionalnu strategiju inovacija, nisu samo nadahnuli ekonomiste da usmjere svoju pažnju na veze između industrije i akademske zajednice,[42] već su na međunarodnom planu djelovali i kao poti-

[38] Usp. Chatterjee & Rohrbaugh, NIH Inventions Translate into Drugs and Biologics with High Public Health Impact, 2014:52-58, tabela 3 (str. 54).
[39] Ibid, tabela 1 (str. 53). Osnovni aplikant bio je Nacionalni institut za istraživanje raka sa 12 prijava patenata, i izdati patenti po tom osnovu (tabela 1 (str. 53)).
[40] Ibid, tabela 3 (str. 54).
[41] Ibid (str. 56-57).
[42] Ovdje se može referirati samo na selekciju: Collier, Alan, Australian Framework for the Commercialization of University Scientific Research, 2007:51-68; Eun & Lee & Wu, Explaining the "University-run Enterprises" in China: A Theoretical Framework for University-Industry Relationship in Developing Countries and its Application to China, 2006:1329-1346; Abetti, University Incubators as Agents for Technology Transfer and Economic Growth: Case Studies in USA, Ukraine and Finland, 2006:308-337; Rubenstein & Heisey & King, Public Sector Technology Transfer Through Patents and Licensing: The Case of US Agriculture, 2006:401-420; Steenhuis & Gray, The University as the Engine of Growth: An Analysis of How Universities can Contribute to the Economy, 2006:421-432; Walsh & Cohen & Cho, Where Excludability Matters, Material vs. Intellectual Property in Academic Biomedical Research, 2007:1184-2003; Chaves & Moro, Investigating the Interaction and Mutual Dependence Between Science and Technology, 2007:1204-1220; Woolgar, New Institutional

caj za aktivnosti mnogih drugih zakonodavaca. Sve te aktivnosti imale su za cilj kreiranje nacionalnih politika za inovacije, uzimajući u obzir važnu ulogu koju akademska istraživanja moraju igrati u tom kontekstu.

Najbliži sljedbenik bio je Japan, gdje je parlament 1995. godine donio Osnovni zakon o nauci i tehnologiji. Godine 1996. usvojen je prvi, a 2001. drugi Osnovni plan za nauku i tehnologiju. Potonjim je uspostavljeno novo Vijeće za nauku i tehnologiju, povezano direktno sa Uredom vlade.[43] Japanski parlament je 1998. godine usvojio Zakon o promociji transfera tehnologije sa univerziteta u privatno poslovanje.[44] Implementacijom Osnovnog zakona o nauci i tehnologiji, u oktobru 2003. godine Japan je transformisao svoju Naučno-tehnološku korporaciju (JST) u Japansku agenciju za nauku i tehnologiju (JST) kao nezavisnu administrativnu instituciju. Zadatak Agencije je ojačati infrastrukturu za promociju nauke i tehnologije i provesti inicijative utvrđene Osnovnim zakonom.[45] U 2017. godini, JST je posjedovao 3.604 patenta širom svijeta i podnio je 75 patentnih prijava.[46] Na svojoj web stranici JST nudi odabrane tehnologije za licenciranje, čineći tako sve informacije o odgovarajućim patentima / patentnim prijavama dostupnim online.[47] Međutim, do sada postignuti rezultati intenzivnih i dugotrajnih napora japanske vlade na promoviranju saradnje univerziteta i industrije s ciljem poticanja nesmetanog prevođenja akademskih istraživanja u inovativne i tržišne proizvode i procese čine se skromnim. Izravno uključivanje vlade u strukturu i funkcionisanje univerziteta, ograničeno prihvatanje ekskluzivnog licenciranja rezultata državno finansiranih istraživanja od strane privatnog biznisa i

Policies for University-Industry Links in Japan, 2007:1261-1274 and D‘Este, & Patel, University-Industry Linkages in the UK: What are the Factors Underlying the Variety of Interactions with Industry? 2007:1295-1313.

43 Usp. Edgington, The Japanese Innovation System: University-Industry Linkages, Small Firms and Regional Technology Centers, 2008:1-19 (str. 10 *et seq*). Za inicijative politika koje promoviraju veze između univerziteta i industrije u Japanu pogledajte i Walsh & Baba & Goto & Yasaki, Promoting University-Industry Linkages in Japan: Faculty Responses to a Changing Policy Environment, 2008:39-54; te Holroyd, Reinventing Japan Inc.: Twenty-First Century Innovation Strategies in Japan, 2008:21–38.

44 Act No. 52 of May 6, 1998 (English translation WIPO) (https://www.wipo.int/edocs/lexdocs/laws/en/jp/jp193en.pdf – posljednja posjeta 22. februara 2021). Usp. i Fujisue, Promotion of Academia-Industry Cooperation in Japan – Establishing the “Law of Promoting Technology Transfer from University to Industry”, 1998:371-381.

45 See https://www.jst.go.jp/EN/about/history.html (posljednji pristup 20. februara 2021).

46 See https://www.jst.go.jp/EN/about/jstdata.html (posljednji pristup 20. februara 2021).

47 See https://www.jst.go.jp/chizai/en/univ-ip/cips/licensing/details_01.html (posljednji pristup 20. februara 2021).

činjenica da univerziteti nisu direktni korisnici prihoda od licenciranja, može biti kombinirani razlog za takvu situaciju.[48]

Kao i u SAD-u, tako i u Japanu, univerziteti su posebno aktivni u patentima u području nauka o životu. U junu 2008. godine, Univerzitet u Kjotu, na kojem su istraživači bili vrlo uspješni u području tehnologije indukovanih pluripotentnih matičnih ćelija (iPS), osnovao je kompaniju iPS Academia Japan Inc., čiji je cilj licenciranje tehnologije iPS-ćelija. Od januara 2016. godine, iPS Academia ima status službene organizacije za prenos tehnologije prema Zakonu o unapređenju transfera tehnologije između univerziteta i industrije iz 1998. godine.[49] U svom portfelju, koji je popunjen ne samo iz prava Univerziteta u Kjotu već i iz prava drugih japanskih univerziteta, pa čak i nekih stranih institucija, iPS Academia je 2012. godine imala oko 450 prijava patenata (oko 125 porodica patenata), među kojima oko 200 njih za koje su do septembra 2016. godine patenti već bili dodijeljeni u Japanu, SAD-u, Evropi i nekim drugim zemljama.[50] Prema svojim smjernicama za licenciranje, iPS Academia omogućava neprofitnim organizacijama besplatno korištenje njihovog intelektualnog vlasništva u obrazovne svrhe, pod uslovom da ne postoji komercijalni cilj. Što se tiče komercijalnih subjekata, oni u principu mogu sticati neekskluzivne licence samo pod razumnim uslovima. Međutim, od promjena smjernica iz oktobra 2015. godine, u izuzetnim slučajevima, kada su uključene neplatformske tehnologije, komercijalni subjekti mogu dobiti ekskluzivne licence.[51] Do 2018. godine, iPS Academia je dodijelila 96 licenci japanskim, 29 američkim i 21 evropskim kompanijama. Među njima su farmaceutski giganti kao što su Ajinomoto i Sumitomo iz Japana i, npr. Boehringer Ingelheim, Roche i Sanofi iz Evrope.[52] [53]

[48] Za detaljnu analizu razvoja u Japanu do 2003. godine usp. Kneller, University-Industry Cooperation and Technology Transfer in Japan Compared with the United States: Another Reason for Japanese Malaise? 2003:329-449 (str. 347-449).

[49] Vidi http://ips-cell.net/e/about/outline.html (posljednji pristup 21. februara 2021).

[50] Vidi http://ips-cell.net/e/patent/ (posljednji pristup 21. februara 2021).

[51] Vidi http://ips-cell.net/e/license/policy.html (posljednji pristup 21. februara 2021).

[52] Vidi http://ips-cell.net/e/license/licensees.html (posljednji pristup 21. februara 2021). Usp. i Straus, Patentierung und Kommerzialisierung im Bereich der Stammzellforschung, 2018:237-276 (str. 244-245).

[53] Kao i Japan, Korea i Taiwan su kasnih 1990-ih usvojili slične osnovne zakone o nauci i tehnologiji. Omogućili su institucijama višeg obrazovanja vlasništvo u rezultatima istraživanja finansiranih od strane vlade, te su otvorili put njihovom decentraliziranom licenciranju. Usp. Chang & Chen & Yang & Hua, Universities as Patent- and Licensing Income-Generating Institutions: A survey in Taiwan, 2008:290-309 (str. 292).

(ii) Kina

Nedugo nakon Japana, Narodna Republika Kina je 15. maja 1996. godine usvojila Zakon o unapređenju transformacije naučnih i tehnoloških dostignuća, koji je stupio na snagu 1. oktobra 1996. Važna izmjena tog zakona stigla je Predsjedničkom naredbom br. 32, 29. avgusta 2015. godine, koja je stupila na snagu 1. oktobra 2015. godine.[54] Kao što proizlazi iz njegovog člana 1, zakon je razvijen u svrhu promocije transformacije naučnih i tehnoloških dostignuća u stvarne proizvodne snage, standardizacije takve transformacije, ubrzavanja naučnog i tehnološkog napretka i promicanja ekonomskog i socijalnog razvoja. Njegova 52 člana predstavljaju sveobuhvatan i koherentan pravni okvir čiji je cilj uspješno prevođenje nalaza istraživanja "državnih institucija za istraživanje i razvoj i institucija visokog obrazovanja" u inovativnu praksu. Te institucije mogu svoja naučna dostignuća prenijeti na preduzeća ili druge organizacije dodjelom, licencom, ulaganjem kao zamjenom i drugim sredstvima. Međutim, oni djeluju na temelju vlastitih neovisnih odluka, s cijenama koje se određuju prema ugovorenim cjenama, uvrštavanjem na tržište razmjene tehnologija, aukcijama i na druge načine. U slučaju određivanja cijena prema dogovoru, bit će naznačena imena naučnih i tehnoloških dostignuća i predložene transakcijske cijene u njihovim entitetima.[55] U nizu odredbi navode se mjere poput uspostavljanja javne platforme za istraživanje i razvoj, pružanja tehnološke integracije,[56] podrške razvoju inkubacije naučno-tehnološkog preduzeća kao naučnog i tehnološkog inkubatora preduzeća i univerzitetskih naučnih parkova.[57] Štaviše, Zakonom je predviđeno da se finansijski fondovi za transformaciju naučnih i tehnoloških dostignuća uglavnom koriste kao fondovi za usmjeravanje, subvencije kamata na zajmove, fondovi subvencija, rizična ulaganja za transformaciju,[58] i da će država, u skladu s odredbama relevantnih poreznih zakona i propisa, implementirati porezne povlastice za aktivnosti transformacije.[59] Prema članu 43. ovoga zakona, prihodi od

[54] PKULAW.COM [CLI Code]: CLI.1.256285(EN). Neki od kineskih autora ovaj zakon zovu "svježe revidiranim 'Bayh-Dole zakonom'," usp. npr. Wang & Xue & Shi, Characteristics and Logical Framework of Chinese Universities' Response to the Newly Revised ,Bayh-Dole Act', 2021.

[55] Članovi 17 i 18.

[56] Član 31.

[57] Član 32.

[58] Član 33.

[59] Član 34. Prema članovima 36. i 38. država ohrabruje osiguravajuće institucije da razviju proizvode osiguranja "srazmjerne karakteristikama". Država također ohrabruje institucije rizičnog kapitala da investiraju u ovakve projekte.

transformacije, odnosno komercijalizacije rezultata istraživanja, postignutih unutar državnih institucija za istraživanje i razvoj i visokoškolskih ustanova, "u potpunosti će se zadržati u njima i uglavnom će se koristiti za istraživanje i razvoj u nauci i tehnologiji, za transformaciju postignuća i drugi relevantan rad, nakon što se nagrade i naknade dodijele ljudima koji su dali značajan doprinos u završetku i transformaciji naučnih i tehnoloških dostignuća povezanih sa ovim radom." Član 45. reguliše raspodjelu prihoda od "komercijalizacije" i nagradu zaposlenih za tzv. postignuća u vezi sa radom, koji su značajno doprinijeli prenijetim postignućima, i daje sljedeća zanimljiva rješenja:

> "(1) Tamo gdje je naučno i tehnološko dostignuće u vezi sa radom dodjeljeno ili licencirano drugima, povući će se najmanje pedeset posto neto prihoda od dodjele ili licence takvog naučnog i tehnološkog dostignuća.
> (2) Tamo gdje se naučno i tehnološko dostignuće vezano za rad koristi kao zamjena za ulaganje, povući će se najmanje pedeset posto dionica ili kapitalnih uloga nastalih iz takvih naučnih i tehnoloških dostignuća.
> (3) Tamo gdje se naučno i tehnološko dostignuće u vezi sa radom provodi samostalno ili u saradnji s drugima, najmanje pet posto poslovne dobiti od primjene naučnog i tehnološkog dostignuća uzastopno se povlači tri do pet godina nakon transformacije i uspješne proizvodnje istoga.
> Način i iznos nagrada i naknada koje javno održavane istraživačke i razvojne institucije i visokoškolske ustanove odrede ili dogovore sa naučnim i tehničkim osobljem moraju biti u skladu sa kriterijima navedenim u tački (1) do tačke (3) prethodnog stava.
> Državna preduzeća i javne ustanove, u skladu sa odredbama ovog zakona, uključuju izdatke za nagrade i naknade koji se dodjeljuju ljudima koji su dali značajan doprinos završetku i transformaciji naučnih i tehnoloških dostignuća u vezi sa radom u njihove ukupne plate u tekućoj godini, ali navedeni izdaci neće biti predmet ograničenja njihovih ukupnih plata u tekućoj godini i neće biti uključeni u njihovu ukupnu osnovicu plata."

Empirijski podaci o rezultatima ovog kineskog zakonodavstva nisu dostupni. Međutim, statistike o patentnim prijavama koje su podnijeli kineski univerziteti i javne istraživačke institucije poput Kineske akademije nauka (CAS) jasno otkrivaju da su oni vrlo aktivni. Naprimjer, u području tehnologija umjetne (AI) inteligencije, kineske organizacije čine 17 od 20 najboljih akademskih igrača na svijetu, a CAS je zauzeo 17. mjesto u prvih 100 svih prijavitelja. Statistike prijava patenata povezanih sa AI otkrivaju generalno visoku aktivnost univerziteta i javnih istraživačkih institucija. Među prvih 500 od svih prijavitelja, 167 je akademskih institucija, od toga 110 kineskih.[60]

(c) Evropa

Iako je Evropa također zamijetila Bayh-Doleov zakon i druga povezana američka zakonodavna zbivanja iz 1980-ih, i unatoč prijedlozima za slijeđenje američkog primjera,[61] evropski zakonodavci i na razini unije i na nacionalnoj razini do danas se opiru bilo kakvoj vrsti regulativa nalik na Bayh-Doleov zakon. Umjesto toga, dizajnirali su model sporazuma za industrijsko-akademske odnose. U svojoj Preporuci 2008/416 od 10. aprila 2008. o upravljanju intelektualnim vlasništvom u aktivnostima prenosa znanja i Kodeksu prakse za univerzitete i druge javne istraživačke organizacije,[62] Evropska komisija je preporučila da države članice, između ostalog, osiguraju da sve javne istraživačke organizacije (PRO) definiraju transfer znanja kao strošku misiju. Dalje, da podstaknu PRO-e da uspostave i objavljuju politike i postupke za upravljanje intelektualnim vlasništvom u skladu sa Kodeksom prakse, podržavaju razvoj kapaciteta i vještina za prijenos znanja u PRO-ima, podižu svijest i vještine učenika u vezi sa intelektualnim vlasništvom, prijenosom znanja i preduzetništvom, i da promoviraju širenje znanja stvorenog javnim sredstvima. Sve to poduzimanjem koraka za poticanje otvorenog pristupa rezultatima istraživanja, istovremeno omogućavajući, prema potrebi, zaštitu srodnih intelektualnih prava, itd.[63]

U svojoj Studiji o prijenosu znanja, Evropska komisija prepoznala je da su evropske javne istraživačke institucije manje efikasne u komercijalizaciji rezultata istraživanja i generiranju otkrića pronalazaka, prijava patenata ili prihoda od licenci u poređenju sa američkim kolegama. Da bi zaradile jedan milion eura prihoda od licenci, Evropske javno finansirane istraživačke institucije troše u prosjeku 3,3 puta više za istraživanje nego američke javno finansirane istraživačke institucije.[64] Studija je otkrila da većina evropskih institucija

[60] Usp. WIPO Technology Trends 2019 – Artificial Intelligence, 2019:16-17; i Straus, Artificial Intelligence – Challenges and Chances for Europe, 2021:142-158 (str.146-147).
[61] Usp. Straus, The Present State of the Patent System in the European Union, 1997. (fusnota 111 (str. 55 i 56) i Suggestion xiii (str. 63)).
[62] Usp. EU Commission, OJ EC No. L 146, 2008:19.
[63] Usp. i Collins, European Tools up for Industry-Academic Collaborations, 2006:2-4, u kojem se izvještava o tzv. Lambert Agreement modelu ugovora u UK.
[64] https://ec.europa.eu/research/innovation-union/pdf/knowledge_transfer_2010-2012_report.pdf (posljednji pristup 25. februara 2021), str. 128-129.

uključenih u komercijalizaciju rezultata akademskih istraživanja gubi novac, uprkos bogatom izvoru intelektualnog vlasništva. S ciljem poboljšanja efikasnosti prijenosa intelektualnog vlasništva i tehnologija od strane istraživačkih institucija javnog sektora u industriju putem ugovora o istraživanju i razvoju, licenciranja i izdvajanja, Komisija je pokrenula poziv za Izgradnju kapaciteta u transferu tehnologije.[65] Taj poziv rezultirao je trogodišnjim projektom Progress-TT – "*Public Research Organization Growing Europe through best practice Solutions for Technology Transfer*". Ipak, Evropa još uvijek daleko zaostaje za Sjedinjenim Američkim Državama u pogledu transfera znanja i tehnologija iz akademske zajednice u industriju. Bez obzira na to, institucije poput Oxford University Innovation (OUI), Oxford Nanopore Technologies i University College London Business iz Velike Britanije, njemački Max Planck Innovation i francuski CERN primjeri su uspješne komercijalizacije rezultata istraživanja njihovih institucija. Brojni patenti, ugovori o licenciranju i novoosnovana preduzeća svjedoče o tom uspjehu.[66]

(d) Njemačka

Nadahnuti američkim zakonodavnim dešavanjima, koja su suzila akademsku slobodu javno finansiranih istraživača i njihovih poslodavaca da objavljuju i slobodno šire svoje istraživanje, njemački zakonodavci su 2002. godine iz temelja revidirali odgovarajuću odredbu Zakona o izumima zaposlenih.[67] Na osnovu ustavnog prava na slobodu nauke i istraživanja iz člana 5. stavka 3. Njemačkog osnovnog zakona (Grundgesetz - Ustava), član 42. stavak 1. Zakona, propisivao je da izumi profesora, predavača i naučnih asistenata u njihovom kapacitetu kao takvih na univerzitetima i višim naučnim školama bit će slobodni izumi. To znači da su pripadali svojim pronalazačima bez ikakvih ograničenja i da su stoga mogli biti objavljeni ili prijavljeni za patent po njihovom nahođenju. Izmijenjeni član 42. Zakona sad propisuje da izumi zaposlenih na univerzitetima i drugim visokoškolskim ustanovama, što se tiče prava na njih, u načelu podliježu istim pravilima predviđenim Zakonom

[65] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/cbtt-1-2014 - posljednja posjeta 25. februara 2021.
[66] Usp. ALLEA Statement "The Need for Intellectual Property Rights Strategies at Academic Institutions" (https://allea.org/wp-content/uploads/2019/11/The_Need_for_IPR_Strategies_at_Academic_Institutions_ALLEA_2019-1.pdf - posljednja posjeta 25. februara 2021), 2019:6-7, sa daljnjim referencama.
[67] Federal Official Journal 2002 I, 2002:414.

o izumima svih ostalih zaposlenika. Međutim, suprotno općenitom pravilu, ova grupa pronalazača ima pravo otkriti svoje "izume u radu" u okviru svojih nastavnih ili istraživačkih aktivnosti, pod uslovom da su na vrijeme (u pravilu, dva mjeseca unaprijed) poslodavcu prijavili svoj izum (Član 42 (1) br. 1). Štaviše, u slučaju da izumitelj odluči da ne iznese svoj izum tokom svojih nastavnih i istraživačkih aktivnosti, on uopšte nije dužan da obavijesti poslodavca o svom izumu na radu. Još jedna temeljna razlika koja postoji između izuma na radu univerzitetskog osoblja i izuma svih ostalih zaposlenih odnosi se na nagradu koju poslodavac (tj. Univerzitet) mora platiti izumitelju u slučaju eksploatacije izuma koji je stekao. Statutom je ta nagrada utvrđena na 30% od ostvarenog dohotka (član 42 (4)), što je mnogo više od one koja se izračunava za druge pronalazače među zaposlenicima. Savezna vlada Njemačke iskoristila je nekoliko miliona eura iz milijardi generisanih aukcijama Univerzalnog mobilnog telekomunikacijskog sistema (UMTS) za finansiranje infrastrukture neophodne da univerzitetima omogući da preuzmu zadatak prijenosa znanja i tehnologija. Osnovano je 19 profesionalnih agencija za patentiranje i eksploataciju javno finansiranih istraživanja koja su 2002. godine počela obučavanje 170 univerziteta i 40 manjih istraživačkih institucija.[68] Teško je procijeniti koliko je uspješna bila takozvana "eksploatacijska ofanziva" Savezne vlade. Nedavno su izašle na vidjelo kritike nezadovoljnih fakulteta zbog njihovog udjela u prihodima, pa čak i ukazivanje na to da neki profesori koriste "lažnjake" kao podnosioce patentnih zahtjeva kako bi zaobišli svoje zakonske obaveze i održali svoje uspostavljene industrijske veze.[69]

Odlukom od 18. septembra 2007. godine,[70] Njemački savezni vrhovni sud priznao je, s jedne strane, da obaveza profesora i ostalog univerzitetskog osoblja da na određeno vrijeme odlože objavljivanje rezultata istraživanja koji su u osnovi izuma zaista utječe na slobodu nauke, tj. na akademske slobode. S druge strane, međutim, Sud je smatrao da sloboda istraživanja i podučavanja ne zahtijeva vlasništvo nad pravima eksploatacije rezultata istraživanja koji su pridruženi profesoru. Sud je, osim toga, primijetio da član 5 (3) Osnovnog zakona ne kontrolira samo pojedinačna prava, već predstavlja i osnovnu normu koja sadrži vrijednosnu prosudu koja regulira odnos između nauke i države. Prema ovoj osnovnoj normi, država mora poduzeti odgovarajuću organizaciju

[68] Usp. odgovor Savezne vlade od 21. avgusta 2002. u Bundestagu (Saveznom parlamentu), Drucksache 14/9874, str. 26.

[69] Usp. Technologietransfer kommt nicht in Schwung (bez autora), Handelsblatt od 3. marta 2021, https://www.handelsblatt.com/politik/deutschland/verwertunsoffensive-der-bundesre...

[70] GRUR Int. 2008:251-254 (at 254) – Freedom of Publication.

i mjere na području javno finansiranih istraživanja kako bi osnovno pravo na besplatnu naučnu djelatnost ostavila netaknutom u onoj mjeri u kojoj je to moguće uzimajući u obzir druge legitimne zadatke naučne institucije i ustavna prava ostalih uključenih. U tom kontekstu, Sud je pojasnio da dotični zadaci moraju predstavljati pravne vrijednosti ustavnog rangiranja, ali smatrao je da se prikupljanje sredstava univerziteta, uključujući iz grupe patentabilnih izuma njegovog osoblja, odnosi na operativnu sposobnost univerziteta koji ima takav ustavni rang.

Novo pravilo uvedeno 2002. godine, prema razumijevanju Suda, uzima u obzir fiskalni interes države, kako bi se omogućilo univerzitetima da steknu finansijska sredstva od eksploatacije svojih izuma. Dalje je naglasio da je prikupljanje sredstava od izuma zaposlenih na univerzitetima, u principu, bilo primjereno za jačanje ekonomije univerziteta. S obzirom na to da u njemačkom Zakonu o patentima nema grejs perioda za novine, Sud je dalje primijetio da je za osiguranje legitimnih interesa univerziteta neophodno da zakonodavac uvede pravilo koje sprečava prerano otkrivanje izuma. Nadalje, sve dok se od univerziteta nije očekivalo ili se od njih tražilo da odustanu od osnovnih istraživanja ili da ih izvrše samo u ograničenoj mjeri i koncentriraju se na specifične projekte koji su pogodniji za komercijalnu eksploataciju, to ne predstavlja pomjeranje istraživačkog mandata univerziteta sa slobodnog osnovnog istraživanja bez konkretne svrhe na istraživanje usmjereno na učinkovitu komercijalnu upotrebu. Dakle, ovo ne krši ustavno pravo na slobodu istraživanja i podučavanja. Takvo obrazloženje, međutim, prema mišljenju suda ne može se zaključiti iz člana 42 revidiranog Zakona o izumima zaposlenih.

III. Prava intelektualnog vlasništva

(a) Osnovne karakteristike

Prema članu 1 (2) Međunarodnog sporazuma o trgovinskim aspektima prava intelektualnog vlasništva (TRIPS) iz 1994. godine, koji je uveo standarde zaštite obavezne za sve države članice Svjetske trgovinske organizacije (WTO), pojam “intelektualno vlasništvo” pokriva patente, autorska i srodna prava, zaštitne znakove, industrijske dizajne, geografske oznake, nacrte (topografije) integrisanih krugova i neotkrivene informacije. Zajednička karakteristika svih ovih prava je da se sva ona odnose na nematerijalne sveprisutne rezultate ljudskog stvaralačkog poduhvata. U ovom kontekstu, a koji je od posebnog značaja za istraživačke aktivnosti akademske zajednice, su i patenti i autorska prava.

Patenti se odnose na nove, ne očigledne i industrijski primjenjive izume,[71] tj. upute za rješavanje tehničkih problema tehničkim sredstvima. Otkrića kao takva ne predstavljaju predmet patentiranja. Međutim, primijenjena otkrića, tj. konkretna tehnička učenja, a ne teorijsko objašnjenje dato za njeno funkcioniranje, u principu su prihvatljiva za patent. Naprimjer, član 3. stav 2. Direktive 98/44/EC Evropskog parlamenta i Vijeća o pravnoj zaštiti biotehnoloških izuma iz 1998. godine[72] navodi da: "Biološki materijal koji je izoliran iz svog prirodnog okoliša ili je proizveden pomoću tehničkog postupka može biti predmet izuma čak i ako se prethodno pojavljivao u prirodi." Ovo se odnosi i na elemente izolirane iz ljudskog tijela, uključujući sekvencu ili djelomičnu sekvencu gena (član 5 (2) Direktive).[73]

Autorska prava se odnose na književna i umjetnička djela, uključujući svaku produkciju u književnom, naučnom i umjetničkom domenu, bez obzira na način ili oblik njenog izražavanja. Autorska prava također pružaju zaštitu za računarske programe, bilo u izvornom ili objektnom kodu, kao i za kompilaciju podataka prema članu 2 (1) Bernske konvencije za zaštitu književnih i umjetničkih djela iz 1886. godine (posljednji put revidirana 1971. godine) (u vezi sa članom 10 TRIPS-a).

I patenti i autorska prava su ekskluzivna prava ograničena vremenom. Patenti su u pravilu ograničeni na 20 godina, koje se računaju od datuma podnošenja.[74] Trajanje zaštite autorskih prava je najmanje životni vijek autora i 50 godina nakon njegove smrti, ili, ako se računa na osnovi koja nije život fizičke osobe, najmanje 50 godina od kraja kalendarske godine odobrenog objavljivanja, ili, ukoliko takva ovlaštena publikacija ne izađe, u roku od 50 godina od nastanka djela ili 50 godina od kraja kalendarske godine nastanka

[71] Član 27. (1) TRIPS-a zahtijeva od svih članica WTO-a da obezbijede patente za bilo koje izume, bili oni proizvodi ili procesi, u svim poljima tehnologije, pod uslovom da su oni novi, uključuju inovativne korake (‚nisu očigledni') i imaju mogućnost industrijske primjene (‚korisni' su). Za detalje, posebice za izuzetke dozvoljene prema članu 27. (2) i (3) TRIPS-a, vidi Straus, Implications of the TRIPS Agreement in the Field of Patent Law, 1996:160-215.
[72] OJ EC No. L 213/13 of August 30, 1998.
[73] Za specifični problem patentiranja matičnih ćelija ljudskog embrija vidi Straus, Research, Exploitation and Patenting in the Area of Human Embryonic Stem Cells in Europe – A Case of Concern Causing Inconsistency, 2017:107-120.
[74] Član 33. TRIPS-a. U velikom broju država, npr. u SAD-u, Japanu i članicama EU, u slučaju farmaceutskih i agrohemijskih proizvoda, može se postići produženje roka na osnovu tzv. Dodatnog zaštitnog certifikata (Supplementary Protection Certificate - SPC) u trajanju do 5 godina, kako bi se kompenziralo za period vremena potrebnog za dobivanje tržišnog odobrenja.

djela.[75] Osim pojma zaštite, dvije kategorije prava intelektualnog vlasništva najvažnije za akademski svijet razlikuju se i u nizu drugih aspekata, od kojih treba spomenuti samo sljedeće: autorska prava ne zahtijevaju bilo kakve formalnosti, već štite autora, u principu, samo od "kopiranja", ali ne i od nezavisnih kreacija. Također se odnosi samo na oblik izražavanja, tj. ne štiti sadržaj kreacije. Patenti u većini patentnih zakona zahtijevaju skupe formalne postupke za dodjelu patenata uz ispitivanje uslova za patentiranje. Patenti su "blokirajuća prava", tj. oni su učinkoviti i protiv neovisnih izumitelja, koji se nisu prijavili za patent ili su to učinili samo s kasnijim prioritetom.

Kao instrument ekonomske politike, prava intelektualnog vlasništva pružaju poticaje i nagrađuju širok spektar korisne ljudske kreativnosti. Ona posebno igraju ključnu ulogu kao poticaj i zaštita rizičnog ulaganja u istraživanje i razvoj. Važno je naglasiti da prava intelektualnog vlasništva postižu svoje makro-, ali i mikroekonomske učinke samo putem tržišnih mehanizama, za koje čine važan, pa čak i neophodan instrument. Nisu sami patenti, koji svojim nosiocima osiguravaju ekskluzivna prava na eksploataciju, ti koji nagrađuju izumitelje i izume, već njihov uspjeh na tržištu u konkurenciji sa tehničkim i ekonomskim alternativama. Na vlasnicima prava intelektualnog vlasništva je da potraže takve mogućnosti i odaberu one najperspektivnije.[76] Zbog ovih mehanizama, svojstvenih sistemu intelektualnog vlasništva, samo su američke zakonodavne aktivnosti 1980-ih mogle sinhronizirati aktivnosti istraživačkih institucija javnog sektora s privatnim istraživačko-razvojnim aktivnostima i optimalno iskoristiti njihove potencijale. Iako važnost prava intelektualnog vlasništva, posebno patenata, iz sasvim očiglednih razloga u velikoj mjeri ovisi o određenoj grani industrije i najviše je cijenjena u području farmaceutskih proizvoda, postalo je očito i općenito prihvaćeno da ta prava predstavljaju učinkovit i neophodan podsticaj za istraživanje i inovacije.[77]

[75] Član 7. (1) Konvencije iz Berna u vezi sa članom 12. TRIPS-a.
[76] Usp. Beier, Significance of the Patent System for Technical Economic and Social Progress, 1980:563-584 (str. 563).
[77] Usp. sveobuhvatnu analizu Sherwood, Intellectual Property Rights and Economic Development, 1990:67; Mansfield, Intellectual Property, Technology and Economic Growth, in Rushing, 1990:17-30; von Hippel, The Sources of Innovation, 1988:47; Mowery & Rosenberg, Technology and the Pursuit of the Economic Growth, 1989:72 and Cohen & Merrill, Introduction, 2003:3.

(b) Specifični aspekti

Za uticaj koji prava intelektualnog vlasništva, posebno patenti, imaju, ili radije koji bi trebali imati, na rad akademskih istraživača, neophodno je da sistem zaštite prava intelektualnog vlasništva adekvatno uzima u obzir potrebe koje proizlaze iz njihove misije u nacionalnom inovacijskom ekosistemu.

Kao važnom generatoru patentabilnih rezultata istraživanja, akademskoj zajednici je potrebno pravno okruženje u kojem može optimalno ispuniti svoju primarnu misiju, tj. da generira nova znanja i pravovremeno ih širi, bez gubitka vlasničkih prava nad tim znanjem. Dakle, patentni sistem mora široko uključiti sve rezultate istraživanja u najnaprednijim oblastima nauke i tehnologije među predmete koji ispunjavaju uslove za zaštitu. Drugim riječima, dostignuća u genomici, proteomiki, tehnologiji matičnih ćelija, nanotehnologiji, računalno implementiranim izumima i npr. u tehnologiji umjetne inteligencije, koja u principu ispunjavaju redovne zahtjeve za patentibilnost, trebaju biti patentibilna. Štaviše, patentni sistem treba osigurati uslove u kojima željeno stavljanje na raspolaganje i širenje istraživačkih dostignuća ne rezultira automatski gubitkom vlasničkih prava. Zahvaljujući obaveznom objavljivanju prijava patenata u roku od 18 mjeseci od datuma podnošenja / prioriteta, i uslovu da se izum objelodani u prijavi patenta na dovoljno jasan i potpun način da bi ga kvalificirana osoba mogla provesti, patenti djeluju odlučno protiv tajnosti u korist ranog objavljivanja rezultata istraživanja i njihovog širenja.

Kako bi se spriječilo da bilo koja objava u naučnom časopisu ili bilo koja usmena prezentacija na konferenciji ili javna upotreba izuma automatski rezultira gubitkom prava na njegovo ekskluzivno iskorištavanje, zemlje poput Australije, Brazila, Kanade, Japana, SAD i mnogi drugi, u svojim zakonima o patentima predviđaju takozvani "grejs period". Pravilo grejs perioda predviđa imunitet protiv vlastite publikacije od strane podnosioca prijave, ako je prijava podnesena u roku od šest ili dvanaest mjeseci od dana objavljivanja.[78] Nažalost, Evropska patentna konvencija (EPC) i zakoni o patentima svih njenih ugovornih strana usvojili su članom 55. EPC-a uski "grejs period" koji regulira slučaj da je otkrivanje nastalo kao rezultat očigledne zloupotrebe u odnosu na podnosioca prijave ili njegovog pravnog prethodnika. Ponovljeni pokušaji evropske akademske zajednice, koje zastupa Federacija evropskih

[78] Usp. Straus, Grace Period and the European and International Patent Law, Analysis of Key Legal and Socio-Economic Aspects, 2001.

akademija nauka i humanističkih nauka (ALLEA),[79] da se standard novine izmijeni i uskladi sa standardima povoljnim za akademsku zajednicu kakve imaju neki od evropskih kolega, bili su uzaludni.

Kada je u pitanju položaj akademske zajednice kao korisnika patentiranih izuma trećih strana, patenti im ne bi trebali predstavljati ozbiljnu prepreku da imaju što je moguće slobodniji pristup najnovijim dostignućima nauke i tehnologije i koriste ih za obrazovne, eksperimentalne i istraživačke svrhe. Izuzevši od učinaka patenta, između ostalog, radnje učinjene u eksperimentalne svrhe koje se odnose na predmet patentiranog izuma i upotrebu biološkog materijala u svrhu uzgoja ili otkrivanja i razvoja drugih biljnih sorti,[80] u Evropi zaštita patenata ne predstavlja prepreku za dalji naučni i tehnološki razvoj. Naprimjer, Njemački savezni vrhovni sud (BGH) i Njemački savezni ustavni sud presudili su da svaki eksperiment koji se odnosi na temu patentiranog izuma i teži poboljšanju znanja, tj. za dobivanje daljnjih rezultata istraživanja, uključujući pronalaženje daljnje medicinske upotrebe patentiranog lijeka, koji je u konačnici proveden u komercijalne svrhe, ne predstavlja kršenje patenta.[81]

IV. Zaključci

Događaji započeti 1980-ih u SAD-u i oni koji su uslijedili u drugim zemljama, kako je navedeno i u Njemačkoj, jasno otkrivaju evolucijsku promjenu u osnovnom razumijevanju akademske slobode u mjeri u kojoj se rezultati akademskog istraživanja javno finansiraju. Osnovno razumijevanje je da mašta i kreativnost predstavljaju važne nacionalne resurse i da sistem prava intelektualnog vlasništva olakšava i dozvoljava širenje rezultata istraživanja javnosti, kao i njihovo prevođenje u inovativne proizvode i procese. Štaviše,

[79] Usp. npr. ALLEA Statement on Grace Period, usvojenu na Konferenciji o ‚grejs periodu' u Kijevu (https://www.allea.org/wp-content/uploads/2015/08/Statement_Grace-Period_Kiev.pdf (posljednji pristup 3. februara 2021), sazvanu od strane ALLEA-e i Ukrajinske akademije nauka (NAS).

[80] Član 27. (b.) i (c.) Sporazuma o zajedničkom sudu za patente, OJ EC 2013/C 175/01 of 20. 6. 2013. Iako ovaj Sporazum zbog problema sa Brexitom još uvijek nije stupio na snagu, nacionalni zakoni o patentima u državama članicama EU već pružaju ograničenja koja imaju efekt patenta.

[81] Usp. BGH odluke od 11. jula 1995. [1997] IIC 01, 103 – Clinical Tests, i od 17. aprila 1997. [1998] R.P.C. 423 – Clinical Trials II, te odluke Saveznog ustavnog suda od 10. maja 2000. [2001] GRUR 43 – Klinische Versuche.

da je efikasno upravljanje rezultatima javno finansiranog istraživanja u javnom interesu i uključuje prava intelektualnog vlasništva.

Prema tome, prava intelektualnog vlasništva igraju važnu ulogu u bilo kojem nacionalnom naučnom sistemu. Međutim, čak i ako su optimalno prilagođena potrebama akademskih istraživača, ona su samo jedan od mnogih elemenata koji su odgovorni za uspješno funkcioniranje nacionalnog naučnog sistema. Američki izvještaj "Nauka, beskrajna granica" već 1947. godine jasno je stavio doznanja da "nauka može biti djelotvorna u nacionalnoj dobrobiti samo kao član tima". Drugim riječima, zajedno s drugim dijelovima društva. Pored neophodne finansijske podrške, naučni sistem treba i odgovarajuće pravne posljedice. Sistem intelektualnog vlasništva predstavlja samo jednu od njih. Poreski zakon, koji daje preferencijalni tretman za ulaganje u istraživanje i razvoj i za prihode ostvarene rezultatima istraživanja, te racionalne regulatorne odredbe koje se bave sigurnošću ili etikom, su drugi dio. Kao što pokazuju američko zakonodavstvo iz 1980-ih i njegovi sljedbenici u Japanu i Kini, njegovanje nacionalnih naučnih sistema zahtjevan je i složen zadatak, koji zahtijeva velike napore sva tri dijela "*Triple helix*" alijanse da bi bio uspješan. Da parafraziram nobelovca Karyja Banks Mullisa, izumitelja patentirane lančane reakcije polimeraze (PCR), jednog od tehnoloških stupova rDNA tehnologije, čije su riječi u uvodu ovog rada, pravo treba izbjegavati da "oslobodi" ili "porobi" nauku. Pravo treba njegovati nauku na uravnotežen način između te dvije krajnosti. Kary Mullis je vjerovatno u pravu kada kaže da nauka "svake godine raste poput korova", ali i korovu treba plodno tlo. Nikada ne treba zanemariti mudre riječi ser Charlesa Cartera: "Ne možete imati zdravu nauku u bolesnoj ekonomiji".[82] Dakle, zdrava ekonomija je tlo koje je potrebno nacionalnoj nauci i ako se pravilno njeguje, nauka zauzvrat može doprinijeti zdravlju nacionalne ekonomije.

Literatura

Abbott, Frederick M. and Reichman, Jerome H. (2020). Facilitating Access to Cross-Border Supplies of Patented Pharmaceuticals: The Case of the COVID-19 Pandemic. JIEL, Vol. 23, str. 535-561

Abetti, Pierre A. (2006). University Incubators as Agents for Technology Transfer and Economic Growth: Case Studies in USA. Ukraine and Finland. Int. J. Technology Transfer and Commercialization, Vol. 5 (No. 4), str. 308-337

Act on the Promotion of Technology Transfer from Universities to Private Business Operators (Tentative translation) (1998) [Digital Edition]. Preuzeto sa https://www.wipo.int/edocs/lexdocs/laws/en/jp/jp193en.pdf

[82] Sir Carter, Conditions for the Successful Use of Science, 1983: 1295-1298.

Agreement on a Unified Patent Court, OJ EC 2013/C 175/01 (2013) [Digital Edition]. Preuzeto sa https://eur- lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2013:175:0001:0040:EN:PDF

ALLEA Statement on Grace Period (2013) [Digital Edition]. Preuzeto sa https://www.allea.org/wp-content/uploads/2015/08/Statement_Grace-Period_Kiev.pdf

ALLEA Statement "The Need for Intellectual Property Rights Strategies at Academic Institutions" (2019) [Digital Edition]. Preuzeto sa https://allea.org/wp-content/uploads/2019/11/The_Need_for_IPR_Strategies_at_Academic_Institutions_ALLEA_2019-1.pdf

Asgari, Nikou, Mancini, Donato Paolo and Kuchler, Hannah (2021). Pharma Industry Fears Biden's Patent Decision Sets Dangerous Precedent, Financial Times of May 7, 2021

AUTM 2018 Licensing Activity Survey: A Survey of Technology Licensing and Related Activity for US Academic and Nonprofit Research Institutions [Digital Edition]. Taken from https://autm.net/AUTM/media/SurveyReportsPDF/AUTM_FY2018_US_Licensing_Survey.pdf

Beier, Friedrich-Karl (1980). Significance of the Patent System for Technical Economic and Social Progress, IIC, Vol. 11, str. 563-584

Benz, Matthias and Feldges, Dominik (2021). Ein Turbo für die Impfstoff-Hersteller: Lässt sich die Produktion von Corona-Vakzinen Beschleunigen? [Digital Edition]. Preuzeto sa https://www.nzz.ch/wirtschaft/corona-impfung-moeglichkeiten-zur-beschleunigung-der-produktion-ld.1599788

Bush, Vannevar (1945). Science the Endless Frontier. [Digital Edition]. Preuzeto sa https://www.nsf.gov/od/lpa/nsf50/vbush1945.htm.

Carter, Charles (1983), Conditions for the Successful Use of Science. Science Vol. 219 (No. 4590), str. 1295-1298

Chang, Yuan-Chieh, Chen, Ming-Huei, Yang, Phil Y. and Hua, Mingshua (2008). Universities as Patent- and Licensing Income-Generating Institutions: A survey in Taiwan. Int. J. Technology Management, Vol. 42 (No. 3), str. 290 - 309

Chatterjee, Sabarni K. and Rohrbaugh, Mark L. (2014). NIH Inventions Translate into Drugs and Biologics with High Public Health Impact. Nature Biotechnology, Vol. 32 (No. 1), str. 52-58

Chaves, Catari V. and Moro, Sueli (2007). Investigating the Interaction and Mutual Dependence between Science and Technology. Research Policy, Vol. 36 (No. 8), str. 1204-1220

Cohen, Wesley M. and Merrill, Stephen A. (2003). Patents in the Knowledge Based Economy. Study of the National Research Council of the National Academies. The National Academic Press, Washington D.C.

Collier, Alan (2007). Australian Framework for the Commercialization of University Scientific Research. Prometheus, Vol. 25 (No. 1), str. 51-68

Collins, Luke (2006). European Tools Up for Industry-Academic Collaborations. Research Technology Management, Vol. 49 (No. 5), str. 2-4

Corum, Jonathan and Zimmer, Carl (2021). How the Oxford-AstraZeneca Vaccine Works [Digital Edition]. Preuzeto sa https://www.nytimes.com/interactive/2020/health/oxford-astrazeneca-covid-19-vaccine.html

D'Este, P. and Patel, Parimal (2007). University-Industry Linkages in the UK: What are the Factors Underlying the Variety of Interactions with Industry? Research Policy, Vol. 36, No. 8, str. 1295-1313

Dipanjan, Nag, Gupta, Antara and Turo, Alex (2020). The Evolution of University Technology Transfer: By the Numbers [Digital Edition]. Preuzeto sa https://researchgate.net/publication/340766806

EC Commission, Knowledge Transfer Study [Digital Edition]. Preuzeto sa https://ec.europa.eu/research/innovation-union/pdf/knowledge_transfer_2010-2012_report.pdf

Edgington, David W. (2008). The Japanese Innovation System: University-Industry Linkages, Small Firms and Regional Technology Centers. Prometheus, Vol. 26, (No. 1), str. 1-19

Etzkowitz, Henry and Leydesdorff, Loet (1997). Universities and the Global Knowledge Economy: A Triple Helix of University-Industry-Government Relations. Cassells Academic, str. 1-8

Eun, Jong-Hak, Lee, Keun and Wu, Guisheng (2006). Explaining the "University-run Enterprises" in China: A Theoretical Framework for University-Industry Relationship in Developing Countries and its Application to China. Research Policy, Vol. 35 (No. 9), str. 1329-1346

Fauci, Anthony S. (2021). The Story Behind COVID-19 Vaccines. Science, Vol. 372 (No. 6538), str. 109

Frangioni, John V. (2008). The Impact of Greed on Academic Medicine and Patient Care. Nature Biotechnology, Vol. 26, str. 503-507

Fraser, Claire M. (2021). Editorial: A Genome to Celebrate. Science, Vol. 371 (No. 6529), str. 545

Fujisue, Kenzo (1998). Promotion of Academia-Industry Cooperation in Japan – Establishing the "Law of Promoting Technology Transfer from University to Industry". Technovation, Vol. 18, (No. 6 – 7), str. 371-381

Gaveria, Mario and Kilic, Burcu (2021). A Network Analysis of COVID-19 mRNA Vaccine Patents. Nature Biotechnology, Vol. 39, str. 546-549

Gibson, Emily K. (2020). Overseeing Innovation: 75 Years after Vannevar Bush's Impactful Report, debate continuous about directing science. Science, Vol. 369 (No. 6501), str. 258-259

Hippel, Eric von (1988). The Sources of Innovation. Oxford University Press, Oxford

Hoerr, Ingmar, Obst, Reinhard, Rammensee, Hans-Georg and Jung, Günther (2000). In Vivo Application of RNA Leads to Induction of Specific Cytotoxic T-Lymphocytes and Antibodies. Eur J Immonol, Vol. 30 (No. 1), str. 1-7

Hoerr, Ingmar (2017). A Successful Founder off the Beaten Path. Nature Biotechnology, Vol. 35, (No. 10), str. 900-903

Holroyd, Carin (2008). Reinventing Japan Inc.: Twenty-First Century Innovation Strategies in Japan. Prometheus, Vol. 26 (No. 1), str. 21–38

Huggett, Brady and Paisner, Kathryn (2020). Biotech Patenting 2019. Nature Biotechnology, Vol. 38 (No. 8), str. 921-922

Jones, Kathryn M. and Cook-Deegan, Robert (2021). Complicated Legacies: The Human Genome at 20. Science, Vol. 371 (No. 6529), str. 564-569

Karikó, Katalin, Buckstein, Michael, Ni, Houping and Weissman, Drew (2005). Suppression of RNA Recognition by Toll-like Receptor: The Impact of Nucleoside Modification and the Evolution Origin of RNA. Immunity, Vol. 23 (No. 2) str. 165-175

Keener, Amanda B. (2018). Just the Messenger: A New Class of Therapeutic Instruct the Body to Make its Own Drugs, Nature Medicine, Vol. 24, str. 1294-1300

Kneller, Robert (2003). University-Industry Cooperation and Technology Transfer in Japan Compared with the United States: Another Reason for Japanese Malaise? U. Pa. J. Int'l Econ. L., Vol. 24 (No. 2), str. 329-449
Kolata, Gina (2021). Kati Karikó Helped Shield the World From the Coronavirus. The New York Times of April 8, 2021
Kuhn, Thomas S. (1970). The Structure of Scientific Revolutions, Second Edition, Enlarged, Vol. 2, No. 2, University of Chicago Press, Chicago/London
Leydesdorff, Loet and Etzkowitz, Henry (1996). The Future Location of Research: A Triple Helix of University-Industry-Government Relations II: EASST Review, Vol. 15 (No. 4), str. 20-25
Leydesdorff, Loet and Etzkowitz, Henry (1996). Emergence of a Triple Helix of University-Industry-Government Relations. Science and Public Policy, Vol. 23, str. 279-286
Leydesdorff, Loet (2000). The Triple Helix: An Evolutionary Model of Innovations. Research Policy, Vol. 29 (No. 2), str. 243–255
Mansfield, Edwin (1990). Intellectual Property, Technology and Economic Growth. Rushing, Francis W. and Ganz-Brown, Carol (eds.), Intellectual Property Rights in Science, Technology, and Economic Performance - International Comparisons (str. 17-30), Routledge, New York
Mowery, David C. and Rosenberg, Natan S. (1989). Technology and the Pursuit of the Economic Growth. Cambridge University Press, Cambridge
Mowery, David C., Nelson, Richard R., Sampath, Bhaven N. and Ziedonis, Arvids A. (2001). The Growth of Patenting and Licensing by US Universities: An Assessment of the Effect of the Bayh-Dole Act of 1980. Research Policy, Vol. 30 (No. 1), str. 99-119
OJ EC No. L 213/13 (1998) [Digital Edition]. Preuzeto sa https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1998:213:0013:0021:EN:PDF
OJ EC No. L 146 (2008) [Digital Edition]. Preuzeto sa https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008H0416&from=EN
Peel, Michael (2021). EU Leaders Confront US over Vaccine Patent Waiver, Financial Times of May 8, 2021, str. 2
Report "A Missed Opportunity – The Patent Saga" [Digital Edition]. Preuzeto sa http://www.whatisbiotechnology.org/exhibitions/milstein/patents
Rubenstein, Kelly D., Heisey, Paul W. and King, John L. (2006). Public Sector Technology Transfer Through Patents and Licensing: The Case of US Agriculture. Int. J. Technology Transfer and Commercialization, Vol. 5 (No. 4), str. 401-420
Sherwood, Robert M. (1990). Intellectual Property Rights and Economic Development. Westview Press, Boulder
Stacey, Kiran and Williams, Aime (2021). Biden's Diplomatic Victory Blunts Pharma Lobby. Financial Times of May 10, 2021, str. 4
Steenhuis, Harm-Jan and Gray, Denis O. (2006). The University as the Engine of Growth: An Analysis of How Universities can Contribute to the Economy. Int. J. Technology Transfer and Commercialization, Vol. 5 (No. 4), str. 421-432
Stevens, Ashley J., Jensen, Jonathan J., Wyller, Katrine, Kilgore, Patrick C., Chatterjee, Sabarni and Rohrbaugh, Mark L. (2011). The Role of Public-Sector Research in the Discovery of Drugs and Vaccines. New England Journal of Medicine, Vol. 364 (No. 6), str. 535-541
Straus, Joseph (1996). Implications of the TRIPS Agreement in the Field of Patent Law. Beier, Friedrich-Karl and Schricker, Gerhard (Eds.), From GATT to TRIPS – The Agreement

on Trade-Related Aspects of Intellectual Property Rights (str. 160-215.), Wiley VCH, Weinheim

Straus, Joseph (1997). The Present State of the Patent System in the European Union. Office for Official Publications of the European Communities, Luxembourg

Straus, Joseph (2001). Grace Period and the European and International Patent Law, Analysis of Key Legal and Socio-Economic Aspects. IIC-Studies, Vol. 20 C.H. Beck Publishers, Munich

Straus, Joseph (2017). Research, Exploitation and Patenting in the Area of Human Embryonic Stem Cells in Europe – A Case of Concern Causing Inconsistency. European Review, Vol. 25 (No. 1), str. 107-120

Straus, Joseph (2017). Intellectual Property Rights and Bioeconomy. JIPLP, Vol. 12 (No. 7), str. 576-590

Straus, Joseph (2018). Patentierung und Kommerzialisierung im Bereich der Stammzellforschung. Zenke, Martin, Marx-Stölting, Lilian and Schickl, Hannah (Eds.), Stammzellforschung: Aktuelle wissenschaftliche und gesellschaftliche Entwicklungen. (str. 237-276), Nomos, Baden-Baden

Straus, Joseph, Artificial Intelligence – Challenges and Chances for Europe (2021). European Review, Vol. 29 (No. 1), str. 142-158

Thorp, Holden H. (2020). Editorial: Science has always been Political. Science, Vol. 369 (No. 6501), str. 227

Viale, Riccardo and Etzkowitz, Henry (2005). Third Academic Revolution: Polyvalent Knowledge; The "DNA" of the Triple Helix [Digital Edition]. Preuzeto sa https://www.researchgate.net/publication/242406526_Third_academic_revolution_polyvalent_knowledge_theDNA_of_the_triple_helix

Walsh, John P., Cohen, Wesley M. and Cho, Charlene (2007). Where Excludability Matters, Material vs. Intellectual Property in Academic Biomedical Research. Research Policy, Vol. 36 (No. 8), str. 1184-2003

Walsh, John P., Baba, Yasunori, Goto, Akira and Yasaki, Yoshihito (2008). Promoting University-Industry Linkages in Japan: Faculty Responses to a Changing Policy Environment. Prometheus, Vol. 26 (No. 1), str. 39–54

Wang, Xiuqin, Xue, Lan and Shi, Dongbo (2021). Characteristics and logical framework of Chinese universities‘ response to the newly revised 'Bayh-Dole Act'. Studies in Science of Science [Digital Edition]. Preuzeto sa https://doi.org/10.16192/j.cnki.1003-2053.20201125.001 (only abstracts in English)

WIPO Technology Trends 2019 – Artificial Intelligence (2019) [Digital Edition]. Preuzeto sa https://www.wipo.int/edocs/pubdocs/en/wipo_pub_1055.pdf

Woolgar, Lee (2007). New Institutional Policies for University-Industry Links in Japan. Research Policy, Vol. 36 (No. 8), str. 1261-1274

DOI: 10.5644/PI2021.200.05

Kriza etički neutralne znanosti

Mile Babić[*]

Sažetak: Današnja kriza morala u znanstveno-tehničkoj civilizaciji vodi nas u zajedničku propast, jer je suvremena znanost (koja je slobodna od morala) nerazdvojivo povezana s tehnikom, pa se može nazivati tehnoznanost. Kao takva ona ima danas monopol na znanje o svijetu te zbog toga posjeduje najveću moć u dosadašnjoj povijesti i u tijesnoj je sprezi s nosiocima moći: s ekonomijom, politikom, medicinom, medijima, državama i međunarodnim kompanijama. Imati najveću zamislivu moć (koja, po Kantu, kvari slobodu umnoga rasuđivanja), a pritom biti slobodan od morala koji ograničuje tu moć, znači pretvoriti svijet u svijet najmodernijeg barbarstva i nasilja, uništenja i samouništenja. Samo moralno odgovorna znanost sposobna je za budućnost i ona je pretpostavka civilizacije sposobne za budućnost. Samo odgovorna znanost može spriječiti pretvaranje znanosti u sveobuhvatnu dogmu. Stoga znanost mora biti slobodna od svake ideologije koja prikazuje stvarnost crno-bijelom tehnikom te tako proizvodi taštinu, mržnju i nasilje. Globalna znanost zahtijeva globalni etos (globalnu odgovornost). Znanosti je stalo do istine koja nas oslobađa od laži i povezuje nas u jednu zajednicu. Temeljni etički imperativ *primum non nocere* ('najprije ne škoditi životu') vrijedi svuda i zauvijek. Etički odgovorna znanost zahtijeva promjenu svijesti pojedinca i ponovno otkrivanje ideje bratstva. Nijedno ljudsko djelovanje postojeću stvarnost ne smije razarati i uništavati, nego je mora usavršavati.

Ključne riječ: znanost, kriza etički neutralne znanosti, etički odgovorna znanost, globalna moć, globalna odgovornost, temeljni etički imperativ, nova ideja bratstva

Uvod

U ovom ću radu najprije u uvodu izložiti kako je Alexander Görlach ustvrdio da nitko – ni ljudi ni institucije – nije razumio težinu financijske krize 2008. godine u Sjedinjenim Američkim Državama zato što je svima bila vidljiva samo materijalna strana krize, a duhovna (moralna) nije bila zamijećena. Nitko, dakle, nije primijetio duhovni (moralni) uzrok krize, najveće nakon Velike depresije (1929–1933). Zatim ću pokazati što kažu suvremeni, svjetski relevantni mislioci o tome kako je došlo do duboke krize morala (do njegova skoroga nestanka) na svim područjima i razinama ljudskog života. Pritom se

[*] Dopisni član Akademije nauka i umjetnosti Bosne i Hercegovine.
E-mail: dekan.babic@gmail.com

postavlja pitanje je li to kraj humanuma, tj. kraj čovjeka. Nakon toga treba reći da danas svjetski priznat njemački moralni filozof Otfried Höffe ističe da svakom obliku znanosti mora korespondirati odgovarajući oblik etike tijekom povijesti. Höffe razlikuje pet faza u razvoju znanosti i njoj odgovarajuće etike. Naposljetku, valja naglasiti da Günther Mack, umirovljeni profesor eksperimentalne fizike u njemačkom Tübingenu, dokazuje da je potrebno umjesto znanosti slobodne od vrijednosti (tj. od morala i etike) uspostaviti znanost koja će biti odgovorna individualno, institucionalno i javno; umjesto dosadašnje paradigme znanosti slobodne od morala uspostaviti paradigmu znanosti sposobnu za budućnost.

Kao uvod u temu navodim tvrdnju Alexandera Görlacha (lingvista, teologa, gostujućeg profesora na Harvardu i Cambridgeu, te profesora etike i teologije u njemačkom Lüneburgu) iz njegove knjige *Homo empathicus* (usp. Görlach 2019: 29), koja glasi da nijedan političar, nijedna vlada i nijedan nadnacionalni entitet nisu razumjeli težinu financijske krize nastale 2008. godine kad je bankrotirala Banka Lehman Brothers u Sjedinjenim Američkim državama. Svi su gledali samo materijalnu stranu novonastale krize, a nisu tražili njezin duhovni uzrok koji je zove pohlepa, jedan od sedam smrtnih grijeha po kršćanskom nauku. Nijedno društvo ne može opstati ako glavni poroci (oholost, pohlepa, pohota, zavist, srditost, lijenost), tvrdi Görlach, određuju djelovanje njegovih članova, a to tvrdi oslanjajući se na tekst Ralfa Dahrendorfa, njemačko-britanskoga sociologa, filozofa, ekonomiste i političara (usp. Dahrendorf 2009), koji pak konstatira da privredni sustav danas razara svoje vlastite mentalitetske pretpostavke. Dahrendorf nas podsjeća da je prvi oblik kapitalizma (*Sparkapitalismus*, kapitalizam štednje) bio utemeljen na Calvinovoj protestantskoj etici, kako je to dokazao veliki njemački sociolog Max Weber u svom djelu *Protestantska etika i duh kapitalizma*. Naime, Dahrendorf ističe da se korijeni ekonomskog mišljenja nalaze u moralnoj filozofiji jer čovjek koji privređuje, utemeljuje svoje djelovanje na određenim vrijednostima. Kao primjer on navodi Adama Smitha, škotskog ekonomistu i etičara, koji tvrdi da je temelj moralne filozofije čovjek, a ne tržište (ne kapital i ne profit). Kratko rečeno, suvremena ekonomija odvojila se od morala i postala važnijom od njega. Dahrendorf analizira tri oblika kapitalizma. U prvom obliku (kapitalizmu štednje) poštuje se etika, a u drugom (*Konsumkapitalismus*, potrošački kapitalizam) već je važnija potrošnja od poštenoga rada, dok u trećem (*Pumpkapitalismus*, kapitalizam pozajmljenog novca) ljudi žive od potrošnje novca koji su pozajmili od banaka, koji nisu zaradili i koji ostaje bez pokrića. Glavna deviza kapitalizma pozajmljenog novca glasi: *Enjoy, pay later* (Uživaj sada, a plati kasnije). Dubina i silovitost spomenute financijske krize sastojala se u tome da su akteri financijskoga sustava apsolutizirali svoje probitke (dobili su velike otpremnine) te nisu pokazali ni osobnu i sustavnu odgovornost. Nitko nije sankcioniran, jer nijedna država nije stajala iza toga financijskog sustava. Iz toga slijedi da cijeli sustav treba temeljito reformirati na osnovi glavnih moralnih vrijednosti (usp. Görlach 2019: 16–19, 21–36).

Kriza morala na svim područjima i razinama ljudskog života

Nakon uvoda izlažem stajališta i tvrdnje svjetski relevantnih mislilaca o krizi morala i o predvidivom nestanku morala iz svih područja i sa svih razina ljudskoga života te iz svih dijelova kulture, počevši od znanosti, pa do umjetnosti i religije. Oslanjam se na sljedeće autore: Charles Taylor, Pascal Bruckner, Robert N. Bellah, Peter Sloterdijk, Hans Jonas, Edgar Morin, Hans Küng, Žarko Paić, Jürgen Habermas, Yuval Noah Harari, Otfried Höffe i Günther Mack.

A. Charles Taylor

Kanadski svjetski priznat filozof, *professor emeritus*, uza sve ostalo poznat po vlastitom doprinosu moralnoj filozofiji. U svojoj izvrsnoj knjizi *Quellen des Selbst* [Izvori sebstva] (Taylor 1994) pokazao je kako su nastala dva novovjekovna individualizma. Začetnik prvoga (racionalnoga) individualizma bio je René Descartes, a drugoga (ekspresivnog) Michel de Montaigne. Za Descartesa čovjek je čisti um, i to dezangažirani um, koji je odijeljen od tijela. Takav um ima instrumentalan odnos prema vlastitom tijelu i prema ukupnoj stvarnosti: on vlada nad svime i odgovoran je samome sebi. De Montaigneov ekspresivni individualizam želi izraziti čovjekovu originalnost, posebnost i neponovljivost. Takav je individualizam emotivan, jer izražava čovjekove težnje i želje, tj. posebnost čovjekova osjećanja, ali on potiskuje moralnu ontologiju, što znači da čini nemogućim moral kao teoriju i kao praksu. Oba individualizma, po Tayloru, zanemaruju moralnu dimenziju ljudskoga bića i ne pitaju o biti dobroga života niti o tome po čemu je ljudski život vrijedan življenja. Također, Taylor pokazuje da oba individualizma sadržavaju stanovite moralne imperative i norme, ali im nedostaje ontološko utemeljenje moralnih normi. Oba su individualizma okrenuta prema čovjekovoj unutrašnjosti.

Descartes ističe ono što je svim ljudima zajedničko (um), a de Montaigne ono po čemu je svaki čovjek poseban.

U knjizi *Negative Freiheit?* [Negativna sloboda?] (Taylor 1998) kritizira novovjekovni individualizam te pokazuje u čemu je zabluda negativne slobode. Naime, u liberalnom društvu sloboda se shvaća isključivo kao neovisnost individuuma o drugima, kao odsutnost vanjskih fizičkih i zakonskih zapreka. Treba reći da uz vanjske zapreke postoje i unutrašnje. Za unutrašnje zapreke najviši je sudac sam subjekt, što isključuje mogućnost da o njegovu djelovanju sude vanjski subjekti. Iz toga proizlazi da se tako shvaćena sloboda ne može ostvariti, jer su prepreke u ostvarivanju i širenju takve slobode drugi ljudi, pravo i zakon. U knjizi *Das Unbehagen an der Moderne* [Nelagoda u moderni] (Taylor 1995) imenuje tri neugodne pojave u moderni. 1. Nestanak moralnoga horizonta, smisla i viših vrijednosti. Nekad su ljudi sebe smatrali sastavnim dijelovima obuhvatnijega kozmičkog poretka. Diskreditiranje ovoga poretka označeno je kao "raščaranje" svijeta (*Entzauberung*, Max Weber). Tim je procesom svijet izgubio svoju čarobnu snagu. Prvi je, dakle, uzrok nelagode individualizam, koji je, po shvaćanju mnogih, najviše dostignuće moderne civilizacije. Takva individualistička (negativna) sloboda postignuta je tako što smo se oslobodili od starijega moralnog horizonta, pa sada čovjeku nedostaje osjećaj za više vrijednosti, za koje se isplati živjeti i umrijeti. Ljudi danas teže isključivo za "ugodom koja pobuđuje sažaljenje" (*erbärmliches Behagen*, Friedrich Nietzsche). Na taj je način čovjekov život osiromašen jer je čovjek koncentriran samo na svoje *ja*. 2. Druga nelagoda moderne jest fenomen koji nazivamo primatom instrumentalnoga uma. Um služi samo kao instrument za pronalaženje sredstava koja služe za postizanje postavljenog cilja. Sve što postoji svedeno je na sredstvo za uporabu, pa tehnika ima dominantnu ulogu, što znači da je, na primjer, pacijent za medicinsku struku objekt obrade, a ne osoba: pacijent je, dakle, tehnički problem. 3. Treća se nelagoda sastoji u tome da individualizam i instrumentalni um u političkom životu vode ljude u blagi despotizam (Alexis de Tocqueville). Riječ je o vladi koja s građanima postupa blago i paternalistički te koja se tako pretvara u skrbnika svojih građana. To se odigrava u krajnje centraliziranom i birokratiziranom političkom svijetu.

Nadalje, u knjizi *A Secular Age* [Sekularno doba] (usp. Taylor 2007) dokazuje da u novom vijeku zlo više nije u čovjeku, dakle, zlo više nije endogeno, nego je egzogeno. Naime, zlo se sada nalazi izvan čovjeka: u sustavu, u povijesti, u strukturama, što će reći u stvarnosti izvan čovjeka. Time je čovjek sebe proglasio bezgrešnim i bezazlenim, a sva zla smjestio u druge: u pripadnike drugih naroda, religija, kultura, politika i civilizacija. Taj bezgrešni čovjek danas ubija zlo u drugim ljudima bez grižnje savjesti. Bezazlene moderne ubojice svoja ubojstva drugih ljudi proglašavaju dobrim djelima. Ti bezgrešni ljudi ubili su milijune i milijune ljudi u ime dviju najopasnijih modernih ideologija: u ime nacionalizma (u liku fašizma i nacizma) te u ime komunizma (u liku staljinizma i u liku kineske i južnoazijske varijante komunizma). Takav moderni bezgrešan čovjek postao je amoralno biće, naprosto biće s onu stranu dobra i zla: on nema osjećaja za moralnu normu ni za moralnu obvezu. Moralna pitanja jednostavno su odsutna iz njegove svijesti. Što se prije zvala moralna filozofija ili etika sada se zove terapeutika. Dogodio se čuveni "terapeutski obrat" (*therapeutic turn*), što znači da zla nema u čovjeku, pa on nikada ne može biti kriv, nego može biti samo duševno bolestan. Umjesto moralnoga registra danas postoji terapeutski. Njime je umanjeno čovjekovo dostojanstvo, jer je čovjek postao puki objekt terapeutske obrade. Odbacujući skrbništvo religije (tj. Crkve i klera) moderni su ljudi željeli afirmirati svoje dostojanstvo, ali su sada potpali pod skrbništvo terapeutike, gdje ih tretiraju kao stvari i ušutkuju više nego nekada vjernike u crkvama. Ako je moderni čovjek nesposoban za grijeh (za zlo), nesposoban je i za slobodu i za odgovornost, jer grijeh (zlo) nastaje iz čovjekove slobode, a iz te slobode nastaje i čovjekova odgovornost. Time je proizveden kraj etike, o čemu su govorili mnogi marksisti, a danas govore mnogi scijentisti.

B. Pascal Bruckner

Francuski pisac i jedan od "novih filozofa" poznat po svojim kritikama (ne samo) francuskoga društva i francuske kulture. U svojoj knjizi *Napast nedužnosti* (usp. Bruckner 1997) pokazuje kako je došlo do nasilja na prostoru nekadašnje Jugoslavije. Ljudi i cijele skupine, cijeli narodi žele se osloboditi odgovornosti na dva načina: infantilizam i viktimizacija. To su dva simptoma današnjega čovjeka i današnjega društva. Infantilizam se sastoji u tome da se odrasli ljudi i cijeli narodi ponašaju infantilno, tj. kao razmažena djeca: čine zlo, a ne osjećaju se krivima, nego za počinjeno zlo očekuju priznanja i nagrade. Viktimizacija se očituje u tome da odrasli ljudi i cijeli narodi smatraju sebe žrtvama, koje su nesposobne za zlo. Oni navodno podnose tuđa zla, a od drugih očekuju priznanje njihove žrtve.

C. Robert N. Bellah

Američki sociolog međunarodno poznat po svom radu u vezi sa sociologijom religije. U koautorskoj knjizi *Habits of Heart* [Navike srca] (Bellah et al. 1996) kritizira dva oblika američkoga individualizma pozivajući se na istaknutoga francuskog socijalnog filozofa Alexisa de Tocquevillea, koji je 1830. neke aspekte američke demokracije nazvao individualizmom. Bellah dokazuje da oba američka individualizma (utilitarni i ekspresivni) vladaju u američkom društvu, a za oba je individuum primarna realnost, dok je društvo sekundarna, tj. izvedena realnost.

D. Peter Sloterdijk

Svjetski poznat njemački filozof, televizijski voditelj i esejist. U svom trosveščanom djelu pod naslovom *Sphären* [Sfere] (usp. Sloterdijk 1998; 1999; 2004) tvrdi da je novovjekovni individualizam placentalan, jer u novom vijeku i pojedinci i sustavi funkcioniraju kao sveti egoisti. Kritizirajući individualizam Sloterdijk dokazuje da je ljudsko biće od samoga začetka "bipolarno biće", jer *par* predstavlja veličinu stvarniju od individuuma.

E. Hans Jonas

Istaknuti američko-židovski filozof, rođen u Njemačkoj, poznat po svojim djelima o gnosticizmu i etici odgovornosti. Davno je Jonas u knjizi *Das Prinzip Verantwortung* [Princip odgovornosti] (usp. Jonas 1984) dokazao da su znanost i tehnika postale najveća prijetnja prirodi, čovjeku i čovječanstvu. Nekada su one čovjeku obećavale spasenje, a danas mu nude propast, dakle, vode ga u uništenje i samouništenje. Povezane s ekonomijom (osobito s vojnom) i medijima one imaju dosad neviđenu moć. Zato je Jonas formulirao nov etički imperativ, koji glasi: "Djeluj tako da učinci tvoga djelovanja ne budu razaralački za permanentnost autentičnoga ljudskog života na Zemlji" (Jonas 1984: 36).

F. Edgar Morin

Francuski filozof i sociolog, jedan od najpoticajnijih mislilaca današnjice. U knjizi *Etika* (usp. Morin 2008) upozorava nas da današnje čovječanstvo može završiti u barbarstvu umjesto u istinskoj civilizaciji i humanizaciji. On ističe da je odnos znanosti i tehnike postao toliko nerazdvojan da nam se danas naprosto nametnuo izraz *tehnoznanost*. Razvoj znanja radi spoznaje (to je znanstveni imperativ) postao je nerazdvojan od ovladavanja prirodom (to je tehnički imperativ). Treba dodati da se suvremena vladavina nad vanjskom prirodom pretvorila i u vladavinu nad čovjekovom prirodom. Znanost i tehnika u službi ekonomije (industrije, transporta i komunikacija) te znanstvena istraživanja na području kemije i genetike uvele su znanost u svijet profita. Tako je suvremena tehnoznanost najmoćniji pokretač društva. Znanost objašnjava strukturu atoma i gena te time postaje moćno sredstvo za uništenje i manipulaciju u rukama političkih sila. Znanstvenici su lišeni moći koja se koncentrira u rukama velikih kompanija i državnih sila. Atomska je bomba izmakla kontroli znanstvenika. Znanost je danas prisutna na svim područjima i na svim razinama ljudskoga života, ima neograničenu moć, "ali je potpuno nemoćna da kontrolira vlastitu moć" (Morin 2008: 71).

G. Hans Küng

Najglasovitiji katolički teolog, a poznat i kao filozof, utemeljitelj dijaloga među religijama postavljenoga na principima svjetskog etosa. U knjizi *Projekt Weltethos* [Projekt svjetski etos] (usp. Küng 2006) tvrdi da svjetski etos vrijedi za sva područja i za sve razine ljudskoga života: za politiku, gospodarstvo, znanost, medije i ostala područja javnoga života. Potreban nam je globalan etos koji će vrijediti za cijeli svijet. Naime, etos nas oslobađa od svih ideologija koje crno-bijelo prikazuju stvarnost i tako proizvode taštinu, mržnju i nasilje.

H. Žarko Paić

Hrvatski sociolog i filozof, svestran intelektualac. U knjizi *Politika identiteta. Kultura kao nova ideologija* (usp. Paić 2005) zahtijeva pristup kulturi i ideologiji drukčiji od dosadašnjega, jer želi "deideologijazciju kulture i dekulturalizaciju ideologije" (Paić 2005: 209). Kultura je, po Paiću, postala univerzalna ideologija globalnoga kapitalizma. Trijada *biopolitika identiteta – ideologija humanitarizma – genetska tehnologija* određuju suvremeni globalni kapitalizam. U kulturu kao novu ideologiju spadaju i znanost, i religija, i umjetnost. U doba globalizacije došlo je do "kulturalnog obrata" (*cultural turn*), po kojem kultura postaje novom ideologijom novoga svjetskog poretka. Prema tome, suvremena kultura opravdava razvitak globalnoga kapitalizma, a time izdaje svoju bit (autonomiju, samousavršavanje i integraciju). Treba spomenuti da je Paić napisao peterosveščano djelo pod naslovom *Tehnosfera* (usp. Paić 2018–2019), u kojem se pita je li u tehnosferi moguć obrat prema humanizmu.

I. Jürgen Habermas

Glasovit njemački filozof u knjizi *Glauben und Wissen* [Vjera i znanje] (usp. Habermas 2001) ističe da znanost danas ima monopol na znanje o svijetu te da je znanost revolucionirala naše svakidašnje znanje. Ali, suvremena se znanost, u Habermasovu tumačenju, pretvorila u lošu filozofiju jer ukida razliku između opisivanja stvarnosti (što je zadaća znanosti) i opravdavanja stvarnosti (što je zadaća filozofije). Takva znanost ne priznaje čovjeka kao slobodno i odgovorno biće. U knjizi *Dialektik der Säkularisierung* [Dijalektika sekularizacije] (usp. Habermas / Ratzinger 2011) tvrdi o našoj civilizaciji da je ugrožena "sekularizacijom koja skreće s kolosijeka" (*ibid.*: 17), jer su presušili moralni izvori (osobito solidarnost). Zbog toga ustavna država želi sačuvati sve kulturne izvore "iz kojih se hrane svijet o normi i solidarnost građana" (*ibid.*: 33). Ako ljudi nisu svjesni moralne norme koja ih bezuvjetno obvezuje, prestaju biti moralna bića, tj. slobodna i odgovorna bića; ako su izgubili osjećaj solidarnosti i ako ih tuđa patnja ne pogađa, postali su moderni barbari.

J. Yuval Noah Harari

Izraelski intelektualac, strukom povjesničar, profesor povijesti u Jeruzalemu. Svoju knjigu *Homo Deus. Eine Geschichte von Morgen* [Homo Deus. Povijest sutrašnjice] (usp. Harari 2017) zaključuje tvrdnjom da u 21. stoljeću cenzura znači (umjesto nekadašnje zabrane) preplaviti ljude nevažnim informacijama. Ljudi tada naprosto ne znaju na što treba skrenuti pažnju, pa svoje vrijeme troše na bavljenje sporednim aspektima nekog problema. U prethodnim vremenima moć je značila pristup podacima, a danas znači znati što treba ignorirati, znati na što se u našem kaotičnom svijetu treba koncentrirati (usp. *ibid.*: 536). Harari najavljuje promjene na početku trećeg tisućljeća. Ističe da glad, bolest i rat čovječanstvo već sada može kontrolirati. Po prvi put u povijesti više ljudi umire od prejedanja nego od gladi; više umire od starosti nego od zaraznih bolesti; više je samoubojica nego žrtava kriminala, rata i terorizma. Početkom našega stoljeća prosječan će čovjek s većom vjerojatnošću umrijeti od prejedanja u McDonald'su nego od suše, ebole i napada Al-Kaide (usp. *ibid.*: 10). Moguće je, po Harariu, da ljudi postanu bogovi na tri načina: putem biotehnologije, putem *cyborg* tehnologije i putem proizvodnje neorganskih živih bića. Biotehnologija polazi od spoznaje da se razvoj kreće od amebe, preko gmazova i sisavaca, do homo sapiensa, a može ići i dalje od homo sapiensa. *Cyborg* tehnologija organsko će tijelo snabdjeti umjetnim rukama, očima i milijunima nanorobota (usp. *ibid.*: 64). Treći veliki projekt bit će da čovječanstvo sebi prisvoji božansku moć stvaranja i razaranja te da homo sapiensa uzdigne u *homo deusa*. Dakle, po Harariju, svi se projekti svode na jedan projekt: postići božanskost, ali ta božanskost je shvaćena više u smislu grčkih i hinduističkih bogova, a manje u smislu svemoćnoga Boga Biblije. Naši će potomci, pretpostavlja Harari, vjerojatno imati svoje vlastitosti, sklonosti i slabosti, ali će na posve drukčiji način moći voljeti, mrziti, stvarati i razarati (usp. *ibid.*: 69).

Pogledamo li ljudski život u cjelini, slijedeći Hararija, svi će problemi i razvoji biti u sjeni triju uzajamno povezanih procesa: 1. Pretvaranje znanosti u sveobuhvatnu dogmu koja tvrdi da su organizmi algoritmi, a da je život prerada podataka; 2. Inteligencija se odvaja od svijesti; 3. Nesvjesni, ali visokointeligentni algoritmi mogli bi nas već uskoro bolje poznavati nego mi sami sebe. Ta tri procesa nameću tri ključna pitanja: 1. Jesu li organizmi stvarno algoritmi i je li život stvarno prerada podataka?; 2. Što je vrednije – inteligencija ili svijest?; 3. Što nastaje iz našega društva, naše politike i našega svakidašnjeg života ako nesvjesni, ali visokointeligentni algoritmi poznaju nas bolje nego mi sami sebe? (usp. *ibid.*: 536–537).

K. Otfried Höffe

Njemački svjetski priznat moralni filozof, specijalist za filozofiju Immanuela Kanta. U petom poglavlju svoje knjizi *Die Macht der Moral im 21. Jahrhundert* [Moć morala u 21. stoljeću] (usp. Höffe 2014: 64–79) daje prikaz razvoja znanosti i tehnike u pet faza. uzmemo li u obzir povijest znanosti, tvrdi Höffe, vidjet ćemo da povijest znanosti (osobito povijest istraživanja prirode) pokazuje koje promjene u znanosti zahtijevaju razgovor s etikom, zapravo, koju vrstu etike zahtijevaju. Ovakav pristup ima dvije prednosti: ne podliježe opasnosti od moraliziranja koje je udaljeno od stvarnosti, nego počinje od istraživanja i proširuje etiku istraživanja poznatom kritičkom etikom i kontrolnom etikom. Pogledamo li povijest znanosti u bitnim crtama, možemo razlikovati pet faza, od kojih svaka ima svoj karakterističan odnos prema etici. Na starom Istoku bilo je, moralno gledano, lako sa znanošću. Medicina, astronomija, matematika i plansko promatranje bili su u službi ljudskoga života, pa je razgovor s etikom bio suvišan. Jedino se može prigovoriti da su rezultati znanosti služili tankom društvenom sloju: vladaru, njegovoj obitelji, plemstvu i visokim činovnicima, kratko rečeno, znanost je tamo bila humanitarna, ali nepravedna.

U drugoj fazi Höffe tvrdi da iza enormnoga napretka u grčkom prostoru stoji epistemska revolucija koja je usmjerena na znanje, tj. na otkrivanje logičkog poretka koji je već bio pripremljen na starom Istoku. Ta revolucija razvlašćuje mit u ime logosa. Dva aspekta (dva evolucijska pomaka) te revolucije ovdje valja istaknuti. Znanstvenoteoretski pomak oduzima znanju karakter recepta i čini ga preispitivim tako što se ono može prenositi dalje poučavanjem i učenjem. Znanje je u punom smislu određeno općim pojmovima, razlozima, uzrocima i zakonima. Da bi se ostvario prvi aspekt revolucije potreban je i drugi aspekt, tj. intencionalna revolucija, po kojoj je istraživanje slobodno od koristi na dva načina: ono inicira novu vrstu etike istraživanja, etiku koja inicira i legitimira istraživanje, te sužava rang danas dominantno humanitarnoga znanja.

Znanost spoznaje najviše i najopćenitije uzroke i razloge te teži za spoznajom radi spoznaje. Kao što slobodan čovjek, za razliku od roba, živi radi sebe, tako i u spoznajnom smislu slobodno se znanje traži radi sebe. U taj rang spada ne samo Prva filozofija, koju kasnije nazivamo metafizikom, nego i matematika, astronomija, teoretska fizika i biologija. Istraživanje ne služi vanjskim interesima ni vanjskim obvezama. Druga epistemska revolucija povezana je s moralnom revolucijom, s moralnim evolucijskim pomakom. Želja za znanjem pripada naravi čovjeka obdarena razumom i zato epistemsko slobodno istraživanje ima humani i istodobno moralni rang. Takvo istraživanje ispunjuje kriterije antičkoga moralnog principa (*eudaimonia*), sreće u najvećoj mjeri. U slobodnom istraživanju usavršava se i ostvaruje čovjekova razumna narav, a to se zove sreća. Kod Grka epistemsko slobodno istraživanje dobra ima najviši moralni rang. Tko se bavi filozofijom ili istraživanjem prirode, vodi dobar život (*eu zen*), sretan i uspješan život. To čini jezgru etike znanosti i etike istraživanja. Takva etika afirmira znanost jer ona inicira i legitimira istraživanje, potvrđuje slobodno istraživanje kao najvišu formu humanog života. Veliki zastupnik takve etike bio je Aristotel, koji ne poriče vrijednost očeva liječničkoga poziva, ali na vrhu hijerarhije znanosti stoje isključivo filozofija i znanost koja nije utilitarna ni humanitarna.

Aristotel nije zanemario mnogostrukost prirode, jer on pokazuje da i najniže životinje u svojoj svrsishodnosti imaju na sebi nešto vrijedno divljenja. To divljenje beskonačnom bogatstvu prirode upućuje na treći epistemski evolucijski pomak. Sam Charles Darwin naziva Aristotela jednim od najvećih, ako ne i najvećim promatračem prirode. Grci su u medicini postigli značajan dijagnostički i terapeutski napredak. Učinili su drugi evolucijski pomak: svečanu samoobvezu liječnika. U njoj naznačuju drugu etiku istraživanja, čak kontrolnu etiku. Hipokratski liječnik se podvrgava dvjema moralnim obvezama. Prva hipokratska zapovijed sadržava treći razlog koji legitimira i ujedno kontrolira istraživanje. To je prvi element kontrolnoga morala: dobro pacijenta najviši je zakon (*salus aegroti suprema lex*). Druga obveza postavlja granicu zabranom da se ne smije nikome škoditi (*nil nocere*). Novija medicinska etika ovim načelima dodaje i treće: zapovijed prosvijećenoga pristanka.

U trećoj fazi, po Höffeu, dolazi do sukoba između prirodne želje za znanjem i znanja koje dolazi iz božanske Objave. Ovdje želim dopuniti autora novim spoznajama. Treba, naime, reći da je bilo pretjerivanja na obje strane: i na strani prirodnoga uma, i na strani vjere (Objave). Neki su htjeli svesti vjeru na znanje, a drugi znanje na vjeru. Oboje je nasilno. Pravo se rješenje nalazi u postizanju sklada između uma i vjere. Nova istraživanja srednjovjekovne filozofije i teologije pokazuju da je već kod velikih franjevačkih teologa i filozofa došlo do primata praktičnog (moralnog) intelekta pred spekulativnim (teoretskim). To je jasno iskazano kod Rogera Bacona, za kojega je moralna filozofija vrhunac filozofije, jer je praktični intelekt ili slobodna volja intelekt slobode, iz koje nastaje odgovornost. Time je obrnut hijerarhijski redoslijed znanosti koji je vladao kod Aristotela: teoretske, praktične i poietičke znanosti. Kod Bacona, Ivana Duns Škota i Vilima Ockhama prednost imaju praktične znanosti pred teoretskima (usp. Babić 2015: 67–86). U svojoj povijesti filozofije J. Habermas dokazuje da su dvojica franjevačkih velikana u srednjem vijeku (*Škot* i Ockham) začetnici moderne paradigme, tj. modernoga puta (*via moderna*), jer stavljaju skretnice za znanstvenu, religioznu i društveno-političku modernu (usp. Habermas 2019: 761–851). Glasoviti istraživač srednjovjekovne filozofije Ludger Honnefelder tvrdi da su glavne karakteristike *Škotove* filozofije intencionalnost, transcendentalnost i moralnost. Svojim poimanjem slobode *Škot* utemeljuje svoju etičku teoriju, koja je s onu stranu voluntarizma i naturalizma (usp. Honnefelder 2005).

U četvrtoj fazi Höffe pokazuje kako se nasuprot antici i srednjem vijeku razvija istraživanje u ranom novom vijeku. Glavno djelo proroka znanstveno-tehničke civilizacije Francisa Bacona *Instauratio magna* odnosno *Novum organum* (1620) ima na naslovnoj stranici sliku broda koji se vraća sa svoga putovanja po bezgraničnom oceanu u morski tjesnac. Time su očito naznačena dva evolucijska pomaka karakteristična za novi vijek: brod se oslobađa užadi morskoga tjesnaca i tako simbolizira intelektualnu emancipaciju koja uključuje neograničeno slobodnu volju za znanjem. Nasuprot Prvoj filozofiji, koja traga za najvišim znanjem, za najopćenitijim uzrocima i razlozima, sada nastupa humanitarno obvezatna inovacija: pustolovina otkrivanja na bezgraničnom oceanu. Kod istraživanja Bacon inzistira na preispitivim eksperimentima. U tom evolucijskom koraku Kant je vidio epistemsku revoluciju, koja se sastoji u tome da istraživači prirodu ne promatraju pasivno, nego je aktivno obrađuju. Istraživači postavljaju ili izmišljaju precizna pitanja prirodi, hipoteze, te s pomoću zahvata, eksperimenata, prisiljavaju je na odgovor. I Bacon i Kant, međutim, zanemaruju moralne posljedice takvoga istraživanja, jer istraživanje koje zahvaća u svijet života nameće odgovornost za takvo djelovanje, za rizike koji nastaju takvim zahvaćanjem u prirodu. Bacon od znanstvenika zahtijeva da nauče gledati prirodu na posve nov način, kao mala djeca, da budu slobodni od predopterećenja i od predrasuda. Treba reći da mala djeca žive bez predopterećenja, ali i u određenom pogledu djeluju ne misleći, tj. ne zamjećuju negativne posljedice i previđaju troškove svoga pothvata.

Dugo je novi vijek pokušavao svojim inovacijama dodijeliti karakter nedužnosti. Mora se priznati da su eksperimenti kakav je Galilejev s padom kamena bili nedužni jer ispunjuju pet uvjeta: 1. Eksperimenti se provode u maloj mjeri; 2. i to na neživoj materiji; 3. promjene koje oni izazivaju u prirodi mogu se dobro unaprijed procijeniti; 4. ne nanose nikakvu veliku štetu; 5. pričinjavaju samo reverzibilnu štetu. Baconov treći evolucijski pomak sastoji se u tome da on ne obnavlja antički ideal slobodnoga istraživanja, jer kod njega istraživanje ima humanitarnu svrhu. U njegovoj znanstvenoj utopiji *Nova Atlantida* (1627) istraživačka republika traži sredstva protiv gladi, pošasti i bolesti, i to pod devizom: “medicina umjesto metafizike”. Dakle, u humanitarnom smislu istraživanje je bezgranično. U svom djelu *Instauratio magna* Bacon tvrdi da se ne može pretjerati u ljubavi u humanitarnom istraživanju. Novovjekovno je istraživanje odgovorno za dvije stvari: 1. suodgovorno je za promjenu stava, tj. za novo utilitarističko razumijevanje sebe i svijeta; 2. odgovorno je za ispunjavanje svoga humanitarnog obećanja. Jedan od prvih Baconovih velikih pristaša René Descartes pretpostavljao je “da bi se moglo osloboditi od beskonačno mnogih bolesti, kako tijela tako i duha, možda čak i od starosti”. Posebno ekstreman primjer neozbiljnih *očekivanja nudi Kongres vodećih molekularnih biologa održan u Londonu 1962, koji je očekivao oslobođenje* svijeta od zaraznih bolesti, život bez patnje, i – zahvaljujući transplantaciji organa – beskonačan život, što znači poboljšanje genetske opskrbe. Etika kao kritika ideologije odbacuje podmetanje svemoći. Već je sam Bacon kritizirao neka biomedicinska istraživanja koja su željela imati ulogu

Boga, koji je stvorio svijet u šest dana, a sedmi se dan odmarao. Čovjek ne može stvoriti prirodu iz ništa (*ex nihilo*) kao Bog i ne može se sedmi dan odmarati te gledati na ono što je stvorio kao dobro. Čovjekova želja za znanjem ne može se zasititi (to mu je urođeno), i njegov interes da olakša i poboljša ljudski život ostaje stalan. Ali, ljudsko stvaranje nije nikad tako dobro da ga nije moguće dalje usavršavati niti je sekularni raj moguć za čovjeka.

U petoj fazi razvoja znanosti Höffe pokazuje da najnovija istraživanja zahtijevaju odgovornost jer mijenjanju prirodu i jer su posljedice istraživanja ireverzibilne, što znači da je nastalu štetu nemoguće popraviti. Nemoguće je suzbiti radioaktivno zračenje, što je očito i kod atomskih eksperimenata. Galilei je u svom eksperimentu morao paziti samo toliko da nitko ne prolazi putem na koji pada kamen, a sam je kamen poslije mogao vratiti na mjesto s kojega ga je uzeo. Okvirni uvjeti istraživanja u ranom novovjekovlju znatno su prekršeni u istraživanju gena. Tu se eksperimentira osnovnim elementima života i ne mogu se procijeniti posljedice za svijet izvan laboratorija. A posljedice mogu biti sudbonosne epidemije. Filozofska etika ne može odlučivati o opasnosti koje nam prijete, ali može imenovati odgovornost koja je primjerena takvom istraživanju i pritom razviti kontrolnu etiku i etiku rizika. Treba istražiti vrste opasnosti koje nam prijete (posve nepoznate i zbog toga neugodne) i rizike (koje su svladivi ili nisu) tako što se poduzimaju biološke i fizikalne mjere opreza. Ne naposljetku treba se pitati o cijeni i moneti kojima se plaćaju eksperimenti. Treba uzeti u obzir personalne, socijalne i čak estetske troškove. Pritom rizike treba određivati ne ahistorijski, nego samo u ovisnosti o konkretnoj kulturi. Etika rizika odnosi se ne samo na personalni lik morala, nego i na socijalne mjere koje su potrebne, ali moraju biti fleksibilne kako ne bi gušile kreativnost istraživanja. Međunarodna istraživačka zajednica može pritom biti od pomoći kod uspostave internacionalno vrijedećih pravila tako da nacionalni zakonodavci ne zakidaju svoje istraživače.

Također, u suvremenom istraživanju postaje važan drugi evolucijski pomak novoga vijeka: humanitarna znanost. Sve do 19. stoljeća mnoga istaknuta istraživanja služila su primarno spoznaji. Tako su Newtonovi zakoni, Darwinova teorija evolucije, kvantna teorija i teorija relativnosti, čak dešifriranje DNK bile motivirane čistom željom za znanjem, a ne humanitarnim poticajima. Danas je dominantna protusmjer, jer je nastupila epoha znanosti života, od kojih se očekuje viša korist. Dešifriranje genetskoga koda markira strukturalnu promjenu. Ona se sastoji u novom redoslijedu teorije i prakse, jer se fundamentalno istraživanje može u kratkom vremena pretvoriti u novovrsnu tehniku. Tehnički upotrebljivi bili su već zakoni Gregora Mendela, austrijskoga svećenika i znanstvenika, a oni su nudili samo teoretsku nadgradnju već davno prakticiranoj tehnici, tradicionalnom uzgoju biljaka i životinja. U molekularnoj biologiji obrće se redoslijed: sada teorija prethodi tehnici. Temeljno istraživanje skoro stvara mogućnosti primjene koje se nastoji što više iscrpsti radi imperativa bezgraničnog poboljšanja. Potrebno je, doduše, još međuistraživanje, odnosno istraživanje temelja primjene. Tu je potrebna etika kao kritika ideologije. Tko već za međuistraživanje, na primjer, embrionalnih stanica, zahtijeva humanitarni dobitak, nije samo neozbiljan, nego izvodi i humanistički pogrešan zaključak. On se, naime, poziva na mogućnost pomoći pacijentima, premda se tek bavi predradnjama. U ovom slučaju vrijedi zapovijed: teško bolesnim pacijentima i njihovoj rodbini, koji se hvataju za slamku spasa, ne smiju se davati nikakva otvorena obećanja. Čak netko tko im može obećati nove mogućnosti pomoći ne pruža im još nikakvu aktualnu pomoć. Tko tu razliku prešućuje izvodi drugi humanistički pogrešan zaključak. Neozbiljna je i stanovita procjena epistemske inovacije, na primjer, ako je dešifriran ljudski genom, nije dešifriran sam čovjek. U vrijeme buma znanosti života ne smiju se zaboraviti filozofija i humanističke znanosti. Blagodati medicine dobro su došli svim građanima, ali one su rezultat izvanjskoga istraživanja, tj. zakonskog osiguranja bolesnika, općenito socijalne države, čije opravdanje podliježe socijalnoj etici.

Molekularna biologija kreće se prema petom evolucijskom pomaku, koji možda ima tri gledišta: 1. kod čovjeka bi molekularnobiološki odnosi mogli biti kompliciraniji od odnosa u podljudskom području: 2. zdravlje je elementarno dobro, pa istraživanje ima humanitarni rang; 3. jedino čovjek ima rang samosvrhe, koju nazivamo ljudsko dostojanstvo, pa zato s obzirom na sredstva postoji viša moralna odgovornost. Kao primjer nudi se medicinski potpomognuta oplodnja. Etika se najprije pita je li dopušteno ograničiti moć sudbine, zatim traži argumente koji u okviru oplodnje za dijagnostiku predimplantacije govore za i protiv. Napokon, etika razlikuje pitanje što zakonodavac može iznuditi od pitanja što se smatra ispravnim i što u danom slučaju savjetuju prijatelji i rodbina. Time filozofska etika razlikuje moral prava (ono što smo dužni činiti) i moral kreposti (ono što činimo više od zapovjeđenoga). U ime morala kreposti ne smije se povrijediti moral prava; u ime zapovijedi pomoći drugome ne smije se ubijati ničiji život. Kratko rečeno, ne smije se škoditi životu (*nil nocere*).

L. Günther Mack

U svom tekstu pod naslovom "Die Suche nach einem zukunftsfähigen Wissenschafts-Paradigma" [Traganje za paradigmom znanosti sposobnom za budućnost] (usp. Mack 1998: 308–329) tvrdi da je znanost kulturna aktivnost čija *oblikovna moć* (*Machtförmigkeit*) raste. Moć znanosti, prema tome, raste na svim područjima kulture, društva i politike, osobito na području ekonomije i vojne industrije. *Šire* se osjećaji straha od znanstveno-tehničkih posljedica, koji idu sve do neprijateljstva prema znanosti i tehnici. Dosad su bile zanemarene posljedice znanosti i tehnike, kao i posljedice njihovih posljedica. To su problemi naoružavanja (atomsko, biološko i kemijsko oružje), ekološka ugroženost čovječanstva i katastrofe (klimatske promjene, ozonska rupa, krčenje šuma i pustošenja, kemijske pošasti, izumiranja vrsta itd), informacijska i genetska tehnologija, rast stanovništva kao i ekonomski, društveni, socijalni i politički sukobi. O tome je potrebno posve nanovo razmisliti i pokrenuti *promjenu svijesti* o tome da bismo postigli minimalan konsenzus o najvišim vrijednostima i zajedničkim ciljevima. U tom je najvažnija promjena u poimanju znanosti, nova paradigma znanosti koja će zamijeniti dosadašnju paradigmu znanosti slobodne od vrijednosti, koja nije bila odgovorna ni za svoje primjene ni za svoje posljedice. Zbog toga nije bilo moguće proglasiti znanost odgovornom jer je ona obvezana na čistu spoznaju i na nalaženje istine te zato što njezine primjene u tehnici nisu njezina stvar, premda te primjene mijenjaju svijet, ugrožavaju sve i donose katastrofu. Diskusija o etici i zahtjevu da znanost i tehnika moraju imati odgovornost za sadašnje i buduće posljedice svoga ambivalentnog djelovanja simptom je prijeloma. Poticaj za promjenu razumijevanja znanosti dolazi iz same znanosti, ali i izvan nje. Kriza se znanosti ne smije promatrati kao izoliran fenomen jer je kriza morala danas sveobuhvatna. Ona pogađa sva područja kulturnoga i prirodnoga svijeta (svijeta života). Zavedeni smo modernom civilizacijom zahvaljujući njezinu znanstveno-tehničkom napretku, ali zavedeno je i cijelo društvo i mi sami.

Znanost je danas u visokom stupnju organizirana internacionalno, pa su zato njezine posljedice najvećim dijelom globalne. Zbog toga pitanje o paradigmi znanosti sposobnoj za budućnost uključuje raspravu o svjetskom etosu. Znanost sposobna za budućnost pretpostavka je civilizacije sposobne za budućnost. Vrijedi i obratno. Pitanje o budućnosti znanosti jest pitanje supradisciplinarne vrste. Uzrok krize znanosti jest etos znanosti koji je bio usmjeren na unutarnje upravljanje znanošću i s njom povezane predodžbe o slobodi od vrijednosti i o slobodi znanosti. Naime, znanost nije imala nikakav odnos sa svojim primjenama. Mack navodi kako je Robert K. Merton opisao “čistu” znanost: znanje je opće dobro (*donum commune*); znanstveno znanje vrijedi za sve ljude (ono je, dakle, univerzalno); ne obvezuju ga nikakve izvanznanstvene ideologije ni interesi (nezainteresiranost); znanstveno znanje se stalno izlaže kritičkom preispitivanju po znanstvenim metodama i mjerilima. U toj nezainteresiranosti (slobodi od vanjskih ideologija i interesa) vidi se najbolje da znanost sebe razumijeva kao slobodnu od vrijednosti (*wertfrei*). Time se isključuju izvanznanstvene i supradisciplinarne posljedice znanstvene djelatnosti. Princip vrijednosno neutralne znanosti zanemaruje interdisciplinarne i supradisciplinarne dimenzije znanosti. Znanost slobodna od vrijednosti u praksi je bila više fikcija nego realnost, jer je i sam Max Weber ustanovio da je *teško* odvojiti vrednovanja od empirijskih konstatacija. Ne može se govoriti o nezainteresiranosti “čiste”, slobodne i od vrijednosti slobodne znanosti, jer znanost i istraživanje u svom su realnom socijalnom liku nerazdvojivo povezani i aktivno isprepleteni u znanstveo-tehničko-ekonomskom kompleksu. Kao primjer dostatno je spomenuti da je fundamentalno istraživanje u radiokemiji i u atomskoj fizici oslobodilo revolucionarnu, politički prevratničku opasnost i moć. Tako je i s istraživanjem gena, što vodi radikalnim promjenama. Ljudi iz gospodarstva, društva i politike zahtijevaju produktivnu snagu i kompetentnost za rješavanje problema (zapravo korist), a to čak ni zastupnici teze o znanosti slobodnoj od vrijednosti ne primjećuju.

Diskrepancija između samoograničenja znanosti u tradicionalnom etosu i društvene orijentiranosti na praksu pripada uzrocima krize, jer znanost čuva svoju unutarnju slobodu, dok kritičko vrednovanje njezinih posljedica dolazi od društvenih instancija, što ugrožava autonomiju znanosti. Znanost i istraživanje, osim kompetencije za rješavanje problema, mogu imati i potenciju za proizvođenje problema. Zato se znanost ne može više opravdavati načelima tradicionalnog etosa. Ne može se govoriti samo o odgovornosti znanstvenika (individualnoetički), nego i o odgovornosti znanstvene zajednice u institucijama i organizacijama. Potrebne su sankcije za znanstvenike i institucije koji djeluju protivno etici. Današnja kriza morala u znanosti ne može se riješiti unutar dosadašnje paradigme, pa je potrebno uspostaviti novu. Nova znanost treba biti otvorena drugim znanstvenim disciplinama (interdisciplinarna) i onome što nadilazi sve znanstvene discipline (transdisciplinarna). Potrebno je kvalitativno i kvalitativno proširenje njezina horizonta, koje uključuju njezinu odgovornost. Konture paradigme znanosti koja će biti sposobna za budućnost uključuju priznanje vrijednosnoga karaktera znanstvenoga spoznavanja i djelovanja. Vrijednost je sastavni dio znanosti, što znači da odgovornost bitno pripada znanstvenom spoznavanju i djelovanju. Ne zahtijeva se samo negativna sloboda *od*, nego i pozitivna sloboda, sloboda za više vrijednosti. Odgovornosti pripadaju interdisciplinarnost, transdisciplinarnost i javnost rada.

Odgovorno znanstveno djelovanje očituje se u unutarnjoj, institucionalnoj i javnoj odgovornosti, koja uključuje procjenu posljedica istraživanja, posebno kad je riječ o naoružavanju, istraživanju gena i genetskoj tehnologiji. Pritom je važno odrediti ciljeve istraživanja, koji će biti u skladu s osobnim i institucionalnim etosom. I u sumnji – kako je govorio Hans Jonas – treba dati prednost proroštvu propasti. Znanstveno-tehničkoj odgovornosti pripada i odgovarajući nauk o tome, zatim institucionalni uvjeti, etičke komisije, ljudi ovlašteni za zaštitu etike, društva i udruženja. Uloga znanosti u društvu i politici sastoji se u tome da traga za temeljnim etičkim konsenzusom, s društvom i politikom. Pritom je važan znanstveni žurnalizam, koji će javnosti davati kvalificirane informacije, a ne senzacije. Što trebamo činiti, pita se na kraju svoga teksta G*ü*nther Mack i odgovara da to pitanje nadilazi znanost. Mack citira Leona Eisberga, evangeličkoga župnika koji radi sa studentima, koji kaže da je ideja bratstva u našem vremenu preduvjet našega preživljavanja. Valja nam, dakle, ponovno otkriti ideju bratstva.

Zaključak

Iz dosad izloženoga zaključujem sljedeće. Sve do novoga vijeka čovjekova je spoznaja uglavnom bila receptivna i čovjek je uglavnom bio pasivno biće. Zbog toga su nepravde čovjeku mogle nanijeti samo aktivne sile: prirodne i više sile. Naime, aktivni je princip bio važniji od pasivnoga. Tek u novom vijeku čovjekova spoznaja postaje aktivna, pa čovjek postaje primarno aktivno biće koje mijenja prirodu (svijet oko sebe) i sam sebe. To se dogodilo kopernikanskim obratom u novom vijeku, kad je čovjek, zahvaljujući prirodnim znanostima i tehnici, ovladao ne samo vanjskom prirodom, nego i svojom vlastitom. U znanstveno-tehničkoj civilizaciji znanost je stekla monopol na znanje o svijetu, a sada se nastoji pretvoriti u sveobuhvatnu dogmu. Njoj se može suprotstaviti samo moć morala koja mora biti globalna jer je i moć znanosti globalna.

Moderna društva, po Otfriedu Höffeu, žive od pretpostavki koje sama ne mogu garantirati (usp. Höffeu 2014: 194). Tom se tvrdnjom Höffeu oslanja na tvrdnju Ernsta-Wolfganga Böckenfördea, koji je davno ustvrdio da slobodarska sekularizirana država živi od pretpostavki koje ona sama ne može garantirati (usp. Böckenförde 1991: 112). Pretpostavke bez kojih ne možemo živjeti jesu temeljna vrijednosti: pravda, istina, sloboda, odgovornost, jednakost i bratstvo. U bit ljudskog bića spadaju sloboda i odgovornost. Ako se čovjek odrekne slobode i odgovornosti, odrekao se svoje vlastite biti, tj. samoga sebe, odrekao se svoga humanuma, onoga što ga čini čovjekom.

Potrebno nam je novo poimanje znanosti, koje priznaje da su sloboda i odgovornost imanentne svakom ljudskom spoznavanju i djelovanju. Sloboda i odgovornost nedjeljive su onako kako su danas nedjeljive znanost i tehnika. Da bismo promijenili poimanje znanosti potrebna je promjena svijesti pojedinca. Tajna je u tome što se ta promjena ne može iznuditi silom i strahom. Takva je promjena moguća samo iz slobode, a vrhunska sloboda je pozitivna sloboda, ona koja nastoji ostvariti najviše vrijednosti i ona koja nas povezuje s drugima u jednu zajednicu. Hannah Arendt tvrdi da je Ivan Duns *Škot*, najveći franjevački srednjovjekovni mislilac, ujedno i najveći filozof slobode u zapadnom mišljenju i da se samo Kant može s njim izjednačiti u bezuvjetnoj odanosti slobodi (usp. Arendt 1998: 376). Naime, *Škot* je dokazao da u ljudskoj slobodnoj volji postoje dvije sklonosti: sklonost vlastitoj koristi i sklonost pravdi. Obje su sklonosti (težnje) slobodne. Sklonost pravednosti je urođena sloboda, po kojoj naša volja može htjeti neko dobro koje nije usmjereno na nas, tj. po kojoj naša volja ne traži svoju korist, nego ono što nadilazi našu korist, našu sebičnost i egocentričnost. Sklonost pravdi je uzvišenija od sklonosti vlastitoj koristi, jer voljeti pravdu radi pravde, drugoga radi drugoga, slobodniji je i komunikativniji čin od čina ljubavi prema vlastitoj koristi. Takav čin pozitivne slobode oslobađa nas od egoizma i povezuje nas s drugim ljudima i takva sloboda neizravno govori o ideji bratstva, koja je preduvjet za preživljenje čovječanstva (usp. Babić 2012: 54–55; Duns *Škot* 2012: 154–157).

Za Škota je prirodno djelovanje nužno, ali sebično, dok samo slobodnim djelovanjem koje poštuje drugoga kao drugoga možemo nadići prirodnu nužnost i sebičnost. U svojoj knjizi *Reportatio Parisiensis examinata* on tvrdi da se sloboda može dokazati aposteriorno i da bez slobode ne bi bile potrebne ni kreposti, ni zapovijedi, ni opomene, ni nagrade, ni kazne, ni časti, te da ne bi bila moguća bila koja ljudska zajednice (ni politička, ni religiozna). Sloboda je, dakle, pretpostavka politike, morala i soteriologije. Pritom *Škot* ima na umu slobodu koja je slobodna od egoizma i koja je komunikativna jer nas povezuje u jednu zajednicu (usp. Babić 2019: XXI–XX; Duns Scotus 2005: 78–80). Kratko rečeno, istinska se sloboda ostvaruje u moralu i ljubavi.

Literatura

Arendt, Hannah (1998). *Von Leben des Geistes. Das Denken. Das Wollen*, München/Zürich: Piper.

Babić, Mile (2012). "Sloboda kao *affectio commodi* i *affectio iustitiae* kod I. D. Škota", u: Ivan Duns *Škot*, *Sloboda uzvišenija od nužnosti*, priredio, s latinskoga preveo, tumačenja dodao i bilješkama popratio Mile Babić, Zagreb: Naklada Breza, str. 53–55.

Babić, Mile (2019). "Život i djelo Ivana Dunsa Škota", u: Ivan Duns *Škot*, *O principu individuacije*, priredio i preveo Mile Babić, Zagreb: Demetra, str. XI–XXV.

Bruckner, Pascal (1997). *Napast nedužnosti. Esej*, prevela Višnja Machiedo, Zagreb: Nakladni zavod Matice hrvatske.

Bellah, Robert N. et al. (1996). *Habits of Heart. Individualism and Commitment in American Life*, Berkeley/Los Angeles/London: University of California Press.

Dahrendorf, Ralf (2009). "Nach der Krise: Zurück zur protestantischen Ethik? – Sechs Anmerkungen", u: *Merkur* 63/720, str. 373–381.

Duns Scotus, Johannes (2005). Pariser Vorlesungen *über* Wissen und Kontingenz. Lateinisch – Deutsch. Reportatio Parisiensis examinata I 38 – 44, herausgegeben, *übersetzt* und eingeleitet von Joachim R. Söder, Freiburg/Basel/ Wien: Herder.

Duns *Škot*, Ivan (2012). *Sloboda uzvišenija od nužnosti*, priredio, s latinskoga preveo, tumačenja dodao i bilješkama popratio Mile Babić, Zagreb: Naklada Breza.

Görlach, Alexander (2019). *Homo empathicus. Von Sündenböcken, Populisten und der Rettung der Demokratie*, Freiburg/Basel/Wien: Herder.

Habermas, Jürgen (2001). *Glauben und Wissen*, Frankfurt am Main: Suhrkamp.

Habermas, Jürgen / Ratzinger (2011). *Dialektik der Säkularisierung.* Über *Vernunft und Religion*. Freiburg/Basel/Wien: Herder.

Habermas, Jürgen (2019). *Auch eine Geschichte der Philosophie*. Band 1: *Die okzidentale Konstellation von Glauben und Wissen*, Frankfurt am Main: Suhrkamp.

Harari, Yuval Noah (2017). *Homo Deus. Eine Geschichte von Morgen*, München: C. H. Beck.

Höffe, Otfried (2014). *Die Macht Moral im 21. Jahrhundert. Annährungen an eine zeitgemässe Ethik*, München: C. H. Beck.

Jonas, Hans (1984). *Das Prinzip Verantwortung. Versuch eine Ethik für technologische Zivilisation*, Frankfurt am Main: Suhrkamp.

Küng; Hans (2006). *Projekt Weltethos*, München/Zürich: Piper.

Mack, Günther (1998). "Die Suche nach einem zukunftsfähigen Wissenschafts-Paradigma", u: (ur.) Hans Küng, Karl-Josef Kuschel, *Wissenschaft und Weltethos*, München/Zürich: Piper, str. 308–329.

Morin, Edgar (2008). *Etika*, prijevod Vesna Pavković, Zagreb: Massmedia.

Paić, Žarko (2005). *Politika identiteta. Kultura kao nova ideologija*. Zagreb: Izdanja Antibarbarus.

Paić, Žarko (2018–2019). *Tehnosfera*. Zagreb: Sandorf – Mizantrop.

Sloterdijk, Peter (1998). *Sphären. Mikrosphärologie*. Band I: *Blasen*, Frankfurt am Main: Suhrkamp.

Sloterdijk, Peter (1999). *Sphären. Mikrosphärologie*. Band II: *Globen*, Frankfurt am Main: Suhrkamp.

Sloterdijk, Peter (2004). *Sphären. Mikrosphärologie*. Band III: *Schäume*, Frankfurt am Main: Suhrkamp.

Taylor, Charles (1994). *Quellen des Selbst. Die Entstehung der neuzeitlichen Identität*, *übersetzt* von Joachim Schulte, Frankfurt am Main: Suhrkamp.

Taylor, Charles (1995). *Unbehagen an der Moderne*, *übersetzt* von Joachim Schulte, Frankfurt am Main: Suhrkamp.
Taylor, Charles (1998). *Negative Freiheit? Zur Kritik des neuzeitlichen Individualismus*, *übersetzt* von Hermann Kocyba, Frankfurt am Main: Suhrkamp.
Taylor, Charles (2007). *A Secular Age*, Cambridge/Massatchusetts/London: The Belkamp Press of Harvard University Press.

DOI: 10.5644/PI2021.200.06

Finansiranje istraživanja i razvoja u svijetu, jugoistočnoj Evropi i Bosni i Hercegovini

Fikret Čaušević[*]

Sažetak: Ovaj rad analizira finansiranje naučnog i istraživačkog rada, počevši od globalnog i regionalnog konteksta, završavajući sa specifičnostima i ulaganjima za ove namjene u Bosni i Hercegovini. U prvom dijelu analiziran je globalni kontekst, koji sadrži i analizu deset zemalja s najvećim ulaganjima za ove namjene, kao i strukturom izvora finansiranja po sektorima. U skladu s posljednjim dostupnim podacima UNESCO-a, koji se u vrijeme pisanja ovog rada na globalnom nivou odnose na 2018. godinu, vodeće zemlje po relativnom ulaganju u istraživanje i razvoj bile su Južna Koreja i Japan, dok po apsolutnim iznosima dva vodeća mjesta zauzimaju SAD i Kina. Drugi dio ovog rada fokusiran je na uporednu analizu ulaganja u istraživanje i razvoj u zemljama centralne i jugoistočne Evrope. U ovoj grupi zemalja dominira Slovenija, koju slijede Republika Češka i Mađarska. Treći dio je u cijelosti posvećen specifičnostima Bosne i Hercegovine, kao i nekim od ključnih faktora vrlo niskog nivoa ulaganja za istraživanje i razvoj u ovoj zemlji. U četvrtom dijelu prezentirani su neki od uspješnih primjera bosanskohercegovačkih kompanija po ključnim industrijskim granama u kojima je Bosna i Hercegovina ostvarila natprosječne rezultate u poređenju sa zemljama jugoistočne Evrope, u kontekstu niskih ulaganja u istraživanje i razvoj, s jedne strane, i vrlo dobrih izvoznih rezultata mjerenih Indeksom ekonomske kompleksnosti i Indeksom kompleksnosti proizvoda, s druge strane.

Ključne riječi: istraživanje i razvoj (R&D), finansiranje, svijet, jugoistočna Evropa, Bosna i Hercegovina, Indeks ekonomske kompleksnosti

JEL klasifikacija: O30, O39

1. Globalni kontekst

U skladu s podacima UNESCO-vog Instituta za statistiku (UIS), ukupni izdaci za istraživanje i razvoj (R&D) u svijetu za 2018. (posljednji dostupni podaci) iznosili su 1.700 milijardi USD po paritetu kupovne moći ($PPP). Učešće zbirnih ulaganja u R&D deset zemalja koje najviše ulažu u istraživanje i razvoj (Tabela 1) u apsolutnim iznosima u odnosu na ukupno ulaganje u R&D u svijetu bilo je 84,5%. Iste godine zbirni BDP tih deset zemalja izražen u $PPP iznosio je 76.860 milijardi, što je činilo 59,5% ukupnog svjetskog BDP-a iskazanog u $PPP[1].

[*] Dopisni član Akademije nauka i umjetnosti Bosne i Hercegovine. Profesor na Fakultetu za ekonomiju i biznis Univerziteta u Sarajevu. E-mail: fikret.causevic@efsa.unsa.ba

[1] Dostupno na: https://data.worldbank.org/indicator/NY.GDP.MKTP.PP.CD

Drugim riječima, učešće ukupne vrijednosti sredstava uloženih u istraživanje i razvoj 2018. u SAD, Kini, Japanu, Njemačkoj, Južnoj Koreji, Francuskoj, Indiji, Velikoj Britaniji, Brazilu i Ruskoj Federaciji, iskazano u procentima prema zbirnom BDP-u ovih zemalja (u $PPP) bilo je za 1,5 puta veće od svjetskog prosjeka.

Tabela 1. Deset vodećih zemalja po apsolutnom ulaganju u R&D – 2018.

Zemlja	Ukupna ulaganja u R&D u milijardama $ PPP	Učešće sektora u ukupnim ulaganjima (u %)		
		Poslovni sektor	Vlada	Univerziteti
1. SAD	476,5	71,5	11,4	13,1
2. Kina	372,3	77,3	15,8	6,9
3. Japan	169,6	77,7	8,3	12,6
4. Njemačka	109,6	67,6	14,6	17,7
5. Južna Koreja	73,1	78,2	11,2	9,0
6. Francuska	60,6	63,7	12,7	22,3
7. Indija	51,7	37,1	56,5	6,4
8. V. Britanija	43,8	65,1	7,3	25,8
9. Brazil	42,2	---	---	---
10. Ruska Federacija	40,3	59,6	30,5	9,9

Izvor: UIS – UNESCO Institute for Statistics, dostupno na: http://uis.unesco.org/apps/visualisations/research-and-development-spending/ - pristupljeno 10. 1. 2021.

Učešće SAD, kao vodeće ekonomske i tehnološke sile u svijetu, u ukupnim svjetskim izdacima za R&D bilo je znatno veće u odnosu na učešće iste zemlje u svjetskom BDP-u (28% prema 15,9%). I Kina je, kao druga je najveća svjetska ekonomija, imala značajno veće učešće u izdacima za R&D u odnosu na učešće u svjetskom BDP-u (21,9% prema 16,8%[2]). Međutim, najveće razlike između učešća u ukupnim R&D izdacima i učešća u svjetskom BDP-u evidentirana su u Japanu i Južnoj Koreji. Učešća ove dvije zemlje u svjetskim izdacima za R&D 2018. bila su 2,5 puta veća od njihovog učešća u svjetskom BDP-u – Japana 10% prema 4%, i Južne Koreje 4,3% u odnosu na 1,7%. Ove dvije zemlje su, istovremeno, i dvije vodeće zemlje u svijetu po relativnom ulaganju u R&D, odnosno po ulaganju u R&D u procentima BDP (Tabela 2).

Najveći generatori ulaganja u R&D u Južnoj Koreji, Japanu, Kini i SAD su kompanije iz poslovnog sektora (u prosjeku za ove četiri zemlje približno

[2] Kina je 2018. po učešću u svjetskom BDP iskazanom u $PPP bila najveća svjetska ekonomija. Dakle, da bismo otklonili zabunu koja može proisteći iz navedenih učešća u svjetskom BDP koji se odnose na SAD (15,9%) i Kinu (16,8%) ta učešća su izvedena iz vrijednosti BDP iskazanog u američkim dolarima po paritetu kupovne moći. BDP dvije navedene zemlje izražen u tekućim dolarima i tekućim cijenama za 2018. pokazuje da su SAD najveća svjetska ekonomija (s približnim učešćem 21,2%), a Kina druga najveća ekonomija (s približnim učešćem od 14,3% u 2018).

tri četvrtine ukupnih ulaganja), dok je najveće učešće vlade u finansiranju R&D od deset vodećih zemalja zabilježeno u Indiji (56,5%). Vodeće dvije zemlje po učešćima univerziteta u izdacima za R&D bile su Velika Britanija i Francuska. Prema posljednjim dostupnim podacima (2019) deset vodećih svjetskih kompanija po ulaganju u R&D bile su: Samsung (J. Koreja), Alphabet (SAD), Volkswagen (Njemačka), Microsoft (SAD), Huawei (Kina), Intel (SAD), Apple (SAD), Roche (Švicarska), Johnson&Johnson (SAD) i Daimler (Njemačka)[3]. Ukupan iznos koji su ovih deset kompanija uložile u R&D bio je $122,2 milijarde (USD iz 2019). Ovaj iznos približno je jednak BDP koji su 2019. zajedno generirale Slovenija, Bosna i Hercegovina, i Srbija. Također, to je iznos koji predstavlja gotovo četvrtinu BDP-a koji su generirale sve zemlje koje pripadaju grupi zemalja niskog dohotka (28 zemalja)[4].

Na listi deset vodećih zemalja po relativnom ulaganju u R&D (Tabela 2), odnosno izdacima za R&D u procentima BDP-a, iz grupe deset najvećih ulagača u R&D u apsolutnim iznosima (Tabela 1) nalaze se Južna Koreja, Japan, Njemačka i SAD. Osim ove četiri zemlje u grupi deset najvećih ulagača u R&D nalaze se i sljedeće zemlje: Finska, Švicarska, Švedska, Austrija, Danska i Belgija. Tabela 2 sadrži i jedanaestu zemlju – Sloveniju, koja je po ulaganju u R&D u procentima BDP-a odmah uz Belgiju, pri čemu Belgija ima veći broj istraživača na milion stanovnika.

Tabela 2. Jedanaest vodećih zemalja po relativnom ulaganju u R&D – 2018.

Zemlja	Izdaci za R&D u % BDP	Broj istraživača na milion stanovnika
1. Južna Koreja	4,3	6826
2. Japan	3,4	5328
3. Finska	3,2	7009
4. Švicarska	3,2	4468
5. Švedska	3,1	6875
6. Austrija	3,1	4947
7. Danska	2,9	7310
8. Njemačka	2,9	4320
9. SAD	2,7	4205
10. Belgija	2,4	4528
11. Slovenija	2,4	4147

Izvor: UIS – UNESCO Institute for Statistics, dostupno na: http://uis.unesco.org/apps/visualisations/research-and-development-spending/ - pristupljeno 26. 12. 2020.

[3] Dostupno na: https://spendmenot.com/blog/top-rd-spenders/ (pristupljeno 26. 12. 2020)

[4] Radi upoređivanja konsultovati podatke o BDP-u na web stranici Svjetske banke: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD (pristupljeno 26. 12. 2020)

Budući da je svjetski prosjek ulaganja u R&D (u procentima BDP) 1,35% podaci iz Tabele 2 pokazuju da Južna Koreja izdvaja trostruko više u odnosu na svjetski prosjek, dok su relativna ulaganja SAD u R&D dvostruko veća od svjetskog prosjeka. Prema broju istraživača na milion stanovnika vodeća zemlja svijeta je Danska, koju slijede Finska, Švedska i Južna Koreja. Slovenija, kao vodeća zemlja u tranziciji po visini BDP po stanovniku, kao i prva tranzicijska zemlja koja je postala članica euro-zone, prednjači i po ulaganju u R&D.

2. Regionalni kontekst: zemlje centralne i jugoistočne Evrope

Grupu zemalja centralne i jugoistočne Evrope predvodi, dakle, Slovenija s 1,8 puta većim ulaganjima u R&D u odnosu na svjetski prosjek, dok je Republika Češka na drugom mjestu s približno 1,5 puta većim ulaganjima za ove namjene u odnosu na svjetski prosjek. Trećerangirana Mađarska je na nivou svjetskog prosjeka, a grupu zemalja čija su ulaganja u R&D ispod polovice svjetskog prosjeka predvodi Srbija. Rangiranje zemalja po broju istraživača na milion stanovnika, za ovu grupu zemalja, pokazuje da Slovenija ima 14 puta više istraživača na milion stanovnika u odnosu na Bosnu i Hercegovinu (BiH), a 4,5 puta više u odnosu na Rumuniju.

Tabela 3. Zemlje centralne i jugoistočne Evrope po relativnom ulaganju u R&D – 2018.

Zemlja	Izdaci za R&D u % BDP	Broj istraživača na milion stanovnika
1. Slovenija	2,4	4147
2. Češka Republika	2,0	3402
3. Mađarska	1,4	2673
4. Slovačka	0,9	2715
5. Poljska	0,9	2064
6. Bugarska	0,8	1821
7. Hrvatska	0,8	1437
8. Srbija	0,7	1830
9. Rumunija	0,6	903
10. Sjeverna Makedonija	0,5	837
11. Crna Gora	0,4	671
12. Bosna i Hercegovina	0,3	292
13. Albanija	0,2	155

Izvor: UIS – UNESCO Institute for Statistics, dostupno na: http://uis.unesco.org/apps/visualisations/research-and-development-spending/ - pristupljeno 26. 12. 2020.

Rangiranje zemalja centralne Evrope i bivše SFRJ po ukupnim ulaganjima u R&D, izraženih u $PPP, na prvo mjesto dovodi najmnogoljudniju zemlju ova dva dijela Evropa – Poljsku (Tabela 4). Ukupna ulaganja Poljske u R&D 2018. bila su približno šest puta veća u odnosu na Sloveniju. Međutim, Poljska ima 19 puta više stanovnika od Slovenije, pa je razlika po ulaganju u R&D na per capita osnovi znatno u korist Slovenije. Naime, Slovenija po stanovniku ulaže 3,1 puta više u odnosu na Poljsku (753 naspram 241 u $PPP). Grupu zemalja jugoistočne Evrope koje ulažu ispod polovice svjetskog prosjeka predvodi, kako je već navedeno, Srbija (vidi Tabelu 3). Ukupna ulaganja Srbije u R&D na per capita osnovi u 2018. iznosila su $108 (PPP). Srbija je u poređenju s Hrvatskom uložila 35% manje, a u poređenju sa Rumunijom 48% više finansijskih sredstava za ove namjene. S druge strane, Srbija je u odnosu na BiH i Crnu Goru uložila za 3,1 odnosno 2 puta više sredstava respektivno (po stanovniku).

Tabela 4. Zemlje centralne Evrope i bivše SFRJ po apsolutnoj vrijednosti i strukturi ulaganja u R&D – 2018.

Zemlja	Ukupna ulaganja u R&D u milionima $ PPP	Učešće sektora u ukupnim ulaganjima (u %)		
		Poslovni sektor	Vlada	Univerziteti
1. Poljska	9.149	46,6	23,9	29,2
2. Češka R.	6.699	55,2	19,0	25,4
3. Mađarska	3.408	71,5	13,7	13,5
4. Slovenija	1.506	77,4	12,2	10,4
5. Slovačka	1.380	36,8	28,3	34,4
6. Srbija	756	29,6	24,5	45,9
7. Hrvatska	732	48,2	26,1	25,7
8. S. Makedonija	143	10,5	15,4	73,4
9. BiH	102	19,6	19,0	60,4
10. C. Gora	35	38,3	21,3	37,5

Izvor: UIS – UNESCO Institute for Statistics, dostupno na: http://uis.unesco.org/apps/visualisations/research-and-development-spending/ - pristupljeno 26. 12. 2020.

Međutim, poređenja izdataka za R&D u zemljama centralne i jugoistočne Evrope neophodno je analizirati i u kontekstu ukupne javne zaduženosti, javne zaduženosti po stanovniku, bruto domaćih proizvoda ovih zemalja u ukupnom iznosu i po stanovniku, kao i polaznih osnova u procesu tranzicije, budući da su ove varijable imale, i imaju i dalje, veliki utjecaj na finansijske kapacitete zemalja za finansiranje po svim osnovama, uključujući i mogućnosti finansiranja R&D. Slovenija je jedina zemlja bivše SFRJ koja je u cijelosti bila isključena iz ratnih sukoba tokom raspada te zemlje. U skladu s takvom pozicijom ova zemlja nije imala ratnih šteta, niti je prekidala proizvodnju tokom posljednje decenije prošlog vijeka. Gubici BiH u ljudskom kapitalu iskazani brojem ubijenih osoba četiri puta su veći nego zbirni gubici svih ostalih članica bivše SFRJ zajedno[5]. Nadalje, izgubljeni BDP BiH u periodu 1992–1995, usljed nemogućnosti proizvodnje, približno je jednak trostrukom BDP BiH iz 1990. BDP BiH je te godine iznosio približno DEM17 milijardi odnosno $10,7 milijardi prema podacima Saveznog zavoda za statistiku SFRJ iz 1991[6]. Dakle, izgubljeni BDP tokom rata za nezavisnost (1992–1995) iznosio je $32 milijarde u dolarima iz 1990. Broj civilnih i vojnih invalida rata u BiH približno je 270.000[7], što je u posljednjih 25 godina podrazumijevalo fiskalne rashode po ovom osnovu iz dva entitetska budžeta jednake 4,3% BDP BiH na godišnjoj osnovi. U poređenju s Hrvatskom, kao raspadom SFRJ drugoj najpogođenijoj bivšoj SFRJ republici, ovaj fiskalni rashod je u posljednji četvrt stoljeća u BiH bio približno četiri puta veći u odnosu na Hrvatsku. Sve ostale zemlje u tranziciji nisu bile suočene s ovom vrstom rashoda, što im je davalo znatno povoljniji osnov za strukturiranje budžetskih izdataka, između ostalog i za finansiranje obrazovanja i naučno-istraživačkog rada.

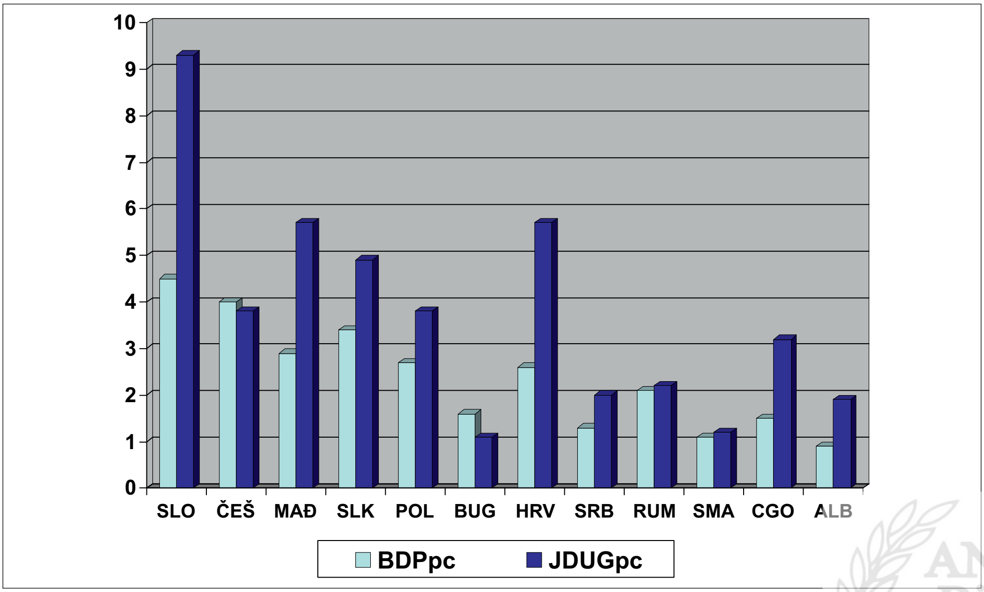
Razlike u BDP-u po stanovniku i javne zaduženosti po stanovniku zemalja centralne i jugoistočne Evrope u odnosu na BiH prezentirane su na Grafikonu 1 za 2018. godinu. Jedine dvije zemlje centralne i jugoistočne Evrope koje su u poređenju sa BiH imale niže nivoe javne zaduženosti po stanovniku u odnosu na BDP po stanovniku bile su Republika Češka i Bugarska. Sve ostale zemlje centralne i jugoistočne Evrope ostvarile su znatno veće nivoe javne zaduženosti u odnosu na nivoe BDP-a po stanovniku u poređenju sa BiH. To se posebno odnosi na Hrvatsku, Sloveniju, Crnu Goru i Albaniju čiji su nivoi javne zaduženosti za 2,1 puta bili veći od nivoa BDP-a po stanovniku u odnosu na BiH.

[5] Dostupno na: https://hr.wikipedia.org/wiki/Raspad_SFRJ

[6] Podatak o BDP-u u USD za 1990. konvertovan po zvaničnom i stabilnom deviznom kursu tadašnjeg jugoslovenskog dinara (YUD) prema njemačkoj marki (DEM) u omjeru 7 YUD za 1 DEM.

[7] Vidjeti procjenu u: Žarko Papić (2008) „Socijalna inkluzija i filozofija razvoja", u: Papić, Ž, Čaušević, F. (urednici) *Ekonomija ubrzanog razvoja*, Forum Bosnae 43/08, Međunarodni forum Bosna, Sarajevo, str. 256-283.

Grafikon 1. Nivoi BDP-a po stanovniku i javnog duga po stanovniku zemalja centralne i jugoistočne Evrope u odnosu na Bosnu i Hercegovinu za 2018. godinu (Bosna i Hercegovina = 1,0; za svaku zemlju lijevi stubac označava nivo BDP-a po stanovniku, dok desni stupac označava nivo javnog duga po stanovniku)



Izvor: konstrukcija autora FČ na osnovu podataka dostupnih na: https://countryeconomy.com/countries/compare/ (pristupljeno 14. 1. 2021)

3. Finansiranje istraživanja i razvoja u Bosni i Hercegovini

Finansiranje istraživanja i razvoja u BiH, od njenog osamostaljenja i potpisivanja Pariškog mirovnog sporazuma, bilo je neposredna posljedica administrativne strukture i, posebno, strukture fiskalnog federalizma definisanog i izvedenog iz mirovnih sporazuma i ugovora u Dejtonu i Parizu (novembar/decembar 1995). Nakon potpisivanja Pariškog mirovnog ugovora (14. 12. 1995), potvrđeno je formalno članstvo BiH u Međunarodnom monetarnom od 14. 12. 1992, pa su time stvoreni preduslovi da BiH postane članica Grupacije Svjetske banke (23. 3. 1996. čime je „aktivirano" formalno članstvo od 25. 2. 1993). Osam dana nakon prijema BiH u članstvo Svjetske banke započet je Program prioritetne obnove i rekonstrukcije BiH, koji je trajao četiri godine. Tokom 1996, kao integralni dio paketa administrativnog restrukturiranja BiH, definisana je struktura fiskalnog federalizma i, u skladu s tom strukturom, ovlasti i odgovornosti različitih nivoa vlasti za finansiranje sva tri nivoa obrazovanja, nauke, naučno-istraživačkog rada i kulture.

Posljedica različite administrativne strukture dva bosanskohercegovačka entiteta bila je i različita nadležnost entitetskih nivoa u finansiranju obrazovanja i naučno-istraživačkog rada. U Federaciji BiH (FBiH) osnovni izvor finansiranja obrazovanja i nauke u prethodnih 25 godina bili su (i ostali) kantonalni budžeti. Iz budžeta kantona, dakle, finansirana su sva tri nivoa obrazovanja, te dio naučno-istraživačkih projekata. U finansiranju naučno-istraživačkih projekata udio je imao i entitetski nivo vlasti (FBiH). Za razliku od FBiH, u Republici Srpskoj (RS) ključnu odgovornost za finansiranje obrazovanja i naučno-istraživačkog rada ima entitetska vlada, u saradnji s opštinskim/gradskim vlastima u ovom dijelu BiH. U Distriktu Brčko sve nivoe javnog obrazovanja kao i naučno-istraživački rad finansira Budžet Distrikta.

Prema podacima Federalnog zavoda za statistiku (FZS) u periodu 2016–2018. prosječan (godišnji) broj naučno-istraživačkih projekata realiziran na univerzitetima bio je 37 (bez podatka za RS).[8] Od tog broja, najveći procenat finansiranih projekata bili su oni vrijednosti do 100.000 KM (ukupno 20). Državni nivo vlasti finansirao je u prosjeku 4 ovakva projekta, kantonalni nivo (u FBiH), također, 4 projekta do navedene vrijednosti, dok su u prosjeku po dva projekta finansirali domaće i inostrane nevladine organizacije i zadužbine/fondacije. Od naučno-istraživačkih projekata vrijednosti 100.000–300.000 KM, po tri projekta su finansirana iz Budžeta FBiH i finansijskih sredstava međunarodnih organizacija. Prosječan broj naučno-istraživačkih projekata vrijednosti 300.000–500.000 KM u navedenom periodu bio je dva, od kojih je po jedan finansiran sredstvima FBiH i međunarodnih organizacija. U prosjeku su tri projekta vrijednosti iznad 500.000 KM bila finansirana u navedene tri godine, a po jedan od ta tri projekta finansirani su iz Budžeta FBiH, kantona (KS), te međunarodnih fondova. Od ukupno 37 projekata svake godine, 31 je realiziran na javnim univerzitetima dok ih je 6 realizirano na privatnim univerzitetima.

U navedenom istraživanju Federalnog zavoda za statistiku kontaktirano je 39 instituta koji su bili registrovani za naučno-istraživački rad. Od tog broja odgovore na postavljena pitanja u Anketi FZS dalo je 18 instituta. Od ukupno 410 zaposlenih na ovih 18 instituta, 134 zaposlenika su bili istraživači. U periodu 2016–2018, ovi instituti su realizirali ukupno 209 projekata (godišnje približno 70). Od 209 projekata najveći broj se odnosio na konsultantske usluge/projekte – ukupno 103. Najznačajniji projekti, sa stanovišta razvoja izvozne konkurentnosti bh. kompanija kao i sposobnosti supstitucije uvoza

[8] Akademija nauka i umjetnosti BiH, „Harmonizacija sistema nauke u Bosni i Hercegovini" – Federalni zavod za statistiku, „Rezultati statističkog istraživanja", Sarajevo, 2020, str. 19.

domaćom proizvodnjom kvalitetnih proizvoda, su projekti koji su se odnosili na razvojna i primijenjena istraživanja, uključujući i unapređenje postojeće tehnologije. U ovoj grupi projekata u navedene tri godine u dijelu anketiranih instituta realizirana su 52 projekta. U Anketi FZS nisu navedeni iznosi, odnosno vrijednosti ovih projekata.

Nisku vrijednost ulaganja u naučno-istraživački rad u BiH zorno odražava i dokument koji je pripremila Vlada RS odnosno nadležno ministarstvo – Ministarstvo za naučnotehnološki razvoj, visoko obrazovanje i informaciono društvo. U dokumentu naslovljenom – „Mapa puta istraživačkih infrastruktura u Republici Srpskoj (Bosna i Hercegovina) – Mapa puta istraživačkih infrastruktura u Republici Srpskoj“[9] navedeni su i podaci o ulaganju u opremu. Dakle, u skladu s podacima prezentiranim u ovom dokumentu ukupna vrijednost finansijskih sredstava koja su transferisana iz Budžeta RS za opremu u 16 istraživačkih institucija (instituti i dijelovi univerziteta odnosno istraživački odjeli fakulteta u RS) za period 2010–2018. iznosila je 1.212.600 KM. Prosječan godišnji iznos sredstava uloženih za naučnoistraživačku infrastrukturu (opremu) u navedenom periodu iznosio je, dakle, za svih 16 institucija 134.733 KM, odnosno 8.420 KM godišnje po instituciji[10].

Vijeće ministara BiH je u septembru 2016. pripremilo dokument posvećen strateškim pravcima razvoja nauke u BiH[11]. U dijelu ovog dokumenta koji se odnosi na finansiranje naučnog i istraživačkog rada, u periodu 2017–2020, planirano je povećanje ulaganja za ove svrhe sa 101,2 na 189,6 miliona KM, te na 268,2 miliona KM u 2022. Planska učešća dva bosanskohercegovačka entiteta - FBiH i RS, približno su određena učešćima ova dva dijela BiH u stvaranju BDP-a 66,1% odnosno 32,9% respektivno. Preostalo učešće od 1% odnosi se na Distrikt Brčko. U skladu s, na ovaj način, planiranim učešćima u ukupnom finansiranju naučno-istraživačkog rada u BiH, vrijednost ulaganja bi u FBiH trebala porasti sa 66,9 na 177,4 miliona KM, a u RS sa 33,3 na 88,1 milion KM u periodu 2017–2022. Povećanje ulaganja u naučno-istraživački rad iskazano u procentima BDP-a u BiH za navedeni period

[9] Dokument dostupan na sljedećoj web stranici: https://www.vladars.net/sr-SP-Cyrl/Vlada/Ministarstva/mnk/Documents/RIRS-RoadMap-SR.PDF

[10] Izvor: Ibid, str. 13. Ukupni podaci za cijeli period (2010–2018) i na godišnjem nivou navedeni u tekstu preračunati su na osnovu podataka prezentiranih u Tabeli 1 na str.13.

[11] Vijeće ministara Bosne i Hercegovine. „Strategija razvoja nauke u Bosni i Hercegovini – Revidirani dokument“, Sarajevo, septembar, 2016. Dokument dostupan na sljedećoj web stranici: https://ekonsultacije.gov.ba/legislativeactivities/details/14-prijedlog-revidiranog-dokumenta-strategije

planirano je s 0,35% (2017) na 0,80% (2022)[12]. Međutim, ostvarena ulaganja u naučno-istraživački rad u BiH već su 2018. bila niža u odnosu na planirana. Naime, prema podacima UIS-UNESCO-a, koje smo u ovom tekstu već analizirali, ukupna ulaganja 2018. bila su 0,3% BDP. Krajem 2020. pripremljeni su budžeti oba bh. entiteta za 2021. i prema planskim iznosima sada je već nedvojbeno da tokom 2021. i 2022. ukupna ulaganja u BiH za nauku i istraživanje neće dostići 0,5% BDP-a, za razliku od planiranih 0,75% BDP-a u prosjeku za dvije navedene godine.

Jedan od najvećih paradoksa finansiranja naučno-istraživačkog rada, odnosno nauke u poslijeratnoj BiH, bio je (i ostao) finansiranje vodećih naučnih institucija od državnog značaja. Ovakav paradoks je neposredna posljedica političke fragmentiranosti i nespremnosti, odnosno kontinuiranog opstruiranja vlasti (dijela vlasti) na entitetskim i državnom nivou da pristanu na finansiranje naučnih institucija (kao i institucija kulture) od značaja za BiH. U ovom smislu nema ilustrativnijeg primjera od finansijskih izvora iz kojih se finansirala Akademija nauka i umjetnosti Bosne i Hercegovine (ANUBiH) u posljednjih 25 godina. Naime, opstanak ove institucije bio je isključivo moguć zahvaljujući finansiranju iz Budžeta Kantona Sarajevo. Ukupni godišnji prihodi ANUBiH u posljednje četiri godine nisu premašili 1,8 miliona KM, iako su bili u porastu u odnosu na prethodnih dvadeset godina. Tačnije, rekordan ukupan prihod ANUBIH je ostvarila u 2019 – 1,769 miliona KM, dok su planirani prihodi za 2020. u iznosu od 1,639 miliona KM.[13] Ukupni planirani prihod Hrvatske akademije znanosti i umjetnosti (HAZU) za 2020. iznosi 19,8 miliona KM (tačnije 76,192 miliona kuna[14]). Od navedenog iznosa godišnjeg prihoda HAZU-a, prihodi iz Budžeta RH čine 83%.

Češka akademija nauka (CAS), prema Godišnjem izvještaju ove institucije za 2019, imala je ukupno 9672 zaposlenika, od kojih su 3926 bili istraživači, a 2014. zaposlenici s univerzitetskim diplomama u istraživačkim institutima CAS[15]. Prosječna plata svih 9672 zaposlenika u ovoj instituciji i njenim organizacionim jedinicama bila je iste godine 1.947 $, dok je prosječna

[12] Izvor, Ibid., str. 62.

[13] ANUBiH, „Izvještaj o radu Akademije nauka i umjetnosti Bosne i Hercegovine za period od 1. jula 2017. do 31. decembra 2020. godine“, Sarajevo, decembar 2020, str. 32.

[14] Izvor: Hrvatska akademija znanosti i umjetnosti – dostupno na: http://info.hazu.hr/upload/File/2020/ODLUKE-2020/PRORA%C4%8CUN-2021.pdf (pristupljeno 8. 1. 2021)

[15] Izvor: The Czech Academy of Sciences, „2019 Annual Report of the Czech Academy of Sciences“, Prague, 2019, str. 45. Dostupan na: https://www.avcr.cz/opencms/export/sites/avcr.cz/.content/galerie-souboru/vyrocni-zpravy/VZ-AV-CR-ENG.pdf

plata istraživača iznosila 2.495 $[16]. Prosječna mjesečna naknada akademika u ANUBiH iste godine bila je 385 $. Radi poređenja, BDP po stanovniku Republike Češke veći je od istog pokazatelja za BiH 300%, dok su mjesečni prihodi istraživača Češke akademije nauka za 550% bili veći od mjesečnih primanja akademika ANUBiH. Ukupna finansijska sredstva, odnosno prihodi CAS u 2019. iznosili su 681,1 milion $, odnosno 15.461,7 miliona CZK [17].

4. Ulaganja u istraživačko-razvojni rad u BiH, konkurentnost i ekonomska kompleksnost

U ukupnoj vrijednosti ulaganja u istraživanje i razvoj u BiH, koja su prema podacima UIS-UNESCO-a u 2018. godini iznosila 102 miliona $ (PPP), učešće univerziteta bilo je nešto veće od tri petine, učešće poslovnog sektora jednu petinu, a ostatak (19%) su bila sredstva koja su finansirale vlade na različitim nivoima vlasti. U poređenju s ostalim zemljama bivše SFRJ, Sjeverna Makedonija i BiH su imale najveća učešća univerziteta u finansiranju naučnog i istraživačkog rada, dok je najveće učešće poslovnog sektora bilo u Sloveniji (iznad 77%) i Hrvatskoj (približno polovina ukupnih ulaganja). Međutim, iako je učešće poslovnog sektora u finansiranju naučnog i istraživačkog rada u BiH bilo 19,6% (2018) poslovni rezultati proistekli iz istraživačkog rada i inovacija bosanskohercegovačkih kompanija u mašinogradnji, automobilskoj industriji, preradi metala i drvnoprerađivačkoj industriji ostvareni u periodu 2015–2020. bili su bolji u poređenju sa zemljama iz okruženja, čija su ulaganja u istraživanje i razvoj bila veća ili znatno veća.

U ovom kontekstu neophodno je razmotriti rangiranje zemalja zapadnog Balkana na osnovu Indeksa ekonomske kompleksnosti i Indeksa kompleksnosti proizvoda kao, u praktičnom smislu, jednog od temeljnih mjerila efekata ulaganja u naučno-istraživački rad, posebno u segmentu primijenjenih istraživanja, na proizvodne i izvozne rezultate zemalja ovog regiona. Prema rangiranju the Observatory of Economic Complexity[18] BiH je od 2015. do 2019. poboljšala svoj rang mjeren Indeksom ekonomske kompleksnosti za tri mjesta (sa 44 na 41). U istom periodu Srbija je poboljšala svoj rang za dva mjesta (sa 41 na 39), dok je Hrvatska u navedene četiri godine zadržala isti

[16] Izvor: Ibid, str. 45 (vrijednosti iz nacionalne valute preračunate po prosječnom godišnjem kursu za 2019)
[17] Izvor: Ibid, str. 48.
[18] Podaci dostupni na web stranici OEC: https://oec.world/en/rankings/eci/hs6/hs96 i https://oec.world/en/profile/country/bih

rang (37). Dakle, prema vrijednosti Indeksa ekonomske kompleksnosti, koji proističe iz specijalizacije u proizvodnji i kompleksnosti proizvodnih procesa odnosno relativnog znanja u tim proizvodnjama, razlike u rangiranju ove tri zemlje bivše SFRJ su vrlo male. U odnosu na utrošena sredstva odnosno ulaganja u istraživanje i razvoj, ukupna i na per capita osnovi, ostvareni rezultati BiH odnosno njenog poslovnog sektora u oblasti prerađivačke industrije su u ovom smislu natprosječni, ne samo u regionu jugoistočne Evrope već i u poređenju sa nekim od zemalja centralne Evrope i južnog dijela EU (Grčka, Portugal, Kipar).

Najkompleksniji proizvodi koje BiH proizvodi i izvozi, rangirani u skladu sa Indeksom kompleksnosti proizvoda koji objavljuje OEC, najvećim su dijelom vezani za metaloprerađivačku djelatnost, proizvodnju mašina i alata, te automobilsku industriju. Preciznije, grupe proizvoda sa najvišim Indeksom kompleksnosti proizvoda su sljedeće:

- proizvodnja vijaka, navrtki, zakovica i podložnih pločica,
- zamjenjivi alati i matrice za ručne i elektro-alate,
- brtve i slični spojevi od metala,
- dijelovi i pribor za mašine i alatne strojeve,
- noževi i sječiva za mašine i uređaje,
- električne mašine i oprema,
- mašine i uređaji,
- vozila i njihovi dijelovi.[19]

Izrazit primjer veoma uspješne i plodonosne saradnje između univerziteta, instituta i poslovnog sektora u kontekstu povećanja konkurentnosti bosanskohercegovačke ekonomije i izvoza zahtjevnih proizvoda, kao i proizvodnje sličnih proizvoda za potrebe domaćih kompanija koje su izvozno orijentisane, predstavlja kompanija „TPS“ (Thermal Process Solutions) doo Zenica. Ova kompanija je u vlasništvu Jusufa Durakovića, profesora koji predaje na Fakultetu za metalurgiju i metale Univerziteta u Zenici. Kompanija TPS je 2019. projektovala i proizvela uređaje koji se koriste za hemijsko-termičku obradu u automobilskoj industriji za najzahtjevnije automobile (Ferrari i Maserati)[20]. TPS je, istovremeno, jedina kompanija koja proizvodi ovakav uređaj na prostoru bivše SFRJ, a ovu mašinu je prodala slovenačkoj kompaniji koja proizvodi dijelove za navedene automobilske marke. Osim ovog uređaja kompanija TPS je, također, proizvela endogenerator za potrebe slovenačkog

[19] Izvor: https://oec.world/en/profile/country/bih

[20] Vidjeti na sljedećoj web stranici - https://www.bljesak.info/gospodarstvo/tvrtke/Zenicki-TPS-Proizveli-uredaje-za-obradu-dijelova-za-Ferrari-i-Maserati/290228

partnera, protočnu liniju za pečenje papirne harmonike, kao jednog od ključnih proizvodnih inputa za proizvodnju filtera, za kompaniju „Mann+Hummel BA“ dd Tešanj (automobilska industrija), te komornu peć za cementaciju za kompaniju „SIM Technik“ Kotor Varoš. Ova kompanija je vrlo aktivno sarađivala sa kompanijama NN doo Konjic i Graewe Tadiv Konjic, dva vrlo uspješna bosanskohercegovačka izvoznika.

Kompanija „Procassa-Fischer“ d.o.o. Jelah kod Tešnja, također, pokazuje da su kao rezultat akumuliranog znanja i nadgradnje tog znanja, integriranjem i upotrebom novih tehnologija bh. kompanije uspjele postići odlične rezultate na osnovu vlastitog ulaganja u istraživanje i razvoj u okviru poslovne grupacije čije su članice. Mehmed Husaković, direktor ove kompanije, sa kolegama inžinjerima iz BiH i poslovnim partnerima iz Njemačke u samo tri godine ostvario je odlične rezultate. Ova kompanija je 2018. proizvela prvu CNC mašinu u BiH, a tokom 2019. i prvu PLC presu. Uprkos činjenici da je 2020. godina bila obilježena Covid-krizom, ova kompanija je promovisala svoj novi proizvod krajem septembra 2020[21]. Taj proizvod je šesto-osovinska CNC mašina[22]. Budući da se radi o proizvodu koji integrira „staru“ s „novom“ ekonomijom, odnosno mašinogradnju s informacionom tehnologijom, taj proizvod je time značajniji za konkurentnost BiH. Novoproizvedena CNC šestoosovinska mašina izvezena je u Njemačku za potrebe njemačke autoindustrije.

Sarajevska kompanija „Dizart“ je krajem decembra 2020. promovisala svoju novu, petoosovinsku CNC mašinu. Kompanija je aplicirala za finansijska sredstva podrške istraživačkim i razvojnim projektima koje finansira USAID WHAM. Ova mašina će služiti za obuku polaznika edukacije, kao i za izradu materijala za evropsko tržište. „Dizart“ ostvaruje uspješnu saradnju s Mašinskim fakultetom Univerziteta u Sarajevu, kao i sa Srednjom tehničkom školom metalskih zanimanja u Sarajevu[23]. Prema riječima direktora, više od tri četvrtine ukupne proizvodnje ova kompanija izvozi na tržišta Engleske, Irske i Australije. „Dizart“ je izrazit primjer male kompanije koja uz skromne finansijske izvore ostvaruje izvanredne rezultate i primjer je odlične saradnje sa Univerzitetom u Sarajevu, odnosno neposredne veze između nauke i prakse.

[21] Vidjeti na web stranici „Procassa-Fischer“ - https://www.akta.ba/Firma/procassa-fischer-doo/279490

[22] Dostupno na: https://www.akta.ba/vijesti/novi-uspjeh-bh-pameti-nova-cnc-masina-najveca-na-balkanu/124096

[23] Vidjeti na portalu BiznisInfo - https://www.biznisinfo.ba/sarajevska-kompanija-predstavila-novu-cnc-masinu-vlastite-proizvodnje/

Tokom 2020. godine, jedan od „najneobičnijih“ primjera koji ilustruje fleksibilnost i sposobnost bosanskih kompanija bila je, sredinom decembra, objavljena vijest da je ventilator koji je proizvela TMD Group d.o.o. Gradačac dobio certifikat MD-TEC-a iz Londona[24]. Prototip ovog ventilatora TMD Group je razvila u saradnji sa Univerzitetskim kliničkim centrom u Tuzli. Ova kompanija je u predratnom periodu, tokom sedamdesetih i osamdesetih godina prošlog vijeka, bila integralni dio Famosa iz Sarajeva, za koji je proizvodila dijelove za transportna sredstva i uređaje. Početkom ovog vijeka ova kompanija je privatizirana metodom tenderske privatizacije i ponovo je razvila proizvodnju dijelova za automobilsku industriju (prvu ugradnju), najvećim dijelom za kompanije iz zapadne Evrope. Višedecenijsko iskustvo i tradicija u metaloprerađivačkoj industriji kompanija u BiH, i na primjeru ove kompanije, pokazuje da je uz skromna ulaganja u inovacije moguće postići odlične rezultate i prilagoditi proizvodnju i u proizvodnim granama u kojima uopšte ranije nisu bile prisutne.

Posebno uspješan primjer saradnje između akademskih institucija i industrije u oblasti inovacija i razvoja proizvoda, odnosno industrijskog dizajna u BiH jeste primjer saradnje predavača koji rade na Akademiji likovnih umjetnosti Univerziteta u Sarajevu i kompanija Yield doo Sarajevo i MS&Wood doo Sarajevo. Kompaniju Yield doo Sarajevo osnovao je Zlatko Tanović 2007, a od 2013. Tanović je započeo intenzivnu saradnju s jednim od najpriznatijih dizajnera u oblasti proizvodnje namještaja iz jugoistočne Evrope Salihom Teskeredžićem[25], koji predaje na Akademiji likovnih umjetnosti Univerziteta u Sarajevu. Teskeredžić je u okviru kompanije Yield d.o.o. razvio produkt-dizajn brend pod nazivom „Gazzda“. Za svoje proizvode ovaj dizajner je dobio nekoliko prestižnih međunarodnih nagrada za dizajn namještaja. Nataša Perković[26], profesorica koja predaje na Akademiji likovnih umjetnosti Univerziteta u Sarajevu, dizajnirala je stolicu za koju je kompanija „MS&Wood“ d.o.o. Sarajevo dobila nagradu na sajmu namještaja u Njemačkoj. Na tom istom sajmu komoda proizvedena u „MS&Wood“ koju je dizajnirao Ado Avdagić[27] dobila je najprestižniju nagradu – the German

[24] Vidjeti na web stranici TMD Group - https://tmd-group.ba/respirator-proizveden-u-gradaccu-certificiran-u-britaniji/

[25] Dostupno na: https://bigsee.eu/salih-teskeredzic-bosnia-and-herzegovina-big-see-visionary-2019/

[26] Dostupno na: https://www.archiproducts.com/en/designers/natasa-perkovic

[27] Vidjeti na: https://www.artisan.ba/en/designers/ado-avdagic

Design Award[28]. Avdo Avdagić i Salih Teskeredžić intenzivno sarađuju i razvijaju nove proizvode u jednoj od najuspješnijih kompanija u oblasti industrije namještaja na području jugoistočne Evrope – kompaniji „Artisan“ doo Tešanj[29]. Na Akademiji likovnih umjetnosti Univerziteta u Sarajevu predaje i Bojan Hadžihalilović, koji je sa svojom kompanijom „Fabrika“ d.o.o. Sarajevo u oblasti grafičkog dizajna u posljednje dvije decenije dostigao regionalnu i evropsku reputaciju.

U oblasti „nove ekonomije“[30], „neopipljive ekonomije“ ili ekonomije bazirane na informaciono-komunikacijskim tehnologijama, bosanskohercegovačke kompanije ne zaostaju za kompanijama iz istog sektora sa područja zapadnog Balkana, a neke ne zaostaju ni za IT kompanijama iz centralne i istočne Evrope. Tokom 2019. godine Deloitte Central Europe je objavio svoju listu 50 najbrže rastućih tehnoloških kompanija sa područja centralne i jugoistočne Evrope (po visini stopa rasta ukupnog prihoda). Na toj listi jedina kompanija sa područja zapadnog Balkana bila je bosanskohercegovačka kompanija „Ministry of Programming“ (MP), sa godišnjim rastom prihoda 2019. od 813%. MP je osnovana 2015. a specijalizirala se u razvoju prvoklasnih start-up kompanija iz ovog sektora. Kompanija je, prema navodima Deloittea, razvila prvoklasne usluge i proizvode u razvoju pretraživanja i analize podataka, razvoja društvenih mreža, softvera za razvoj trgovine, kao i softvera za otkrivanje virusa. Tri od trideset pet start-up kompanija u koje je uložila MP kompanija u periodu 2015–2019, Google, McKinsey i Rocket Internet potvrdili su kao strat-up-ove svjetske klase[31].

Pored „Ministry of Programming“ neke od najznačajnijih kompanija iz IT sektora, koje su višegodišnjim odnosno sada već višedecenijskim ulaganjem u istraživanje i razvoj postigle regionalnu i evropsku reputaciju su kompanije „Lanaco“ i „BS Telecom Solutions“. „Lanaco“ je 2016. postao prva bh. kompanija u ELITE programu Londonske berze i pozicionirao se među 50 najuspješnijih kompanija u Evropi. Sljedeće (2017) godine ova kompanija je dobila bronzanu medalju u konkurenciji za SAP Quality Award – SAP ERP

---

[28] Dostupno na: https://www.sarajevotimes.com/company-ms-wood-won-2-prestigious-german-design-awards-2018/

[29] Vidjeti: https://www.dnb.com/business-directory/company-profiles.artisan_doo_tesanj.f79f8c48dde194e74c0f035898df9cde.html

[30] Za nedavu diskusiju efekata „new economy“ (oktobar 2020) vidjeti tekst dostupan na Brookings web stranici: https://www.brookings.edu/research/whats-new-about-the-new-economy-it-economic-growth-and-productivity/

[31] Deloitte Central Europe: Deloitte Central Europe, „Deloitte Technology Fast 50 Central Europe“, https://www2.deloitte.com/ce/en/pages/about-deloitte/topics/technology-fast-50.html

za poslovnu transformaciju na području centralne i istočne Evrope[32]. U cilju ubrzavanja ulaganja i razvoja ovog sektora „Lanaco“ je u Banja Luci otvorio Lanaco tehnološki centar (2016.) a sljedeće godine su osnovali „ITivity“ softversku akademiju. „Lanaco“ posluje na području cijele BiH, ima svoje urede u Banja Luci i Sarajevu, i prvoklasni je primjer integrativnog ekonomskog pristupa bosanskohercegovačke, na znanju zasnovane, ekonomije. BS Telecom Solutions je još jedan primjer kompanije iz IT sektora, čije su reference u razvoju IT poslovnih rješenja i veoma uspješni projekti realizirani u Republici Češkoj, Ruskoj Federaciji, Bosni i Hercegovini (u oba bh. entiteta) i, odnedavno, u susjednoj Srbiji pokazali da je kontinuirano ulaganje u znanje i inovativni rad najbolji način za dostizanje evropske reputacije u svijetu savremenog poslovanja. „Infobip BH“ d.o.o. Sarajevo, kompanija-kćerka hrvatske kompanije „Infobip“ iz Vodnjana, jedna je od najuspješnijih IT kompanija u BiH. Ova kompanija je započela realizaciju izgradnje razvojnog kampusa u Sarajevu koji bi trebao biti završen 2022. sa planiranih 500 zaposlenih mladih IT inženjerki i inženjera.

Prema već navedenim podacima u Tabeli 2 (vidjeti drugi dio ovog teksta: „Regionalni kontekst: zemlje centralne i jugoistočne Evrope“) relativni izdaci za R&D izraženi u procentima BDP-a u 2018. u četiri industrijski najjače ekonomije bivše SFRJ bili su: Slovenija (2,4), Hrvatska (0,8), Srbija (0,7) i BiH (0,3). U Tabeli 3 prikazali smo učešća tri sektora u finasiranju R&D. U skladu s tim podacima učešća poslovnog sektora bila su sljedeća: Slovenija (77%), Hrvatska (48%), Srbija (30%) i BiH (20%). Na osnovu ovih podataka možemo zaključiti da su izdaci poslovnog sektora u navedene četiri zemlje izraženi u procentima BDP-a 2018. bili sljedeći: Slovenija (1,86), Hrvatska (0,38), Srbija (0,21) i BiH (0,06). Dakle, izdaci poslovnog sektora za finansiranje R&D u Sloveniji bili su 35 puta veći nego u BiH, 8,9 puta veći nego u Srbiji, i 4,9 puta veći nego u Hrvatskoj. Ukupna relativna ulaganja u R&D u Sloveniji su iste godine bila 8 puta veća nego u BiH, 3,4 puta veća nego u Srbiji, i 3 puta veća nego u Hrvatskoj. Vrlo značajne razlike između ulaganja poslovnog sektora u R&D između Hrvatske, Srbije i BiH nisu rezultirale velikim razlikama u rangovima Indeksa ekonomske kompleksnosti.

Drugim riječima, efikasnost uloženih sredstava u R&D i inovacionu aktivnost na kompanijskom nivou pokazuje da su bosanskohercegovačke kompanije sa znatno manjim ulaganjima ostvarile vrlo dobre rezultate, koji dijelom mogu biti objašnjeni sposobnostima menadžera u metaloprerađivačkoj

[32] Vidjeti: LANACO web site - https://www.lanaco.com/nasa-prica/

industriji, mašinogradnji, proizvodnji autodijelova, drvnoprerađivačkoj industriji i IT sektoru da uspješno inoviraju i komercijaliziraju svoje proizvode i usluge na osnovu ranije razvijenih višedecenijskih znanja i tradicije u prve četiri spomenute industrije, odnosno na osnovu razmjerno brzog učenja (IT sektor). Jedno od ključnih objašnjenja značajnog postignuća nekoliko desetina bosanskohercegovačkih kompanija, kao i visokog rangiranja BiH po Indeksu ekonomske kompleksnosti (u top 28% svjetskih ekonomija), uzevši u obzir niska ulaganja u istraživanje i razvoj, sa jedne strane, i efikasnost uloženih sredstava u poslovnom sektoru, sa druge strane, jeste analiza izvora inovativnosti prezentirana u radu Radoševića[33]. Radošević ističe, referirajući se na rad Lorenza i Lundvalla, da se inovativni rad ne dešava samo zahvaljujući ulaganju sredstava u R&D u javnom sektoru, već da je inovativnost posljedica „doing-using-interacting" rada, zasnovanog na proizvodnim i poslovnim iskustvima preduzetnika i inovatora. Ovaj aspekt analize inovativnosti i razmjerno visoke proizvodne kompleksnosti bolje objašnjava visoke rangove Srbije, Hrvatske i, posebno, BiH u odnosu na sama izdvajanja iz javnog sektora za R&D aktivnosti.

5. Zaključna razmatranja

Analiza globalnih i regionalnih iskustava u finansiranju istraživanja i razvoja pokazuje da sve vodeće svjetske ekonomije, kako mjereno po ukupnom BDP-u tako i po BDP-u po stanovniku, imaju veća učešća u ukupnim globalnim izdacima za istraživanje i razvoj u odnosu na učešća tih zemalja u svjetskom BDP-u. Južna Koreja je izrazit primjer male otvorene ekonomije koja je u posljednje tri decenije ostvarila izuzetne tehnološke rezultate i globalnu konkurentnost u nekoliko industrijskih grana. Ova zemlja je dokaz da su ciljana i efikasno kontrolirana namjenska ulaganja u istraživanje i razvoj imala za posljedicu tehnološki proboj na globalnim tržištima. Dvije najveće ekonomije u svijetu po ostvarenom BDP – SAD i Kina su, istovremeno, i najveći ulagači u istraživanje i razvoj u apsolutnim iznosima. Zemlje Skandinavije, kao i vodeće zemlje zapadne Evrope, također, predstavljaju izrazite primjere isplativosti ulaganja u istraživanje i razvoj, ali i neophodnosti da ta ulaganja budu procentualno veća u odnosu na učešća ovih zemalja u kreiranju svjetskog BDP-a.

[33] Slavo Radoševič (2021) „Public R&D and Science – Industry Links in Economic Development: Implications for Bosnia and Herzegovina", London, June, članak pripremljen za konferenciju ANUBiH „ u BiH" u novembru 2021., str. 8-9.

Globalna iskustva i trendove u finansiranju istraživanja i razvoja na području centralne i jugoistočne Evrope najuspješnije je pratila i primijenila Slovenija, kao vodeća zemlja u tranziciji po ostvarenom BDP-u po stanovniku. Ova tranzicijska zemlja, i bivša članica SFRJ, je vodeća po relativnom ulaganju u istraživanje i razvoj ne samo u ovom dijelu svijeta, već je i jedanaesta u svijetu. Odnos Slovenije i njenih kreatora državne i ekonomske politike, kao i strategije razvoja nauke i istraživanja, rezultirao je time da se ova mala zemlja nalazi na dvanaestom mjestu u svijetu po Indeksu ekonomske kompleksnosti, kao i u grupi zemalja sa vrlo visokom vrijednošću Indeksa humanog razvoja. U grupi ostalih zemalja centralne i jugoistočne Evrope najveća ulaganja u istraživanje i razvoj ostvarile su Republika Češka i Mađarska, čije su ekonomije u posljednjih deset godina ostvarile značajne uspjehe.

Osim Slovenije, koja je imala najbolju poziciju tokom raspada bivše SFRJ, budući da nije pretrpjela ratne štete, ostale zemlje bivše SFRJ znatno manje ulažu u istraživanje i razvoj. Hrvatska i Srbija su znatno ispod svjetskog prosjeka po ulaganju za ove svrhe, dok je Bosna i Hercegovina, poslije Albanije, zemlja sa najnižim ulaganjima u istraživanje i razvoj od svih zemalja centralne i jugoistočne Evrope. Vrlo nizak nivo ulaganja u istraživanje i razvoj Bosne i Hercegovine posljedica je jednim dijelom objektivnih faktora, a drugim dijelom izrazito pogrešnog stava vlasti u odnosu na značaj organizovanih ulaganja u istraživanje i razvoj za budući razvoj društva, konkurentnosti i izvozne sposobnosti. Najznačajniji objektivni faktor bitno različite polazne pozicije Bosne i Hercegovine u tranziciji u odnosu na sve ostale tranzicijske zemlje, sa naglaskom na ostale zemlje bivše SFRJ, jeste činjenica da je ova zemlja pretrpjela višestruko veća ratna razaranja (ljudi i oprema) od zbirnih šteta svih ostalih članica bivše SFRJ. Jedna od posljedica su finansijski rashodi budžeta entiteta u BiH za finansiranje socijalne zaštite civilnih i vojnih žrtava rata četvrestruko veći u odnosu na ostale najpogođenije članice te bivše države.

S druge strane, ne postoji niti jedan razlog za opravdanje vlasti koje u strukturi raspoloživih i do Covid-krize rastućih poreskih prihoda nisu bile voljne ostvariti ciljeve finansiranja istraživačkog i razvojnog rada koje su same postavile u ključnim razvojnim dokumentima, usvojenim na različitim nivoima vlasti. Jedna od izravnih posljedica takvog odnosa bila je, a i dalje je, odliv najboljih mladih naučnika i istraživača, najvećim dijelom u zemlje zapadne Evrope, Veliku Britaniju i SAD. Premda poslovni sektor u Bosni i Hercegovini nije puno ulagao u istraživanje i razvoj, poslovni rezultati koje su ostvarile kompanije u metaloprerađivačkoj industriji, mašinogradnji, automobilskoj i drvnoprerađivačkoj industriji, kao i informaciono-komunikacionim tehnologijama rezultirali su pozicioniranjem Bosne i Hercegovine u grupu najboljih 28% zemalja po Indeksu ekonomske kompleksnosti. Talenat, proizvodna znanja i sposobnost da zaposlenici u ovim industrijama uče radeći, odnosno da inoviraju, jeste veliki potencijal za značajno poboljšanje kvaliteta života i ekonomije Bosne i Hercegovine, ali ovaj u prethodnom periodu dokazani potencijal može u godinama i decenijama koje slijede relativno brzo prestati biti vodeći faktor iznenađujuće visokog rangiranja bosanskohercegovačke ekonomije po Indeksu ekonomske kompleksnosti u odnosu na ukupna i vrlo skromna ulaganja u istraživanje i razvoj, ukoliko vlasti i kreatori ekonomskih i razvojnih politika u Bosni i Hercegovini radikalno ne promijene stav u odnosu na svjetska iskustva – da je rastuće ulaganje u istraživanje i razvoj vrlo važan preduslov za promjenu kvaliteta života i strukture ekonomije.

Izvori:

Akademija nauka i umjetnosti Bosne i Hercegovine. „Harmonizacija sistema nauke u Bosni i Hercegovini" – Federalni zavod za statistiku, „Rezultati statističkog istraživanja", Sarajevo, 2020.

Akademija nauka i umjetnosti Bosne i Hercegovine. „Izvještaj o radu Akademije nauka i umjetnosti Bosne i Hercegovine za period od 1. jula 2017. do 31. decembra 2020. godine", Sarajevo, decembar 2020.

Akta.ba - https://www.akta.ba/vijesti/novi-uspjeh-bh-pameti-nova-cnc-masina-najveca-na-balkanu/124096 ; https://www.akta.ba/Firma/procassa-fischer-doo/279490

Biznis.Info - https://www.biznisinfo.ba/sarajevska-kompanija-predstavila-novu-cnc-masinu-vlastite-proizvodnje/

Bljesak.info - https://www.bljesak.info/gospodarstvo/tvrtke/Zenicki-TPS-Proizveli-uredaje-za-obradu-dijelova-za-Ferrari-i-Maserati/290228

CountryEconomy - https://countryeconomy.com/countries/compare/

Deloitte Central Europe, „Deloitte Technology Fast 50 Central Europe", dostupno na: https://www2.deloitte.com/ce/en/pages/about-deloitte/topics/technology-fast-50.html

Hrvatska akademija znanosti i umjetnosti (HAZU) – „Financijsko-planski dokumenti Akademije" – dostupno na: http://info.hazu.hr/hr/o-akademiji/fin_planski_dok/

Budžet HAZU: http://info.hazu.hr/upload/File/2020/ODLUKE-2020/PRORA%C4%8CUN-2021.pdf

LANACO - https://www.lanaco.com/nasa-prica/

Radošević, Slavo (2021) „Public R&D and Science – Industry Links in Economic Development: Implications for Bosnia and Herzegovina", London (June). Članak pripremljen za predstojeću konferenciju ANUBiH „Sistem naučnog i istraživačkog rada u Bosni i Hercegovini" – planirani datum održavanja 5. 11. 2021.

SpendMeNot - https://spendmenot.com/blog/top-rd-spenders/

The Brookings Institution - https://www.brookings.edu/research/whats-new-about-the-new-economy-it-economic-growth-and-productivity/

The Czech Academy of Sciences, „2019 Annual Report of the Czech Academy of Sciences“, Prague, 2019, Dostupan na:https://www.avcr.cz/opencms/export/sites/avcr.cz/.content/galerie-souboru/vyrocni-zpravy/VZ-AV-CR-ENG.pdf

The Observatory of Economic Complexity (OEC) - https://oec.world/en/profile/country/bih

The World Bank Database - https://data.worldbank.org/indicator/NY.GDP.MKTP.CD

TMD Group - https://tmd-group.ba/respirator-proizveden-u-gradaccu-certificiran-u-britaniji/

UIS – UNESCO Institute for Statistics: http://uis.unesco.org/apps/visualisations/research-and-development-spending/

Vijeće ministara Bosne i Hercegovine. „Strategija razvoja nauke u Bosni i Hercegovini – Revidirani dokument“, Sarajevo, septembar, 2016. Dokument dostupan na: https://ekonsultacije.gov.ba/legislativeactivities/details/14-prijedlog-revidiranog-dokumenta-strategije

Vlada Republike Srpske – Ministarstvo za naučnotehnološki razvoj, visoko obrazovanje i informaciono društvo, „Mapa puta istraživačkih infrastruktura u Republici Srpskoj (Bosna i Hercegovina) – Mapa puta istraživačkih infrastruktura u Republici Srpskoj“, dostupno na: https://www.vladars.net/sr-SP-Cyrl/Vlada/Ministarstva/mnk/Documents/RIRS-Road-Map-SR.PDF

DOI: 10.5644/PI2021.200.07

Uloga i značaj kompanija u oblikovanju i funkcionisanju inovacionog sistema

Zijada Rahimić[*]

Apstrakt: Kontinuiranim jačanjem istraživačko razvojnih aktivnosti i inovativnih sposobnosti kompanije postižu dugoročno održive konkurentske prednosti na sve kompleksnijim i neizvjesnijim tržištima današnjice. Istovremeno, stvaranjem novog znanja, inovativnom primjenom postojećih znanja i tehnologija, te olakšavanjem njihovog transfera doprinose izgradnji ekonomije znanja i konkurentnosti zemlje. Jedan od stubova ekonomije znanja jeste efektivan inovacioni sistem, u kojem posebno mjesto i ulogu imaju kompanije. Cilj rada je predstaviti i analizirati doprinos kompanija efikasnom funkcionisanju inovacionih sistema, ispitati vezu i uticaj inovativnosti i izdataka za istraživanje i razvoj na globalnu konkurentnost. Kao metodološki okvir za analizu efekata inovacijskih sposobnosti korišten je Globalni indeks inovacija (GII), kao i Indeks globalne konkurentnosti (GCI), u kojem inovacije i sofisticiranost predstavljaju jednu od tri kategorije konkurentnosti. U fokusu analize bio je odnos između inovacijskih inputa i inovacijskih outputa, kao i odnos između GII i GCI Bosne i Hercegovine, zemalja zapadnog Balkana i grupe odabranih zemalja Evropske unije (EU). Rezultati istraživanja pokazuju da postoji statistički signifikantna veza između inovacijskih inputa i outputa. Evidentne su razlike u jačini veze između varijabli inovativnosti i konkurentnosti za zemlje zapadnog Balkana i za izabrane zemlje članice EU. Također je utvrđeno da izdaci za istraživanje i razvoj značajno utiču na vrijednost indeksa konkurentnosti.

Ključne riječi: inovacioni sistem, ekonomija znanja, istraživanje i razvoj, globalni indeks inovacija, indeks globalne konkurentnosti

1. Uvod

U današnjem dinamičnom, neizvjesnom okruženju kojeg karakteriše globalizacija, iznimno brz razvoj informaciono-komunikacionih tehnologija, te sve brže zastarjevanje znanja za izgradnju i očuvanje konkurentske pozicije posebno bitni su znanje i inovacije. U savremenoj ekonomiji znanje i inovacije predstavljaju ključne faktore dugoročno održivog opstanka i razvoja preduzeća.[1] Generisanje i upotreba znanja igra ključnu ulogu u stvaranju nacionalnog

[*] Prof. dr., Ekonomski fakultet Univerziteta u Sarajevu. E-mail: zijada.rahimic@efsa.unsa.ba

[1] Jovičić J. i Petković S. (2016). Inovacije kao faktor konkurentnosti privrede s osvrtom na Bosnu i Hercegovinu. *Obrazovanje za preduzetništvo*, 6(1), 2016, str. 102.

bogatstva u ekonomijama baziranim na znanju, koje predstavljaju modernu paradigmu konkurentnosti nacionalnih privreda. U tom smislu svrha ovog rada je ukazati na značaj inovativnih sposobnosti i istraživačko-razvojnih aktivnosti kompanija za postizanje njihovih konkurentskih prednosti, za izgradnju i funkcionisanje inovacionih sistema i jačanje konkurentnosti nacionalne privrede. Predmet istraživanja su koncepti inovacionih sistema, te načini mjerenja inovacijskih performansi i konkurentnosti. Cilj rada je usmjeren na predstavljanje i analizu doprinosa kompanija funkcionisanju inovacionih sistema, na ispitivanje odnosa između inovacijskih inputa i outputa, inovativnosti i globalne konkurentnosti, kao i jačine uticaja izdataka za istraživanje i razvoj (IiR) na konkurentnost privrede.

Slijedom definisanog predmeta i postavljenih ciljeva istraživanja rad je strukturiran tako da su nakon Uvoda predstavljene karakteristike i značaj inovacija i inovacionih sistema kao jednog od stubova ekonomije zasnovane na znanju u postizanju konkurentskih prednosti. Posebna pažnja u ovom, drugom dijelu rada je usmjerena na ulogu kompanija u funkcionisanju inovacionih sistema. Potom su navedeni različiti indeksi, kojima se nastoje prikazati i uporediti rezultati inovativnosti i globalne konkurentnosti privrede[2] sa fokusom na prikaz globalnog indeksa inovacija (GII) i indeksa globalne konkurentnosti (GCI). Primjenom navedenih indeksa provedeno je empirijsko istraživanje i predstavljeni rezultati analize za BiH, zemlje zapadnog Balkana i izabrane zemlje EU. Na kraju, u zaključku predstavljene su osnovne spoznaje na temelju rezultata teorijskog i empirijskog istraživanja, te je naglašen značaj kompanija za efektivno i efikasno funkcionisanje inovacionih sistema.

2. Inovacioni sistem kao jedan od stubova ekonomije znanja

Stalne promjene, kao ključna karakteristika današnjeg okruženja ogledaju se između ostalog i u prelasku klasične industrijske u tehnološku eru, odnosno u činjenici da su industrije koje počivaju na prirodnim bogatstvima zamijenjene sa tzv. „brainpower" industrijama. Najrazvijenije zemlje današnjice svoj uspjeh su ostvarile upravo prelaskom sa kapitalom intenzivne na znanjem intenzivnu ekonomiju.[3] Ključnu ulogu u stvaranju nacionalnog bogatstva u tim ekonomijama

[2] Dossou Y.L. i Khvatova T.Y. (2020). Analysis of innovative activity of companies in developing countries on the example of West African countries. *St. Petersburg State Polytechnical University Journal.Economics*, 13 (1).

[3] Rahimić Z. i Kožo A. (2009). Building and Development of the Knowledge Based Economy in Bosnia and Herzegovina. *Journal of Interdisciplinary Management Research*, Vol. V, Ja-

ima generisanje, diseminacija i efektivna upotreba znanja. Stoga je ekonomija zasnovana na znanju postala dominantna ekonomija dvadeset i prvog stoljeća.

Kao stubovi ekonomije zasnovane na znanju navode se: ljudski resursi, moderna i adekvatna informatička infrastruktura, efektivan inovacioni sistem i institucionalni režim. Inovacioni sistem u širem smislu predstavlja funkcionalnu cjelinu svih javnih i privatnih subjekata i institucija koje neposredno učestvuju u stvaranju novog znanja fundamentalnim, primijenjenim i razvojnim istraživanjima, inovativnom primjenom postojećih znanja i tehnologija te olakšavanjem njihovog transfera unutar države i u međunarodnoj razmjeni.[4] U kontekstu ekonomije znanja bitno je ukazati na postojanje djelimične podudarnosti i funkcionalne komplementarnosti između sistema nauke s jedne strane te uže shvaćenog inovacionog sistema s druge strane, tako da se ovi termini koriste i kao sinonimi.[5]

Imajući u vidu predmet istraživanja, u nastavku će se detaljno objasniti karakteristike i značaj inovacija i inovacionih sistema u izgradnji konkurentnosti privrede, kao i uloga kompanija u funkcionisanju inovacionog sistema, te će se predstaviti najvažniji pokazatelji inovativnosti i konkurentnosti privrede.

2.1. Značaj inovacija i inovacionih sistema u postizanju konkurentnosti privrede

Inovacije i inovacioni sistemi postaju sve zanimljiviji kreatorima politika za postizanje ekonomskih i socijalnih ciljeva. Inovacija je stavljena u središte strategije Evropske unije jer pruža „najbolje sredstvo za uspješno rješavanje glavnih društvenih izazova“ (Evropska komisija, 2010).[6] Također se u novije vrijeme ističe da su istraživanje, inovacije i obrazovanje presudni za Evropu pri prelasku ka klimatskoj neutralnosti i digitalnom vodstvu. Evropska industrija, ekonomija i društvo mijenjaju se brzinom svjetlosti, što predstavlja jedinstvenu priliku za pretvaranje EU u pošteno i prosperitetno društvo, sa modernom, resursno efikasnom i konkurentnom ekonomijom koja radi za ljude.[7]

nuary 2009, str. 112.

[4] Trifković M. (2020). *Harmonizacija sistema nauke u Bosni i Hercegovini*. Akademija nauka i umjetnosti Bosne i Hercegovine, Centar za sistemska istraživanja, knjiga 5/1, posebna izdanja, Sarajevo, str. 34.

[5] Trifković M. (2020). str. 40.

[6] Schrempf B., Kaplan D. i Schroeder D. (2013). *National, Regional, and Sectoral Systems of Innovation–An overview*. Report for FP7 Project "Progress". European Comission, str. 3.

[7] European Commision (2020). *Science, research and Innovation Performance of the EU 2020, A fair, green and digital Europe*. Publication Office of the European Union. Luxem-

Najčešće se pojam inovacija veže za tehnološke izmjene, koje uključuju nov ili inovirani način rada ili proizvodnje postojećih proizvoda ili pak proizvodnju sasvim novih proizvoda. Ipak, sve izmjene i sva poboljšanja u okviru jednog preduzeća ali i u ostalim sferama života mogu se obuhvatiti pojmom inovacija.

Najpouzdanijim izvorom inovacija smatra se znanje temeljeno na istraživanju i razvoju. Međutim, izuzetno važni su i drugi načini sticanja i akumuliranja znanja poput "učenja radom" i "učenja korištenjem". Perspektiva prakse konceptualizira inovacije smještene u svakodnevnim aktivnostima organiziranja, učenja i rada. Ljudi stvaraju nova znanja dok rade na rješavanju problema s kojima se suočavaju u praksi. Drugim riječima, znanje, rad i inovacije su isprepleteni. U ekonomiji znanja, stvaranje baze znanja zavisi od sinergija ostvarenih između tri glavna aktera u ekonomiji: akademske, poslovne zajednice i vlade.

Inovacije postaju sve značajniji faktor u borbi za očuvanje i poboljšanje konkurentske pozicije preduzeća na domaćem i internacionalnom tržištu.[8] U globalnom ekonomskom kontekstu, inovacije su postale temeljni i odlučujući stub razvoja zemlje i njenog potencijalnog uspjeha. Preciznije rečeno, inovacije predstavljaju instrument ekonomske sigurnosti države i faktor poboljšanja međunarodne konkurentnosti.[9] Pozitivna korelacija između inovacija i privrednog razvoja potvrđena je u brojnim empirijskim i teorijskim istraživanjima,[10] te je ukazano da povećane inovacijske sposobnosti mogu dovesti do značajnog industrijskog razvoja i razvoja društva općenito.[11]

Povećana svijest o važnosti inovacija za privredni rast rezultirala je razvojem koncepta nacionalnog inovacionog sistema. Posebne zasluge za razvoj ovog koncepta pripisuju se britanskom ekonomisti Christopheru Freemanu, koji nacionalni inovacioni sistem (NIS) definiše kao mrežu institucija privatnog i javnog sektora koje međusobnim interakcijama iniciraju, uvoze,

bourg. https://ec.europa.eu/info/publications/science-research-and-innovation-performance-eu-2020_en

[8] Rahimić Z. (2006). *Izgradnja konkurentskih prednosti preduzeća kroz njegova strateška opredjeljenja.* Ekonomski fakultet u Sarajevu, str. 275.

[9] Chuvakhina L.G., Terskaya G.A. i Buevich S.Y. (2018). Innovations as a factor of state's improved performance in the World Economic System. *Revista Espacios*, Vol. 39 (# 04) Year 2018.

[10] Kaynak S., Altuntas S. i Dereli T. (2017). Comparing the innovation performance of EU candidate countries: an entropy-based TOPSIS approach. *Economic Research-Ekonomska Istraživanja*, 30:1, 31-54.

[11] Yongabo P. i Göransson B. (2020). Constructing the national innovation system in Rwanda: efforts and challenges, Innovation and Development. DOI:10.1080/2157930X.2020.1846886

modifikuju i šire inovacije.[12] NIS se može posmatrati kao društveno-ekonomski sistem u kojem komuniciraju različiti akteri, poput kompanija, istraživačkih i akademskih organizacija, javne uprave, profesionalnih posrednika i drugih formalnih i neformalnih institucija. NIS koristi sve raspoložive resurse u zemlji, tj. ljudske, finansijske, infrastrukturne i institucionalne resurse. Nacionalni inovacioni sistem se također može smatrati nematerijalnom imovinom[13] koja doprinosi privrednom rastu zemlje, stvaranju vrijednosti i blagostanju.

Koncept nacionalnih inovacionih sistema zasniva se na pretpostavci da privredni rast zemlje, kao rezultat tehnološkog napretka, ne zavisi toliko od veličine istraživačko-razvojnih resursa, koliko od načina organizovanja i upravljanja tim resursima na nacionalnom nivou. Ovakav stav posebno je bitan za male zemlje i za zemlje u razvoju, koje po pravilu ne raspolažu značajnim inovacionim kapacitetom.[14] Stoga treba temeljito ispitati nacionalni inovacioni sistem u kontekstu zemalja u razvoju[15] uzimajući u obzir kapacitet proizvodnje znanja kao i apsorpcijski kapacitet krajnjih korisnika, te ulogu inovacijskih politika.

Koncept efikasnosti nacionalnog inovacionog sistema direktno je povezan s konceptom produktivnosti. Smatra se da je inovacioni sistem efikasan kada s jednakom količinom inovativnih inputa generira više inovacijskih rezultata, odnosno kada je potrebno manje inputa da bi se stvorila ista količina inovacija.[16]

Priručnik iz Osla (Oslo Manual OECD, 2005.) identificira četiri faktora koja utiču na efikasnost inovacijskog procesa: okvirni uslovi, institucije

---

[12] Freeman, C. (1995). The "National System of Innovation" in historical perspective. *Cambridge Journal of Economics*, 19 (1) 5–24, preuzeto iz Cvetanovic D., Cvetanović S. i Bogić D. (2020).

[13] Gogodze J. (2016). Mechanisms and Functions within a National Innovation System. *Journal of Technology Management&Innovation*,Universidad Alberto Hurtado, Facultad de Economía y Negocios. Volume 11, Issue 4, str. 12-21.

[14] Cvetanovic D., Cvetanović S. i Bogić D. (2020). Rastući značaj koncepta regionalnih inovacionih sistema za ekonomski i društveni razvoj.
https://konferencija.komorapirot.com/44.RASTUCI%20ZNACAJ%20KONCEPTA%20REGIONALNIH%20INOVACIONIH%20SISTEMA%20ZA%20EKONOMSKI%20I%20DRUSTVENI%20RAZVOJ.pdf

[15] Yongabo P. i Göransson B (2020). Constructing the national innovation system in Rwanda: efforts and challenges. *Innovation and Development*, DOI:10.1080/2157930X.2020.1846886

[16] Jankowska B., Matysek-Jędrych A. i Mroczek-Dąbrowska K. (2017). Efficiency of national innovation systems: Poland and Bulgaria in the context of the Global Innovation Index. *Comparative Economic Research*, De Gruyter, Warsaw, Vol. 20, Iss. 3, pp. 77-94.

za nauku i tehnologiju, mehanizmi prenosa i inovativni pogoni specifični za kompanije. Opšti okvirni uslovi oblikuju aktivnosti preduzeća i njihovu sposobnost obavljanja inovativnih aktivnosti. Efikasnost institucija za nauku i tehnologiju pokreće akumulaciju znanja. Mehanizmi prenosa poboljšavaju protok informacija i vještina između zainteresiranih strana i osiguravaju da inovativne ideje dospiju na tržište. Konačno, same kompanije trebaju identificirati i koristiti potencijal za inovacije kako bi ojačale inovacijski proces. Predstavljeni faktori odgovaraju određenim oblastima interventnih politika. Od vlade se očekuje da kreira mjere za rješavanje potencijalnih prepreka i postavi prioritete.[17] Inače, smatra se da je država najuticajniji faktor u većini nacionalnih inovacionih sistema, pošto finansira veći dio osnovnih istraživačkih i razvojnih aktivnosti u zemlji.[18]

Pored navedenih faktora, istorijsko nasljeđe može imati dubok uticaj na oblik nacionalnih inovacionih sistema.[19] Doista su istorijski događaji i društvene norme u svakoj zemlji imali veliki uticaj na oblik institucija, artikulaciju prioriteta i rezultate inovacija. Ipak, zahvaljujući trendu kontinuiranog učenja razlike između nacionalnih inovacionih sistema uočene u prethodnim decenijama danas su manje očite.[20] Primjera radi, inovacioni sistem Japana zasnovan je na "alternativnoj energetskoj tehnologiji" ili energetskoj efikasnosti, a u Sjedinjenim Američkim Državama dominirajući koncept je "inovacioni ekosistem".

Inovacioni sistemi mogu funkcionisati na nacionalnom, regionalnom ili međunarodnom nivou. Bez obzira na nivo, dimenziju posmatranja inovacionog sistema naglašava se značaj proizvodnje i korištenja novih znanja u stvaranju vrijednosti.[21] U procesu proizvodnje i širenja znanja posebno bitnim

---

[17] OECD (2013). *Triple Helix partnerstva za inovacije u Bosni i Hercegovini.* Razvoj privatnog sektora – Priručnik za politike. Sarajevo, str. 17. i OECD (2005). *Oslo Manual: Guidelines for collecting and interpreting innovation data*, 3. izdanje, OECD, Pariz.

[18] Melaas A. i Zhang F. (2016). *National Innovation Systems in the United States and China A Brief Review of the Literature*. The Center for International Environment&Resource Policy, Tufs University. Medford.

[19] Radošević S. (2002). Regional innovation systems in Central and Eastern Europe: Determinants, organizers and alignments. *The Journal of Technology Transfer*, 27, 87–96. Preuzeto iz: Mosurović Ružičić M., Miletić M. i Dobrota, M. (2021). Does a National Innovation System Encourage Sustainability? Lessons from the Construction Industry in Serbia. *Sustainability 2021*, 13, 3591, str. 5.

[20] Fatma A. (2018). Overview of the Japanese Innovation Systems vs. the American Innovation System. *Journal of Global Economics,* 6: 312. doi:10.4172/2375-4389.1000312

[21] Schrempf B., Kaplan D. i Schroeder D. (2013). National, Regional, and Sectoral Systems of Innovation–An overview. *Report for FP7 Project "Progress". European Comission*.

smatra se angažman svih aktera, povjerenje i odanost među akterima i podržavajuće okruženje.[22]

2.2. Uloga kompanija u funkcionisanju inovacionog sistema

Početno istraživanje nacionalnih inovacionih sistema, ranih 1990-ih je imalo za cilj izmjeriti inovacijske rezultate kompanija kroz razvoj novih proizvoda, kao i njihovu sposobnost apsorpcije inovativnih tehnologija.[23] Upravo u tom periodu, krajem 20. stoljeća zbog sve veće neizvjesnosti i turbulentnosti promjena u okruženju, uspjeh preduzeća se zasnivao na inovativnoj sposobnosti, za razliku od 60-ih godina kada je cilj preduzeća bio usmjeren na povećanje obima proizvodnje, ili 70-ih godina na snižavanje troškova proizvodnje, te 80-ih godina na postizanje visokog kvaliteta. Inovativne sposobnosti kompanija doprinose kako postizanju i očuvanju njihovih konkurentskih prednosti, tako i konkurentnosti zemlje.

Polazeći od činjenice da će se dinamika tržišta i tržišna neizvjesnost u budućnosti povećati može se reći da preduzeća trebaju nastojati da jačaju svoju istraživačko razvojnu aktivnost, odnosno da jačaju inovativne sposobnosti. Istraživačko-razvojna aktivnost jednog preduzeća zavisi ne samo od sposobnosti, kojima raspolaže to preduzeće nego i od faktora iz eksternog okruženja. Među njima se posebno ističu stav vlade (države) prema naučno istraživačkoj djelatnosti, snažna veza između naučno-istraživačkih institucija (univerziteta i instituta) sa privrednim subjektima, brzina tehnološkog transfera i stopa zastarjevanja tehnologija, što je vezano za vrstu djelatnosti preduzeća. Stoga su se novija istraživanja koncentrirala na specifične uloge drugih aktera u okviru inovacionog sistema, poput uloge vlade u stvaranju poticaja i uloga univerziteta u provođenju istraživanja.[24] S tim u vezi, interesantno je navesti da EU podržava istraživanje i inovacije u industriji, jer dvije trećine ulaganja u istraživanje i razvoj privatnog sektora generira 80% izvoza iz EU.[25]

---

[22] Chaminade, C. i Lundvall B. (2019*). Science, Technology, and Innovation Policy:Old Patterns and New Challenges*. Oxford University Press. Oxford.

[23] Melaas A. i Zhang F. (2016). *National Innovation Systems in the United States and China A Brief Review of the Literature.* The Center for International Environment&Resource Policy, Tufs University. Medford.

[24] Melaas A. i Zhang F. (2016). str. 3.

[25] https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation_en

Konceptualni model odnosa industrije i nauke (Conceptual Model for Analysing Industry-Science Relations)[26] smatra se alatom za podizanje konkurentnosti i tehnoloških performansi preduzeća korištenjem znanja dostupnih u javnim istraživanjima. Cilj promocije odnosa industrije i nauke je osigurati da se javna ulaganja u visoko obrazovanje prelijevaju na preduzeća i čine ta ulaganja ekonomski produktivnim. Model odnosa industrije i nauke se smatra rezultatom aktivnosti aktera na "tržištu znanja", kojeg karakteriše visoka asimetrija informacija između učesnika i niska transparentnost tržišta, visoki transakcijski troškovi razmjene znanja, ograničenja za finansiranje proizvodnje i razmjene znanja zbog finansijskih tržišta nesklonih riziku i kratkoročnih orijentacija. Na performanse odnosa industrije i nauke utiču u prvom redu karakteristike glavnih aktera (preduzeća i javnih naučnih ustanova) kroz potražnju i ponudu na nacionalnom tržištu znanja, drugo, okvirni uslovi poput infrastrukture, zakonodavstva i propisa i institucionalnih postavki, i treće intenzitet međusobne komunikacije industrije i nauke.

Inovativnost se može podstaknuti primjenom modela trostruke spirale, tj. saradnjom između akademske i poslovne zajednice te lokalne vlade, odnosno tzv. *Triple Helix* modela (trostruke spirale).[27] Koordinacijom aktivnosti sve tri zainteresirane strane i efikasnom komunikacijom omogućava se postizanje sinergetskih efekata i stvaranje veće vrijednosti.[28] U teoriji i praksi postoji više modela stvaranja znanja i inovacione kreativnosti. Tako je Četvorostruki Heliks model baziran na *Triple Heliks* modelu i kao četvrtu spiralu dodaje društvo bazirano na kulturi i medijima i civilno društvo. Četvrti heliks se povezuje sa medijima, kreativnom industrijom, kulturom, vrijednostima, stilom života i umjetnošću. Petostruki *Quintuple Heliks* dodaje kao petu spiralu prirodno okruženje ili životnu sredinu, a *Quintuple Heliks* može biti predložen kao okvir za transdisciplinarnu (i interdisciplinarnu) analizu održivog razvoja i socijalne ekologije.[29]

[26] Polt W., Rammer Ch., Schartinger D., Gassler H. i Schibany A. (2001). Benchmarking Industry-Science Relations in Europe – the Role of Framework Conditions. *Science and Public Policy* 28 (4), August 2001, pages 247-258.

[27] Leydesdorff L. i Strand Ø. (2013). The Swedish System of Innovation: Regional Synergies in a Knowledge-Based Economy. *Journal of the American Society for Information Science and Technology*. DOI: 10.1002/asi.22895

[28] OECD (2013). *Triple Helix partnerstva za inovacije u Bosni i Hercegovini*. Razvoj privatnog sektora – Priručnik za politike. Sarajevo, str. 17. i OECD (2005.), Oslo Manual: Guidelines for collecting and interpreting innovation data, 3. izdanje, OECD, Pariz.

[29] Ješić J. (2015). *Model četverostruke spirale (Quadruple Helix Model) kao osnova nacionalnog inovacionog sistema,* doktorska teza. Univerzitet Edukons Fakultet poslovne ekonomije Sremska Kamenica, Novi Sad.

Poseban naglasak u procesu stvaranja inovacija stavlja se na fenomen industrijskih klastera, koji doprinose kvaliteti poslovnog okruženja i predstavljaju važan faktor poboljšanja konkurentnosti.[30] U literaturi se „industrijski klasteri“ zajedno sa konceptima, „inovativni miljei“ i „samoučeće regije“[31] mogu naći pod zajedničkim nazivom prostornih inovacionih sistema. Prostorni inovacioni sistemi[32] obuhvataju međusobno povezana preduzeća u određenim sektorima, zajedno s odgovarajućim dobavljačima i uslužnim sektorom, kao i niz pratećih institucija, uključujući univerzitete, institute, laboratorije, profesionalna udruženja i agencije. Ovo je posebno bitno za mala preduzeća, jer imaju manje resursa i mogućnosti za interna vlastita istraživanja. Zahvaljujući interakciji sa drugim institucijama malim i mikro kompanijama je olakšan pristup novim znanjima, koja postaju izvor za njihove inovacije.[33]

Postojeće temelje saradnje u okviru inovacionog sistema moguće je nadopuniti zagovaranjem kulture otvaranja naučnih i inovacijskih procesa, tj. otvorenim inovacijama (open innovation) i otvorenom naukom (open science).[34] Nova paradigma otvorenosti neće zamijeniti postojeće temelje saradnje, nego će ih nadopuniti što će omogućiti kompanijama da se lakše i brže transformišu u kompanije koje kreiraju znanje (Knowledge-Creating Company)[35] i učeće organizacije (Learning Organizations). Takvim poslovnim pristupom i strateškim opredjeljenjem navedene kompanije uspijevaju da izgrade dugoročno održivu konkurentsku prednost, intenziviraju saradnju sa univerzitetima, te doprinose efikasnosti inovacionih sistema, bržem privrednom rastu i konkurentnosti zemlje.

---

[30] Porter M. i Stern, S. (2002). National innovative capacity. In K. Scwab, M. Porter, & J. Sachs (Eds.), *The global competitiveness report 2001–2002*, 102–118. Oxford University Press. New York.

[31] Puljiz, J. (2009). *Faktori regionalnog razvoja i regionalnih nejednakosti u Republici Hrvatskoj*. Doktorska disertacija. Ekonomski fakultet, Sveučilište u Splitu. Split, str. 40.

[32] Despotović D. i Cvetanović S. (2017). The theoretical explication of the factors of regional growth and the economic convergence (divergence) of the region. *Economic Horizons*, May - August 2017, Volume 19, Number 2, 111 – 125.

[33] Rigg C., Coughlan P., O’Leary D. i Coghlan D. (2021). A practice perspective on knowledge, learning and innovation – insights from an EU network of small food producers. *Entrepreneurship & Regional Development.*

[34] Hetze P. i Meyer M. (2018). *Was bringt die Oeffnung von Wissenschaft und Innovation?* Stifterverband Bildung. Wissenschaft. Innovation, Berlin i Warnke P. et al. (2016). *Opening up the innovation system framework towards new actors and institutions.* Fraunhofer ISI Discussion Papers - Innovation Systems and Policy Analysis, No. 49, Fraunhofer ISI, Karlsruhe.

[35] Vukotić S., Zakić N. i Ćurčić N. (2017). Menadžment znanja i upravljanje inovacijama kao izvor poslovnog uspeha i konkurentske predosti preduzeća. *Četvrti naučno-stručni skup POLITEHNIKA 2017*, str. 436-442.

2.3. Pokazatelji inovativnosti privrede

Danas smo svjedoci eksplozije istraživanja kojima se pokušavaju prikazati i uporediti rezultati inovacija u najširem smislu.[36] Razne organizacije i istraživači razvili su niz složenih pokazatelja za mjerenje inovacija na nivou države.[37] Najsveobuhvatniji uvid u inovacijski kapacitet i inovacijske performanse pojedine zemlje daju: 1. Globalni indeks inovacija (GII-Global Innovation Index), 2. Bloombergov indeks inovacija (Bloomberg Innovation Index), te 3. Evropska ljestvica inovativnosti (European Innovation Scoreboard). Pored navedenih indeksa koji su isključivo fokusirani na inovacije, postoje indeksi koji se bave širim temama poput konkurentnosti, ali dijelom i inovacijama, npr. Indeks globalne konkurentnosti (GCI-Global Competitiveness Index). Rezultati ispitivanja sadržaja[38] Indeksa globalne konkurentnosti, Indeksa humanog razvoja, Indeksa ekonomije znanja, Evropske ljestvice inovativnosti ukazuju da ovi indeksi pružaju vrlo slične informacije.[39] U nastavku će se dati kratki opis specifičnosti dva indexa, koji su korišteni u empirijskom istraživanju i to: globalni indeks inovacija (GII) i indeks globalne konkurentnosti (GCI).

Globalni indeks inovacija je kreiran u saradnji dviju poslovnih škola "Cornell -SC Johnson College of Business" i "INSEAD -The Business School for the world" i UN-ove organizacije za intelektualno vlasništvo "WIPO -World Intellectual Property Organization". Prepoznajući ključnu ulogu inovacija kao pokretača privrednog rasta i prosperiteta, GII uključuje pokazatelje koji nadilaze tradicionalna mjerenja inovacija. Ovaj indeks je povezao ekonomske indikatore koji utiču na inovativnost zemlje objedinjujući ih u određeni okvir.

Analiza inovacijske aktivnosti prema GII je sastavljena od sedam stubova inovativnosti grupisanih u dva podindeksa: inovacijski input (III-Innovation Input Index) i inovacijski output (IOI-Innovation Output Index).[40] Inovacijski

[36] Adam F. (2014). *Measuring National InnovationPerformance – the Innovation Union Scoreboard Revisited.* Springer. Berlin, Heidelberg.

[37] Gogodze J. (2016). Mechanisms and Functions within a National Innovation System. *Journal of Technology Management & Innovation* © Universidad Alberto Hurtado, Facultad de Economía y Negocios. Volume 11, Issue 4, str. 12.

[38] Wojciech N. (2016). Composite Indexes Economic and Social Performance: Do They Provide Valuable Information. *Foundations of Management*, Vol. 8, str. 167- 174.

[39] Kaynak S., Altuntas S. i Dereli T. (2017). Comparing the innovation performance of EU candidate countries: an entropy-based TOPSIS approach. *Economic Research-Ekonomska Istraživanja*, 30:1, 31-54.

[40] Bilas V., Bošnjak M. i Novak I. (2019). Inovacijska izvedba zemalja članica Europske unije. *Oeconomica Jadertina* 1/2019, str. 34-44.

input je ustvari infrastruktura koja omogućava inovacije, razvija inovacijsku kulturu i podstiče inovativno ponašanje. Tu spadaju: institucije, ljudski kapital i istraživanje, infrastruktura, sofisticiranost tržišta, te poslovna sofisticiranost. Krajnji rezultat inovacija predstavljen je u inovacijskom outputu, koji obuhvata dva podindeksa: outputi znanja i tehnologija i kreativni outputi. Suština izvještaja ogleda se u rangiranju inovacijskih sposobnosti i rezultata svjetskih privreda, te u prikazu snaga i slabosti određene zemlje. GII omogućava privredama da analiziraju svoje inovacijske učinke, kreiraju odgovarajuće inovacione politike i odrede prioritete u poduzimanju mjera za jačanje inovativne aktivnosti. Pored toga djeluje i proaktivno, npr. GII 2020 istražuje nove metode finansiranja inovacija u svijetu nakon COVID-a, koje su nužno potrebne u trenutku u kojem je svjetska privredna situacija značajno otežana posljedicama globalne pandemije.

Indeks globalne konkurentnosti razvijen od stane Svjetskog ekonomskog foruma (WEF – World Economic Forum) koristi se za rangiranje zemalja na temelju analize 12 stubova konkurentnosti grupiranih u tri podindeksa (osnovni faktori, faktori povećanja efikasnosti i faktori inovacija i sofisticiranosti). Zemlje čija je ekonomija bazirana na osnovnim faktorima prema indeksu globalne konkurentnosti se nalaze na prvom nivou razvoja. Održavanje konkurentnosti na ovom nivou razvoja zavisi prvenstveno od dobro funkcionirajućih javnih i privatnih institucija (1. stub), dobro razvijene infrastrukture (2. stub), stabilnog makroekonomskog okruženja (3. stub) i zdrave radne snage koja je stekla najmanje osnovno obrazovanje (stub 4). Na drugom nivou razvoja se nalaze zemlje koje ostvaruju efikasnije proizvodne procese i rastući kvalitet proizvoda. U ovoj fazi na rast konkurentnosti utiču visoko obrazovanje i stručne obuke (stub 5), efikasno tržište roba (stub 6), efikasno tržište rada (stub 7), razvijeno finansijsko tržište (stub 8), tehnološka spremnost (stub 9) i veličina tržišta (stub 10). Konačno, na trećem nivou su zemlje čija je ekonomija bazirana na inovacijama ili brzom usvajanju inovativnih tehnologija. Na ovom nivou rast konkurentnosti je uslovljen faktorima visoke poslovne sofisticiranosti (11. stub) i inovacijama (12. stub). Postoje i grupe zemalja koje su u tranziciji između prvog i drugog, odnosno drugog i trećeg nivoa. Bosna i Hercegovina se već godinama nalazi u grupi zemalja čija je ekonomija bazirana na efikasnosti, zajedno sa Albanijom, Sjevernom Makedonijom, Crnom Gorom i Srbijom. Od zemalja u regionu jedino se

Hrvatska nalazi u grupi zemalja koje su u tranziciji od ekonomije bazirane na efikasnosti do ekonomije bazirane na inovacijama.[41]

Inače, mjerenjem konkurentnosti nacionalnih ekonomija bavi se Svjetski ekonomski forum (World Economic Forum) od 1979. godine i izdaje godišnji Izvještaj o globalnoj konkurentnosti. Posljednja promjena metodologije sprovedena je tokom 2018. godine, kada je uveden novi način obračuna indeksa GCI 4.0 i prema istom je urađen Izvještaj o globalnoj konkurentnosti za 2019. godinu. Stoga će se za provođenje analize uticaja inovativnosti na konkurentnost izabranih zemalja u empirijskom dijelu koristiti GII za period 2008–2018. godina.[42]

3. Rezultati empirijskog istraživanja

U skladu s postavljenim ciljevima istraživanja urađena je komparativna analiza globalnog indexa inovacija (GII), indeksa inovacijskog inputa (III-Innovation Input Index), indeksa inovacijskog outputa (IOI-Innovation Output Index), ukupno i prema sedam varijabli koje su navedene u odjeljku 2.3.[43] Na Slici br. 1 dat je prikaz navedenih varijabli za BiH, zemlje zapadnog Balkana (Albanija, BiH, Crna Gora, Sjeverna Makedonija i Srbija) i izabrane zemlje EU i to: Austrija, Bugarska, Grčka, Hrvatska, Mađarska, Njemačka, Rumunija i Slovenija. Potom je urađena regresiono-korelaciona analiza između inovacijskih inputa i inovacijskih outputa,[44] te regresiono-korelaciona analiza između inovativnosti i globalne konkurentnosti. Cilj je bio ispitati povezanost između inovativnih aktivnosti i konkurentnosti privrede, kao i između izdataka za istraživanje i razvoj i konkurentnosti privrede.

[41] CPU-Centre for Policy and Gouvernance (Centar za politike i upravljanje) *Konkurentnost ekonomije u BiH i regionu 2014-2018.* http://www.cpu.org.ba/media/35585/Konkurentnost-ekonomije-u-BiH-i-regionu-2014-2018.pdf

[42] https://tcdata360.worldbank.org/indicators/gci?indicator=632&viz=line_chart&years=2007,2017&indicators=944

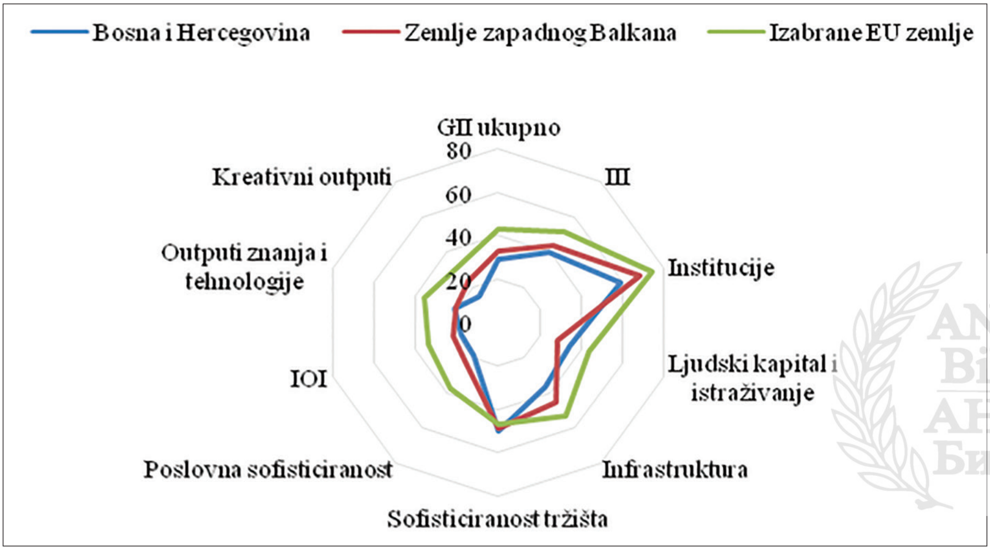
[43] https://www.globalinnovationindex.org/analysis-indicator

[44] Cvetanović S., Despotović D., Mladenović I. i Jovović D. (2014). The analysis of innovation in Western Balkan countries in 2012. *Economic Research-Ekonomska Istraživanja*, 27:1, 830-846.

3.1. Komparativna analiza inovacijskih performansi BiH i izabranih zemalja

Na temelju podataka o vrijednostima GII, III, IOI, kao i njihovih osnovnih komponenti za Bosnu i Hercegovinu, zemlje zapadnog Balkana i odabrane zemlje članice EU, urađen je grafički prikaz, tj. slika br. 1. Riječ je o prikazu odnosa između analiziranih varijabli inovativnosti, koje odslikavaju inovativnost izabranih zemalja.

Slika br. 1 Komparativna analiza varijabli inovativnosti



Izvor: Kalkulacija autora na bazi podataka GII za 2020. godinu
https://www.globalinnovationindex.org/analysis-indicator

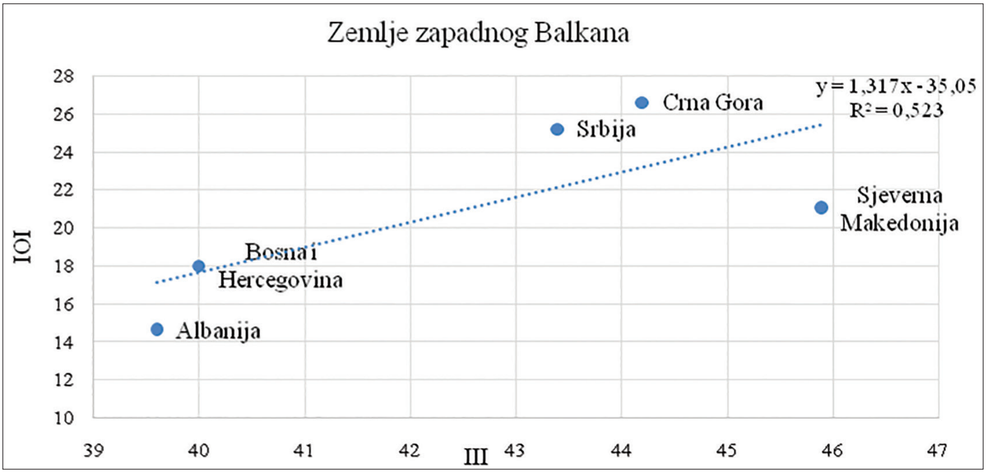
Jasno su uočljive razlike, tj. niže vrijednosti u inovacijskim performansama između BiH, zemalja zapadnog Balkana i odabranih zemalja članica EU uz izuzetak dimenzije sofisticiranost tržišta. BiH ima visoke rezultate u odnosu na zemlje regiona u dimenziji ljudski kapital i istraživanje, te je neznatno bolja u dimenzijama sofisticiranost tržišta i rezultati znanja i tehnologije.

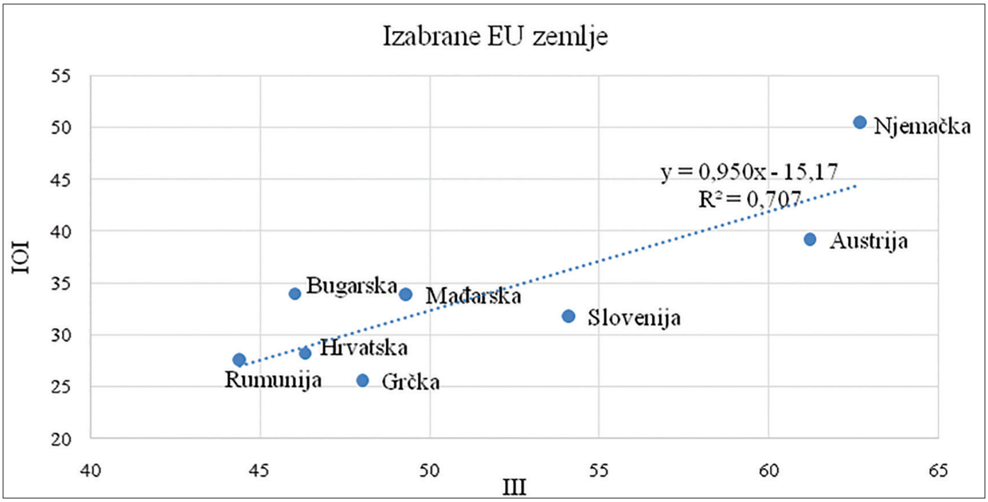
Prema Izvještaju globalnog indeksa inovacija za 2020 godinu Bosna i Hercegovina je zauzela 74. mjesto od 131 zemlje, dok je u 2019. godini bila na 76. mjestu. Indeks globalnih inovacija (GII) kao relativne prednosti navodi slijedeća područja u 2020. godini: ljudski kapital, sofisticiranost tržišta, rezultati znanja i tehnologije. Bosna i Hercegovina postiže rezultate ispod prosjeka za svoju dohodovnu grupu, u četiri stuba: institucije, infrastruktura, poslovna sofisticiranost i kreativni rezultati. Još preciznije možemo navesti neke identifikovane posebno izražene slabosti u kontekstu našeg istraživanja, a to su: jednostavnost u pokretanju posla (130. mjesto), inovacijske veze (123. mjesto); apsorpcija znanja (128), univerzitetska i industrijska saradnja u istraživanju (124).

3.2. Korelaciona analiza indeksa inovativnosti i konkurentnosti

Pored komparativne analize varijabli inovativnosti, urađene su i regresiono-korelacione analize i to: analiza veze, odnosa između varijabli III (Innovation Input Index) kao nezavisne varijable i IOI (Innovation Output Index) kao zavisne varijable za zemlje zapadnog Balkana i za izabrane zemlje članice EU u 2020-oj godini, te analiza odnosa inovativnosti i konkurentnosti (GII kao nezavisne varijable i GCI kao zavisne varijable). Standardni način prikazivanja odnosa između dvije varijable je dijagram rasipanja. Uz dijagram rasipanja na slikama su prezentirani i rezultati regresiono-korelacionih linearnih modela. Reprezentativnost regresionih modela izražena je koeficijentom determinacije (R^2) i na osnovu vrijednosti koeficijenta determinacije interpretirana je jačina linearne veze prezentirane kroz regresione modele (kao udio objašnjenog varijabiliteta, nastalog pod uticajem nezavisne varijable, u ukupnom varijabilitetu zavisne varijable).

Slika br. 2 Dijagram rasipanja i regresiono-korelacioni model za III i IOI za zemlje zapadnog Balkana i izabrane EU zemlje





Izvor: Kalkulacija autora na bazi podataka GII za 2020. godinu
https://www.globalinnovationindex.org/analysis-indicator

Slika br. 2 prikazuje dva zasebna dijagrama rasipanja između varijabli III i IOI i to za zemlje zapadnog Balkana i za izabrane zemlje članice EU. Linearni model ukazuje na vezu osrednje jačine (52,3%) u zemljama zapadnog Balkana dok kod izabranih EU zemalja isti model ukazuje na statistički značajniju vezu između III i IOI, jačine 70,7%.

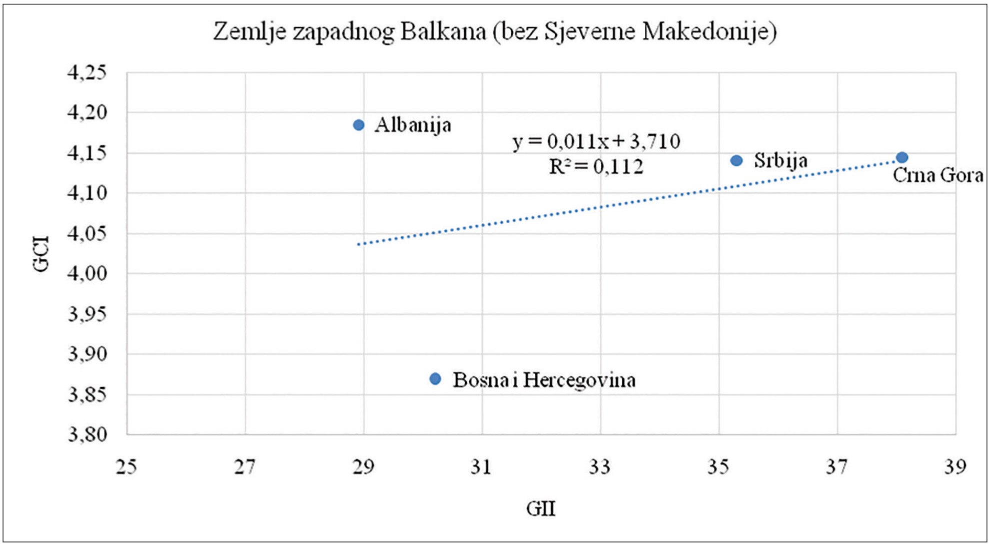
Da bismo došli do odgovora u kojoj mjeri inovativnost utiče na konkurentnost izabranih zemalja, odnosno utvrdili jačinu veze između inovativnosti i konkurentnosti koristili smo podatke iz Izvještaja za GII iz 2017. godine i za GCI iz 2018. godine. Smatrali smo neopravdanim uzeti pokazatelje iz iste godine, jer je za očekivati da inovativne i istraživačko-razvojne aktivnosti mogu doprinijeti konkurentnosti zemlje najbrže moguće tek naredne godine.

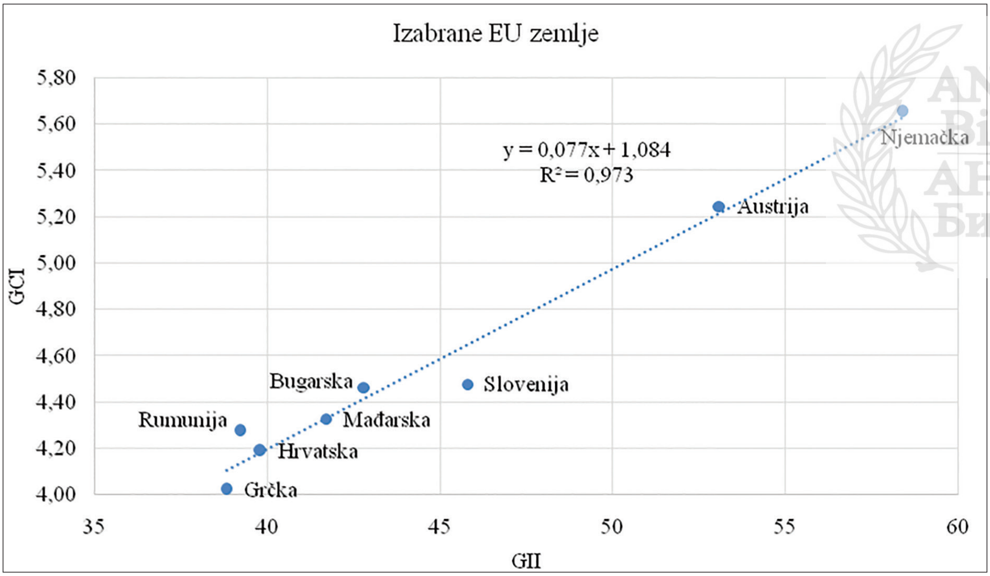
Na Slici br. 3 dat je prikaz parova podataka varijabli GII i GCI[45] za zemlje zapadnog Balkana i odabrane zemlje EU. Očito je da kod odabranih zemalja EU postoji snažna direktna linearna korelacija, kao i statistički signifikantan uticaj GII na GCI (97,3%). S druge strane, analiza odnosa između GII i GCI na nivou zapadnog Balkana bez Sjeverne Makedonije[46] je pokazala da, prema linearnom modelu, ne postoji statistički značajan uticaj GII na GCI (11,2%).

[45] https://govdata360.worldbank.org/indicators/ha03bec65?indicator=41619&viz=line_chart&years=2017,2019

[46] Napomena: nije bilo podataka za Sjevernu Makedoniju za GCI za 2018. godinu.

Slika br. 3 Dijagram rasipanja i regresiono-korelacioni model za GII i GCI za zemlje zapadnog Balkana i izabrane EU zemlje





Izvor: Kalkulacija autora na bazi podataka GII za 2017. i GCI za 2018. godinu https://www.globalinnovationindex.org/analysis-indicator i https://tcdata360.worldbank.org/indicators/gci?indicator=632&viz=line_chart&years=2007,2017&indicators=944

S ciljem pronalaženja odgovora na izuzetno slab uticaj varijabli inovativnosti na konkurentnost kod zemalja zapadnog Balkana, u nastavku smo analizirali određene varijable iz GCI za period 2008–2018. za sve odabrane zemlje i to 12. stub – inovacije, te varijable koje se odnose na izdatke kompanija za istraživanje i razvoj, sposobnost za inovacije i saradnju univerziteta i industrije u istraživanju i razvoju. Za sve navedene varijable daleko veće vrijednosti i bolja rangiranja imaju odabrane zemlje članice EU, u prvom redu Njemačka i Austrija. Primjera radi, najveći izdaci za istraživanje i razvoj, prikazano % GDP za 2018. godinu su zabilježeni u Austriji (3,17%) i Njemačkoj (3,09%), dok između 1 i 2% GDP izdvajaju Slovenija (1,94%), Mađarska (1,55%) i Grčka (1,18%). Najniži izdaci su zabilježeni u BiH (0,20%), potom slijede Crna Gora (0,37%), Rumunija (0,51%), Bugarska (0,77%), Srbija (0,92%) i Hrvatska (0,97%).[47]

Ipak, rezultati analize prosječne godišnje stope promjene tokom deset godina pokazuju različitu brzinu kretanja prethodno predstavljenih varijabli. Najbrži porast GCI su ostvarile Albanija i Sjeverna Makedonija, u prosjeku vrijednost indeksa godišnje je rasla 1,85% odnosno 1,39%, dok je kod Grčke, Hrvatske, Mađarske i Slovenije evidentan blaži pad indeksa. Kod BIH GCI u prosjeku godišnje raste po stopi od 0,96%. Slična situacija je kod 12. stuba, inovacija, gdje je najbrži rast ostvarila Albanija 4,30% dok je BiH postigla prosječni godišnji rast od 0,81%. Odgovor se dobrim dijelom može naći i u strukturi izvoza i strukturi privredne djelatnosti, odnosno zastupljenosti određenih industrija u zapošljavanju i ostvarenom prometu.[48]

Za dobijanje sveobuhvatnije slike o ulozi kompanija u funkcionisanju inovacionog sistema, analizirali smo statističke podatke za Bosnu i Hercegovinu i to: bruto domaće izdatke za IiR, udio ukupnih bruto domaćih izdataka za istraživanje i razvoj u GDP, broj zaposlenih na poslovima istraživanja i razvoja, broj objavljenih istraživačkih radova i broj jedinica koje se bave istraživanjem i razvojem za period 2012-2019. godina. Naš fokus je bio na pokazateljima vezanim za poslovni sektor u odnosu na državni sektor, visoko obrazovanje i neprofitni sektor. Primjetna je dominantna zastupljenost zaposlenih na poslovima istraživanja i razvoja u visokom obrazovanju u odnosu na poslovni sektor, dok je manja zastupljenost u državnom i neznatna u neprofitnom sektoru. Prema broju objavljenih istraživačkih radova takođe dominira visoko obrazovanje u odnosu na ostale posmatrane sektore, dok je kod broja jedinica koje se bave istraživanjem i razvojem manja razlika između sektora, ali i dalje na prvom mjestu je visoko obrazovanje. Prema istraživanju

[47] https://tcdata360.worldbank.org/indicators/GB.XPD.RSDV.GD.ZS?indicator=2013&viz=line_chart&years=1996,2017
uz napomenu da nisu bili raspoloživi podaci za Albaniju i Sjevernu Makedoniju.

[48] Matusiak M. i Kleibrink A. (ed.) (2018). *Supporting an Innovation Agenda for the Western Balkans: Tools and Methodologies.* Publications Office of the European Union, Luxembourg, doi:10.2760/48162, JRC111430.

inovativnih aktivnosti preduzeća u Bosni i Hercegovini, koje je provedeno na uzorku od 3.116 preduzeća za period 2016-2018. godina 35,6% je provelo bar jednu inovativnu aktivnost, dok 64,4% preduzeća nije provodilo inovativne aktivnosti.[49]

Posebno interesantno je analizirati izdatke za IiR, gdje ponovo dominira visoko obrazovanje u odnosu na poslovni sektor, a potom slijede državni i neprofitni sektor. Ukupni bruto domaći izdaci za istraživanje i razvoj u BDP se kreću oko 0,20% u periodu 2015–2019. godina. Od toga je polovina usmjerena na IiR u visokom obrazovanju. Slične podatke nalazimo i u Izvještaju Evropske komisije i to da je procijenjeni ukupni iznos sredstava koja zemlja odvaja za istraživanja još nizak, na nivou od 0,3% BDP-a. Nije postignut napredak u obezbjeđivanju pouzdanih i sveobuhvatnih statističkih podataka o istraživanjima i inovacijama.[50] Inače, budžetska sredstva institucija koje finansiraju aktivnosti istraživanja i razvoja su namijenjena najviše sektoru visokog obrazovanja 91,4%, zatim slijedi državni sektor sa namijenjenih 6,6% budžetskih sredstava. Ostala budžetska sredstva su namijenjena neprofitnom sektoru 1,6% i poslovnom sektoru 0,5%.[51]

U narednoj Tabeli su prikazani svi prethodno obrađeni indeksi (GII, GCI i GCI lag[52]) i pokazatelji izdvajanja za IiR za Bosnu i Hercegovinu s ciljem utvrđivanja koeficijenta korelacije.

Tabela br. 1 Prikaz GII, GCI i ukupnih bruto domaćih izdataka za IiR u BiH

varijabla/godine	2013	2014	2015	2016	2017	2018
GCI BiH	3,93	4,02		3,71	3,80	3,87
Ukupno bruto domaći izdaci za IiR u BiH, u KM	86.046.335	70.381.152	62.494.336	64.576.461	62.904.269	65.164.302
GII BiH	36,2	32,4	32,3	29,6	30,2	31,1
GCI BiH lag	4,02		3,71	3,80	3,87	

Izvor: Kalkulacija autora

[49] Agencija za statistiku Bosne i Hercegovine (2020). *Nauka, tehnologija i inovacije – Inovativne aktivnosti preduzeća, 2016-2018*, Godina IV, broj 1, Sarajevo, 30. 4. 2020. https://bhas.gov.ba/data/Publikacije/Saopstenja/2020/RDE_04_2016_Y2_0_BS.pdf

[50] Izvještaj o Bosni i Hercegovini za 2020, Saopštenje o politici proširenja EU-a za 2020. Evropska komisija, Brisel 6. 10. 2020, nezvanični prevod. https://europa.ba/wp-content/uploads/2020/10/Izvjestaj_za_BiH_za_2020_godinu.pdf, str. 92.

[51] Agencija za statistiku Bosne i Hercegovine (2020). *Nauka, tehnologija i inovacije – budžetska izdvajanja za istraživanje i razvoj, 2019.-2020.*, Godina VI, broj 1, Sarajevo, 21. 12. 2020. https://bhas.gov.ba/data/Publikacije/Saopstenja/2020/RDE_03_2019_Y2_0_BS.pdf

[52] Objašnjenje za GCI lag – u odnos su stavljani podaci visine izdataka za IiR iz jedne godine i GCI naredne godine, npr. izdaci iz 2017. a GCI iz 2018. godine.

Koeficijent linearne korelacije između izdataka za IiR i GCI iznosi 0,8673 što znači da je veza između izdataka za IiR[53] i GCI za BiH u posmatranom periodu 2013–2018. godina direktna jačine 86,73%. Sličnost je primjetna i kod koeficijenta korelacije GII sa GCI koji iznosi 0,6381, a znači da je veza između GII i GCI za BiH u posmatranom periodu direktna jačine 63,81%. Možemo zaključiti da su oba koeficijenta korelacije visoki odnosno relativno visoki što znači da postoji statistički značajna veza između izdataka za IiR i GCI, te da izdaci za IiR utiču na vrijednost indeksa konkurentnosti. Nešto slabija veza između GII i GCI u odnosu na vezu IiR i GCI ukazuje da globalni indeks inovacija uključuje više komponenti, te bi dublja analiza uzroka ovih odstupanja bila korisna i interesantna.

4. Zaključak

Inovacije i znanje u današnjem dinamičnom i nadasve neizvjesnom poslovnom okruženju predstavljaju ključne faktore za postizanje i očuvanje konkurentnosti kako kompanija tako i nacionalne privrede. Najrazvijenije zemlje današnjice svoj uspjeh su ostvarile upravo prelaskom sa kapitalom intenzivne na znanjem intenzivnu ekonomiju. Jedan od stubova ekonomije znanja jeste efektivan inovacioni sistem u kojem posebno mjesto i ulogu imaju kompanije, odnosno privredni subjekti. Jačanjem svojih istraživačko razvojnih aktivnosti i inovativnih sposobnosti kompanije doprinose oblikovanju i funkcionisanju inovacionog sistema. Međutim, istraživačko-razvojna aktivnost jednog preduzeća ne zavisi samo od njegovih sposobnosti nego i od faktora iz eksternog okruženja, kao što su stav vlade prema naučno istraživačkoj djelatnosti, veza između naučno-istraživačkih institucija (univerziteta i instituta) sa privrednim subjektima, brzina tehnološkog transfera i stopa zastarjevanja znanja. Samo koordinacijom aktivnosti poslovne i akademske zajednice i lokalne vlade, tj. primjenom *Triple Helix* modela mogu se postići sinergetski efekti i stvoriti veće vrijednosti.

Efekti inovativne aktivnosti na konkurentnost zemalja istraživani su primjenom globalnog indeksa inovacija (GII) i indeksa globalne konkurentnosti (GCI) i to na primjeru Bosne i Hercegovine, zemalja zapadnog Balkana i izabranih zemalja članica EU. Istovremeno, analiza doprinosi procjeni kvalitete njihovih nacionalnih inovacionih sistema. Na temelju provedenih analiza može se zaključiti da BiH i zemlje Zapadnog Balkana postižu niže

[53] https://bhas.gov.ba/data/Publikacije/Saopstenja/2020/RDE_03_2019_Y2_0_BS.pdf budžetska izdvajanja za istraživanje i razvoj, 2019–2020.

vrijednosti u inovacijskim performansama i to posmatrano za ukupni GII, potom III (indeks inovacijskog inputa) i IOI (indeks inovacijskog outputa). Od sedam varijabli globalnog indeksa inovacija za 2020. godinu, izuzetak predstavlja dimenzija sofisticiranost tržišta gdje zemlje zapadnog Balkana ne zaostaju (npr. za BiH vrijednost ove varijable je 50,1 a kod Austrije je 51,1). Međutim, vrijednost GII za BiH je 29, u poređenju sa ostalim posmatranim zemljama samo kod Albanije je niža vrijednost globalnog indeksa inovacija (27,1). Najveće vrijednosti GII u 2020. godini bilježe Njemačka 56,5 a slijede je Austrija (50,1) i Slovenija (42,9).

Slijedeći zaključci su rezultat analize korelacije između III i IOI na nivou zemalja zapadnog Balkana i na nivou izabranih zemalja EU. Linearnim modelom utvrđeno je postojanje veze osrednje jačine (52,3%) u zemljama zapadnog Balkana dok kod izabranih EU zemalja isti model ukazuje na statistički značajniju vezu između III i IOI, jačine 70,7%. U procesu analize korelacije između GII za 2017. godinu i GCI za 2018. godinu utvrdili smo kod odabranih zemalja EU snažnu direktnu linearnu korelaciju, kao i statistički signifikantan uticaj GII na GCI (97,3%), dok na nivou zemalja zapadnog Balkana ne postoji statistički značajan uticaj GII na GCI (11,2%). Kao uzroci izuzetno slabog uticaja varijabli inovativnosti na konkurentnost zemalja zapadnog Balkana mogu se posebno istaći izdaci za istraživanje i razvoj (% GDP) i izdvajanje kompanija za istraživanje i razvoj. Doprinos kompanija funkcionisanju inovacionog sistema može se pratiti i prema broju zaposlenih istraživača, broju istraživačkih jedinica i broju objavljenih radova. Ovi pokazatelji su predstavljeni za Bosnu i Hercegovinu, urađena je korelaciona analiza između izdataka za IiR i GCI, kao i između GII i GCI, te je utvrđeno postojanje statistički značajne veze između izdataka za IiR i GCI, kao i između GII i GCI.

Na temelju izloženog možemo zaključiti da se ne mogu očekivati visoke inovacijske performanse u privredi s malim postotkom izdataka za istraživanje i razvoj, te da niska inovativnost predstavlja ograničavajući faktor konkurentnosti. Stoga kompanije trebaju razvijati inovativne sposobnosti, podsticati istraživačko razvojne aktivnosti i kontinuirano učenje. Takvim, proaktivnim pristupom i intenzivnom saradnjom sa naučno-istraživačkim institucijama, uz podršku vlade doprinose efektivnom i efikasnom funkcionisanju inovacionih sistema, konkurentnosti privrede i dugoročnom ekonomskom i socijalnom razvoju.

Literatura

1. Adam F. (2014). *Measuring National InnovationPerformance – the Innovation Union Scoreboard Revisited.* Springer. Berlin, Heidelberg.
2. Agencija za statistiku Bosne i Hercegovine (2020). *Nauka, tehnologija i inovacije – Patenti 2019*, Godina VI, broj 1, Sarajevo, 15. 10. 2020, https://bhas.gov.ba/data/Publikacije/Saopstenja/2020/RDE_02_2019_Y1_0_BS.pdf
3. Agencija za statistiku Bosne i Hercegovine (2020). *Nauka, tehnologija i inovacije – budžetska izdvajanja za istraživanje i razvoj, 2019.-2020.,* Godina VI, broj 1, Sarajevo, 21. 12. 2020, https://bhas.gov.ba/data/Publikacije/Saopstenja/2020/RDE_03_2019_Y2_0_BS.pdf
4. Agencija za statistiku Bosne i Hercegovine (2020). *Nauka, tehnologija i inovacije – Inovativne aktivnosti preduzeća, 2016-2018*, Godina IV, broj 1, Sarajevo, 30. 4. 2020.
5. Bilas V., Bošnjak M. i Novak I. (2019). Inovacijska izvedba zemalja članica Europske unije. *Oeconomica Jadertina* 1/2019, str. 34-44.
6. Chaminade, C. i Lundvall B. (2019). *Science, Technology, and Innovation Policy:Old Patterns and New Challenges*. Oxford University Press. Oxford.
7. Chuvakhina L.G., Terskaya G.A. i Buevich S.Y.(2018). Innovations as a factor of state's improved performance in the World Economic System. *Revista Espacios*, Vol. 39 (# 04) Year 2018.
8. CPU-Centre for Policy and Gouvernance. *Konkurentnost ekonomije u BiH i regionu 2014-2018.* http://www.cpu.org.ba/media/35585/Konkurentnost-ekonomije-u-BiH-i-regionu-2014-2018.pdf (pristup 15. 6. 2021. godine)
9. Cvetanovic D., Cvetanović S. i Bogić D. (2020). *Rastući značaj koncepta regionalnih inovacionih sistema za ekonomski i društveni razvoj*, https://konferencija.komorapirot.com/44.RASTUCI%20ZNACAJ%20KONCEPTA%20REGIONALNIH%20INOVACIONIH%20SISTEMA%20ZA%20EKONOMSKI%20I%20DRUSTVENI%20RAZVOJ.pdf. (pristup 11. 6. 2021. godine)
10. Cvetanović S., Despotović D., Mladenović I. i Jovović D. (2014). The analysis of innovation in Western Balkan countries in 2012. *Economic Research-Ekonomska Istraživanja*, 27:1, 830-846, DOI: 10.1080/1331677X.2014.974920
11. Despotović D. i Cvetanović S. (2017). The theoretical explication of the factors of regional growth and the economic convergence (divergence) of the region. *Economic Horizons*, May - August 2017, Volume 19, Number 2, 111 – 125.
12. Dossou Y.L. i Khvatova T.Y. (2020). Analysis of innovative activity of companies in developing countries on the example of West African countries. *St. Petersburg State Polytechnical University Journal. Economics*, 13 (1) (2020) 79–90. DOI: 10.18721/JE.13107
13. European Commision (2020). *Science, research and Innovation Performance of the EU 2020, A fair, green and digital Europe.* Publication Office of the European Union. Luxembourg. https://ec.europa.eu/info/publications/science-research-and-innovation-performance-eu-2020_en. (pristup 11. 6. 2021. godine)
14. Fatma A. (2018). Overview of the Japanese Innovation Systems vs. the American Innovation System. *Journal of Global Economics,* 6: 312. doi:10.4172/2375-4389.1000312
15. Freeman, C. (1995). The "National System of Innovation" in historical perspective. *Cambridge Journal of Economics*, 19 (1) 5–24.
16. Gogodze J. (2016). Mechanisms and Functions within a National Innovation System. *Journal of Technology Management&Innovation*, Universidad Alberto Hurtado, Facultad de Economía y Negocios. Volume 11, Issue 4, str. 12-21.

17. Hetze P. i Meyer M. (2018). *Was bringt die Oeffnung von Wissenschaft und Innovation?* Stifterverband Bildung. Wissenschaft.Innovation, Berlin.
18. http://ec.europa.eu/europe2020/index_en.htm, (pristup 10. 6. 2021. godine)
19. https://tcdata360.worldbank.org/indicators/GB.XPD.RSDV.GD.ZS?indicator=2013&viz=line_chart&years=1996,2017, (pristup 10. 6. 2021. godine)
20. https://bhas.gov.ba/data/Publikacije/Saopstenja/2020/RDE_03_2019_Y2_0_BS.pdf
21. https://bhas.gov.ba/data/Publikacije/Saopstenja/2020/RDE_04_2016_Y2_0_BS.pdf
22. https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation_en, (pristup 10. 6. 2021. godine)
23. https://govdata360.worldbank.org/indicators/ha03bec65?indicator=41619&viz=line_chart&years=2017,2019, (pristup 10. 6. 2021. godine)
24. https://tcdata360.worldbank.org/indicators/gci?indicator=632&viz=line_chart&years=2007,2017&indicators=944, (pristup 10. 6. 2021. godine)
25. https://www.globalinnovationindex.org/analysis-indicator, (pristup 10. 06. 2021. godine)
26. Izvještaj o Bosni i Hercegovini za 2020, *Saopštenje o politici proširenja EU-a za 2020*. Evropska komisija. Brisel 6. 10. 2020, nezvanični prevod, https://europa.ba/wp-content/uploads/2020/10/Izvjestaj_za_BiH_za_2020_godinu.pdf (pristup 11. 06. 2021.)
27. Jankowska B., Matysek-Jędrych A. i Mroczek-Dąbrowska, K. (2017). Efficiency of national innovation systems: Poland and Bulgaria in the context of the Global Innovation Index. *Comparative Economic Research*, De Gruyter, Warsaw, Vol. 20, Iss. 3, pp. 77-94.
28. Ješić J. (2015). *Model četverostruke spirale (Quadruple Helix Model) kao osnova nacionalnog inovacionog sistema.* Doktorska teza. Univerzitet Edukons Fakultet poslovne ekonomije Sremska Kamenica, Novi Sad.
29. Jovičić J. i Petković S. (2016). Inovacije kao faktor konkurentnosti privrede s osvrtom na Bosnu i Hercegovinu. *Obrazovanje za preduzetništvo*, 6(1), str. 99-110.
30. Kaynak S., Altuntas S. i Dereli T. (2017). Comparing the innovation performance of EU candidate countries: an entropy-based TOPSIS approach. *Economic Research-Ekonomska Istraživanja*, 30:1, 31-54, DOI: 10.1080/1331677X.2016.1265895
31. Leydesdorff L. i Strand Ø. (2013). The Swedish System of Innovation: Regional Synergies in a Knowledge-Based Economy. *Journal of the American Society for Information Science and Technology*, DOI: 10.1002/asi.22895
32. Mandić S. i Trivunović D. (2020). Analiza konkurentnosti ekonomije Bosne i Hercegovine. *Jahorina Business Forum 2020*, str. 511-520.
33. Melaas A. i Zhang F. (2016). *National Innovation Systems in the United States and China A Brief Review of the Literature.* The Center for International Environment&Resource Policy, Tufs University. Medford.
34. Mosurović Ružičić M., Miletić M. i Dobrota, M. (2021). Does a National Innovation System Encourage Sustainability? Lessons from the Construction Industry in Serbia. *Sustainability 2021*, 13, 3591. https://doi.org/10.3390/su13073591
35. OECD (2013). *Triple Helix partnerstva za inovacije u Bosni i Hercegovini.* Razvoj privatnog sektora – Priručnik za politike, Sarajevo.
36. OECD (2005). *Oslo Manual: Guidelines for collecting and interpreting innovation data.* 3. izdanje, OECD, Pariz.
37. Piljić J. (2018). Analiza konkurentnosti Bosne i Hercegovine i preporuke za jačanje konkurentnosti, Tranzicija/Transition. *Časopis za ekonomiju i politiku tranzicije/ Journal of economic and politics of Transition*, Godina XX, Vitez-Tuzla- Zagreb-Beograd-Bukurešt, br. 41.

38. Polt W., Rammer Ch., Schartinger D., Gassler H. i Schibany A. (2001). Benchmarking Industry-Science Relations in Europe – the Role of Framework Conditions. *Science and Public Policy*, 28 (4), pages 247-258, August 2001.
39. Porter M. i Stern, S. (2002). National innovative capacity. In K. Scwab, M. Porter, & J. Sachs (Eds.), *The global competitiveness report 2001–2002*, 102–118. Oxford University Press. New York.
40. Puljiz J. (2009). *Faktori regionalnog razvoja i regionalnih nejednakosti u Republici Hrvatskoj*. Doktorska disertacija, Ekonomski fakultet, Sveučilište u Splitu. Split, Republika Hrvatska. https://www.bib.irb.hr/393855
41. Radošević S. (2002). Regional innovation systems in Central and Eastern Europe: Determinants, organizers and alignments. *The Journal of Technology Transfer*, 27, 87–96.
42. Rahimić Z. (2006*). Izgradnja konkurentskih prednosti preduzeća kroz njegova strateška opredjeljenja.* Ekonomski fakultet u Sarajevu. Sarajevo.
43. Rahimić Z. i Kožo A. (2009). Building and Development of the Knowledge Based Economy in Bosnia and Herzegovina. *Journal of Interdisciplinary Management Research*, Vol. V, January 2009, str. 111-122.
44. Rigg C., Coughlan P., O'Leary D. i Coghlan D. (2021). A practice perspective on knowledge, learning and innovation – insights from an EU network of small food producers. *Entrepreneurship & Regional Development*, DOI: 10.1080/08985626.2021.1877832
45. Schrempf B., Kaplan D. i Schroeder D. (2013). *National, Regional, and Sectoral Systems of Innovation–An overview*. Report for FP7 Project "Progress", progressproject.eu. https://www.progressproject.eu/wp-content/uploads/2013/12/Progress_D2.2_final.pdf
46. Sciene, research and Innovation Performance of the EU 2020, A fair, green and digital Europe, European Commission,https://ec.europa.eu/info/publications/science-research-and-innovation-performance-eu-2020_en
47. Trifković M. (2020). *Harmonizacija sistema nauke u Bosni i Hercegovini.* Akademija nauka i umjetnosti Bosne i Hercegovine, Centar za sistemska istraživanja, knjiga 5/1, posebna izdanja. Sarajevo.
48. Vukotić S., Zakić N. i Ćurčić N. (2017). Menadžment znanja i upravljanje inovacijama kao izvor poslovnog uspeha i konkurentske predosti preduzeća. *Četvrti naučno-stručni skup POLITEHNIKA 2017*, str. 436-442.
49. Warnke P. et al. (2016). *Opening up the innovation system framework towards new actors and institutions.* Fraunhofer ISI Discussion Papers - Innovation Systems and Policy Analysis, No. 49, Fraunhofer ISI, Karlsruhe.
50. Wojciech N. (2016). Composite Indexes Economic and Social Performance: Do They Provide Valuable Information. *Foundations of Management*, Vol. 8, str. 167- 174.
51. Yongabo P. i Göransson B (2020). Constructing the national innovation system in Rwanda: efforts and challenges. *Innovation and Development*, DOI:10.1080/2157930X.2020.1846886

DOI: 10.5644/PI2021.200.08

Uticaj razvoja scienciometrije na izgled i funkcionisanje sistema nauke u svijetu i pojedinim državama[*]

Enver Zerem[**]
Suad Kunosić[***]

Sažetak: Društveni značaj i kvalitet naučnog istraživanja u velikoj mjeri ovise o korisnosti rezultata istraživanja za društvenu i naučnu zajednicu. Nedostatak sredstava i želja da se sredstva dodijele visokokvalitetnim istraživanjima čine sve značajnijim procjenu kvaliteta istraživanja i valorizaciju znanja. Međutim, vrlo je teško primijeniti kriterije koji mogu objektivno procijeniti naučna istraživanja, pružajući precizne kvalitativne i kvantitativne podatke na kojima bi agencije za finansiranje mogle temeljiti svoje odluke. Proizvod naučnog istraživanja uglavnom su informacije objavljene u naučnim časopisima. One su temelj širenja znanja i osnovni kriterij za akademsku i naučnu evaluaciju, regrutovanje sredstava za naučna istraživanja i napredovanje u karijeri. Pored evaluacije naučnih publikacija, postoji širok spektar drugih aktivnosti koji odražavaju naučni kredibilitet znanstvenika, kao što su: broj i kvalitet grantova za naučnoistraživačke projekte, liderstvo u nacionalnim ili međunarodnim akademskim društvima, članstvo u redakcijama uglednih časopisa, mentorstva u doktorskim disertacijama i slično.

Mada su te aktivnosti važne i daju kredibilitet znanstveniku, relevantni scientimetrijski sistemi pokrivaju samo publikacije, izostavljajući druge kriterije od naučne važnosti, u ocjenjivanju prilikom akademskog napredovanja znanstvenika, kao i konkursima za dobijanje grantova za finansijsku potporu naučnim istraživanjima. Razlog tome je činjenica da su ove aktivnosti, bez obzira na važnost, vrlo heterogene, sa specifičnim karakteristikama i zahtijevaju veoma raznolike parametre za ocjenu. Stoga, za ove aktivnosti ne postoje univerzalni kriterijumi vrednovanja i njihov se kvalitet, uglavnom, procjenjuje individualno, ovisno o namjeni procjene. Bez obzira na manjkavosti, sistemi rangiranja univerziteta su važni komparativni parametri za procjenu kvaliteta naučne i edukativne vrijednosti univerziteta.

Ključne riječi: međunarodno priznati kriteriji, naučnoistraživački rad, edukacija, liste rangiranja univerziteta

[*] Ovaj rad je finansijski podržan od strane Federalnog ministarstva obrazovanja i nauke, Federacija Bosne i Hercegovine, kao dio naučno-istraživačkog projekta pod nazivom "Uticaj pandemije COVID-19 na naučnu produkciju, citiranost naučnika i rangiranje univerziteta u Bosni i Hercegovini"

[**] Redovni član Akademije nauka i umjetnosti Bosne i Hercegovine, Odjeljenje medicinskih nauka; Kantonalna bolnica "Dr. Safet Mujić", Mostar. E-mail: zerem@live.com

[***] Dr. sci., Odsjek za fiziku, Prirodno-matematički fakultet Univerziteta u Tuzli. E-mail: kunosic@gmail.com

Autor za korespodenciju: Enver Zerem

Uvod

Malo je procesa i događaja u istoriji čovječanstva koji su više od nauke transformirale društvo i doprinijele opštem dobru. Dostignuto znanje stečeno naučnim istraživanjima je milijarde ljudi spasilo od siromaštva, potaknulo industrijalizaciju i masovne komunikacije neslućenih razmjera, iskorijenilo brojna oboljenja i omogućilo čovjeku da ostavi svoje otiske na mjesecu. Danas je nauka velika industrija koja proizvodi nova znanja, obično za rješavanje određenih problema ili pitanja s kojima se suočava čovječanstvo. Kao i svaka druga industrija, tako i naučna, koristi svoje alate i resurse - naučnike, novac i vrijeme - za stvaranje svojih proizvoda: naučnog znanja, koje se prezentira preko publikacija u naučnoj literaturi.

Tokom 20. vijeka, ali i početkom 21. finansiranje nauke sve više preuzimaju vlade i javni fondovi bogatih zemalja i internacionalnih korporacija. Najznačajniji javni fondovi i druge organizacije koje finansiraju većinu naučnih istraživanja, ujedno su i glavni potencijalni korisnici ishoda naučnih istraživanja, koji trebaju biti pretočeni u opšti društveni progres, te obezbjediti profit i održivost fondacija. Upravo to je razlog da se najviše finansijskih sredstava ulaže u istraživanja koja trebaju donijeti benefite vojnoj industriji i kompetitivne prednosti u ekonomiji. Spoznaja da su investicije u biomedicinskim istraživanjima pretočene u konkretni praktični napredak u više medicinskih disciplina, ostvarila je snažnu društvenu potporu za ulaganje javnih fondova u cilju podrške biomedicinskoj znanosti.

Velike investicije u nauku uglavnom su usmjerene u bazična naučna istraživanja, što nedvojbeno rezultira povećanjem baze znanja. Međutim, rezultati istraživanja dobijeni kroz bazična naučna istraživanja često nisu komparabilni s očekivanom brzinom primjene tih rezultata u praktičnim unapređenjima u industriji, društvenom progresu i javnom zdravlju. Usporeni rezultati primjene naučnih istraživanja nose rizike da potkopaju povjerenje u nauku, donesu negativne implikacije na finansiranje naučnih istraživanja i relativno usporavanje naučnih inovacija. Često je neophodno sprovesti dodatna, takozvana, translacijska istraživanja koja bi omogućila transfer znanja dobijenih fundametalnim istraživanjima ka njihovoj praktičnoj primjeni.

Treba napomenuti da fundamnentalna (bazična) naučna istraživanja imaju vrlo važno suštinsko značenje i društvenu vrijednost u proizvodnji novih informacija koje uvećavaju sveukupnu ljudsku znanost, te su korisna i kada nemaju neposredni opipljivi ishod na primjenjene djelatnosti. Također je logično pretpostaviti da sva temeljna naučna istraživanja imaju određenu vjerojatnost za generiranje opipljivih rezultata u praktičnoj djelatnosti, iako takvi ishodi mogu biti nepredvidljivi i udaljeni kako u vremenu tako i u sadržaju primjene (naprimjer, teorija opšteg relativiteta, koja je znanstveno dokazana 1916. godine, donijela je koristan ishod za javno dobro tek krajem 20. vijeka[1].

Međutim, uprkos suštinskoj društvenoj vrijednosti znanja postignutim fundamentalnim naučnim istraživanjima, očito je da javne agencije i finansijski fondovi podržavaju naučna istraživanja s ciljevima usmjerenim na ishod, uključujući dobrobit za zdravlje i sprečavanje bolesti, unapređenja i inovacije u industriji i ekonomiji te povećanje profita i povrata ulaganja. Upravo zbog toga razvila se velika konkurencija među ponuđačima usluga (univerziteti i naučni instituti) koji konkuriraju za dobijanje grantova koji suportiraju naučnoistraživačke projekte. Svi univerziteti, a često i naučni instituti, su institucije koje uz naučnoistraživački rad imaju i važnu ulogu u edukaciji i odgajanju novih kadrova. Edukativna djelatnost univerziteta se, također, u visokom procentu finansira iz javnih fondova i državnih proračuna[2].

Rad akademskog osoblja prije nekoliko decenija bio je mnogo lagodniji nego danas. Univerzitetski nastavnici imali su obavezu da se bave nastavom i drugim oblicima edukacije studenata. Neki od njih su radili na naučnoistraživačkim projektima koji nisu imali imperativan ishod niti rok završetka. Naprimjer, u Velikoj Britaniji univerzitetski nastavnici su imali ugovor po kome su obavezni da se bave nastavom, religijom i da održe najmanje četiri predavanja tokom akademske godine. Imali su i načelnu obavezu da se bave naučnoistraživačkim radom, ali bez preciznih kriterija za ocjenu rezultata istraživanja, niti roka za završetak istraživanja. Ipak, i u tako ležernoj atmosferi bez presije na naučnike i bez velikih ulaganja u infrastrukturu i istraživanja, naporan rad inovatora i istraživački um znanstvenika ostvarili su neka epohalna otkrića (npr. Sir Godfrey Hounsfeld, otkriće računarske tomografije)[3]. Dolaskom u premijersku fotelju Margaret Thatcher, u akademskoj zajednici Velike Britanije, a kasnije i cijele Evrope, uvode se nova pravila za univerzitetske nastavnike: petogodišnji obnovljivi ugovori prema precizno dogovorenim ciljevima i uslovima za obnovu ugovora prema kriterijima zasnovanim na scientimetrijskim parametrima.

Novi ugovori za univerzitetsko osoblje koje je uvela premijerka Margaret Thatcher nisu dočekani s oduševljenjem u akademskoj zajednici, ne samo kod neambicioznih univerzitetskih nastavnika nego čak i kod uglednih

[1] Ashby, 2003:1–42; Bowen &Casadevall, 2015:11335-40.
[2] Horton, 1998:892.
[3] Hounsfield, 1973:1016-22

naučnika i pronalazača epohalnih otkrića. Naprimjer, Max Perutz, suotkrivač strukture hemoglobina (sa Johnom Kendrewom), energično je zastupao stajalište da do otkrića poput njihovih nije moglo doći po novim principima tretiranja nauke kratkoročnim ugovorima, jer određeni pronalazak zahtijeva gotovo dvije decenije razvoja, nakon početnog otkrića, prije ulaska u rutinsku primjenu u praksi[4]. Brojni naučnici su tvrdili da negativni pritisci na naučne institucije i naučnike i vremenska ograničenja za istraživanja mogu doprinijeti relativnom usporavanju znanstvenih inovacija i dovesti do zanemarivanja edukativne/nastavne komponente u radu univerziteta. Za razliku od definicije efikasnosti zasnovane na proizvodnji (output-input), ocjenjivanje prethodnih rezultata istraživanja naučnika i naučnih institucija, koji konkurišu na dobijanje grantova, mnogo je komplikovanije.

Međutim, bez proučavanja i praćenja ishoda ne može se saznati isplati li se ulaganje društva u istraživanje u odnosu na inpute i ne može se procijeniti efikasnost i učinkovitost naučnih institucija, kao i praktični značaj naučnih inovacija u usporedbi sa ulaganjima u istraživanje. Praćenje naučnih inputa, rezultata i ishoda može koristiti za procjenu produktivnosti naučnoistraživačkih institucija i može biti korisno u procjena budućih reformi i promjena politike. Da bi bio primjenjiv. sistem pokazatelja kvaliteta treba biti što jednostavniji i racionalniji u pogledu pružanja potrebnih informacija za adekvatnu procjenu kvaliteta istraživanja. Ovisno o kontekstu upotrebe, moguće je razlikovati različite aspekte kvaliteta. Kvalitet istraživanja ukazuje na korisnost rezultata istraživanja za naučnu zajednicu u okviru jedne ili više naučnih disciplina. Društveni kvalitet, koji sve više dobija na značaju, ukazuje na korisnost rezultata istraživanja za širu grupu: vladu, privredu i industriju, institucije kulture i civilnog društva. U stvarnoj praksi kvalitet naučnog istraživanja određuju nezavisni experti (takozvana "peer-review" recenzija) na osnovu internacionalnih scietimetrijskih parametara. U zavisnosti od namjene "peer-review" procjena može biti podržana i dopunjena drugim indikatorima kvaliteta koji se ne mogu izraziti scientimetriskim parametrima (dobijeni grantovi, uredništvo naučnih časopisa, pozicije u akademskoj zajednici, mentorstvo u naučnim projektima i doktoratima i slično).

[4] Kendrew&Perutz, 1948:375-98.

Kriteriji za procjenu kvaliteta naučnog istraživanja

Društveni značaj i kvalitet naučnog istraživanja u velikoj mjeri ovise o korisnosti rezultata istraživanja za društvenu i naučnu zajednicu. Nedostatak sredstava za naučna istraživanja i želja da se sredstva dodijele visokokvalitetnim istraživanjima čine sve značajnijim mjerenje i procjenu kvaliteta istraživanja i valorizacije znanja. Međutim, vrlo je teško primijeniti naučne kriterije koji mogu objektivno procijeniti naučna istraživanja, pružajući precizne kvalitativne i kvantitativne podatke na kojima bi agencije za financiranje mogle temeljiti svoje odluke.

Ključno pitanje, koje je uvijek u nauci i obrazovanju ostajalo nedorečeno, je na osnovu kojih kriterija se mjeri taj kvalitet, te kako se može osigurati ispunjenje standarda da svi daju adekvatni kvalitet izlaznih kompetencija. Pošto se naučno-istraživački rad preko inovacija, patenata i publikacija može puno egzaktnije mjeriti i evaluirati, u odnosu na edukativne i ostale djelatnosti zastupljene u visokom obrazovanju, ovi parametri se često pojavljuju kao predeterminirajuće mjere u evaluaciji kvaliteta visokog obrazovanja[5].

Na kvalitet naučno-istraživačkog rada i na ukupnu naučnu produkciju evaluiranu kroz inovacije, patente i publikacije najviše utječu: nacionalni dohodak, procenat izdvajanja iz nacionalnog dohotka za naučno-istraživački rad, internacionalni kriteriji za valorizaciju naučnih istraživanja, uslovljenost akademskog napredovanja i znanstvene valorizacije i međunarodne naučne komunikacije.

Proizvod naučnog istraživanja uglavnom su informacije objavljene u naučnim časopisima i one su temelj širenja znanja, kao i osnovni kriterij za akademsku i naučnu evaluaciju, regrutovanje sredstava za naučna istraživanja i napredovanje u karijeri. Tačno je da, pored evaluacije naučnih publikacija, postoji i širok spektar drugih naučnih aktivnosti koji takođe odražavaju naučni kredibilitet znanstvenika, kao što su: broj i kvalitet grantova za naučnoistraživačke projekte, liderstvo u nacionalnim ili međunarodnim akademskim društvima, članstvo u redakcijama uglednih časopisa, služba u nacionalnim komitetima za ekspertnu provjeru naučnoistraživačkih projekata koje sponzorira država, mentorstva u doktorskim disertacijama, broj ekspertnih i tematskih članaka u takozvanoj laičkoj štampi i slično[6].

Iako su te aktivnosti važne i daju određeni značaj naučnoj vjerodostojnosti znanstvenika, relevantni metrički znanstveni sistemi pokrivaju samo

[5] Dixon, 2009: 847-50; Zerem, 2017: 107-9;Zerem & Kunosić, 2018: 133-4.
[6] Miles, 1991:643-5; Zerem, 2013:128.

publikacije i izostavljaju druge kriterije od naučne važnosti, koje bi imalo smisla koristiti u ocjenjivanju prilikom akademskog napredovanja znanstvenika kao i konkursima za dobijanje grantova za finansijsku potporu naučnim istraživanjima. Razlog tome je činjenica da su ove aktivnosti, bez obzira na važnost, vrlo heterogene, jer svaka od njih ima specifične karakteristike i zahtijeva različite parametre za ocjenu. Stoga za ove parametre od naučne važnosti ne postoje univerzalni kriterijumi vrjednovanja i njihova se vrijednost uglavnom procjenjuje pojedinačno, ovisno o namjeni procjene[7].

Rangiranje univerziteta i odnos prema rangiranju u zemljama našeg regiona

Borba za zauzimanje prestižnog mjesta na svjetskoj rang listi vrhunskih univerziteta sve više se rasplamsava i poprima karakteristike bitke za status i različite vrste dominacije najrazvijenijih zemalja svijeta. Ulažu se značajna finansijska sredstva u formiranje različitih internacionalnih listi rangiranja univerziteta. Relevantne liste rangiranja univerziteta uzimaju u obzir različite parametre, ali za većinu univerziteta (s djelimičnim izuzetkom prvih 100) najveći značaj pri rangiranju ima broj publikacija i utjecaj koje te publikacije ostvare citiranjem.

Najprestižnije liste rangiranja univerziteta u svijetu objavljuju svoje rezultate jednom ili dva puta godišnje. U akademskim zajednicama, pa i u medijima zemalja regiona, tim rezultatima se daje veliki značaj i oni budu propraćeni vrlo aktivno, nekada burno, a nekada čak i preemotivno u odnosu na racionalnost koja se očekuje od pripadnika akademskih zajednica. Neki univerziteti iz zemalja regiona, a to se u prvom redu odnosi na Univerzitete u Ljubljani, Beogradu i Zagrebu, ostvarili su tokom posljednjih godina značajan napredak na internacionalnim listama rangiranja. Akademske zajednice u tim zemljama stalno evaluiraju i iznalaze mogućnosti za napredovanje svojih univerziteta na rang listama, a mediji analiziraju i upoređuju rezultate svojih univerziteta sa rezultatima drugih univerziteta u svijetu i posebno u regionu.

Paradoksalna je situacija u Bosni i Hercegovini. Nasuprot dugogodišnjem, u našoj javnosti već etabliranom, aksiomskom mišljenju da smo najbolji, svi naši univerziteti, ili nisu uopšte rangirani na internacionalnim listama, ili su rangirani značajno ispod univerziteta sličnog ranga u regionu. Koliko se u javnosti zna, nijedan osnivač (politički mentor) naših univerziteta nije tražio

[7] Marušić&Marušić, 1999:1713-14; Zerem, 2014:248-51; Zerem, 2018:147-8.

da, poboljšavanje pozicije na internacionalnim rang listama, bude uslov u procjeni uspješnosti rada univerziteta čiji je osnivač, niti je na početku godine neki univerzitet to sebi postavio za cilj. Kako u ovakvoj atmosferi na univerzitetu i u društvu naći dovoljno snage koja stremi pravim (svuda u svijetu priznatim) vrijednostima i koja bi naše univerzitete mogla unaprijediti na svjetskim rang listama kvaliteta?[8]

Zašto rangirati univerzitete?

U nastojanju da se tradicionalni sistem obrazovanja učini otvorenijim i fleksibilnijim primjetan je korak ka njegovoj decentralizaciji, i to ne samo teritorijalnoj, nego i više funkcionalnoj, kao i jačanju autonomije u obrazovanju i edukaciji. U decentraliziranom obrazovnom sistemu upravljanje se provodi pomoću ciljeva i rezultata koji promovišu jednakost i reproduciraju zajedničku vrednosnu osnovu.

U tom procesu, posebno je komplikovana pozicija visokog obrazovanja, jer je naučno-istraživački rad njegov neminovni dio i bez tog dijela, visoko obrazovanje ostaje neinventivno i u nemogućnosti da opravda svoju svrhu. Pošto se naučno-istraživački rad, preko inovacija, patenata i publikacija može puno egzaktnije mjeriti i evaluirati u odnosu na edukativne i ostale djelatnosti zastupljene u visokom obrazovanju, ovi parametri se često pojavljuju kao predeterminirajuće mjere u evaluaciji kvaliteta visokog obrazovanja. Oponenti ovakvom načinu evaluacije univerziteta napominju da se na ovaj način ne ocjenjuje nastava, već samo naučni rad, pa ovaj način rangiranja univerziteta ne odražava sve parametre kvaliteta univerziteta, posebno one koji odražavaju savremenost i kvalitet programa, nastave i profesora. Ipak, većina se slaže da se te neregularnosti odnose samo na niskorangirane univerzitete kod kojih, relativno mali broj publikacija može uzrokovati statističke "artefakte", dok je za publikovanje velikog broja značajnih znanstvenih publikacija, što je karakteristika visokorangiranih univerziteta, potrebno postići adekvatan kvalitet i u ostalim segmentima djelatnosti[9].

Globalne rang-liste su izložene čestim kritikama i negodovanju, posebno od strane onih koji su nezadovoljni pozicijom svojih univerziteta pri rangiranju i evaluacijama na raznim nivoima, ali je činjenica da za sada nisu ponuđene eventualne alternative ovom trendu. Zato je logično zaključiti da, uprkos stalnim promjenama i evoluciji u dizajnu rangiranja akademskog kvaliteta,

[8] Zerem, 2013:128; Zerem, 2014:248-51.
[9] Petković, 2013; Zerem, 2014:248-51.

kao i ostalih manjkavosti, analize sistema rangiranja pokazuju da oni postaju dio realnosti i rada hiljada univerziteta u svijetu.

Uporedive informacije o institucijama visokog obrazovanja, njihovom podučavanju i istraživačkim programima treba da olakšaju studentima i istraživačima da odaberu gdje i šta studirati i gdje raditi. Bolja informisanost također bi pomogla i onima koji donose politike na institucionalnom, nacionalnom i evropskom nivou, u razvijanju buduće strategije za visoko obrazovanje. Trenutna, u najvećoj mjeri jednodimenzionalna rangiranja, ne ispunjavaju ove svrhe jer imaju tendenciju fokusiranja na određene aspekte istraživanja i na cijele institucije, a ne na individualne programe i discipline. Ovakav pristup zahtijeva nove oblike upravljanja i programiranja naučnoistraživačkog i edukativnog rada. Glavni cilj u tom pravcu je uspostaviti efikasan i fleksibilan sistem akreditacije davalaca/organizatora obrazovnih usluga i certificiranja stečenih znanja i vještina.[10]

Postojeći sistemi rangiranja univerziteta

Rangiranje univerziteta bi trebalo da obuhvati kriterijume kao što su: obrazovanje, istraživanje, kvalitet nastavnika, međunarodnu saradnju i sredstva (finansije) koje ostvaruju univerziteti svojim radom. Relevantna su mjerila koja se mogu izraziti kvantitativno, kao što su: broj upisanih studenata, procenat diplomiranih studenata, odnos broja nastavnika i broja studenata, broj doktorskih disertacija, nagrade kako nastavnika tako i studenata i "alumni" studenata, citiranost, broj radova objavljenih na SCI ili SSCI listi, broj patenata, broj međunarodnih časopisa koje univerzitet ili fakultet izdaje, broj stranih autora u tim časopisima, web sajt i dostupni web servisi, univerzitetske biblioteke, opremljenost laboratorijskog i učioničkog prostora itd. Važna mjerila kvaliteta univerziteta su i prihodi koji se ostvaruju od školarine, sredstva koja se ostvaruju iz državnih fondova, sredstva koja potiču od fondova EU itd. Jedan od veoma važnih kriterijuma je i međunarodna saradnja gdje bi se vršila analiza o broju stranih studenata koji studiraju na univerzitetu kao i broj studenata koji je otišao da studira na druge univerzitete (mobilnost studenata). Isto tako, za ukupnu ocjenu rada univerziteta značajan je broj gostujućih profesora na univerzitetu, kao i broj profesora izabranih na tom univerzitetu koji su izabrani u zvanje gostujućeg profesora na drugim univerzitetima.

[10] Petković, 2015.

Iako je broj sistema za rangiranje univerziteta svake godine sve veći, četiri su najznačajnije i najreprezentativnije liste, koje rangiraju univerzitete na nivou cijelog svijeta koristeći različite parametre i načine bodovanja. Najznačajnije liste rangiranja univerziteta su: Šangajska lista,The times higher education supplement – THES, WEBOMETRICS rangiranje i SCImago rangiranje[11].

Šangajska lista

Akademsko rangiranje svjetskih univerziteta (the Academic Ranking of World Universities) (ARWU) prvi je put objavljeno u junu 2003. godine. Pedagoški fakultet Univerziteta Shanghai Jiao Tong, Kina, ažurira ovu listu svake godine. ARWU koristi šest objektivnih indikatora za rangiranje univerziteta, uključujući broj alumnija i profesora koji su osvojili Nobelovu nagradu i medalje za određene oblasti, broj visokocitiranih istraživača u časopisima koji su citirani u bazi Thomson Scientific (sada "Clarivate Analytics journal list"), broj članaka objavljenih u časopisima "Nature" i "Science", broj članaka indeksiranih u Science Citation Index – Expanded i u Social Sciences Citation Index, te učinak *per capita* u odnosu na veličinu institucije. Svake godine ARWU rangira više od 1000 univerziteta, a najboljih 500 objavljuje na mreži.

The Times higher education supplement – THES

Časopis Times u dodatku o visokom obrazovanju - THES (The Times Higher Education Supplement) rangira univerzitete od 2004. godine. THES rangiranje se bazira na četiri kriterijuma za koje se smatra da reprezentuju kvalitet rada univerziteta i to: visokokvalitetno istraživanje, visokokvalitetna nastava, visoka stopa zaposlenosti diplomiranih i dobar "internacionalni imidž". Problem ovakvog načina rangiranju su neki kriteriji koji su objektivno teško mjerljivi kao što je naprimjer kriterij visokokvalitetna nastava.

WEBOMETRICS rangiranje

Rangiranje univerziteta na listi **Ranking Web of World universities** je inicijativa laboratorija Cybermetrics (**Cybermetrics Lab**), istraživačke grupe Centra za humanističke i društvene nauke (Centro de Ciencias Humanas y

[11] Hall,1998:1230; Klaic,1997:88-98.

Sociales - CCHS), u sastavu National Research Council – **CSIC** u Španiji. Laboratorij “Cybermetrics” rangira univerzitete na osnovu kvantitativne analize sadržaja na internetu i webu, posebno onih koji su povezani s procesima nastave i akademske komunikacije. Ovim rangiranjima tim webometricsa želi istraživače širom svijeta dodatno motivisati da objavljuju više i kvalitetnije naučne sadržaje na webu, te da ih učine dostupnim kolegama i drugim zainteresovanim u cijelom svijetu. Rangiranje svjetskih univerziteta “Webometrics” službeno je pokrenuto 2004. godine i ažurira se svakih 6 mjeseci (podaci se prikupljaju u januaru i julu, a objavljuju jedan mjesec kasnije).

SCImago rangiranje

SCImago je istraživačka grupa koja se bavi informatičkom analizom u različitim oblastima. Čine je Institut za politiku i javne poslove Nacionalnog istraživačkog vijeća Španije (CSIC), SCImago Institut i više univerziteta (Univerzitet u Granadi, Univerzitet Carlos III u Madridu, Univerzitet Ekstramadura, Univerzitet Alcala de Hanares i Univerzitet Porto). SCImago Institutional Ranking – SIR je globalna lista rangiranja koja rangira institucije iz sfere RDI (univerziteti, fakulteti, instituti, istraživački centri, bolnice, poslovne kompanije i sl.) koje imaju najmanje 100 indeksiranih publikacija na godišnjem nivou. U SIR tabelama rangiranja visokoškolske organizacije i RDI institucije su rangirane na bazi ukupnog broja publikacija na bazi pretraživanja u bazi podataka SCOPUS [12].

Rangiranje univerziteta u Bosni i Hercegovini

Univerziteti i fakulteti u BiH su sve više edukacijske, a sve manje naučne institucije, te simboliziraju miks srednjeg i visokog obrazovanja, ne postajući niti jedno niti drugo, u prvom smislu riječi. Prije posljednjeg rata 1992–1995. godine u BiH su postojala 4 javna univerziteta (Sarajevo, Tuzla, Mostar i Banja Luka). Bosanskohercegovački fakulteti i univerziteti su u tom periodu, uglavnom, nastajali iz već postojećih naučnih institucija (najčešće instituta), koje su se godinama prije toga bavili naučno-istraživačkim radom. Fakulteti su se osnivali na logičan način kojim su instituti, kao već respektabilne naučne institucije, dobijali i svoju obrazovnu ulogu, te na taj način prerastali u fakultete za tu naučnu oblast.

[12] Brennan-Krohn, 2011.

Šta se dogodilo sa našom akademskom zajednicom u toku i nakon posljednjeg rata? Ukoliko nam je rat mogao biti izgovor za određene propuste u prvim poslijeratnim godinama, teško da nam to može biti opravdanje i 25 godina nakon rata. Zbog čega nismo u međuvremenu uspjeli vratiti onu poziciju i značaj visokom obrazovanju kakvu ono zaslužuje? Najkraći odgovor na ovo pitanje bio bi: nismo uspjeli uvesti kriterije, kojima bi nekontrolisano-rastući kvantitet visokoškolskih ustanova pretvorili u kvalitet[13].

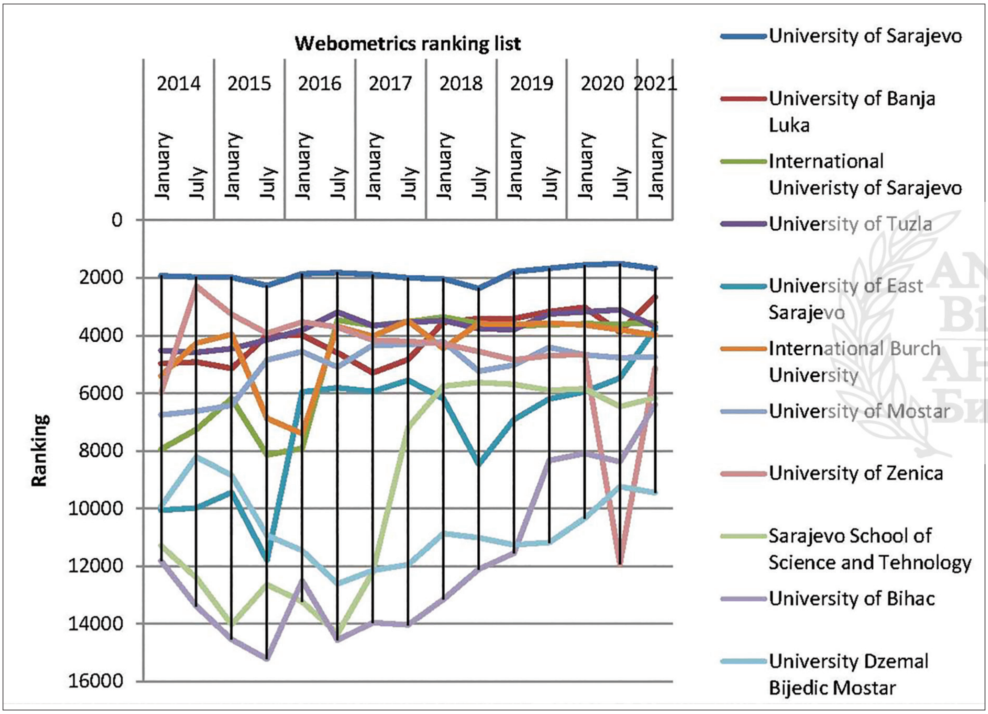
Tako, tokom 2002. godine u sistemu bosanskohercegovačkog visokog obrazovanja prisutne su 43 institucije visokoškolskog obrazovanja u rangu univerziteta/koledža ili samostalnih fakulteta (10 javnih univerziteta/fakulteta i 33 u privatnom vlasništvu), a 2012. godine u BiH egzistira 25 univerziteta sa 177 fakulteta, 10 akademija i 4 vjerska fakulteta. Od tada broj visokoškolskih ustanova u našoj zemlji stalno raste. Međutim, taj nekontrolisani rast broja visokoobrazovnih institucija nije ni približno praćen porastom znanstvene produkcije, koju bi od tolikog broja univerziteta i fakulteta bilo logično očekivati. Naučno-istraživački rad i znanstvene publikacije kao njegova najrelevantnija evaluacijska konfirmacija su osnovna pokretačka energija visokog obrazovanja. Bez te pokretačke energije, naše visoko obrazovanje postalo je teški bolesnik kome se “krv pretvara u vodu” (ili znanost zamjenjuje politikantstvom), svedeno na puku obrazovnu komponentu koju sprovode nekompetentni protagonisti.

Ako primijenimo liste rangiranja, opisane u ovom članku (Šangajska lista, The Times higher education supplement – THES, SCImago rangiranje, Webometrics list) na naše univerzitete, treba napomenuti da su naši univerziteti rangirani samo na Webometrics listi. Ostale tri liste rangiraju, direktno, samo univerzitete koji su rangirani do hiljaditog mjesta na njihovim listama i na njima se ne prezentira niti jedan naš univerzitet. Webometrics rangira dva puta godišnje (januar i juli), praktično sve prijavljene univerzitete (preko 30.000 univerziteta i fakulteta) na osnovu edukativnih i znanstvenih kriterija. Ti kriteriji kontinuirano evoluiraju i u manjoj mjeri se mijenjaju, ali u suštini ostaju navedene (edukativna i znanstvena) komponente, koje su osnova Webometrics rangiranja.

Na Slici 1. prikazano je rangiranje najuspješnijih univerziteta u BiH od 2014. do 2021. godine, pri čemu su prikazani presjeci za oba godišnja rangiranja (januar i juli). Univerzitet u Sarajevu je jedini naš univerzitet koji je na Webometricsovoj listi pozicioniran među 2000 najboljih univerziteta (između

[13] Zerem, 2013:128; Zerem, 2014:248-51

1500. i 2000. mjesta) u svijetu, izuzev u julu 2015. i 2018. godine, kada je bio pozicioniran ispod 2000. mjesta. Činjenica je da je Sarajevski univerzitet naš najbolje rangirani univerzitet, ali je isto tako činjenica da je niže rangiran u odnosu na sve javne univerzitete u Sloveniji, Hrvatskoj (izuzev Univerziteta u Osijeku) i Srbiji. Isto tako, na grafikonu je uočljivo da u posmatranom periodu stagnira, ne pokazujući tendenciju napretka koji bi ga doveo u poziciju da bude rangiran i na ostalim listama rangiranja. Tako skromna pozicija našeg najvećeg univerziteta, s ubjedljivo najvećim resursima i budžetom, imala je negativan impakt na razvoj nauke, drugih naših univerziteta i visokog obrazovanja u našoj zemlji.



Slika 1. Prikaz najuspješnijih univerziteta u BiH na webometrics listi za period 2014–2021.

Univerzitet u Banjoj Luci je drugorangirani univerzitet u našoj zemlji na posljednjoj (januar, 2021. godine) listi rangiranja i uz Sarajevski je jedini naš univerzitet rangiran u 3000 najuspješnijih univerziteta. U analiziranom periodu (od 2014. godine) Banjalučki univerzitet pokazuje postepeni rast i s 4977. mjesta dostigao je 2658. mjesto, a u rangiranju naših univerziteta s četvrtog na drugo mjesto. Univerzitet u Tuzli je bio drugorangirani univerzitet u BiH do kraja 2016. godine, da bi nakon toga bio pozicioniran između 3500. i 4000. mjesta na ukupnoj Webometricsovoj listi i pomjeren s drugog na četvrto mjesto u konkurenciji naših univerziteta[14]. Ostali naši javni univerziteti bili su locirani iza 4000. mjesta na Webometricsovoj listi u analiziranom periodu s povremenim kratkotrajnim uzlaznim trendovima (Zenica 2014. godine), koji su bili više rezultat prilagođavanja trenutnim kriterijima Webometrics liste, nego kontinuiranog objektivnog kvaliteta. Na grafiku se uočava da su najveći nominalni napredak u analiziranom periodu ostvarili Univerzitet u Istočnom Sarajevu (za 6270 pozicja) i Univerzitet u Bihaću (za 5412 pozicija). Iako je njihov uspjeh, fokusirajući se samo na brojeve impozantan, ako posmatramo pozicije tih univerziteta s trendom izmjena kriterija na Webometricsovoj listi prikazanoj na Tabeli 1, koje ne idu u prilog malim univerzitetima, trebamo zadržati rezervu prema daljem napredovanju, na Webometrics listi, ovih univerziteta.

Od privatnih univerziteta u BiH najbolje je pozicioniran International University of Sarajevo, koji je ujedno i treći najbolje pozicionirani univerzitet u BiH. Ovaj univerzitet prezentira činjenicu da je selekcioniranje kadrova i kolaboracija s kadrovski moćnijim matičnim univerzitetom dobar recept za solidan uspjeh u konkurenciji naših univerziteta. Sličan način rada sa sličnim rezultatima do 2016. godine ima i International Burch University. Nakon 2016. godine, International Burch University ima određene kadrovske probleme što se odražava i padom na listi rangiranja.

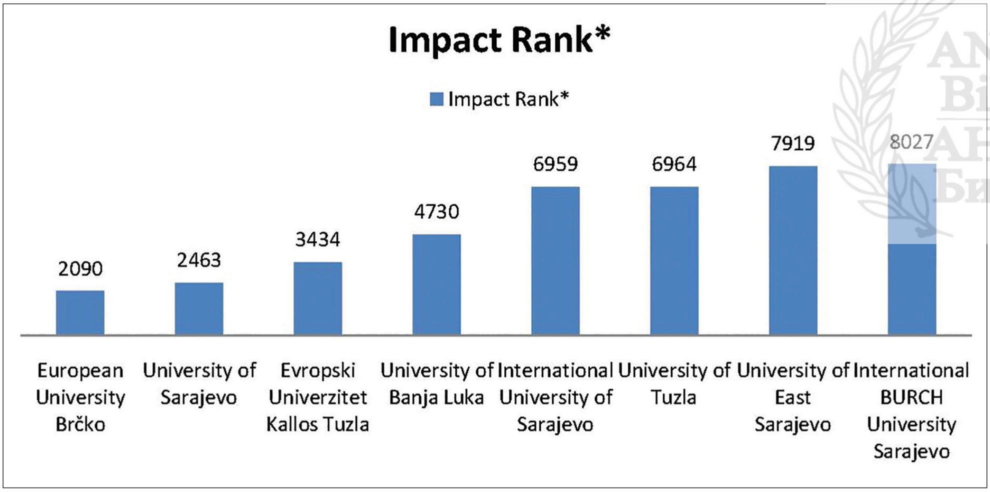
U rangiranju za januar 2021. izmijenjena je metodologija rangiranja koju koristi Webometrics tako da su za rangiranje univerziteta korištena samo 3 kriterija (Tabela 1). Na slikama 2, 3. i 4. prikazano je rangiranje naših najuspješnijih univerziteta po svakom od tri kriterija odvojeno. Na tim slikama su prikazane neke činjenice koje objektivnije prezentiraju kvalitet rada naših univerziteta. Najuočljivija je činjenica da prema kriteriju "Impact Rank" dva privatna univerziteta (Evropski univerzitet Brčko i Evropski univerzitet Kallos) koji imaju istog vlasnika, rangirani su na prvom i trećem mjestu u konkurenciji naših univerziteta. Istovremeno, u rangiranju "Openness Rank" i "Excellence Rank" nijedan od ta dva univerziteta nije rangiran u prvih 10 u konkurenciji naših univerziteta. Ove činjenice svakako zahtijevaju podrobniju analizu, ali se i bez analize može reći da postoji velika zainteresovanost nekih privatnih univerziteta za brže napredovanje na listama rangiranja koje nije u skladu sa njihovim realnim kvalitetom i nedovoljnu zainteresovanost nekih drugih, u prvom redu javnih univerzioteta.

[14] Kunosić, S., Čeke, D., Zerem, E, 2019; Čeke&Kunosić, 2021.

Tabela 1. Webometrics university ranking methodology (January edition, 2021)

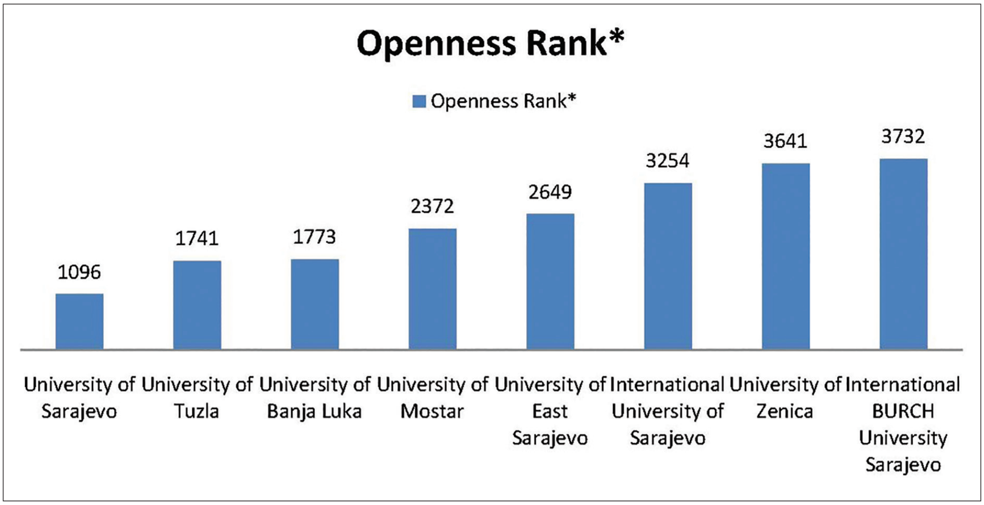
INDICATORS	MEANING	METHODOLOGY	SOURCE	WEIGHT
PRESENCE		This indicator has been discontinued		
VISIBILITY	Web contents Impact	Number of **external networks** (subnets) linking to the institution's webpages (normalized and then the maximum value is chosen)	*Ahrefs Majestic*	**50%**
TRANSPARENCY (or OPENNESS)	Top cited researchers	Number of **citations** from **Top 210 authors** (excl. top 20 outliers)	*Google Scholar Profiles*	**10%**
EXCELLENCE (or SCHOLAR)	Top cited papers	Number of **papers** amongst the top 10% most cited in each one of the all 27 disciplines of the full database Data for the five year period: **2015-2019**	*Scimago*	**40%**

Novom metodologijom Webometrics je ujednačio procenat težina između edukativnih i znastavenih kriterija. Osim toga iz godine u godinu Webometrics povećava uticaj znastvenih kriterija koji utiču na rangiranje univerziteta u cijelom svijetu. Izmjena kriterija je značajno uticala i na pozicije pojedinih univerziteta u BiH što se jasno vidi na slikama 2, 3. i 4.



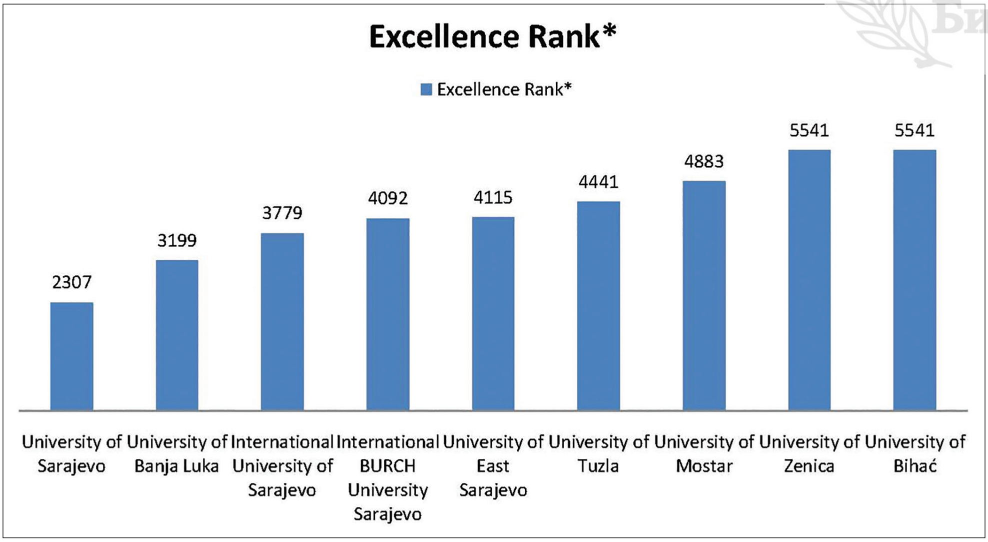
Slika 2. Prikaz najuspješnijih univerziteta u BiH po kriteriju "Impact rank" za januar 2021.

Prema "impact ranku" (Slika 2) najbolje je pozicioniran Europen University Brčko, a među 8 najboljih u ovoj kategoriji su 4 privatna univerziteta. Uočljivo je da javni univerziteti u BiH imaju mnogo prostora za napredovanje prema ovom kriteriju rangiranja po kojem se objektivno može najbrže i najlakše napraviti progres na listi rangiranja



Slika 3. Prikaz najuspješnijih univerziteta u BiH po kriteriju "Openness rank" za januar 2021.

Za razliku od prethodnog kriterija "Impact Rank", prema kriteriju "Opennness Rank" tj. broju citata naučnika s google scholar na Slici 3. uočljiva je prednost javnih univerzieta, među kojima prednjače univerziteti koji imaju više zaposlenih znanstvenika.



Slika 4. Prikaz najuspješnijih univerziteta u BiH po kriteriju "Exellence rank" za januar 2021.

Najznačajniji znastveni kriterij “exellence rank” koji je zastupljen s 40 procenata od ukupnog scora na Webometrics rangiranju, a prva tri mjesta rangiranja univerziteta u BiH po ovom kriteriju identična su kao i prve tri pozicije na ukupnoj Webomwtricsovoj listi (Slika 1. i 4).

U izvještaju SJR: Scimago za period 1996–2019. godina (Slika 5). Bosna i Hercegovina zauzima 95. mjesto u svijetu po broju objavljenih naučnih članka, ali s nižom stopom citiranosti od Makedonije koja ima manji broj publiciranih članka. Najbolju poziciju na listi zauzima Hrvatska koja je na 50. poziciji, Slovenija (52. mjesto) i Srbija (53. mjesto)   Slovenija ima najveći broj citata i najveći H index u odnosu na sve ostale države koje su nastale nakon raspada Jugoslavije.

Rank	Country	Doc	Citable doc	Citations	Self-citat	Citat per doc	H index
50	Croatia	113256	107688	1146885	197804	10,13	282
52	Slovenia	101460	96022	1490029	224168	14,69	310
53	Serbia	101388	95763	989159	184758	9,76	247
95	Bosnia and Herzegovina	13884	12961	94225	9735	6,79	103
97	Macedonia	12815	12117	133726	12137	10,44	121
123	Montenegro	4717	4474	32182	5984	6,82	64

Slika 5. Analiza broja članaka, citata, H indexa za prema listi SJR: Scimago za period 1996–2019. godina.

Međutim, kada se napravi analiza broja dokumenata i citata po stanovniku (Slika 6), Bosna i Hercegovina je na posljednjem mjestu, u konkurenciji zemalja slijednica bivše Jugoslavije i prema broju dokumenata i prema broju citata. Podaci navedeni na slikama 5. i 6, jasno ukazuju da je u poslijeratnom periodu Bosna i Hercegovina najviše zaostajala u važnim parametrima koji prezentiraju stanje nauke u određenoj državi ili društvenoj zajednici.

Number of Articles per population	
Slovenia	0,049
Croatia	0,026
Serbia	0,014
Montenegro	0,008
Macedonia	0,006
Bosnia and Herzegovina	0,004

Number of quotations per population	
Slovenia	0,713
Croatia	0,268
Serbia	0,141
Montenegro	0,064
Macedonia	0,052
Bosnia and Herzegovina	0,027

Slika 6. Broj članka i citata po stanovniku, a prema listi SJR: Scimago za period 1996–2019. godina.

Zbog čega nismo uspjeli kontrolisati taj nagli porast broja fakulteta, univerziteta i naučnika i usaglasiti ga s realno očekivanom znanstvenom produkcijom koja je to trebala pratiti i biti mu nužni korektiv?

Prvo treba pomenuti objektivne uzroke. Svi univerzitetski centri u Bosni i Hercegovini su, odmah na početku rata (ali i tokom cijelog rata pa i kasnije), ostali bez značajnog broja kadrova, koji su do tog momenta bili nosioci aktivnosti na tim univerzitetima. Te kadrove bilo je nužno zamijeniti drugim nastavnicima da bi se održalo funkcionisanje univerziteta u ratnim uslovima. Normalno je i očekivano da te zamjene u ratnim uslovima, vrlo često, nisu bile adekvatne. Međutim, nakon toga se pravi odlučujuća greška. Akademska zajednica se ne uspijeva suprotstaviti propagandi i stvaranju opšte klime, da se u akademskoj zajednici trebaju napustiti etablirani i univerzalni internacionalni znanstveni kriteriji i uvesti lokalni kriteriji koji su jedino primjereni za zemlju u ratnim uslovima. Uvođenjem lokalnih kriterija, ratom izolovana akademska zajednica, postaje meta lokalne politike, koja počinje sa sve frekventnijim 'ubacivanjem' svojih kadrova koji po novim kriterijima, potpuno ispunjavaju uslove. To dovodi do slabljenja uticaja nauke, kao osnovne pokretačke snage akademske zajednice i jačanja uticaja politike u našim visokoškolskim institucijama.

Jedan dio odgovora sadržan je u Dejtonskoj postavci položaja obrazovanja, pa tako i visokog obrazovanja u našoj zemlji, gdje o radu pa i o osnivanju novih visokoškolskih ustanova odlučuju entitetske, a u Federaciji čak kantonalne političke strukture. Te strukture su pokazale potpunu nekompetentnost da odlučuju o tako sofisticiranim problemima, bez razumjevanja suštine funkcionisanja visokog obrazovanja. To se odnosi i na sredine kao što su Sarajevo, Banjaluka, Tuzla i Mostar koji su bili univerzitetski centri i prije rata. Sa druge strane, mali kantoni, koji su ranije jedva održavali sistem srednjeg obrazovanja dobili su pravo da osnivaju univerzitete i postali su pravi eldorado za privatne fakultete nekontrolisanog i sumnjivog kvaliteta i lokalne moćnike željne univerzitetske slave. Neki kantoni otvorili su po nekoliko privatnih fakulteta, pa čak i univerziteta, prije nego što su donijeli Zakon o visokom obrazovanju. Znači te ustanove su praktično radile prema svom vlastitom nahođenju, bez ikakve zakonske pa i suštinske kontrolne regulative[15]. Sve navedeno, dovelo je do prave poplave naučnih zvanja i nastavnih titula koje nisu niti u kakvoj korelaciji s realnom znanstvenom produkcijom[16]. Na taj način studenti dobijaju već u startu pogrešnu poruku pa se ne identificiraju

[15] Zerem, 2014:248-51

[16] Zerem, E., Kunosić, S., Imširović, B., & Kurtčehajić, A. 136-142.

s nastavnicima koji su ostvarili znanstvena dostignuća, nego se usmjeravaju na dobijanje naučnih titula bez nauke i što brži uspon u karijeri bez objektivnih pokazatelja znanstvene izvrsnosti. Postavlja se pitanje da li sada uopšte vrijedi uvesti neke standarde u visoko obrazovanje, jer smo mi već nafabrikovali kadrove po dosadašnjim kriterijima, koji će biti aktivni bar do 2040. godine[17].

Perspektive i zaključna razmatranja

Društveni značaj i kvalitet naučnog istraživanja u velikoj mjeri ovise o korisnosti rezultata istraživanja za društvenu i naučnu zajednicu. Nedostatak sredstava za naučna istraživanja i želja da se sredstva dodijele visokokvalitetnim istraživanjima čine sve značajnijim mjerenje i procjenu kvaliteta istraživanja i valorizacije znanja.

Međutim, u nauci i obrazovanju uvijek je ostajalo otvoreno pitanje, koji kriteriji mogu objektivno procijeniti kvalitet rada visokoškolskih ustanova i tako osigurati ispunjenje standarda koji daju adekvatan kvalitet izlaznih kompetencija. Pošto se naučnoistraživački rad preko inovacija, patenata i publikacija može puno egzaktnije mjeriti i evaluirati, u odnosu na edukativne i ostale djelatnosti univerziteta, ovi parametri se često pojavljuju kao predeterminirajuće mjere u evaluaciji kvaliteta visokog obrazovanja.

U sadašnjoj situaciji, kada niti u jednom segmentu našeg visokoškolskog obrazovanja ne postoji dovoljan nivo znanja, posvećenosti i opredjeljenosti ka preduzimanju sistemskih mjera za poboljšanje kvaliteta rada naših visokoškolskih institucija, teško je reći koje bi mjere trebalo preduzeti da bi se to stanje popravilo, te da bi naši univerziteti napredovali na listama rangiranja. Jasno je, da se u kriterijima za formiranje listi rangiranja univerziteta mogu pronaći brojne manjkavosti, ali da sistemi rangiranja, htjeli mi to prihvatiti ili ne, postaju dio realnosti postojanja i rada hiljada univerziteta u svijetu.

Činjenica je da investicije u naučno-istraživački rad utiču na poboljšanje znanstvene produkcije. Ali, bez uvođenja međunarodno-priznatih naučnih kriterija u evaluaciji naučnih istraživanja, i koordinacije akademskog napretka u skladu s kriterijima, čak i trenutačne mizerne investicije u nauku su u biti beskorisno trošenje novca poreznih obveznika. Drugi, ne manji, važan razlog za ovakvo stanje našeg visokog obrazovanja i nauke, je njegova rascjepkanost i spuštanje nadležnosti nad njima na entitete i kantone, koji su potpuno

[17] Zerem, 2013;38:128; Zerem, 2014:248-51.

nekompetentni za tu ulogu. Postojanje efektivne regulatorne institucije na nivou Bosne i Hercegovine, koja bi utvrđivala jedinstvene kriterije u visokom obrazovanju na nivou cijele države sa posjedovanjem kompentencija i mehanizma za efektivan nadzor njihovog sprovođenja, doprinijelo bi popravljanju stanja u nauci i visokom obrazovanju..

Reference

1. Ashby, N. (2003). Relativity in the Global Positioning System. Living Rev Relativ. Vol. 6(1):1. DOI: 10.12942/lrr-2003-1
2. Bowen, A., Casadevall A. (2015). Increasing disparities between resource inputs and outcomes, as measured by certain health deliverables, in biomedical research. Proc Natl Acad Sci U S A. 112(36):11335-40. DOI: 10.1073/pnas.1504955112.
3. Brennan-Krohn, Z. The Bologna Process in Bosnia-Herzegovina: Strengthening, Re-Branding, or Undermining Higher Education? In: 1st International Conference on Foreign Language Teaching and Applied Linguistics (FLTAL), Sarajevo/Bosnia and Herzegovina, 5-7 May 2011.
4. Dixon, A.K. (2009) Publishing and academic promotion. Singapore Med J. 50(9):847-50.
5. Hall, T. (1998) The haunted forest: a ghost story. Lancet 352:1230. DOI: 10.1016/S0140-6736(05)60578-8.
6. Horton, R. Publication and promotion. A fair reward. Lancet. 352:892. DOI: 10.1016/S0140-6736(05)60578-8
7. Hounsfield, G.N. (1973) Computerized transverse axial scanning (tomography). 1. Description of system. Br J Radiol 46:1016-22. DOI: 10.1259/0007-1285-46-552-1016
8. Kendrew, J.C., Perutz, M.F. (1948). A comparative X-ray study of foetal and adult sheep haemoglobins. Proc R Soc Lond A Math Phys Sci 194:375-98. DOI: 10.1098/rspa.1948.0087.
9. Klaic, B. (1997). Analysis of scientific prodictivity in Croatia according to the Science Citation Index, Social Science Citation Index, and Arts & Humanities Citation Index for the 1980-1995 period. Croat Med J. 38:88-98.
10. Kunosić, S., Čeke, D., Zerem, E.: Advantages and disadvantages of the webometrics ranking system. In: Kunosić, S., Zerem, E., (eds.) Scientometrics Recent Advances (2019). https://www.intechopen.com/books/scientometrics-recent-advances/advantages-and-disadvantages-of-the-webometrics-ranking-system
11. Čeke D and Kunosić S. (2021) Analiza kvalitete naučno-istraživačkog rada bazirana na citiranosti naučnih radnika i rangiranosti univerziteta u Covid-19 vremenu u Bosni i Hercegovini. Quality 2021 (S.Brdarević, S. Jašarević, editors)", ISSN 1512-9268, Neum, B&H, 17-19 June 2021., pp. 17-22
12. Marušić, A., Marušić M. (1999). Authorship criteria and academic reward. Lancet 353:1713-14.
13. Miles, K.A., Hayball, M., Dixon, A.K. Colour perfusion imaging: a new application of computed tomography. Lancet 1991; 337:643-5. DOI: 10.1016/0140-6736(91)92455-b.
14. Petković,B., Petković,D., Ćatić, R. (2013). Kako povezati sistem osiguranja kvaliteta u visokom obrazovanju sa aspekta postojećih sistema rangiranja univerziteta. Naučno-stručni skup sa međunarodnim učešćem "QUALITY 2013", Neum, B&H, 06. – 08. juni 2013.

15. Petković, B., Pehlić, I., Ćatić, R. Petković, D. Analiza spremnosti BH visokoškolskih organizacija za procese međunarodnih rangiranja rangiranja. Naučno-stručni skup sa sa međunarodnim učešćem "QUALITY 2015", Neum, B&H, 10. – 13. juni 2015.
16. Zerem, E. (2013). Right criteria for academia in Bosnia and Herzegovina. Lancet. 382:128. DOI: 10.1016/S0140-6736(13)61565-2
17. Zerem, E. (2014). Academic community in a developing country: Bosnian realities. Med Glas (Zenica). 11:248-51.
18. Zerem, E. (2017). The ranking of scientists based on scientific publications assessment. J Biomed Inform. 75:107-109. DOI: 10.1016/j.jbi.2017.10.007.
19. Zerem, E. (2018). The ranking of scientists. J Biomed Inform. 79:147-148. DOI: 10.1016/j.jbi.2018.02.007
20. Zerem, E.; Kunosić, S. (2018) The ranking of scientists: Computational calculation of Z-score. J. Biomed. Inform. 81: 133–134. DOI: 10.1016/j.jbi.2018.04.002.
21. Zerem, E., Kunosić, S., Imširović, B., & Kurtčehajić, A. (2021). Science metrics systems and academic promotion: bosnian reality. Psychiatria Danubina, 33(suppl 3), 136-142.

DOI: 10.5644/PI2021.200.09

Teškoće u unapređenju nauke i oblikovanju sistema nauke i univerziteta kao nosioca tehnološkog razvoja u Bosni i Hercegovini

Dejan Milošević[*]
Benjamin Fetić[**]

Apstrakt: Osnovna funkcija univerziteta, pored obrazovanja, je naučnoistraživački rad. Na bosanskohercegovačkim univerzitetima je naučnoistraživački rad zapostavljen. Dva su osnovna razloga za to. Prvi je nedovoljno finansijsko ulaganje u nauku i istraživanja, a drugi je nedovoljno razvijena svijest o značaju naučnoistraživačkog rada, kako u bosanskohercegovačkom društvu, tako i na samim univerzitetima. U ovom radu je ukazano na to šta je potrebno uraditi da se ova druga teškoća prevaziđe. Pored toga, analizirane su mogućnosti unapređenja nauke i oblikovanja sistema nauke na bosanskohercegovačkim univerzitetima, kako bi oni postali i istraživački univerziteti. Na naučnoistraživački rad se nadovezuju istraživačko-razvojni rad, tehnološki razvoj, saradnja s privredom i razvoj naučno-tehnoloških parkova. Ove djelatnosti su još manje zastupljene na bosanskohercegovačkim univerzitetima nego naučnoistraživački rad. U ovom radu je ukazano na načine kako prevazići te teškoće, kako bi istraživački univerziteti postali nosioci tehnološkog razvoja Bosne i Hercegovine.

Ključne riječi: bosanskohercegovački univerziteti, nauka, istraživanje, razvoj, tehnologija

Uvod

U Bosni i Hercegovini postoji osam javnih univerziteta, šest u entitetu Federacija Bosne i Hercegovine u pet kantona (Univerzitet u Sarajevu, Univerzitet u Bihaću, Univerzitet „Džemal Bijedić" u Mostaru, Sveučilište u Mostaru, Univerzitet u Tuzli i Univerzitet u Zenici) i dva u entitetu Republika Srpska (Univerzitet u Banjoj Luci i Univerzitet u Istočnom Sarajevu). Privatnih univerziteta u Bosni i Hercegovini ima ukupno osamnaest, od čega devet u Federaciji Bosne i Hercegovine, sedam u entitetu Republika Srpska i dva u distriktu Brčko. Pored toga, u Bosni i Hercegovini djeluje šesnaest

[*] Redovni član Akademije nauka i umjetnosti Bosne i Hercegovine i redovni profesor na Prirodno-matematičkom fakultetu Univerziteta u Sarajevu. E-mail: milo@bih.net.ba
[**] Doc. dr., Prirodno-matematički fakultet Univerziteta u Sarajevu.
E-mail: benjamin.fetic@pmf.unsa.ba

samostalnih fakulteta i visokih škola u privatnom vlasništvu. Nažalost, nema podataka o tome u kojoj se mjeri ove institucije bave naučnoistraživačkim radom.[1] Nijedan javni ili privatni univerzitet nema u svom sastavu jedinice koje su proglašene centrima izvrsnosti. Povezanost ovih institucija sa privredom je ocijenjena kao nedovoljna (Trifković, 2020).

Naučna istraživanja se klasifikuju kao fundamentalna, primijenjena i razvojno-istraživačka (Trifković, 2020). Uz obrazovanje, naučnoistraživački rad je osnovna funkcija univerziteta. Nažalost, na bosanskohercegovačkim univerzitetima naučnoistraživački rad je zapostavljen. To se može uvidjeti kroz analizu položaja bosanskohercegovačke nauke i bosanskohercegovačkih univerziteta na svjetskim rang listama. U okviru projekta „Harmonizacija sistema nauke u Bosni i Hercegovini“ (Trifković, 2020) Akademije nauka i umjetnosti Bosne i Hercegovine pokazano je da je glavni razlog nezadovoljavajućeg stanja nauke u Bosni i Hercegovini njena policentrična i atrofirana organizacija. Predložene mjere za poboljšanje stanja nauke baziraju se na harmonizaciji sistema nauke putem zakonodavstva nadležnih političko teritorijalnih jedinica. Ukazano je na to da je, pored usklađivanja postojećih i donošenja novih zakona, potrebno revidirati postojeće strategije, pojačati i modernizovati odgovarajuće kapacitete javne uprave, odvojiti budžetsko finansiranje naučnoistraživačke i tehnološko-razvojne djelatnosti od finansiranja nastavne komponente visokog obrazovanja, znatno povećati izdvajanja za nauku u odnosu na trenutnih 0,1% bruto nacionalnog dohotka, odrediti prioritete u međunarodnoj saradnji i formirati savjete za nauku.

Većina gore navedenih predloženih mjera za poboljšanje položaja nauke su „top-down“ tipa. Predviđeno je da se odluke donose na višem nivou (npr. promjena zakona, donošenje strategija) uz očekivanja da će to dovesti do željenih promjena. Nažalost, realnost bosanskohercegovačkog društva je takva da se zakoni različito interpretiraju, a strategije ne sprovode. Vlasti ne shvataju koliko je nauka važna za društvo. Ne postoji državno ministarstvo za nauku jer je, prema Ustavu Bosne i Hercegovine, obrazovanje, zajedno s naučnoistraživačkim radom, u nadležnosti kantona u Federaciji Bosne i Hercegovine, odnosno entiteta Republika Srpska. Zakonska regulativa zavisi od nivoa vlasti, tako da se donose parcijalna rješenja. Ne postoji politika nadležnih institucija za povratak u domovinu najboljih studenata koji su otišli iz Bosne i Hercegovine u svrhu obrazovanja. Kadrovska politika univerziteta

[1] Vidjeti: *Odgovori na Upitnik Evropske komisije – Poglavlje 25 – Nauka i istraživanje*, Direkcija za evropske integracije Vijeća ministara Bosne i Hercegovine, DEI | Odgovori na Upitnik EK. (2. 11. 2020)

je neadekvatna, odnosno praktično ne postoji. Ovaj rad ukazuje na mogućnost drugačijeg pristupa. „Bottom-up“ pristup bi trebao postepeno dovesti do promjene svijesti vlasti i pojedinaca o značaju nauke i naučnoistraživačkog rada za razvoj bosanskohercegovačkog društva. Potrebno je stvoriti kritičnu masu naučnika koji se zaista bave naučnoistraživačkim radom, što se može izmjeriti egzaktnim pokazateljima utvrđenim međunarodnim standardima i kriterijima, kao što su to broj i kvalitet objavljenih radova koje prati baza podataka Web of Science Core Collection, h-index i sl.

Nakon ovoga uvoda, u narednim poglavljima su prvo predstavljeni egzaktni pokazatelji o položaju bosanskohercegovačke nauke i bosanskohercegovačkih univerziteta u svijetu. Dobijeni rezultati su bazirani na analizi pažljivo odabranih svjetskih rang listi. Nakon toga su predstavljeni Strategija razvoja naučnoistraživačkog/umjetničkoistraživačkog rada na Univerzitetu u Sarajevu i Pravilnik o nagrađivanju akademskog i naučnoistraživačkog osoblja Univerziteta u Sarajevu na osnovu rezultata naučnog/umjetničkog rada kao primjeri „bottom-up“ mjera za poboljšanje položaja nauke u Bosni i Hercegovini. Prikazat će se i rezultati analize broja i citiranosti radova s afilijacijom Univerziteta u Sarajevu. U preostalom dijelu rada su predstavljeni podaci o institutima, naučnoistraživačkim centrima, tehnološkim parkovima i patentima u Bosni i Hercegovini. Ukazano je na slabosti sistema prikupljanja podataka o naučnoistraživačkom radu. Finansiranje i problemi realizacije zapošljavanja naučnika i istraživača su razmotreni neposredno prije zaključaka s kojima se ovaj rad završava.

Položaj bosanskohercegovačke nauke u svijetu

Položaj nauke neke države u svijetu se utvrđuje prema doprinosu naučnika te države naučnoj produkciji izraženoj brojem i značajem naučnih publikacija. Postoje različite rang liste država.[2] Npr. Nature index[3] je baza podataka zasnovana na radovima objavljenim u izabranoj grupi od 82 visokokvalitetna časopisa. S obzirom da je broj takvih radova objavljenih od bosanskohercegovačkih autora zanemarljiv, opredijelili smo se za analizu podataka dostupnih

[2] Akademska rangiranja, Agencija za znanost i visoko obrazovanje, Zagreb, 2019. (brošura tiskana u okviru projekta SKAZVO: https://skazvo.azvo.hr/images/stories/dokumenti/24_Bro%C5%A1ura_Akademska_rangiranja.pdf).

[3] https://www.natureindex.com/

na The SCImago Journal & Country Rank portalu.[4] Analizom objavljivanja i citiranja u preko 34 hiljade naslova prema specifičnom algoritmu (Guerrero-Botea & Moya-Anegón, 2012) rangirano je 239 država. Redoslijed za 2020. godinu je: Kina, Sjedinjene Američke Države, Velika Britanija, Indija, Njemačka, Italija, Japan, Francuska, Kanada, Ruska Federacija, Australija, Španija itd. Tabela 1 prikazuje položaj Bosne i Hercegovine na osnovu objavljenih naučnih radova prema SCImago Journal&Country Rank u periodu od 1996. do 2020. godine. Navedeno je i rangiranje država u našem okruženju. Zaključak je da znatno zaostajemo u odnosu Srbiju, Hrvatsku i Sloveniju, ali da smo bolji od Makedonije, Crne Gore i Albanije. Uzimajući u obzir prijeratni razvoj ovih država, ovaj rezultat je očekivan. Interesantno je uočiti da se, za razliku od država u okruženju, položaj Bosne i Hercegovine na ovoj rang listi popravio u zadnjim godinama. Ipak, razlika za preko trideset mjesta na svjetskoj rang listi u odnosu na Srbiju, Hrvatsku i Sloveniju je prevelika i može se pripisati lošem odnosu bosanskohercegovačkih vlasti prema nauci i naučnoistraživačkom radu, kao i nedovoljno razvijenoj svijesti članova akademske zajednice o značaju naučnoistraživačkog rada.

Tabela 1. Rangiranje Bosne i Hercegovine i država u njenom okruženju u periodu 1996–2020. prema SCImago Journal & Country Rank portalu (1. 6. 2021)

	1996–2020.	2015.	2016.	2017.	2018.	2019.	2020.
BiH	96	92	92	92	93	92	92
Srbija	52	50	51	51	54	54	56
Hrvatska	50	52	53	53	55	59	58
Slovenija	53	53	55	55	59	60	60
Makedonija	97	93	95	95	95	98	101
Crna Gora	122	118	112	111	114	112	114
Albanija	118	107	117	126	116	118	119

Položaj bosanskohercegovačkih univerziteta na Webometricsovoj listi

U zadnjih nekoliko godina rukovodstvo Univerziteta u Sarajevu je uložilo značajan napor kako bi univerzitet napredovao na svjetskim rang-listama. Ovo se posebno odnosi na Webometricsovu rang listu koja uključuje sve univerzitete u svijetu. Naime, akademsko osoblje Univerziteta u Sarajevu publikuje zanemarljivo malo radova u vrhunskim naučnim časopisima, tako

[4] https://www.scimagojr.com. Ovaj portal koristi informacije baze podataka Scopus® (www.scopus.com; Elsevier B.V.: www.elsevier.com).

da Univerzitet u Sarajevu uopšte nije rangiran na prestižnim svjetskim rang listama kao što je Shanghai lista.[5] Pri rangiranju po Webometricsu koriste se četiri kriterija prema Tabeli 2.

Tabela 2. Kriteriji za rangiranje prema Webometricsu.

INDIKATORI	OPIS	IZVOR	UDIO
PRISUTNOST (PRESENCE)	**Veličina web domene** institucije (s pod-domenama) – uključuje i broj dokumenata postavljenih na domenu i pod-domene u vidu *rich* teksta, pdf.	Google	5%
VIDLJIVOST (VISIBILITY)	**Vidljivost** (broj pojavljivanja linka web stranice institucije na web stranicama drugih institucija).	Ahrefs Majestic	50%
OTVORENOST (TRANSPARENCY or OPENNESS)	**Broj citata top 10 autora** institucije na Google Scholaru (sabiraju se citati od drugog do desetog rangiranog autora, dok se broj citata prvog ne sabira).	Google Scholar Citations	10%
IZVRSNOST (EXCELLENCE or SCHOLAR)	**Broj objavljenih radova** među 10% najcitiranijih radova u 26 disciplina u periodu od pet godina.	Scimago	35%

Prema Webometrics listi iz jula 2020. godine redoslijed univerziteta iz našeg regiona je sljedeći (u zagradi je rang u svijetu): 1. Ljubljana (314), 2. Beograd (441), 3. Zagreb (590), 4. Novi Sad (934), 5. Split (1098), 6. Maribor (1118), 7. Niš (1397), 8. Rijeka (1420), 9. Sarajevo (1508). Među prvih 2000 univerziteta su i: Skoplje (1556), Kragujevac (1750), Univerzitet Crne Gore (1915) i Osijek (1993). Prema očekivanju, univerziteti u Ljubljani, Beogradu i Zagrebu su daleko ispred Univerziteta u Sarajevu koji je najbolje plasirani bosanskohercegovački univerzitet. Prema tradiciji i prijeratnom položaju, Univerzitet u Sarajevu bi trebao biti u rangu Univerziteta u Novom Sadu, a ispred Univerziteta u Splitu, Mariboru, Nišu i Rijeci. Ostali univerziteti u Bosni i Hercegovini su rangirani ispod 3000. mjesta (vidjeti Tabelu 3). Dakle, jasno je da su univerziteti u Bosni i Hercegovini, koji bi trebali biti nosioci nauke i naučnoistraživačkog rada, rangirani daleko ispod očekivanja. Taj zaostatak je još i veći ako se uzme u obzir samo kriterij naučne izvrsnosti (kriterij „excelence" doprinosi 35% prema Tabeli 2; uporediti zadnju kolonu u Tabeli 3). Razlozi za ovaj neuspjeh bosanskohercegovačke nauke su navedeni u Uvodu.

[5] http://www.shanghairanking.com/

Tabela 3. Rang lista prvih 14 univerziteta u Bosni i Hercegovini prema Webometricsu.

Ranking	World	University	Presence	Impact	Openness	Excellence
1	1508	Univerzitet u Sarajevu	905	1979	1209	2214
2	3107	Univerzitet u Tuzli	1228	5553	1870	4011
3	3604	International University of Sarajevo	1120	6976	3472	4064
4	3800	International BURCH University Sarajevo	3767	7529	3762	4011
5	3882	Univerzitet u Banjoj Luci	970	5861	5819	3383
6	4767	Sveučilište u Mostaru	940	12342	2531	4942
7	5478	Univerzitet u Istočnom Sarajevu	1871	20450	2883	4011
8	6463	Sarajevo School of Science &Technology	17018	12688	4394	5379
9	6732	Evropski Univerzitet „Kallos" Tuzla	11938	4117	5593	6626
10	6881	Evropski univerzitet Brčko	10345	3724	5819	6626
11	8378	Univerzitet u Bihaću	9031	13550	5018	5902
12	9240	Univerzitet „Džemal Bijedić" Mostar	7267	11634	4329	6626
13	10866	Internacionalni Univerzitet Travnik	12903	8983	5819	6626
14	11916	Univerzitet u Zenici	3519	23196	3706	5681

Napominjemo da je najnoviji položaj Univerziteta u Sarajevu na 1508. mjestu u svijetu najbolji do sada. To je rezultat napornog rada na povećanju prisustva i vidljivosti web prostora Univerziteta u Sarajevu (izrada nove web stranice) i zahtjeva da se akademsko osoblje i istraživači registruju na Google scholar.[6] To se vidi i po tome što je Univerzitet u Sarajevu znatno bolje rangiran po prisutnosti (905) i transparentnosti (1209). Ovo je ostvareno u relativno kratkom vremenskom periodu. Univerzitet u Sarajevu zaostaje po kriteriju utjecaja (1979) (ovaj kriterij nosi 50%; pojednostavljeno rečeno, pri izračunavanju ovog kriterija računaju se svi vanjski linkovi koje web domena univerziteta dobija od trećih strana). Ovi rezultati ukazuju da je moguće poboljšati položaj nauke u Bosni i Hercegovini i „bottom-up" pristupom. Pored Univerziteta u Sarajevu, na sličan način se planira popraviti položaj drugih univerziteta.[7] Očito je da Univerzitet u Sarajevu najviše zaostaje po kriteriju izvrsnosti (2214. mjesto) koji doprinosi 35% ukupnom rangiranju. Poboljšanje izvrsnosti je moguće ostvariti samo dugoročnim mjerama. Tu, naravno, spadaju „top-down" mjere, spomenute u uvodu. Primjer dugoročnih „bottom-up" mjera su Strategija razvoja naučnoistraživačkog/umjetničkoistraživačkog rada na Univerzitetu u Sarajevu i Pravilnik o nagrađivanju

[6] https://scholar.google.com/

[7] Milošević, D. Uloga, značaj, promocija i popularizacija nauke u BiH: Primjer Univerziteta u Sarajevu, predavanje, Univerzitet „Džemal Bijedić" Mostar, 24. decembar, 2019.; kontakti s kolegama s Univerziteta u Tuzli itd.

akademskog i naučnoistraživačkog osoblja Univerziteta u Sarajevu na osnovu rezultata naučnog/umjetničkog rada o kojima će biti riječi u narednim dijelovima rada.

Strategija razvoja naučnoistraživačkog/umjetničkoistraživačkog rada na Univerzitetu u Sarajevu

Savjet za nauku i umjetnost Univerziteta u Sarajevu je stručno i savjetodavno tijelo Senata Univerziteta u Sarajevu imenovano odlukom Senata od 28. 12. 2016. godine. Osnovni dokument relevantan za ovaj rad je Strategija razvoja naučnoistraživačkog/umjetničkoistraživačkog rada na Univerzitetu u Sarajevu koja je usvojena 22. 9. 2017. na sjednici Senata na prijedlog Savjeta.[8] Ovom strategijom je predviđeno da se izvrsna istraživanja i objavljivanje kvalitetnih publikacija posebno podstiču i nagrađuju. U drugom poglavlju te strategije (2. Kreiranje kriterija naučne izvrsnosti i relevantnosti) u dijelu „Novi kriteriji za izbore u zvanja i podsticaji izvrsnim istraživačima“ navodi se da: „U naučne radove treba ubrajati radove objavljene u naučnim časopisima zastupljenim u bazi podataka WoSCC (Web of Science Core Collection). Pri izradi pravilnika o izboru u akademska zvanja kojim će se uspostaviti bodovni sistem vrednovanja naučnih radova kao uslova za izbor u akademska zvanja posebnu pažnju posvetiti izvještajima o citiranosti JCR (Journal Citation Reports) i SJR (SCImago Journal Rank indicator) i, u skladu s tim, naučne časopise razvrstati po značaju koji imaju u svojoj oblasti (npr. u tzv. kvartile Q1, Q2, Q3 i Q4).“

U zaključku Strategije razvoja naučnoistraživačkog/umjetničkoistraživačkog rada na Univerzitetu u Sarajevu je naglašeno da su ključni elementi za provođenje ove strategije:

„– formiranje registara naučnih/umjetničkih radova, istraživača/umjetnika, projekata i infrastrukture,
– aktiviranje/osnivanje centra za istraživanje i razvoj Univerziteta u Sarajevu (i u okviru njega naučnotehnološkog parka),
– novi kriteriji za izbore u zvanja i podsticaji izvrsnim istraživanjima,
– reforme i unapređenje doktorskog studija kao bitnog segmenta naučnoistraživačkog rada i općenito razvoja akademske zajednice,
– racionalizacija postojeće naučnoistraživačke infrastrukture i planska nabavka krucijalne opreme.“

[8] https://www.unsa.ba/index.php/istrazivanje-i-saradnja/istrazivanje/strategija

Navedeni registri još nisu formirani. Centar za istraživanje i razvoj UNSA je osnovan, ali još nije aktiviran. Kriteriji za podsticaje izvrsnim istraživačima su usvojeni i izvrsni istraživači su nagrađeni za rezultate u 2017, 2018. i 2019. godini. Pravilnik o kriterijima za izbore u zvanja tek treba napraviti i usvojiti. Usvojena su nova pravila doktorskog studija. Za racionalizaciju postojeće naučnoistraživačke infrastrukture i plansku nabavku krucijalne opreme potrebno je prvo formirati registar i na osnovu njega napraviti odgovarajuću analizu.

Pravilnik o nagrađivanju akademskog i naučnoistraživačkog osoblja Univerziteta u Sarajevu na osnovu rezultata naučnog/umjetničkog rada

Kao sljedeći primjer „bottom-up" poboljšanja kvaliteta i položaja nauke navodi se Pravilnik o nagrađivanju akademskog i naučnoistraživačkog osoblja Univerziteta u Sarajevu na osnovu rezultata naučnog/umjetničkog rada.[9] Senat Univerziteta u Sarajevu je donio ovaj pravilnik na 19. sjednici održanoj 29. 5. 2018. godine. Prije donošenja pravilnika napravljena je analiza radova objavljenih u 2017. godini s afilijacijom Univerziteta u Sarajevu prema bazi podataka Web of Science Core Collection. Na osnovu rezultata te analize pravilnik je koncipiran tako da se postigne što ravnopravnije vrednovanje doprinosa naučnika iz različitih oblasti. U Tabelama 4, 5 i 6 su predstavljeni rezultati za 2017, 2018. i 2019. godinu.[10] Za svaku grupaciju nauka i svaku organizacionu jedinicu predstavljen je broj radova objavljenih u časopisima kojima je pridružena određena kvartila (Q1, Q2, Q3 i Q4).[11]

9 https://www.unsa.ba/o-univerzitetu/propisi/pravilnik-o-nagradivanju-akademskog-i-naucnoistrazivackog-osoblja

10 Podatke u datim tabelama je obradila Služba za naučnoistraživački rad Univerziteta u Sarajevu.

11 Rangiranje po kvartilima (quartile ranking) je bazirano na impakt faktoru (IF) časopisa prema Journal Citation Reports (JCR) koji izdaje Clarivate Analytics svake godine. Informacije se mogu dobiti preko Web of Science Core Collection. Q1 se pridružuje najboljim časopisima (rangiranih u prvih 25%), Q2 odgovara 25-50%, Q3 - 50-75%, a Q4 zadnjih 75-100% časopisa prema IF-u.

Tabela 4. Lista broja objavljenih radova i bodovi za 2017. godinu po grupacijama i organizacionim jedinicama Univerziteta u Sarajevu prema Pravilniku o nagrađivanju.

GRUPACIJA	Organizaciona jedinica/institucija	WoS Docs	Docs in JIF Journals	Docs in Q1 Journals	Docs in Q2 Journals	Docs in Q3 Journals	Docs in Q4 Journals	Docs other than JIF	Q1 (10)	Q2 (7)	Q3 (4)	Q4 (2)	UKUPNO BODOVA
Društvene nauke	Ekonomski fakultet	25	13	3	5	3	2	12	30	35	12	4	93
	Pravni fakultet	1	0	0	0	0	0	1	0	0	0	0	1
Humanističke nauke	Filozofski fakultet	6	3	0	2	1	0	3	0	14	4	0	21
	Pedagoški fakultet	2	2	0	0	1	1	0	0	0	4	2	6
Medicinske nauke	Fakultet zdravstvenih studija	1	1	1	0	0	0	0	10	0	0	0	10
	Farmaceutski fakultet	10	10	2	2	0	6	0	20	14	0	12	46
	Medicinski fakultet	40	38	6	12	18	2	2	60	84	72	4	222
	Stomatološki fakultet	8	4	0	4	0	0	4	0	28	0	0	32
	Veterinarski fakultet	12	12	6	2	3	1	0	60	14	12	2	88
Prirodno-matematičke i biotehničke nauke	INGEB	10	10	0	3	5	2	0	0	21	20	4	45
	PMF	103	97	22	10	32	31	6	220	70	128	62	486
	Poljoprivredno-prehrambeni fakultet	14	14	3	6	0	5	0	30	42	0	10	82
	Šumarski fakultet	14	13	5	3	1	4	1	50	21	4	8	84
Tehničke nauke	ETF	9	9	1	2	2	4	0	10	14	8	8	40
	Fakultet za saobraćaj i komunikacije	2	2	1	0	0	1	0	10	0	0	2	12
	Građevinski fakultet	11	11	2	2	0	7	0	20	14	0	14	48
	Mašinski fakultet	10	10	0	2	0	8	0	0	14	0	16	30

Tabela 5. Lista broja objavljenih radova i bodovi za 2018. godinu po grupacijama i organizacionim jedinicama Univerziteta u Sarajevu prema Pravilniku o nagrađivanju.

GRUPACIJA	Organizaciona jedinica/institucija	WoS Docs	Docs in JIF Journals	Docs in Q1 Journals	Docs in Q2 Journals	Docs in Q3 Journals	Docs in Q4 Journals	Docs other than JIF	Q1 (10)	Q2 (7)	Q3 (4)	Q4 (2)	UKUPNO BODOVA
Društvene nauke	Ekonomski fakultet	27	8	1	3	3	1	19	10	21	12	2	64
	Fakultet političkih nauka	5	2	0	0	2	0	3	0	0	8	0	11
	Fakultet sporta i tjelesnog odgoja	21	7	0	0	0	7	14	0	0	0	14	28
Humanističke nauke	Filozofski fakultet	11	7	2	5	0	0	4	20	35	0	0	59
	Katolički bogoslovni fakultet	1	0	0	0	0	0	1	0	0	0	0	1
	Pedagoški fakultet	11	1	1	0	0	0	10	10	0	0	0	20
Medicinske nauke	Fakultet zdravstvenih studija	2	2	1	0	1	0	0	10	0	4	0	14
	Farmaceutski fakultet	60	19	2	4	7	6	41	20	28	28	12	129
	Medicinski fakultet	51	27	3	9	8	7	24	30	63	32	14	163
	Stomatološki fakultet	3	0	0	0	0	0	3	0	0	0	0	3
	Veterinarski fakultet	36	35	17	4	12	2	1	170	28	48	4	251
Prirodno-matematičke i biotehničke nauke	INGEB	22	22	1	0	10	11	0	10	0	40	22	72
	PMF	124	88	18	30	26	14	36	180	210	104	28	558
	Poljoprivredno-prehrambeni fakultet	41	36	3	14	9	10	5	30	98	36	20	189
	Šumarski fakultet	27	19	3	5	4	7	8	30	35	16	14	103
Tehničke nauke	Arhitektonski fakultet	1	1	1	0	0	0	0	10	0	0	0	10
	ETF	33	27	2	6	10	9	6	20	42	40	18	126
	Građevinski fakultet	24	16	3	1	2	10	8	30	7	8	20	73
	Mašinski fakultet	32	10	0	3	3	4	22	0	21	12	8	63
Umjetnost	Muzička akademija	2	2	0	0	2	0	0	0	0	8	0	8

Tabela 6. Lista broja objavljenih radova i bodovi za 2019. godinu po grupacijama i organizacionim jedinicama Univerziteta u Sarajevu prema Pravilniku o nagrađivanju.

SAVJET ZA NAUKU I UMJETNOST UNIVERZITETA U SARAJEVU													
UTVRĐENA LISTA RADOVA I BODOVA PO ORGANIZACIONIM JEDINICAMA U SKLADU SA PRAVILNIKOM O NAGRAĐIVANJU (2019. GODINA)													
OJ lista za nagrade													
								BODOVANJE					
GRUPACIJA	Organizaciona jedinica/institucija	WoS Docs	Docs in JIF Journals	Docs in Q1 Journals	Docs in Q2 Journals	Docs in Q3 Journals	Docs in Q4 Journals	Docs other than JIF	Q1 (10)	Q2 (7)	Q3 (4)	Q4 (2)	UKUPNO BODOVA
Društvene nauke	Ekonomski fakultet	36	22	9	7	5	1	14	90	49	20	2	175
	Fakultet političkih nauka	5	1	0	1	0	0	4	0	7	0	0	11
	Fakultet sporta i tjelesnog odgoja	10	2	1	0	1	0	8	10	0	4	0	22
	Fakultet za kriminalistiku, kriminologiju i sigurnosne studije	2	1	1	0	0	0	1	10	0	0	0	11
	Pravni fakultet	1	0	0	0	0	0	1	0	0	0	0	1
Humanističke nauke	Filozofski fakultet	18	1	1	0	0	0	17	10	0	0	0	27
	Katolički bogoslovni fakultet	1	0	0	0	0	0	1	0	0	0	0	1
	Pedagoški fakultet	10	2	0	0	0	2	8	0	0	0	4	12
	Institut za historiju	2	0	0	0	0	0	2	0	0	0	0	2
Medicinske nauke	Fakultet zdravstvenih studija	5	4	1	0	1	2	1	10	0	4	4	19
	Farmaceutski fakultet	46	26	2	0	10	14	20	20	0	40	28	108
	Medicinski fakultet	108	87	28	6	20	33	24	280	42	80	66	492
	Stomatološki fakultet	4	0	0	0	0	0	4	0	0	0	0	4
	Veterinarski fakultet	19	17	2	1	1	13	2	20	7	4	26	59
Prirodno-matematičke i biotehničke nauke	INGEB	26	26	2	0	4	20	0	20	0	16	40	76
	PMF	131	105	8	35	28	34	38	80	245	112	68	543
	Poljoprivredno-prehrambeni fakultet	36	24	5	6	3	10	12	50	42	12	20	136
	Šumarski fakultet	42	30	12	0	0	18	12	120	0	0	36	168
Tehničke nauke	ETF	41	28	15	4	3	6	13	150	28	12	12	215
	Fakultet za saobraćaj i komunikacije	3	1	1	0	0	0	2	10	0	0	0	12
	Građevinski fakultet	29	16	6	1	0	9	13	60	7	0	18	98
	Mašinski fakultet	52	19	1	5	11	2	33	10	35	44	4	126
Umjetnost	Akademija likovnih umjetnosti	1	0	0	0	0	0	1	0	0	0	0	1
	Muzička akademija	1	0	0	0	2	0	1	0	0	8	0	9

Analiza broja i citiranja naučnih radova objavljenih s afilijacijom Univerziteta u Sarajevu

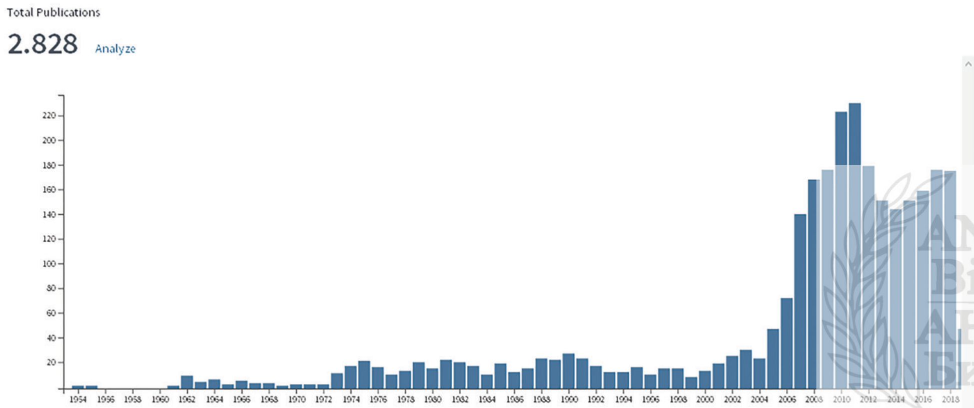
U ovom dijelu rada analizira se broj i citiranje naučnih radova s afilijacijom Univerziteta u Sarajevu (adresa ustanove „Univ Sarajevo") koji su objavljeni u časopisima koje prati baza podataka Web of Science Core Collection. Iz razmatranja su isključeni radovi s adresama: Int Univ Sarajevo, Burch Univ Sarajevo i SSST. Uzimajući u obzir da autori nisu uvijek vodili računa da se u afilijaciji navede Univerzitet u Sarajevu (ponekad je navođen samo naziv fakulteta ili odsjeka) dobijeni rezultati se ne mogu smatrati potpunim. Ipak, i ovako dobijeni rezultati ukazuju na trend razvoja naučnog rada na univerzitetu.

Na slikama 1 i 2 su prikazani broj objavljenih radova i njihova citiranost po godinama od 1949. do 2019. Mogu se uočiti četiri vremenska perioda/faze:

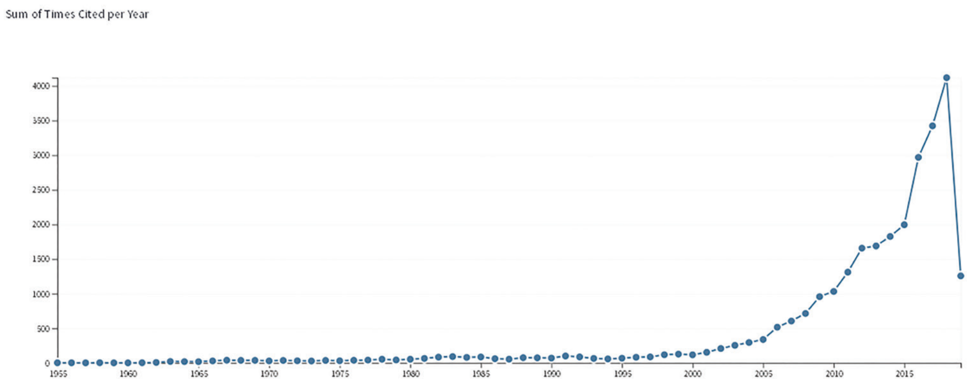
- Od 1949. do 1972. godine: ovo je period početaka naučnog rada na Univerzitetu u Sarajevu i broj radova i citata tih radova je mali.
- Od 1973. do 1991. godine: u ovom periodu već postoji dobra osnova za naučni rad i broj objavljenih radova i citata je znatno veći nego u prvom periodu i u blagom je porastu s godinama.

– Od 1992. do 2004. godine: Ovo je period rata i obnavljanja naučnih potencijala nakon rata. Broj publikacija je smanjen.
– Od 2005. do 2019. godine: nakon 2005. godine dolazi do naglog povećanja broja objavljenih naučnih radova i broja citata. Ovaj porast je znatno veći od očekivanog i bilo bi korisno ispitati zašto je do toga došlo. Moguće je da je to povezano s početkom Bolonjskog procesa, uvođenjem internacionalizacije i poboljšanjem međunarodne saradnje sa drugim univerzitetima.

Slika 1. Broj objavljenih naučnih radova sa afilijacijom Univerziteta u Sarajevu po godinama (prema Web of Science Core Collection za period od 1949. do 2019. godine, pristup preko Max Born Instituta u Berlinu 2020).

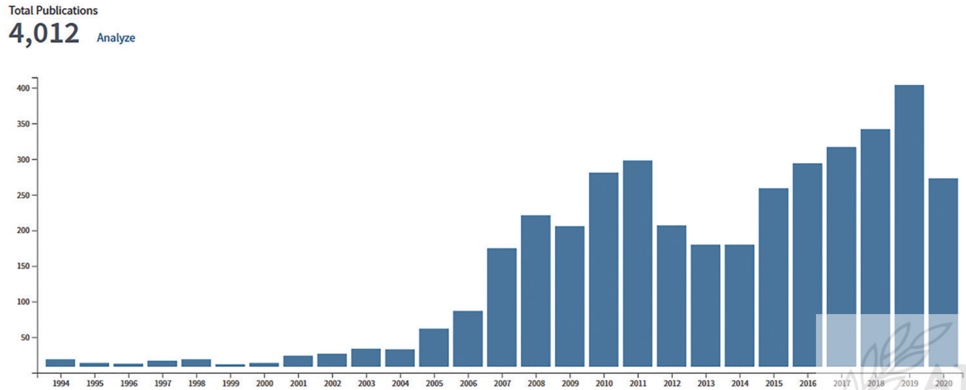


Slika 2. Broj citata za radove sa Slike 1.

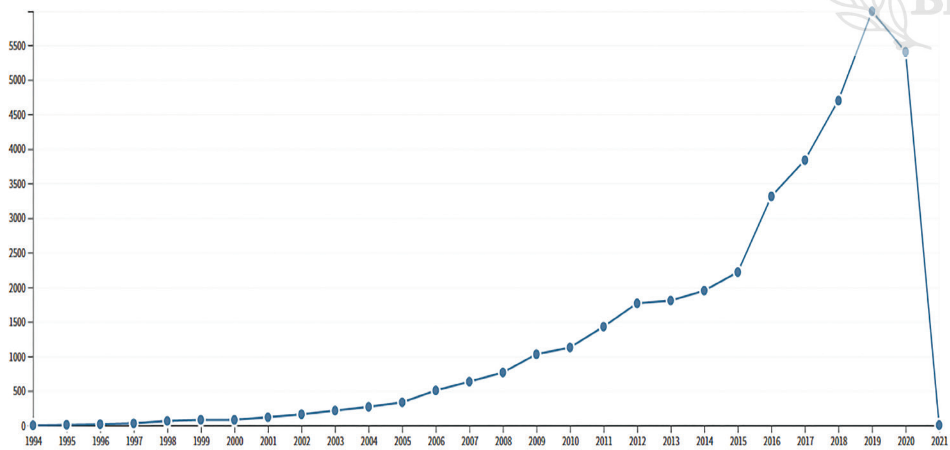


Na Slici 3 je predstavljena analiza broja i citiranja radova sa afilijacijom Univerziteta u Sarajevu prema Web of Science Core Collection za period od 1994. do 2020. godine (pretplata Univerziteta u Sarajevu uključuje ovaj period). Vidimo da je objavljeno preko 4000 radova i da je od 2007. godine broj radova naglo porastao. Nakon izvjesne stagnacije u periodu 2012–2014. godina broj radova i njihova citiranost je u stalnom porastu. Ova analiza ukazuje da je, i pored loših uslova u kojima se odvija naučnoistraživački rad, naš doprinos svjetskoj naučnoj produkciji u porastu.

Slika 3. Broj objavljenih radova po godinama od 1994. do 2020. godine.[12]



Slika 4. Broj citata po godinama za radove sa Slike 3.



[12] Citation report WoSCC (2020., ORGANIZATION-ENHANCED: (University of Sarajevo) *NOT* TOPIC: (Int Univ Sarajevo) *NOT* TOPIC: (Burch). Indexes: SCI-EXPANDED, SSCI, A&HCI, ESCI).

Instituti, naučnoistraživački centri i tehnološki parkovi

Prema Odgovorima na dodatna pitanja iz Upitnika Evropske komisije[13] u Federaciji Bosne i Hercegovine djeluje oko 20 instituta u sklopu fakulteta ili univerziteta i desetak instituta u svojstvu samostalnih pravnih lica. Korištena terminologija („oko“, „desetak“) ukazuje na problem nepostojanja jasnog načina prikupljanja osnovnih podataka o institutima. Kako se onda može očekivati poboljšanje položaja tih instituta? Nešto preciznije su informacije za Republiku Srpsku. U tom entitetu djeluje ukupno 30 instituta, od čega je 12 instituta pri javnim univerzitetima, osam instituta pri privatnim univerzitetima te deset samostalnih instituta.

U pomenutoj Strategiji razvoja naučnoistraživačkog/umjetničkoistraživačkog rada na Univerzitetu u Sarajevu, tehnološki/naučno-tehnološki parkovi su definisani kao organizacije čiji je osnovni zadatak da promoviraju inovativnost i kooperativnu aktivnost poduzetnika i istraživačkih institucija s potencijalom podizanja nivoa konkurentnosti. Te organizacije upravljaju protokom znanja i tehnologija između univerziteta, istraživačko-razvojnih institucija i privrednih subjekata. Time se omogućava kreiranje i uspostava kompanija baziranih na inovacijama i to kroz *spin-off* i *startup* privredne subjekte. Primarni zadatak takvih centara je generiranje inovativnih rješenja koja proizlaze iz djelatnosti naučnoistraživačkih subjekata (fakulteta, akademija, instituta, laboratorija, zavoda itd.) i uspostava veze i translacija inovacija u privredni sektor.“ Prema pomenutim Odgovorima na dodatna pitanja iz Upitnika Evropske komisije, u Federaciji Bosne i Hercegovine trenutno postoje četiri tehnološka parka: „Technopark“ u Zenici, „INTERA“ u Mostaru, „BIT centar“ u Tuzli i „HUB 387“ u Sarajevu. Pitanje je koliko se navedeni tehnološki parkovi uklapaju u gore navedenu definiciju naučno-tehnoloških parkova. U Republici Srpskoj djeluje Inovacioni centar Banja Luka (ICBL) koji podržava razvoj preduzeća s potencijalom da tržištu ponude komercijalna rješenja u vidu proizvoda, usluga i unapređenja poslovnih procesa, zasnovanih na znanju i primjeni inovativnih i naprednih tehnologija. Ministarstvo nauke i tehnologije vodi Registar pravnih i fizičkih lica koja se bave razvojem tehnologija. Organizacije za infrastrukturnu podršku razvoju tehnologija su: Fondacija inovacioni centar Banja Luka, Univerzitetsko-preduzetnički centar Banja Luka, Biznis inkubator Gradiška, Tehnološki biznis park Banja Luka

[13] Vidjeti: *Odgovori na Upitnik Evropske komisije – Poglavlje 25 – Nauka i istraživanje*, Direkcija za evropske integracije Vijeća ministara Bosne i Hercegovine, DEI | Odgovori na Upitnik EK.

(od 2015. transformisan u poslovnu zonu „Ramići-Banja Luka“) i Tehnološki centar „LANACO“ Banja Luka.

Među navedenim institutima, naučnoistraživačkim centrima i tehnološkim parkovima ne spominje se novoosnovani Centar za istraživanje i razvoj (R&D centar) Univerziteta u Sarajevu, kao ni javna ustanova „Centar za napredne tehnologije u Sarajevu“. Za implementaciju strateških ciljeva pomenute Strategije razvoja naučnoistraživačkog/ umjetničkoistraživačkog rada na Univerzitetu u Sarajevu bitno je uspostavljanje Centra za istraživanje i razvoj „koji će doprinijeti etabliranju Univerziteta u Sarajevu kao vodeće institucije u istraživanju, kreiranju i realizaciji naučnih i razvojnih projekata, te promoviranju inovativnosti i izvrsnosti, kao i jačanju saradnje s javnim, privatnim i nevladinim sektorom u našoj zemlji. S druge strane, apliciranjem i implementacijom EU i drugih međunarodnih projekata, ali i intenzivnijom saradnjom s privrednim sektorom obezbijedit će se značajni resursi za finansijsku i drugu vrstu podrške ne samo aplikativnim već i fundamentalnim istraživanjima te profesionalnom razvoju i većoj mobilnosti naučnika i istraživača. Zasigurno će uspostavljanje ovakvog centra pospješiti integriranost Univerziteta u Sarajevu u Evropski prostor visokog obrazovanja – European Higher Education Area (EHEA) i Evropski istraživački prostor – European Research Area (ERA) te ojačati R&D saradnju u međunarodnim okvirima. Centar za istraživanje i razvoj UNSA će biti integrirani centar koji će uključivati tri temeljna područja:

– inovacije, inkubator i naučno/tehnološki park kroz „Open innovation” model koji predstavlja sve zastupljeniji model organizacije i upravljanja inovacijama, a podrazumijeva R&D saradnju svih ključnih stakeholdera u cilju kreiranja potpuno novih proizvoda, procesa i sl. Osim adekvatne podrške start-up projektima, R&D centar će koordinirati i njihovu implementaciju, te komercijalizaciju inovacija kroz spin-off kompanije. Ova komponenta podrazumijeva značajnu uključenost mladih istraživača i studenata;
– izvrsnost i institucionalizirani pristup razvitku i prenosu najboljih praksi uključujući podršku nastavnom i istraživačkom osoblju UNSA u kontekstu njihovog profesionalnog razvoja, istraživanja, edukacije, zaštite intelektualnog vlasništva (spin-off) itd.;
– EU i domaći projekti: većina realiziranih projekata, bilo da je riječ o međunarodnim (EU) ili domaćim projektima, ovisi o individualnom angažmanu pojedinih istraživača bez ikakve sistemske podrške. Tako-

đer, nesrazmjerno je veliki broj projekata u kojim UNSA ima ulogu partnerske institucije, a ne ulogu koordinatora ili pak vodećeg partnera. Uspostavljanjem centra za istraživanje i razvoj UNSA, kao integriranog mehanizma institucionalne podrške projektnim aktivnostima na našem Univerzitetu, taj omjer bi se značajno poboljšao, a poseban doprinos kvalitetu pisanih i realiziranih projekata bio bi obezbijeđen kroz multidisciplinarne projektne timove kao i savremene mehanizme upravljanja portfoliom projekata uz racionalnije korištenje resursa."

Statistički podaci o naučnoistraživačkom radu. Patenti

Agencija za statistiku BiH publikuje saopštenje „Patenti" kao rezultat obrade podataka preuzetih od Instituta za intelektualno vlasništvo Bosne i Hercegovine. Podaci su dobijeni prema definisanim tabelama i obrađeni prema zadanoj metodologiji. U Tabeli 7 su prikazani patenti u periodu 2010–2016. Interesantno je uočiti da je broj stranih prijavitelja znatno veći nego broj domaćih prijavitelja patenata. Pored toga, broj patenata kontinuirano opada. Očito je da naše društvo ne stimuliše inovacije i patente. U 2019. godini je priznato šest patenata u nacionalnom postupku, od čega je *samo jedan* domaći prijavitelj i pet stranih prijavitelja.[14]

Tabela 7. Patenti priznati u nacionalnom postupku, BiH 2010–2016.

	2010.	2011.	2012.	2013.	2014.	2015.	2016.
Ukupno	207	148	99	85	45	30	13
Domaći prijavitelji	29	36	16	7	2	12	0
Fizičke osobe	28	34	16	6	2	11	0
Pravne osobe	1	2	0	1	0	1	0
Strani prijavitelji	178	112	83	78	43	18	13
Fizičke osobe	7	5	4	5	0	0	2
Pravne osobe	171	107	79	73	43	18	11

Analizom sadržaja predstavljenih na web stranici Agencije za statistiku Bosne i Hercegovine[15] zaključili smo da bi trebalo poboljšati način prikupljanja statističkih podataka o naučnoistraživačkoj djelatnosti. Npr., prema saopćenju Agencije za statistiku Bosne i Hercegovine,[16] broj naučnih radova

[14] http://bhas.gov.ba/data/Publikacije/Saopstenja/2020/EDU_06_2018_Y1_0_BS.pdf
[15] www.bhas.gov.ba
[16] http://bhas.gov.ba/data/Publikacije/Saopstenja/2019/RDE_01_2018_Y1_0_BS.pdf

objavljenih u visokom obrazovanju u 2018. godini iz oblasti prirodnih nauka je 18. Međutim, stvarni broj bi trebao biti daleko veći. Toliko radova je objavio sam Odsjek za fiziku Prirodno-matematičkog fakulteta u Univerziteta Sarajevu. Prirodno-matematički fakultet (PMF) i Institut za genetičko inženjerstvo i biotehnologiju (INGEB) su, prema Tabeli 5, objavili u 2018. godini 146 radova iz prirodnih nauka (ovi radovi su bili osnova za nagrađivanje i registrovani su u bazi Web of Science Core Collection; ako se uzmu u obzir i druge manje značajne baze, broj objavljenih radova je znatno veći).

Finansiranje i problemi realizacije zapošljavanja naučnika i istraživača

U ovom radu se ne analiziraju problemi finansiranja naučnoistraživačkog rada u Bosni i Hercegovini, već se ukazuje na to da, čak i ako se dobiju sredstva za naučnoistraživačka radna mjesta, problem predstavlja nepostojanje mehanizama za realizaciju zapošljavanja (potrebno je odobrenje vlade, odnosno nadležnih vlasti, a one ograničavaju broj radnih mjesta). Zakonsku regulativu i „društvenu atmosferu“ treba mijenjati paralelno s odobravanjem sredstava za nauku. Uzimajući u obzir mali broj mladih naučnika i istraživača u Bosni i Hercegovini, bilo bi posebno značajno planirati finansijska sredstva iz budžeta za obezbjeđivanje naučnoistraživačkog podmlatka, odnosno zapošljavanje mladih asistenata i istraživača. Paralelno bi trebalo raditi na mijenjanju kadrovske politike, razvijanju međunarodne saradnje (s posebnim naglaskom na našu naučnu dijasporu) i uvesti posebne mjere koje bi omogućile povratak najboljih studenata i naučnika u Bosnu i Hercegovinu.

Zaključci

U ovom radu je ukazano na neke od mogućnosti otklanjanja poteškoća s kojima se sreću bosanskohercegovački univerziteti pri unapređenju nauke i oblikovanju sistema nauke i naučnoistraživačkog rada. Na rang listi država u svijetu prema The SCImago Journal & Country Rank portalu Bosna i Hercegovina se trenutno nalazi na 90. mjestu, a najbolje plasirani univerzitet u Bosni i Hercegovini prema Webometricsu je Univerzitet u Sarajevu (1508. mjesto). Ovi rezultati, ako se uzmu u obzir specifično ustavno i teritorijalno uređenje Bosne i Hercegovine i problemi uzrokovani ratom i poslijeratnom tranzicijom, i nisu tako loši. Ipak, zaostajanje u odnosu na susjedne države Hrvatsku i Srbiju je preveliko i nužne su promjene. U okviru projekta

„Harmonizacija sistema nauke u Bosni i Hercegovini“ Akademije nauka i umjetnosti Bosne i Hercegovine akcenat je na harmonizaciji sistema nauke putem zakonodavstava nadležnih teritorijalnih jedinica u Bosni i Hercegovini. U ovom radu naglasak je na alternativnom pristupu poboljšanju položaja nauke i naučnoistraživačkog rada u Bosni i Hercegovini. To je „bottom-up“ pristup prema kojem sami univerziteti, instituti i drugi nosioci razvoja nauke i naučnoistraživačkog rada, kao i sami pojedinci koji se bave naučnoistraživačkim radom, mogu mnogo učiniti da se poboljša položaj nauke, ne čekajući izmjene postojećih i donošenje novih zakona. Kao primjeri takvog pristupa navedeni su Strategija razvoja naučnoistraživačkog rada i Pravilnik o nagrađivanju na osnovu rezultata naučnoistraživačkog rada na Univerzitetu u Sarajevu. Pored toga, koristeći primjere statističkih podataka o naučnoistraživačkom radu i patentima (postoji samo jedan priznati domaći patent u Bosni i Hercegovini u 2019. godini) ukazano je na potrebu poboljšanja načina prikupljanja statističkih podataka o naučnoistraživačkom radu. Nadamo se da će ovaj rad i navedeni primjeri poslužiti kao putokaz kako se individualnim naporima i djelovanjem samih univerziteta i instituta može poboljšati položaj nauke u Bosni i Hercegovini.

Literatura

Trifković, M. (2020). *Harmonizacija sistema nauke u Bosni i Hercegovini*. Akademija nauka i umjetnosti Bosne i Hercegovine. Posebna izdanja. Knjiga CLXXXV. Centar za sistemska istraživanja. Knjiga 5/1. Sarajevo.

Guerrero-Botea, V. P. i Moya-Anegón, F. (2012). A further step forward in measuring journals’ scientific prestige: The SJR2 indicator. *Journal of Informetrics*, Vol. 6, str. 674–688. ISSN: 1751-1577

DOI: 10.5644/PI2021.200.10

SWOT analiza inovacionog sistema u Bosni i Hercegovini

Miloš Trifković[*]
Dženana Husremović[**]

Sažetak: Aktualna globalna pozicija Bosne i Hercegovine potvrđuje nalaz prethodnih istraživanja da u našoj državi ne postoji jedinstven ili barem harmonizovan i efikasan inovacioni sistem, primjeren potrebama razvoja društva i ekonomije znanja. Prvi koraci u utvrđivanju razloga ovakvog stanja su SWOT analize položaja i uloge inovacionog sistema u okviru opšteg strateškog planiranja i sektorskog planiranja istraživanja i transfera tehnologije. Najvažniji rezultati dobiveni iz tih matrica su diskutovani u radu. Oni su potom uspoređeni sa rezultatima naših najnovijih istraživanja. Prvi rezultat je sažeta SWOT matrica inovacionog sistema. Rezultate razrade pojedinih faktora smo prikazali u detaljnoj SWOT matrici zasnovanoj na elementima snage. I ova matrica je pokazala da je ujednačeno i stabilizirano visoko obrazovanje najvažniji element snage inovacionog sistema. Zbog toga su obilježja univerziteta kao subjekta inovacionog sistema posebno razmotrena.

Ključne riječi: Bosna i Hercegovina, društvo i ekonomija znanja, inovacioni sistem, SWOT analiza inovacionog sistema, opšte strategije razvoja, sektorske strategije razvoja inovacionog sistema, univerziteti kao subjekti inovacionog sistema.

I. Uvodne napomene

Inovacioni sistem i globalna ekonomska pozicija Bosne i Hercegovine

Inovacioni sistem je složen socijalni podsistem nastao interakcijom subjekata u procesima stvaranja, primjene, distribucije i diseminacije naučno zasnovanih znanja radi dostizanja ciljeva koje društvo postavlja.[1] Uporedno posmatrano, osnovni elementi inovacionih sistema na nacionalnom ili supranacionalnom nivou su isti: resursi, subjekti i regulatorni sistemi. Izgled elemenata, njihove uzajamne veze, način funkcionisanja cijelog inovacionog sistema i njegovi odnosi s drugim podsistemima zavise od historijskih i aktuelnih, spoljnih i unutrašnjih okolnosti svakoga društva. Isti faktori određuju sistem ciljeva. U savremenim uslovima, najouopšteniji teorijski cilj inovacionog sistema je

[*] Redovni član Akademije nauka i umjetnosti Bosne i Hercegovine. E-mail: iucomt@yahoo.com
[**] Redovna profesorica Filozofskog fakulteta Univerziteta u Sarajevu, prorektorica za nastavu Univerziteta u Sarajevu. E-mail: dzenana.husremovic@ff.unsa.ba
[1] Trifković, 2020a: 41, vidjeti i Trifković, 2020b: 40-41.

stvaranje i dalji razvoj društva i ekonomije znanja kao instrumenta podizanja individualne i opšte dobrobiti, prvenstveno unutar zajednice. Hijerarhijski niži ciljevi se određuju prema pragmatičnom zahtjevu podizanja konkurentnosti nacionalne privrede. Zbog toga zadaci, struktura, način djelovanja i rezultati konkretnog inovacionog sistema u krajnjoj liniji zavise od ustrojstva države i stepena ukupne razvijenosti društva.[2] Ta zakonitost se ispoljava i u slučaju Bosne i Hercegovine.

Za potrebe ovog rada, ustrojstvo države će se sažeti na njen pravni sistem. Opis i kritička analiza ustavne i zakonske regulative i njenog nezadovoljavajućeg uticaja na stanje inovacionog sistema Bosne i Hercegovine već postoje.[3] Loše normativno i stvarno uređenje inovacionog sistema je istovremeno i posljedica i uzrok nezadovoljavajuće razvijenosti bosanskohercegovačkog društva, države i privrede i slabog položaja Bosne i Hercegovine u globalnoj utakmici. Za ovakav stav postoji obilje argumenata. U globalnim sintetičkim indeksima razvijenosti i konkurentnosti država u posljednjih deset godina, osim u ljudskom kapitalu, Bosna i Hercegovina po pravilu zauzima mjesto u donjoj polovini zemalja obuhvaćenih rangiranjem.[4] Podaci Svjetske banke o indikatorima razvoja nauke i tehnologije u periodu 2010 - 2018. g. nisu ništa povoljniji za nas.[5] Njihovo ispitivanje pokazuje da Bosna i Hercegovina zaostaje ne samo za svijetom, Evropom i Centralnom Azijom, nego i za državama koje su u procesu disolucije Jugoslavije nastale osamostaljivanjem njenih najnerazvijenijih republika.[6] Zbog toga ne začuđuje što je Svjetski ekonomski forum u svome Izvještaju o konkurentnosti za period 2017–2018.

[2] Izvanrednu ilustraciju ove teze, poučnu i za BiH, vidjeti kod Raadošević & Lepori, 2009: 659-666.

[3] O ustavnom sistemu BiH vidjeti Trifković. 2020b: 83 – 95 i Trifković, 2020a: 44 – 48. Za uporedni pregled najvažnijih zakonskih rješenja sva tri nivoa vlasti u BiH vidjeti Trifković, 2020b: 109 – 120 i Trifković, 2020b: 173 – 186.

[4] Jedan od najopštijih pokazatelja razvijenosti je BDP po glavi stanovnika izračunat prema kupovnoj snazi valute (PPP). Prema rangiranju Svjetske banke, Bosna i Hercegovina je u 2019. g zauzimala 96. mjesto od 189 zemlja. Iste godine UN je svrstao BiH na 95. poziciju od 193 države. Prema Wikipedia, 2021. g. BiH se nalazi na 92. mjestu od 141 države To je bolji plasman nego u 2016. g (107) i 2017 -18. g.(103). Navedeni podaci su indikativni čak i kad se uzmu u obzir relevantni prigovori metodologiji WEF, te promjene cilja rangiranja i izboru indikatora za 2019. godinu, prema Schwab, 2019.. *Global Innovation Indeks (GII)* Kornell Univerziteta i WIPO u 2020. g. svrstava BiH na 74. mjesto među 131 državom, što je poboljšanje za dva mjesta u odnosu na 2019. g. i za četiri mjesta prema rangu za 2018. g. Ipak, i s navedenim poboljšanjima plasmana, BiH među 39 ekonomija u Evropi, zauzima 38. tj. pretposljednje mjesto prema World Intelectual Property Organization, 2020.

[5] Vidjeti podatke u World Bank (2021).

[6] Trifković, 2020a: 55.

svrstao Bosnu i Hercegovinu grupu zemalja koje svoj razvitak zasnivaju na efikasnosti u iskorištavanju resursa, a ne na inovacijama.[7] Očito, proces intenzivnog stvaranja društva i ekonomije znanja kod nas je tek u začetku.[8]

Razlozi nezadovoljavajućeg stanja inovacionog sistema i loših rezultata ekonomske, ali i socijalne[9] konkurentnosti Bosne i Hercegovine najvećim dijelom imaju unutrašnju provenijenciju i sistemski karakter. Oni se mogu sažeto izraziti kao *razvojnim potrebama neprilagođen tretman inovacionog sistema u zemlji*. Drugim riječima, inovacioni sistem Bosne i Hercegovine, unutar društva i države kojima služi, funkcioniše u nepovoljnom socijalnom, političkom, ekonomskom i pravnom okruženju. Ovakva situacija zahtijeva analizu stanja i mogućnosti inovacionog sistema da prevaziđe postojeću situaciju.

Metodološke odrednice

Aktualna globalna pozicija Bosne i Hercegovine potvrđuje nalaz prethodnih istraživanja da „u našoj državi ne postoji jedinstven ili harmonizovan i efikasan inovacioni sistem primjeren društvenim potrebama."[10] Stoga, glavni problem rada je: utvrditi najvažnije snage i slabosti koje, povezane sa prilikama i prijetnjama, oblikuju inovacioni sistem u Bosni i Hercegovini i determinišu njegov potencijal za razvoj cjelokupnog društva. U postojećoj situaciji, glavni cilj istraživanja mora da bude ukazivanje na elemente inovacionog sistema koji suštinski određuju njegovu stagnaciju ili razvojnu dinamiku, a time i kretanje Bosne i Hercegovine ka društvu i ekonomiji znanja. Primarna hipoteza glasi: sadašnji položaj inovacionog sistema ubjedljivo determiniraju slabosti koje ograničavaju ne samo njegov, nego i razvoj Bosne i Hercegovine. U skladu s navedenom glavnom pretpostavkom dominantan predmet istraživanja će biti inovacioni sistem.

Izložene metodološke odrednice nameću interdisciplinarni pristup istraživanju. U njemu dominiraju postupci karakteristični za ekonomske, pravne i

[7] Schwab, 2017:320.

[8] O uslovima i problemima razvoja koji bivše socijalističke države vodi u grupu zemalja čiju privredu pokreću efikasnost i inovacije, vidjeti Radošević, 2011.

[9] Bez obzira na svega 3,5 miliona stanovnika, Bosna i Hercegovina se 21. 5. 2021. g. nalazila na 45. mjestu svjetske liste po apsolutnom broju umrlih od COVID-19 prema Statista, 2021). Pored toga, dostupan je i podatak u kojem se izvještava da je u Bosni i Hercegovini prvom dozom vakcinisano svega 76.311 građana. Podaci o broju vakcinisanih u R. Hrvatskoj i R. Srbiji su još uvijek nepoznati, prema Babić, 2021.

[10] Trifković, 2020b: . 69. Ovaj zaključak je, na žalost, potvrđen istraživanjem stvarnog stanja inovacionog sistema na teritoriji FBiH. U tom smislu vidjeti Kremić & Trifković, 2020.

političke nauke. Tema i glavni problem rada zahtijevaju kraći osvrt jedino na specifičnosti primjene SWOT analize.

Napomene o načinu korištenja SWOT analize

SWOT analiza je metoda strateškog menadžmenta kojom se utvrđuju i međusobno ispituju sadašnje i buduće[11] unutrašnje snage i slabosti subjekta ili društvenog (pod)sistema, te prilike i prijetnje iz okruženja. Nastala je sedamdesetih godina prošlog vijeka.[12] Najprije se koristila za utvrđivanje tržišnog položaja preduzeća, a potom se proširila i na druge oblasti.[13] Povećan domen primjene SWOT analize i njenog derivata TOWS matrice, rezultirao je sve učestalijim povezivanjem ovih instrumenata s drugim metodološkim postupcima strategijske analize okruženja.[14] Nakon 2017. godine u Bosni i Hercegovini dominira povezivanje SWOT matrice sa PESTEL metodom.

U primjeni na inovacioni sistem uopšte, a konkretno u Bosni i Hercegovini, SWOT analiza ispoljava neke osobine uslovljene predmetom istraživanja. Ona, najprije, ima makro karakter koji zahtijeva da se svaki od četiri SWOT faktora odredi uzimajući u obzir veliki broj elemenata domaće i međunarodne provenijencije. Granicu između unutrašnjih i spoljnih faktora, između nacionalnog i globalnog, te između postojećih i elemenata u nastajanju nije uvijek moguće jasno povući. Pogreške u svakom od tri domena su opasne naročito pri operacionalizaciji međunarodne komponente strategije i izradi strateških scenarija razvoja inovacionog sistema, Drugo, pojedini faktori se sastoje od velikog broja po pravilu složenih elemenata, što nameće potrebu njihovog sažimanja. Taj postupak najprije svakom elementu, a onda i faktoru SWOT analize nužno daje sintetski karakter. Povećana mjera sažimanja stvara opasnost osiromašenja sadržaja pojedinih elemenata i faktora. U narednom koraku, redukcionistički pristup otežava utvrđivanje uticaja inovacionog sistema na ubrzavanje, stagnaciju ili usporavanje ukupnog razvoja Bosne i Hercegovine.[15] Treće, gotovo nijedan od elemenata bilo kojeg faktora SWOT analize inovacionog sistema se u praksi ne pojavljuje u čistom obliku i sa

[11] Fleisher & Bensoussan, 2007: 54-77 i . Fleisher & Bensoussan, 2007: 87-103
[12] Ibidem
[13] Božac, 2008: 20-23
[14] Božac, 2008: 24 -27. i Fleisher & Bensoussan, 2015
[15] Na ovu opasnost upozorenje vidjeti u Nikolić, s.a. gdje se navodi da SWOT analiza „ima tendenciju da previše uprošćava situaciju klasifikujući faktore okruženja u kategorije u koje ne moraju uvek da spadaju u potpunosti“

jednoznačnim efektima. Zbog toga je određivanje sadržaja konkretnih elemenata, njihova klasifikacija po faktorima SWOT analize i mjeri uticaja na inovacioni sistem uvijek značajnim dijelom i rezultat individualne ili grupne procjene. Stoga se nameće zaključak da ni u istraživanju inovacionog sistema nije moguće izbjeći prigovor subjektivizma, koji generalno relativizira vrijednost rezultata SWOT analize.[16] Ipak, prednosti SWOT analize su takve da se ona bez obzira na metodološke probleme redovno koristi pri izradi strategija razvoja u Bosni i Hercegovini.

II. SWOT analiza inovacionog sistema u strategijama razvoja u Bosni i Hercegovini

Odnos strateškog planiranja razvoja u Bosni i Hercegovini prema SWOT analizi

Osnovne protivrječnosti sistema strateškog planiranja razvoja u Bosni i Hercegovini, uključujući i razvoj inovacionog sistema, imaju ustavni karakter.[17] Prva je suprotnost između jedinstvenosti teritorijalnog,[18] ekonomskog i socijalnog[19] prostora Bosne i Hercegovine i izuzetno velikih nadležnosti nižih u odnosu na više nivoe političko teritorijalnog organizovanja. Njen krajnji izraz je ustavna pretpostavka da niži nivoi državne organizacije imaju sve nadležnosti koje nisu izričito date višoj političko-teritorijalnoj jedinici.[20] Druga suprotnost je ograničavanje isključivih nadležnosti države Bosne i Hercegovine i njenih institucija na relativno mali broj ekonomskih funkcija dominanto međunarodnog karaktera[21] bez postojana unutrašnjih mehanizama za samostalno ostvarenje preuzetih obaveza i prava sa elementom inostranosti. Za ilustraciju konačnih posljedica ove protivrječnosti navodimo Odluku Vijeća ministara o sistemu koordinacije procesa europskih integracija u Bosni

[16] Vidjeti Fleisher & Bensoussan, 2007: 94

[17] Pregled ustavnih rješenja u Bosni i Hercegovini, relevantnih za inovacioni sistem, vidjeti u Trifković, 2020b: 83–91.

[18] Vidjeti Čl. I, 1. Ustava Bosne i Hercegovine."

[19] Vidjeti st. 4 Preambule i Čl. I. 4. Ustava Bosne i Hercegovine.

[20] Čl. 3, 1.a) Ustava Bosne i Hercegovine: „Sve vladine funkcije i ovlaštenja koja nisu ovim ustavom izričito dana institucijama Bosne i Hercegovine, pripadaju entitetima." Evolucija ustavnog prava je modifikovala „ustavnu stvarnost" u ovom i u drugim domenima (Vidjeti: Steiner, 2010: 529. i dalje), ali nije promijenila osnovni model organizacije države.

[21] Čl. III.1 Ustava Bosne i Hercegovine. Prema Čl. III. 5 Država može steći dodatne nadležnosti dogovorom entiteta. Treba zapaziti da nadležnosti dodijeljene ovim članom u suštini imaju spoljno-politički karakter.

i Hercegovini.[22] Taj akt, propisivanjem metoda horizontalne i vertikalne koordinacije, uključuje u odlučivanje o pitanjima pridruživanja Evropskoj uniji sve niže nivoe vlasti BiH i time im *de facto* daje pravo na vršenje državnih nadležnosti u međunarodnim odnosima.[23] Navedene protivrječnosti posredno utiču i na SWOT analize za potrebe strateškog planiranja kod nas.

Pravno uređenje jednoobraznog sistema strateškog planiranja u Bosni i Hercegovini je pred završetkom. Shodno ustavnim nadležnostima, na nivou Države ono se odvija kao planiranje institucija Bosne i Hercegovine.[24] Njegovu osnovu čini strateški okvir koji uključuje dokumente Predsjedništva BiH, Parlamentarne skupštine i Vijeće ministara. Na bazi utvrđenog okvira se posebnom metodologijom[25] rade trogodišnji, tj. srednjeročni i dugoročni programi rada Vijeća ministara.[26] Za analizu okruženja Uputstvo o metodologiji posebno preporučuje SWOT i PESTLE pristup. Posljednji javno dostupan „Strateški okvir za BiH" za period 2016.- 2018. g. je analizu društveno-ekonomskog stanja zasnovao na SWOT matrici.[27] Zbog toga iznenađuje da šesti po redu nacrt „Srednjoročnog program rada 2021-2023" Vijeća ministara iz maja 2020. godine.[28] ne koristi ovu metodologiju.[29]

Zakon o razvojnom planiranju i upravljanju razvojem u Federaciji Bosne i Hercegovine iz 2017. godine[30] (ZRP FBiH) je stvorio jedinstven i sa ustavnim nadležnostima entiteta i kantona usuglašen sistem planiranja razvoja. Njegova primjena je operacionalizirana sa deset uredbi i jednom metodologijom za izračun indeksa razvoja jedinica lokalne samouprave.[31] Nama je najinteresantnija Uredba o izradi strateških dokumenata u Federaciji Bosne i Hercegovine.[32] Prema njenom članu 17. prvi korak u izradi strateške platforme

[22] Bosna i Hercegovina. Vijeće Ministara. (2016).
[23] Tačnost navedenog zaključka potvrđuje naročito član 3 Odluke: „Način odlučivanja"
[24] Bosna i Hercegovina. Vijeće Ministara. (2014).
[25] Bosna i Hercegovina. Vijeće Ministara. (2014).
[26] Vidjeti naročito „Dio drugi – srednjoročno planiranje" Bosna i Hercegovina. Vijeće Ministara, 2014.
[27] Bosna i Hercegovina. Vijeće Ministara Bosne i Hercegovine. Direkcija za ekonomsko planiranje, 2015:30 – 33.
[28] Bosna i Hercegovina. Vijeće Ministara Bosne i Hercegovine, 2020.
[29] Bosna i Hercegovina. Vijeće Ministara Bosne i Hercegovine, (2010) je uključivao dokument: „SWOT analiza razvoja ekonomije – integrisana", pa ćemo se kasnije osvrnuti na njega.
[30] *Službene novine Federacije Bosne i Hercegovine br. 32/17*
[31] Vidjeti *Federacija Bosne i Hercegovine. Federalni zavod za programiranje razvoja. Uredbe (https://www.fzzpr/gov.ba/bos/docs/35/8/uredbe).*
[32] *Službene novine Federacije Bosne i Hercegovine br. 74/19*

je situaciona analiza unutrašnjeg i vanjskog okruženja „u cilju utvrđivanja stvarnih faktora i potencijala za razvoj područja, odnosno sektora, te ograničenja i prepreka.“ Time je SWOT analiza, barem na području Federacije Bosne i Hercegovine (FBiH), postala pravno obavezna metodologija. Praksa je potvrdila ovaj zaključak. Generalni strateški dokumenti u Federaciji, završeni nakon donošenja ZRP FBiH, redovno sadrže SWOT analizu koja uključuje i elemente inovacionog sistema.[33]

Osnov strategijskog planiranja razvoja u Republici Srpskoj (RS) je Član 68. st. 1, tačka 8. njenog Ustava, koji obavezuje ovaj entitet da, između ostalog, uređuje i obezbjeđuje „osnovne ciljeve i pravce privrednog, naučnog, tehnološkog … razvoja“. Na toj osnovi je u skladu sa propisima o funkcionisanju Vlade i upravnih organa donesen niz sektorskih strategija. Sâmo Ministarstvo za tehnološki razvoj, visoko obrazovanje i informaciono društvo na svojoj stranici navodi dvije usvojene strategije i tri akciona plana.[34] Sredinom aprila 2021. godine je na stranici Narodne skupštine RS objavljen je nacrt „Zakona o strateškom planiranju i upravljanju razvojem u Republici Srpskoj“.[35] Predložena rješenja upućuje na suštinsku sličnost sa sistemom strateškog planiranja koji postoji u entitetu FBiH.

Donošenjem Zakona o strateškom planiranju i upravljanju razvojem u Republici Srpskoj stručni principi strateškog planiranja će u cijeloj zemlji dobiti i pravni karakter. Među najvažnijim načelima su: partnerstvo svih nivoa državne vlasti sa jedinicama lokalne samouprave, vertikalna i horizontalna koordinacija, sinhronizacija planiranja, komplementarnost strategija, te efikasnost i efektivnost planiranja. Potreba poštivanja navedenih načela uticaće i na način izrade SWOT analize. Ona će, najprije, postati obavezna i koristiti se povezano sa ostalim metodologijama strateškog planiranja. Drugo, pri konkretizaciji elemenata svakog faktora tvorci analize će morati poštovati ustavnu nadležnost nivoa vlasti za koji se strategija radi. I treće, uvažavanje principa strateškog planiranja će sigurno uticati na odabir elemenata koji čine svaki faktor SWOT analize, sadržaj koji se daje odabranim elementima i preciznost formulacija kojima se elementi definišu.

---

[33] Federacija Bosne i Hercegovine. Vlada Federacije Bosne i Hercegovine (2021). Prema čl. 16. st. 5. Zakona o razvojnom planiranju konačnu odluku donosi Parlament FBiH. Pregled stanja poslova na izradi kantonalnih strategija, pretežno za period 2021–2027. g. se nalazi na web tranici Federalnog zavoda za programiranje razvoja (https://www.fzzpr.gov.ba/bs/docs/25/4/kantonalni-strateški -dokumenti)

[34] Republika Srpska. Vlada Republike Srpske (2017).

[35] Republika Srpska. Narodna skupština Republike Srpske. Materijali za 16. Redovnu sjednicu

Elementi SWOT analize inovacionog sistema u strateškim razvojnim dokumentima u Bosni i Hercegovini

Zastupljenost elemenata inovacionog sistema u SWOT analizama opštih strateških razvojnih dokumenata je važan indikator odnosa nosilaca planiranja i političkog odlučivanja u Bosni i Hercegovini prema društvu i ekonomiji znanja. Da bismo utvrdili tretman inovacionog sistema u strateškim planovima, ispitali smo SWOT analize u ukupno 13 pripremnih materijala, prijedloga i generalnih strategija razvoja, bez obzira na njihovo pravno važenje. Time je istraživanjem obuhvaćena cijela teritorija Bosne i Hercegovine u, za naše uslove, relativno dugačkom periodu od 2010. do 2027. godine. Elemente faktora SWOT analize inovacionog sistema koje neki, pretežno noviji, dokumenti navode prema PESTEL metodi, preuzeli smo nezavisno od oblasti u kojoj se nalaze i od učestalosti pojavljivanja. Značenje pojedinog elementa je utvrđivano najprije samo za sebe, a potom i u vezi sa drugim elementima istog i drugih faktora SWOT analize. Pri tome smo imali na umu da zbog različitih nadležnosti pojedinih subjekata strateškog planiranja, analize sadržaja u ovom slučaju može biti korisna samo u ograničenoj mjeri. Tabela br. 1: „Elementi inovacionog sistema u SWOT analizama razvojnih dokumenata", koja se nalazi u prilogu nudi ukupne rezutate. U suštini, Tabela br. 1. je SWOT matrica inovacionog sistema Bosne i Hercegovine, ekstrapolirana iz postojećih dokumenta opšteg strateškog planiranja u državi. Bez obzira na sva metodološka ograničenja, tabelarni pregled omogućava nekoliko osnovnih zaključaka o položaju inovacionog sistema u Bosni i Hercegovini. Navodimo najvažnije.

Najprije, faktori ekstrapolirane SWOT matrice inovacionog sistema imaju sljedeći broj elemenata: snage – 10, slabosti – 16, prilike – 7 i prijetnje – 8. Time se potvrđuje dominacija faktora slabosti, karakteristična za opšte strateške dokumente i za sektorske strategije razvoja inovacionog sistema. Među elementima snage dominiraju oni koji se tiču sistema i kvaliteta visokog obrazovanja. Interesantno je da o ovom elementu postoji saglasnost sva tri nivoa vlasti.[36] Time se Bosna i Hercegovina svrstava u zemlje kojima apsolutno dominira državno finansiranje nauke skoro isključivo preko univerziteta.[37]

[36] Vidjeti Tabelu br. 1, redne brojeve 1.1. -1.4.

[37] Radošević, (2011): Tabela 3, tabelarno prikazuje četiri osnovna institucionalna profila (uključujući i Kazahstan) odnosa finansiranja i izvođenja istraživanja u bivšim socijalističkim zemljama. Bosna i Hercegovina se ne nalazi u tabeli. Na osnovu poznatih podataka može se smatrati da Bosna i Hercegovina spada u treći profil: država je najveći finansijer, a univerziteti najveći izvršioci istraživanja.

Među slabostima na prvom mjestu su one sistemskog karaktera. Od njih devet treba navesti četiri: nedovoljan pravni i strateški okvir, nepoticajnu poresku i carinsku politiku, slabu povezanost javnog, privrednog i univerzitetskog sektora (*Triple Helix*)[38], te nedovoljnu zaštitu autorskih prava itd.[39] Drugo mjesto zauzimaju četiri slabosti vezane za tehnologiju.[40] Napokon, starenje stanovništva i odlazak mladih obrazovanih kadrova u inostranstvo je treća slabost. Izgleda da ovaj proces više pogađa kantone,[41] nego FBiH i Državu Bosnu i Hercegovinu. Od sedam prilika njih četiri imaju eksternu provenijenciju: strana ulaganja povezna sa novim tehnologijama, ubrzavanje 4.0 industrijske revolucije, mogućnosti uključivanja u nove lance vrijednosti uz pametnu specijalizaciju i korištenje fondova EU za istraživanje i razvoj.[42] Od prilika pod dominantnom kontrolom domaćih subjekata nalaze se: razvoj STEM obrazovanja, ubrzavanje *Triple Helix* procesa i osnivanje naučno-tehnoloških parkova.[43] Među prijetnjama se na prvom mjestu nalazi kadrovski odliv u inostranstvo, posebno deficitarnih struka. Iako ova prijetnja nije raščlanjena na više elemenata, ona predstavlja opšte mjesto u strateškim dokumentima kantona.[44] U oblasti tehnologije najveće opasnosti predstavljaju domaća ili strana ulaganja u zastarjele tehnologije,[45] što je samo po sebi znak nerazvijenosti privrednog sistema. Zajednički nazivnik za sve slabosti iz ove matrice je marginalizacija bosanskohercegovačke ekonomije i društva. Najveća skupina prijetnji nalazi se u domenu transfera znanja iz nauke u privredu. U njoj su identifikovana četiri elementa: slaba institucionalna podrška, nedovoljni kapaciteti specijaliziranih institucija, nedostatak specijaliziranih kapaciteta i nedovoljan nivo direktne saradnje nauka – privreda.[46]

Druga grupa zaključaka odnosi se na kontradiktornosti unutar izvedene SWOT matrice inovacionog sistema. Navodimo najvažnije slučajeve. Prvi je slučaj protivrječnost između određivanja stabilne dostupnosti naučnika i kvalifikovanih kadrova kao elementa snage, uz istovremeno navođenje slabosti

[38] Budući da je na upitnik odgovorilo svega pet preduzeća, isključivo kao ilustraciju navodimo da je u periodu 2016 – 2018. g. u FBiH samo jedno od njih dobilo iz javnih fondova podršku za naučnoistraživačke aktivnosti (Kremić & Trifković, 2020:36)

[39] Vidjeti Tabelu br. 1, redne brojeve: 2.6, 2.9, 2.11 - 2.14 i 2.16.

[40] Vidjeti Tabelu br. 1, redne brojeve istraživanja 2.1. – 2.4 i 2.14

[41] Vidjeti Tabelu br. 1, redni broj 2.10

[42] Vidjeti Tabelu br. 1, redne brojeve :3.1., 3.2., 3.5. i 3.7.

[43] Vidjeti Tabelu br. 1, redne brojeve: 3.4., 3.3. i 3.6.

[44] Vidjeti Tabelu br. 1, redni broj 4.1.

[45] Vidjeti Tabelu br. 1, redne brojeve 4.2. i 4.3.

[46] Vidjeti Tabelu br. 1, redne brojeve 4.4 i 4.6. – 4.8.

koja se ogleda u tome da tehnološki usmjerena preduzeća napuštaju BiH zbog nedostatka visokokvalifikovane istraživačke i radne snage. Na istu kontradikciju upućuje i određivanje odliva najkvalifikovanijih kadrova kao opasnosti po privredni razvoj države.[47] Drugi slučaj je međusobno isključivanje navodno dobre saradnje između univerziteta i industrije u oblasti istraživanja i razvoja, kao elementa snage i niskog nivoa dodatne vrijednosti u izvoznim proizvodima kao slabosti cijelog sistema.[48] U trećem slučaju određivanje razvijene organizacije za podršku poduzetništvu kao snage protivrječi tvrdnji da je nedovoljan broj naučnoistraživačkih centara i centara za sticanje vještina slabost našeg inovacionog sistema. [49] Napokon, kao četvrti slučaj ističe se snaga koja se ogleda u dobroj saradnji privrednih subjekata i univerziteta koja se ne može se pomiriti sa više puta istaknutom slabošću u ovim odnosima industrija - univerzitet i nedostacima u operacionalizaciji *Triple Helix* modela.[50] Navedene protivrječnosti mogu se dijelom objasniti različitim ovlaštenjima, ciljevima i politikama stvaralaca strateških dokumenata.[51] Ipak, uzete u cjelini i povezano sa prilikama i prijetnjama, kontradikcije ukazuju na nedovoljnu harmonizaciju inovacionih podsistema i nekoherentnost inovacionog sistema u Bosni i Hercegovini.

Elementi inovacionog sistema koje je SWOT analiza utvrdila kao osnovu strateškog planiranja odražavaju samo jedan dio stvarnog odnosa donosilaca razvojnih odluka prema inovacionom sistemu. Za potpunu sliku potrebno je utvrditi najvažnije elemente sistema nauke i transfera tehnologije koji se ne nalaze u ekstrapoliranoj SWOT matrici inovacionog sistema. Na njih se odnosi treća grupa zaključaka iz Tabele 1. Prvi značajan kompleks problema koji nisu ni spomenuti tiču se zakonske regulative. Efekti Okvirnog zakona o naučnoistraživačkoj djelatnosti na nivou Države,[52] posljedice nepostojanje sistemskog zakona ove vrste u entitetu Federacija BiH i propuštanje šest kantona da donesu nove zakone o inovacionom sistemu nisu kvalifikovani kao generalna strateška slabost ili prilika za ostvarivanje ciljeva razvoja. Unutrašnji

[47] Uporediti tačke 1.2. i 1.4 sa tačkama 2.1. , 2.2. i 2.10 iz Tabele br. 1.
[48] Uporediti tačke 1.3. sa tačkama 2.2. i 2.7. iz Tabele br. 1.
[49] Uporediti tačke 1.8 sa tačkom 2.12. iz Tabele br. 1.
[50] Uporediti tačke 1.3. i 2.15. iz Tabele br. 1.
[51] Država BiH i entitet FBiH smatraju da su nedostali u zaštiti intelektualne svojine slabost BIH razvojnog i inovacionog sistema. Kantoni se na ovaj element uopšte ne osvrću (Vidjeti Tabelu br. 1, tačku 2.5)
[52] Okvirni zakon o osnovama naučno-istraživačke djelatnosti i koordinaciji unutrašnje i međunarodne naučno-istraživačke saradnje Bosne i Hercegovine (Analizu ovoga akta vidjeti kod Trifković, 2020b: 95 – 102).

jaz u znanju očito nije u fokusu strateškog planiranja razvoja. Druga potpuno zanemarena oblast su strategije razvoja inovacionog sistema, kao jednog od stubova društva i ekonomije znanja.[53] Njihovo donošenje nije zabranjeno i kada propisi šute o ovom pitanju. Ipak, zakonodavstvo države BiH, entiteta RS i četiri kantona[54] sadrži obavezu navedenih političko-teritorijalnih jedinica da usvoje strategije razvoja inovacionog sistema. Trenutno u državi, umjesto 14 postoje samo tri strategije inovacionog sistema u različitom proceduralnom statusu: BiH, entitet RS i Kanton Sarajevo. Federacija i tri kantona, koji su u svoje zakonodavstvo unijeli obavezu donošenja sektorske strategije, nisu to učinili.[55] Bez obzira na navedeno stanje, ekstrapolirana SWOT matrica inovacionog sistema potpuno ignoriše nepostojanje strategija i neažurnost onih koje u usvojene. Treće, odnos prema finansiranju inovacionog sistema je istinski test shvatanja njegove uloge u ostvarivanju strategije razvoja. Strategija razvoja Bosne i Hercegovine,[56] istraživanja[57] i teorijski radovi pokazuju da je stanje u ovoj oblasti potpuno nezadovoljavajuće. Najvažniji nedostaci su: apsolutno neprihvatljivo nisko izdvajanje za ove svrhe - između 0,2% i 0,3% BDP-a, dominacija budžetskog (su)finansiranja, usitnjenost i onako malih sredstava, administriranje raspodjelom za namjene i projekte, zamagljeno finansiranje nauke na univerzitetima, vremenska neusklađenost projektnih aktivnosti sa prilivom sredstava, nedovoljno ulaganje države u opremu,[58] te izostanak carinskih i poreskih poticaja. Zbog toga začuđuje da se finansiranje inovacionog sistema ne pojavljuje ni u jednom od faktora SWOT analize opštih strategija razvoja. Umjesto toga, među elementima slabosti ekonomsko-finansijskog karaktera se nalaze oni za koje političko-teritorijalne jedinice nisu direktno odgovorne: nizak nivo dodatne vrijednosti u izvoznim proizvodima, nedovoljna direktna strana ulaganja i tehnološki transferi, slabe veze privrede i univerziteta u oblasti istraživanja, mali broj

[53] Trifković, 2020b: 23 – 25 i 35 – 37.
[54] Vidjeti Trifković, 2020b: 49-50
[55] O pravnom režimu kantonalnih razvojnih strategija inovacionog sistema vidjeti: Trifković, 2020b:131 – 134.
[56] „Strategija razvoja znanosti u Bosni i Hercegovini 2017.-2022. - revidirani okvirni dokument" Vijeće ministara BiH, 20.6.2016., str. 14 -17
[57] Trifković, 2020b: 64, 127 i 192.
[58] Agencija za statistiku Bosne i Hercegovine: „Saopćenje – Nauka, tehnologija i digitalno društvo: Istraživanje i razvoj 2019.", podnaslov 2.1. navodi da je od 39.728.000 KM bruto sredstava uloženih u visoko obrazovanje, za investicione izdatke utrošeno samo 1.992.000 KM ili 19,72%. Iste godine poslovni sektor je u istraživanje i razvoj uložio 25.647.000 KM, od čega 9,871.000 KM ili 38,44% za investicije.

naučnoistraživačkih centara i nedostatak savremene opreme u svim oblastima.[59] Četvrto, posljedica prešutkivanja problema finansiranja inovacionog sistema je potpuno ignorisanje fundamentalnih i razvojnih istraživanja kao instrumenata za rješavanje brojnih razvojnih slabosti i prijetnji, uključujući i one tehnološkog karaktera.[60] U skladu s tim, ni ubrzano formiranje (samostalnih) instituta se ne vidi kao prilika koju nudi inovacioni sistem. Napokon, peto, jedino Zapadnohercegovačka županija smatra da je nepostojanje mehanizama motivacije državnih službenika za razvojne poslove opasnost po razvoj inovacionog sistema i ostvarivanje strategija razvoja.[61] Dvanaest ostalih nosilaca planiranja zaobilaze ovaj problem, relativizirajući tako svoje obaveze iz programa reforme javne uprave.[62]

Sve tri grupe zaključaka baziranih na ekstrapoliranoj SWOT matrici strateškog planiranja daju osnova za pesimističan stav: različiti nivoi državne vlasti, svaki u svom djelokrugu, ne unose u razvojnu SWOT analizu elemente inovacionog sistema koji zahtijevaju njihovo dodatno finansijsko ili radno opterećenje. Posljedice ovakve politike nastoje se barem implicitno podijeliti sa ostalim subjektima sistema. Očito je da državna tijela ulaganje u istraživanje i razvoj tretiraju kao trošak, a ne investiciju. Time se hipoteza o inovacionom sistemu kao pastorčetu političko-teritorijalnih jedinica može smatrati dokazanom. Dvije su krajnje konsekvence postojećeg pristupa inovacionom sistemu: Bosna i Hercegovina se zadržava u grupi država koje svoj razvoj baziraju na efikasnosti iskorištavanja sirovina uz istovremeno usporavanje procesa stvaranja društva i ekonomije znanja.

[59] Vidjeti Tabelu br. 1, brojeve 2.2, 2.4, 2.7, 2.12 i 2.13. Od 209 istraživačkih projekata , koje je od 2016. do 2018, g. obavilo 18 instituta u entitetu FBiH, 13 i 6,22% otpada na fundamentalna, a 13 ili 6,22% na razvojna istraživanja. U isto vrijeme završena su 103 konzultantska projekt ili 49,28% od ukupnog broja projekata (Vidjeti: Kremić & Trifković, 2020: 29.).

[60] Vidjeti Tabelu br. 1, redne brojeve 2.1.-2.4.

[61] Vidjeti Tabelu br. 1, redni broj 2.16.

[62] Kremić & Trifković, 2020:9-15 daje obilje podataka u prilog naše tvrdnje za područje FBiH. Od 111 federalnih i kantonalnih ministarstava obuhvaćenih istraživanjem 31 (27,93%) nije uopšte odgovorilo na upitnik, 36 (32,43%) je navelo da nemaju aktivnosti u oblasti inovacionog sistema, a 44 (39,64%) su popunila upitnik. Prema sistematizaciji radnih mjesta u federalnim ministarstvima pet zaposlenih se bave pitanjima inovacionog sistema sa punim radnim vremenom i još tri sa pola radnog vremena. U kantonalnim ministarstvima koja su odgovorila na upitnik situacija je obrnuta. Šest zaposlenih radi do pola radnog vremena a samo jedan puno radno vrijeme na pitanjima inovacionog sistema. Od 44 ministarstva koja su odgovorila na upitnik, u četiri federalna i 19 kantonalnih ne postoji strategija naučnotehnološkog razvoja niti se na njoj radi. Samo je jedno federalno ministarstvo navelo da premijer vlade i resorni ministar redovno jednom mjesečno razmatraju stanje inovacionog sistema i visokog obrazovanja, itd.

SWOT analize inovacionog sistema u strategijama razvoja nauke u Bosni i Hercegovini

U Bosni i Hercegovini trenutno postoje četiri dokumenta o strategiji razvoja inovacionog sistema za period do 2022. godine. To su: „Strategija razvoja nauke u Bosni i Hercegovini 2017–2022. – Revidirani okvirni dokument“, verzija 01, od 26. 6. 2016. godine, Vijeća Ministara[63] (dalje: SRN BiH); „Strategija razvoja nauke u Federaciji Bosne i Hercegovine za period 2011 – 2021. godine (Nacrt)“[64] (dalje: SRN FBiH), uz napomenu da ovaj dokument nije razmatran u Parlamentu FBiH; „Strategija naučnog i tehnološkog razvoja Republike Srpske 2017 – 2021. godine – ‘Znanje za razvoj’“[65], prijedlog iz aprila 2017, Vlada Republike Srpske (dalje: SNTR RS) i „Strategija razvoja obrazovanja i nauke Kantona Sarajevo za period 2018 – 2022. godine - (Nacrt)“, Ministarstvo za obrazovanje, nauku i mlade Kantona Sarajevo, juni 2017. (dalje: SRON KS). [66]

Formalno-pravni položaj sektorskih strategija inovacionog sistema je različit. SRN BiH je usvojena i važi, SRN FBiH je napušteni dokument nejasnog juridičkog položaja, SRNT RS i SRON KS se nalaze u fazi nacrta. Bez obzira na pravni status dokumenta, podaci, analize i zaključci koje oni sadrže su stručno relevantni, pa ćemo ih uzeti u razmatranje. Ciljevi i oblasti za koje su strategije napisane i njihovi naslovi se donekle razlikuju. Strategija države inovacioni sistem posmatra kao cjelinu, dok je strategija RS najviše pažnje poklonila tehnološkoj komponenti. U strategiji Kantona Sarajevo pažnja je podijeljena između obrazovanja i nauke,[67] SWOT matrice koje pojedine strategije sadrže odražavaju razlike u predmetu i naslovima prethodno spomenutih dokumenata. Pregled dajemo tabelarno.

[63] *Službeni glasnik BiH, broj 22/18*
[64] Federacija Bosne i Hercegovine. Federalno ministarstvo obrazovanja i nauke. (2010).
[65] Republika Srpska. Vlada Republike Srpske (2017).
[66] Kanton Sarajevo. Vlada Kantona Sarajevo. Ministarstvo za obrazovanje, nauku i mlade Kantona Sarajevo (2017). Nacrt je povučen sa 44. sjednice Skupštine KS 12. 10. 2018. g.
[67] Ibidem

Tabela br. 2: Struktura SWOT matrice u sektorskim strategijama inovacionog sistema u BiH

R. br.	Dokument o strategiji	Broj elemenata u faktorima SWOT matrice			
		S	W	O	T
1	2	3	4	5	6
1.	SRN BiH	7	24	14	11
2.	SRN FBiH	8	24	14	11
3.	SNTR RS	5	7	6	7
4.	SRON KS	7 (-3)	19 (-6)	13 (-4)	8 (-1)

Prethodna tabela zahtijeva izvjesne komentare. Najprije, samo dva elementa snage, tri elementa slabosti i dva elementa prilika iz matrice SRN FBiH nisu uključena u državnu SWOT analizu. Dakle, SWOT matrice države i entiteta FBiH su praktično identične, iako su pravljene za različite nadležnosti i okolnosti dvije političko-teritorijalne zajednice. Drugo, u svim matricama dominiraju slabosti. Ta osobina je najmanje izražena u entitetu RS. Treće, SNTR RS je najdosljednije sažela elemente svakog faktora. I četvrto, u redu br. 4, koji se odnosi na Kanton Sarajevo, brojevi u zagradama označavaju elemente pojedinog faktora koji se odnose isključivo na dio obrazovnog procesa bez faktičkog uticaja na inovacioni sistem. Oni, zbog toga, moraju biti isključeni iz analize inovacionog sistema u ovom kantonu.

Strategija razvoja nauke u Bosni i Hercegovini se zasniva na principu koordiniranog planiranja. Ona mora da „ima opšti karakter i da predstavlja najmanji zajednički sadržalac involviranih interesa“.[68] Zbog toga ne začuđuje da SRN BiH ima najveći broj elemenata svakog faktora SWOT matrice. Njihovo agregiranje, bez obzira na rizike uopštavanja, zahtijevaju metodologiju SWOT analize i potrebu upoređivanja matrica BiH i ostalih nivoa vlasti. Rezultate grupiranja dajemo tabelarno. U zagradama pored brojeva se nalaze redni brojevi pojedinih elemenata u matrici BiH.

[68] Trifković, 2020b:101

Tabela br. 3: „Agregirana SWOT matrica Strategije razvoja nauke Bosne i Hercegovine“

R. br.	Agregirani elementi	SWOT matrica Strategije razvoja nauke BiH			
		S	W	O	T
1	2	3	4	5	6
1.	Visoko školstvo i obrazovanje	3 (1,2,3)	6 (2,3,10,12, 17, 24)	/	/
2.	Organizacija i infrastruktura	1(6)	8 (4,8,9,16,20, 21)	2 (2,3,)	/
3.	Ekonomsko-finansijski elementi	/	4 (18,19,22,23)	4 (1,8,10,14)	3 (2,3,11)
4.	Politički i kulturološki elementi	/	3 (5,13,14)	2 (12,13)	8 (1,5,6,7,8, 9,11)
5.	Međunarodna saradnja i ino-elementi	1 (4)	3 (1, 6,15)	6 (4,5,6,7,9)	/
6.	Ostalo	2 (5, 7)	/	/	/

Bez obzira na greške koje su inherentne klasifikaciji polivalentnih elemenata, gornja tabela pruža priliku za veliki broj pitanja i komentara. Zadržaćemo se na suštinskim. Najprije, element visokog obrazovanja je određen protivrječno: nasuprot tri elementa snage stoji čak šest elementa slabosti. Pri tome začuđuje da u faktorima prilika i prijetnji uopšte nema elemenata koji se vežu za visokoškolsko obrazovanje. Drugo, stanje organizacije i infrastrukture inovacionog sistema je tačno identifikovano. Ono pokazuje najveći broj slabosti, čak osam i samo dvije prilike. Značajno je da su nedostaci u finansiranju jasno istaknuti. Iznenađuje, međutim, da se negativne posljedice nedostatka sredstava nisu identifikovane kao prijetnje. Treće, ekonomski i finansijski nedostaci inovacionog sistema su precizno utvrđeni. Iznenađuje da se kao prilika navodi „kompetitivna cijena naučnoistraživakog rada u BiH u poređenju sa inozemstvom“,[69] kada se zna da je to jedan od glavnih razloga za *brain drain.* Pored toga, sedam od 14 prilika su na neki način povezane sa međunarodnom konkurencijom, iako u njoj domaći subjekti u principu imaju slabiji položaj. Četvrto, među politološkim i kulturološkim elementima s pravom su istaknuti kao ključne slabosti: dugogodišnja marginalizacija nauke, demotivacioni egalitarizam i oportunizam u ocjenjivanju rezultata naučnoistraživačkog rada. Među prijetnjama tri elementa imaju ekonomsku provenijenciju,[70] a čak sedam njih – kulturološku.[71] Provjera tačnosti tvrdnje o značaju kulturoloških prijetnji inovacionom sistemu u BiH zaslužuje

[69] SWOT matrica u SRN BiH, prilika br. 8

[70] SWOT matrica u SRN BiH navodi slijedeće ekonomske prijetnje: 2- loša poslovna svijest vlasnika kapitala; 3 – nastavak marginalizacije nauke na svim nivoima; 9 - pojava političkih intervencija u nauci; 11 - očekivanje od države da riješi sve probleme *brain waste* i *barin drain* u državi i u dijaspori

[71] SWOT matrica u SRN BiH, kulturološke prijetnje: 1 – nerazumijevanje važnosti RTD za razvoj zemlje; 4 – nesklonost promjenama, strah od rizika i neuspjeha; 6 – nepostojanje kul-

posebno istraživanje. I peto, elementi koji uključuju međunarodnu saradnju i druge odnose sa elementom inostranosti najbrojniji su u faktoru prilike. Oni čine šest od 14 elemenata, što indicira nepovjerenje u domaće šanse.

Donošenje strategije razvoja inovacionog sistema u Republici Srpskoj uređeno je entitetskim Zakonom o naučnoistraživačkoj djelatnosti i tehnološkom razvoju.[72] Na toj osnovi usvojena je i aktualna petogodišnja strategija naučno-tehnološkog razvoja, nazvana i „Znanje za razvoj“. Nakon razmatranja bitnih izazova, „Znanje za razvoj“ izlože šest osnovnih strateških ciljeva koji u jednakoj mjeri važe za sve subjekte i sve segmente inovacionog sistema.[73] U oblasti nauke i inovativnosti svaki od njih može imati posebne pojavne oblike. Strategija polazi od pretpostavke da je institucionalni sistem „ključni preduslov za podsticanje inovacija“,[74] a pri određivanju elemenata pojedinih faktora insistira na onima koji su zajednički u svim segmentima i subjektima inovacionog sistema. Rezultat ovakvog pristupa je i SWOT matrica.[75] Njene najupadljivije metodološke osobine su: mali broj elemenata u svakom faktoru – najviše sedam i jasna sadržinska veza između faktora prednosti i mogućnosti, te slabosti i opasnosti.

Entitet FBiH iz ustavnih i pravno-političkih razloga nije donio novi zakon o naučno-istraživačkoj djelatnosti.[76] Iz istih razloga je propao pokušaj da se donese entitetska strategija razvoja inovacionog sistema. Time su kantoni ostali jedini nosioci strateškog planiranja u ovoj oblasti. Njihova reakcija na ovaj zadatak je neujednačena.[77] Do 2020. godine svi su kantoni donijeli svoje zakone o visokom obrazovanju. Njima je uređen i dio inovacionog sistema koji se odvija u visokom školstvu.[78] Zakone o naučnoistraživačkoj djelatnosti, koji regulišu najveći dio odnosa inovacionog sistema, promulgiralo je samo četiri kantona: Sarajevski, Zeničko-dobojski, Tuzlanski i Kanton 10. Ti zakoni uredili su i donošenje strategije razvoja naučnoistraživačke djelatnosti, odnosno inovacionog sistema.[79] Od šest kantona koji nisu usvojili

ture cjeloživotnog učenja; 7 – nerazumijevanje posljedica odliva kadrova; 7 – izbjegavanje međunarodne konkurencije i zatvaranje u nacionalne okvire

[72] *Službeni glasnik Republike Srpske* 6/12, 33/14 66/18 i 84/19. O osnovnim principima vidjeti Trifković, 2020b: 194 -195.

[73] Vidjeti ZNTR RS str. 26 – 42

[74] ZNTR RS, str. 6

[75] ZNTR RS, str. 45

[76] Vidjeti Trifković, 2020b: 106 – 107. Detaljna analiza stanja nalazi se u Trifković, 2020a: 46 - 48

[77] Vidjeti Trifković, 2020b: 107 -108

[78] Vidjeti Trifković, 2020b: 169 -171.

[79] Vidjeti Trifković, 2020b:131 – 134.

nove zakone o naučnoistraživačkoj djelatnosti bilo bi suviše očekivati izradu srednjeročnih strategija razvoja inovacionog sistema. Ono što iznenađuje je nepostojanje strategija razvoja inovacionog sistema u tri kantona koji su ovu materiju zakonodavno uredili. Utoliko je važnije makar i djelomično planiranje ove materije u opštim kantonalnim strategijama razvoja.[80]

SWOT matrica koju sadrži Strategija razvoja obrazovanja i nauke Kantona Sarajevo donesena je na osnovu čl. 46, st. 1 Zakona o visokom obrazovanju KS. Time se vjerovatno može objasniti činjenica da ova strategija lavovskim dijelom obuhvata poslove iz nadležnosti kantonalnog ministarstva, a ne ukupnost inovacionog sistema na relevantnom području. Posljedice su dvostruke. Najprije, elementima visokoškolske nastave koji samo indirektno mogu biti značajni za cijeli inovacioni sistem posvećena je značajna pažnja. Njih ćemo u analizi izostaviti. I drugo, fokus strategije je na nauci koja se stvara na univerzitetu. Ostala otvorena pitanja inovacionog sistema, tehnološkog razvoja posebno, nisu ni spomenuta u SWOT analizi. Shodno tome, elemente snage SRON KS nalazi isključivo u visokom obrazovanju.[81] Faktor slabosti je i u ovoj matrici najobimniji. Od 14 elemenata relevantnih za inovacioni sistem njih šest se tiče kadrova,[82] šest se odnosi na organizaciju funkcionisanja sistema,[83] a samo dva na finansiranje i to isključivo naučnog osoblja i njihovog naučno-istraživačkog rada.[84] Prvih šest prilika, već tradicionalno, vide se u međunarodnoj saradnji i to gotovo isključivo u oblasti nastave. Saradnja sa našom naučnom dijasporom trebalo bi da se odvija na istom konceptu.[85] Od ostalih elemenata ovoga faktora Strategija navodi se jedino "saradnju sa poslovnom zajednicom i realizaciju konkretnih stručnih i aplikativnih projekata".[86] Prijetnje su najkontradiktorniji faktor ove matrice. Najprije, nedovoljno finansiranje naučno-istraživačkog rada i profesionalnog razvoja

[80] Kremić & Trifković, 2020:11. Sugeriše da u FBiH zaposleni u ministarstvima nisu u dovoljnoj mjeri kreatori strategije. Od 14 uposlenih samo dva „pripremaju nacrt strategije". Dva uposlena rade na pripremi podloga, pet radi isključivo administrativne poslove, a pet „daju primjedbe i mišljenja".

[81] SRON KS: 1 - imidž i tradicija visokog obrazovanja i naučno-istraživačkog rada; 2 – raznovrsnost naučnih grupacija i 3 – akreditovane visokoškolske ustanove.

[82] SRON KS: Slabosti, tačke 2 – 7. Interesantno je da se slabosti vide u: nedostatku specifičnih vještina pisanja domaćih i međunarodnih projekata, neprepoznatljivosti u realizaciji stručnih i aplikativnih projekata, nedovoljnoj orijentiranosti i motiviranosti, te u nedovoljnom publikovanju Web of Science u odnosu na zemlje iz okruženja.

[83] SRON KS: Slabosti, tačke 1, 10,13, 15, 16 i 19.

[84] SRON KS: Slabosti: tačke 8. i 9.

[85] SRON KS: Prilike, tačka 10.

[86] SRON KS: Prilike, tačka 9.

akademskog osoblja se tretira kao slabost i kao prijetnja.[87] Dalje, u skladu s administrativnom provenijencijom SRON KS, aktuelna „ograničenost dostupnih izvora finansiranja“[88] i „sistemska neizvjesnost u smislu neizvjesnog finansiranja“[89] su tek buduće prijetnje, a ne bitna aktualna slabost inovacionog sistema u Kantonu Sarajevo. Napokon, „neadekvatan imidž univerziteta i visokoškolskih ustanova u javnosti“[90] direktno je suprotan snazi imidža i tradicije u sarajevskoj regiji.[91] Od ostalih elemenata ovoga faktora treba istaći pravilno uočenu opasnost koju po inovacioni sistem predstavljaju nepostojeći ili neusklađeni zakonski propisi, strategije i politike.[92]

III. SWOT analiza aktualnog stanja inovacionog sistema u Bosni i Hercegovini

Novija istraživanja inovacionog sistema u Bosni i Hercegovini i način korištenja njihovih rezultata

Šest od 13 dokumenata opšteg strategijskog planiranja razvoja i sve tri sektorske strategije razvoja inovacionog sistema u BiH, koje smo ispitivali u ovom radu, objavljeni su u periodu 2015–2017. godine. To znači da su podaci na kojima se utvrđuju elementi pojedinih faktora SWOT analize i zasnivaju strategije stari barem četiri do pet godina. Ove činjenice zahtijevaju da se SWOT analiza našeg inovacionog sistema uradi na bazi skorašnjih istraživanja, statističkih i drugih podataka. Od novih izvora koristili smo naročito istraživanja koje je ANUBiH provela samostalno ili sa drugim pravnim i fizičkim licima,[93] nove statističke izvještaje i dokumente subjekata koji se profesionalno bave ovom oblašću.[94]

Postojeće SWOT analize su pokazale je da izbor elemenata pojedinih faktora ne smije biti zasnovan primarno na iskustvu,[95] da SWOT matrica ne

[87] Uporediti SRON KS: Slabosti, tačke 9. i 10. s Prijetnjama, tačke 13. i 14.
[88] SRON KS; Prijetnje, tačka 2.
[89] SRON KS; Prijetnje, tačka 1.
[90] SRON KS: Prijetnje, tačka 8.
[91] SRON KS: Snage, tačka 1.
[92] SRON KS: Prijetnje, tačke 1. i 6.
[93] Cvitković, 2017., Trifković, 2020b, Kremić & Trifković, 2020, Čičić; Trifković, 2020a: 39 -53;
[94] Vidjeti dio rada o visokoškolskom obrazovanju kao faktoru snage.
[95] Fleisher & Bensoussan, 2007: 91-93, navode da je potrebno mnogo „pronicljivog rada“ da bi se na postavljena pitanja odgovorilo na pravi način i u perspektivi.

može biti reducirana na listu elemenata svakog od njena četiri faktora i da formulacije pojedinih elemenata bitno utiču na njihovu poziciju u matrici. Takvi postupci u stvarnosti vode: izostavljanju značajnih elemenata pojedinih faktora, suštinskim kontradikcijama, pojavljivanju istog elementa unutar različitih faktora i – u krajnjoj liniji – manipulaciji ovom metodologijom.

Da bismo makar djelomično izbjegli navedene opasnosti najprije dajemo sažetu SWOT matricu inovacionog sistema u BiH sa minimalnim brojem najvažnijih elemenata svakog faktora. Ovakva matrica je po definiciji uopštena i samo relativno tačna. Zbog toga ona mora biti dopunjena konkretnim elementima do mjere koja sliku odnosa čini jasnom, a SWOT matricu operativnim dokumentom strateškog planiranja. Učinićemo to pridružujući faktoru snage i njegovim elementima suštinski povezane elemente drugih faktora.

Sažeta i razrađena SWOT matrica inovacionog sistema u Bosni i Hercegovini

Sažeta SWOT matrica oslanja se na elemente svakog faktora koji su nužni da bi se dobio relativno tačan makro pogled na stanje inovacionog sistema u BiH. Izrazito visoki nivo uopštavanja elemenata svakog faktora dozvolio je njihovo samo djelomično povezivanje u matrici. Element nekog od faktora koji u drugim faktorima nema svoj neposredan pandan - loš sistem finansiranja i nepostojanje sređenih etičkih pravila, na primjer - djeluje prema svim drugim faktorima podjednako.

Tabela br. 4: Sažeta SWOT matrica inovacionog sistema u Bosni i Hercegovini

Faktori			
R. br.		**R. br.**	
1	**2**	**3**	**4**
1.	**Snage**	**2.**	**Slabosti**
1.1.	Uspostavljen državni okvir za inovacioni sistem	2.1.	Na bazi pretpostavke nadležnosti nižih političko-teritorijalnih jedinica izrazito decentralizovan inovacioni sistem koji znači i pasivizaciju državnih organa u ovom domenu
1.2.	Ista osnovna organizaciona struktura inovacionog sistema	2.2.	Pravne praznine i različita pravna rješenja za niz važnih pitanja uspostave i funkcionisanja inovacionih podsistema nižih političko-teritorijalnih jedinica
1.3.	Dobro stanje ljudskog kapitala		Pad nataliteta, smanjivanje broja đaka i studenata, problemi u STEM obrazovanju, emigracija, odliv pameti

1.4.	Ujednačeno i stabilizirano visoko obrazovanje	2.4.	Apsolutno nedovoljno, dominantno budžetsko i po strukturi neadekvatno finansiranje inovacionog sistema, uključujući i visoko obrazovanje,
1.5.	/	2.5.	Razmrvljen i nepotpun etički regulatorni sistem u oblasti naučnih istraživanja razvoja tehnologije
1.6.	/	2.6.	Parcijaliziran sistem međunarodne saradnje, nedovoljna naučna produktivnost i nezadovoljavajuće međunarodno rangiranje domaćih univerziteta
3.	**Prilike**	**4.**	**Prijetnje**
3.1.	Jačanje zainteresovanosti državnih organa, ministarstava posebno, za popunjavanje pravnih praznina, planiranje rada, funkcionisanje i korištenje inovacionog sistema	4.1.	Zanemarivanje nadležnosti u oblasti inovacionog sistema od strane državnih organa i inertnost organa nižih političko-teritorijalnih jedinica na usavršavanju i boljem funkcioniranju inovacionog sistema.
3.2.	Harmonizacija zakonodavstva i podzakonskih akta, donošenje usaglašenih strategija razvoja	4.2.	Izostanak harmonizacije legislative, zadržavanje pravnih praznina u FBiH, nedostatnost strategija, te dalje produbljivanje spoljnjeg i unutrašnjeg jaza u znanju
3.3.	Sistematičan rad na povezivanju visokoškolskih ustanova, privrede i državnih organa u istraživanjima i razvoju tehnologija	4.3.	Zadržavanje postojećeg neprimjernog nivoa i kvaliteta saradnje univerziteta i privrede uz stagnaciju sistema i prakse transfera tehnologije iz inostranstva posebno
3.4.	Donošenje multidisciplinarne strategije ili programa očuvanja i razvoja ljudskog kapitala	4.4.	Zadržavanje dominacije budžetskog i birokratiziranog finansiranja istraživačkog rada i razvoja tehnologije, čija je posljedica pogoršanje globalne konkurentnosti BiH
3.5.	/	4.5.	Izostanak strategija i mjera za povećanje nataliteta, smanjivanje emigracije i odliv pameti iz BiH.

Iz prethodne tabele se vidi da slabosti ponovo dominiraju. Odnos faktora rizika i šansi je 11:8, čime je potvrđena opšta zakonitost u ovom domenu. Suprotno tome, bliže ispitivanje elemenata snage pokazuje značajno odstupanje uobičajenog stanja. Četiri elementa snage su u stvari temeljni uslovi za postojanje bilo kakvog, a ne samo dobrog inovacionog sistema. Paradoksalno, izgleda da je najveća snaga našeg inovacionog sistema u tome što je njegovo postojanje – moguće! Ovakav stav zahtijeva provjeru razradom sažete matrice prema elementima faktora snage. To prikazuje Tabela br. 5, koja se nalazi u Prilogu 2. Ona pruža relativno cjelovit uvid u skup činilaca koje određuju realan uticaj faktora snage, kao i „sistemsko podudaranje“[96] elementa snage sa elementima drugih faktora.Prva dva razrađena elementa snage u SWOT matrici iz Tabele br. 5. su političke i pravne prirode. Njihova

[96] Fleisher & Bensoussan, 2007: 87-102

normativna struktura i stvarni način funkcionisanja mogu se smatrati dovoljno poznatim.[97] Treći element snage, „Dobro stanje ljudskog kapitala“, ima izrazito interdisciplinarni karakter: demografski,[98] zdravstveni, obrazovni[99] i ekonomski.[100] Rezultanta djelovanja raznorodnih činilaca u ovom slučaju daje proturječan rezultat. Složenost izvoznih proizvoda u periodu 2010. – 2018. godine svrstava Bosnu i Hercegovinu između 33. i 40. mjesta, tj. u „više rangirane zemlje“, što indicira razvijen ljudski kapital. Nasuprot tome stoji iz matrice jasno uočljiv trend pogoršanja stanja svih činilaca vrijednosti ljudskog kapitala.[101] Vrlo je vjerovatno da će negativne demografske tendencije[102] multiplicirati učinke faktora slabosti i ubrzati pretvaranje pojedinih prijetnji u aktualne probleme. Iz ovoga nužno proizlazi zaključak da je sveobuhvatno istraživanje stanja ljudskog kapitala u Bosni i Hercegovini neophodno.

Analizirane SWOT matrice bez izuzetka tretiraju visoko obrazovanje kao faktor snage. Visokoškolske ustanove su najvažniji stvaralac kodificiranog znanja i naučnoistraživakog kadra u Bosni i Hercegovini, pa kvalitet njihovog rada bitno utiče na ostale elemente ostalih faktora. Preko tih elemenata visoko školstvo suštinski određuje razvojni kapacitet i dinamiku inovacionog sistema u cjelini. Zbog toga ćemo ovaj element faktora snage detaljnije ispitati.

[97] Za pravni okvir vidjeti Trifković, 2020b: 95 – 106, i 168 – 188. U ovom radu razmatrali smo strategije razvoja. Odgovori Bosne i Hercegovine na „Upitnik Evropske komisije“, Poglavlje 25: „Nauka i istraživanje“ sadrže oficijelne stavove o inovacionom sistemu. Za prva tri činioca slabosti, koji se odnose na ustavni položaj države, vidjeti i Trifković, 2020a. Kritiku načina finansiranja inovacionog sistema izložili smo u ovom radu, dio: *Elementi SWOT analize inovacionog sistema u strateškim razvojnim dokumentima u Bosni i Hercegovini.*

[98] Emirhafizović & Zolić, 2017: 11 – 54. zaključuju da su rat u BiH 1992 –1995 i društveni trendovi nakon njega „izokrenuli sve trendove u demografiji bosanskohercegovačkog stanovništva“.

[99] Pašalić – Kreso, 2017:93 - 124

[100] Globalni ekonomski indeksi koji različitim indikatorima prate stanje ljudskog kapitala u Bosni i Hercegovini nisu međusobno ujednačeni. Ipak, rezultati devetogodišnjeg razvoja, koje priprema Svjetska Banka su porazni za našu državu. O tome vidjeti Trifković, 2020a: 53 -55.

[101] Vidjeti i Trifković, 2020a: 54

[102] Vidjeti Federalni zavod za statistiku. (2020): 7, Slika br. 1: „Uporedni pregled boja stanovnika 2019 -2070, Varijanta 1 i Varijanta 2“. Osnovano je pretpostaviti da je stanje slično i u entitetu Republika Srpska.

Ujednačeno i stabilizirano visoko obrazovanje

Visoko obrazovanje je pravno najuređeniji element inovacionog sistema u Bosni i Hercegovini.[103] Ono je sistemom međunarodnih konvencija i domaćom legislativom potpuno i ažurno uključeno u EHEA. Planiranje razvoja se ostvaruje opštim i sektorskim strategijama. Bez obzira na različite nivoe ostvarenja juridičkih i strategijskih dokumenata, postojanje planskih akata je bitno uticalo na društvene odnose u ovoj oblasti. Stvarno stanje visokog obrazovanja kao ključne pokretačke snage inovacionog sistema ispitaćemo povezujući elemente njegove snage sa drugim faktorima SWOT matrice.

Prvi element faktora snage je veliki broj raznovrsnih visokoškolskih ustanova. Među njima se nalaze javne i privatni univerziteti. Uprkos neujednačenoj terminologiji i različitom broju evidentiranih privatnih ustanova generalna slika je jasna: postoji osam (8) javnih univerziteta i između 19 i 34 privatne visokoškolske ustanove.[104] Podaci koje ćemo kasnije prezentirati dokazuju da dominacija brojem ne znači i dominaciju kvalitetom. Drugo, zahvaljujući pretežno javnim univerzitetima, na visokoškolskim ustanovama u Bosni i Hercegovini se izučavaju sve naučne i umjetničke oblasti. Obrazovne potrebe i ekonomska situacija dovele su do toga da danas nemamo univerzitete koji su pretežno orijentirani na neku posebnu naučnu oblast. Tome doprinosi i činjenica da Okvirni zakon za status unviverziteta zahtijeva da se na instituciji

[103] Trifković, 2020b: 103-106, 168-172, 213-216

[104] Prema evidenciji akreditiranih visokoškolskih ustanova koju ažurira Agencija za razvoj visokog obrazovanja i osiguranje kvaliteta Bosne i Hercegovine, u Bosni i Hercegovini djeluje osam (8) javnih visokoškolskih ustanova i dvadeset četiri (24) privatne visokoškolske ustanove. Na listi visokoškolskih ustanova koje ažurira Centar za informiranje i priznavanje dokumenata iz oblasti visokog obrazovanja Bosne i Hercegovine (vidjeti Bosna i Hercegovina. Centar za informiranje i priznavanje dokumenata iz oblasti visokog obrazovanja Bosne i Hercegovine, 2021) nalazi se osam (8) javnih visokoškolskih ustanova i trideset četiri (34) privatne visokoškolske ustanove, što predstavlja razliku od deset (10) visokoškolskih ustanova u odnosu na prethodni izvor podataka. Dalje, agencije za statistiku prikupljaju podatke o visokom obrazovanju koji se odnose na upisane i svršene studente, kao i angažirane nastavnike, dok sam broj visokoškolskih ustanova nije indiciran. Napokon, Federalni zavod za statistiku Federacije Bosne i Hercegovine u svojim statistikama visokog obrazovanja indicira postojanje devedeset dvije (92) visokoškolske ustanove, od čega sedamdeset (70) javnih, devetnaest (19) privatnih i tri (3) vjerske visokoškolske ustanove. Za razliku od prethodnog Saopštenja (03.03.2020. godine za školsku 2019/2020 godinu), u Statističkom biltenu visokog obrazovanja za 2019/2020 godinu navodi se postojanje šezdeset sedam (67) javnih fakulteta, pet (5) akademija, tri (3) vjerska fakulteta, sedam (7) visokih škola, te jedanaest (11) privatnih univerziteta. Republički zavod za statistiku Republike Srpske u svom biltenu visokog obrazovanja bilježi postojanje dvadeset (20) ustanova visokog obrazovanja, od čega devet (9) univerziteta i jedanaest (11) visokih škola ne navodeći tip ustanove (javna/privatna).

izučava najmanje pet studijskih programa iz najmanje tri naučne oblasti.[105] Isti društveni razlozi nisu pogodovali formiranju istraživačkih univerziteta, čiji je nedostatak jedna od značajnih slabosti našeg inovacionog sistema.

Indirektan zaključak o diversifikaciji obrazovnog i naučnoistraživakog rada može se donijeti na osnovu distribucije upisa studenata po pojedinim oblastima. Analiza podataka Federalnog zavoda za statistiku i Republičkog zavoda za statistiku RS o broju studenata upisanih na pojedine studijske programe razvrstane u šire naučne i umjetničke oblasti, pokazuje da se oko 55% svih studenata školuje u oblastima društvenih i humanističkih nauka i umjetnosti. Oko 28% studenata upisano je u STEM područjima (fundamentalne nauke, tehnička oblast, elektrotehnika i matematika), 21% studenata se školuje o oblasti medicine i zdravstva, dok se 4% studenata nalazi u oblasti biotehničkih nauka (poljoprivreda, ribarstvo, šumarstvo i veterinarska medicina). Uzimajući u obzir strukturu ekonomije i društva, dominacija društvenih nauka jeste očekivana. Ipak, navedeni podaci ruše tezu po kojoj broj studenata u tradicionalnim STEM područjima bitnim za inovacije i tehničko-tehnološki razvoj, apsolutno ne zadovoljava. Problem se nalazi na drugom mjestu: veliki broj školovanih studenata u STEM i medicinskom području relativno jednostavno nalaze poslove izvan granica BiH. Zbog toga ograničena mogućnost angažiranja ovih stručnjaka u zemlji i nedostatak politike sprečavanja odliva pameti i jesu uvrštene u ključne slabosti inovacionog sistema. Činjenica da školujemo zadovoljavajući broj studenata iz STEM područja ne znači nužno da će oni doprinijeti društvu i ekonomiji znanja u Bosni i Hercegovini. Rješavanje problema školovanja kadrova za druge države, međutim, leži izvan domena inovacionog sistema.

Drugi važan pokazatelj naučne orijentacije u nekoj državi je i broj objavljenih naučnih radova iz pojedinih oblasti. Za potrebe pregleda dominantnih istraživačkih polja djelovanja univerzitetâ u Bosni i Hercegovini informacije smo uzeli iz baze podataka *Scopus*, koja ima nešto širi obuhvat časopisa i duži vremenski raspon indeksiranih radova u odnosu na *Web of Science*.[106] Pregledom je obuhvaćeno sedam javnih univerziteta u Bosni i Hercegovini, osim Univerziteta u Bihaću koji nema ni jedan indeksiran rad pod tom afilijacijom. Kategorije prikazane u Tabeli broj 6: „Pregled objavljenih radova u Scopus bazi podataka prema granama nauke i univerzitetima od 1951. do

[105] Čl. 10, st. 2, alineja 2 Okvirnog zakona o visokom obrazovanju u Bosni i Hercegovini)

[106] Dostup podacima je ograničen pretplatničkim ugovorom između Clarivate Analytics i Elseviera s Univerzitetom u Sarajevu kao nosiocem ugovora za pristup bazama podataka (Scopus od 1951. do danas; Web of Science od 1994. do danas)

2021. godine" odražavaju taksonomiju istraživačkih polja i oblasti prema kojoj se članci svrstavaju u Scopus bazi. „*Scopus* tabela" se nalazi u prilog br. 2. Analiza Table br. 6. daje osnovu za nekoliko relevantnih zaključaka. Najprije, u ukupnoj strukturi radova razvrstanih po istraživačkim oblastima prednjače medicinske nauke, potom inženjerstvo, te kompjuterske nauke. Iz raspoloživih podataka o objavljenim radovima vidljivo je da na univerzitetima u Bosni i Hercegovini dominiraju medicinske i tehničke nauke, dok na trećem mjestu se nalaze prirodno-matematičke i biotehničke nauke. Dalje, nalaz se podudara sa podacima o STEM obrazovanju koje smo već iznijeli. Društvene i humanističke nauke nemaju tako intenzivnu produkciju, s tim što treba uzeti u obzir da je i predmet proučavanja u ovim disciplinama velikim dijelom društveno/ nacionalno relevantan, a ne nužno i internacionalno interesantan. Napokon, razumljivo je da Univerzitet u Sarajevu, kao naša najstarija i najveća visokoškolska ustanova ima i najbolje rezultate. Ipak, politika i strategija razvoja visokog obrazovanja bi morale sadržavati poluge za postupno srazmjerno približavanje učinka javih univerziteta. Jedna od najznačajnijih je postepena reforma sistema finansiranja i podizanje izdvajanja za visoko obrazovanje kao segmenta inovacionog sistema.

Drugi značajan element snage visokoga obrazovanja princip jedinstva naučnoistraživačkog rada i nastave. I on ima nekoliko pojavnih oblika. Na prvom mjestu je jednak tretman naučnoistraživačkih i nastavnih aktivnosti u ugovorima o radu akademskog osoblja. Kao primjer mogu poslužiti Standardi i normativi za obavljanje djelatnosti visokog obrazovanja na području Kantona Sarajevo.[107] Tim aktom su najprije tvrđeni uslovi čije je ispunjavanje neophodno za obavljanje djelatnosti.[108] Njima je, dalje, precizirano da su nastavnici i saradnici dužni aktivno se baviti naučnoistraživačkim, odnosno umjetničkim djelatnošću 20 sati nedjeljno. Ostatak radne sedmice rezervisan je za nastavu, ispite i administraciju. Ipak, rezultati istraživanja pokazuju da odnos naučnog i nastavnog rada u praksi još nije izbalansiran, te da su nastavne aktivnosti dominantne u odnosu na naučni rad.[109] Ova slabost je zasigurno posljedica izmjena nastavnih planova i programa, koje postojećem

[107] Kanton Sarajevo. Vlada kantona Sarajevo. Ministarstvo za obrazovanje, nauku i mlade Kantona Sarajevo Standardi i normativi za obavljanje djelatnosti visokog obrazovanja na području Kantona Sarajevo (2017)

[108] Standardima i normativima utvrđuju se minimalni kadrovski, prostorni i drugi materijalno-tehnički uslovi neophodni za obavljanje djelatnosti visokog obrazovanja i naučnoistraživačkog/umjetničkoistraživačkog rada u skladu sa Okvirnim zakonom o visokom obrazovanju u Bosni i Hercegovini i kantonalnim Zakonom o visokom obrazovanju

[109] Kremić & Trifković, 2020:21, tabele 2-7

nastavnom kadru nameću i moralnu obavezu povećanog obima pedagoškog rada. Integracija nauke i nastave se vidi i iz angažovanosti studenata u naučnoistraživačkom radu[110]. Druga manifestacija jedinstva naučnog i nastavnog rada tiče se studenata. Polaznici prvog ciklusa najčešće se uključuju u manja istraživanja za potrebe nastave, dok se studenti drugog ciklusa, kao i studenti doktorskih studija samostalni nosioci istraživanja ili članovi projektnih timova koje vode nastavnici na nivou organizacionih jedinica, odnosno univerziteta. Uključivanje studenata u istraživanja povećava njihove kompetencije potrebne za budući samostalni istraživački rad te zasigurno doprinositi i povećanju ljudskog kapitala u oblasti nauke u Bosni i Hercegovini. Napokon, institucionalizovani oblik bavljenja načnoistraživačkim radom na univerzitetima su instituti.[111] U zakonodavstvu entiteta FBiH status instituta imai organizaciona jedinica pravnoga lica sa pravom samostalnog nastupa na tržištu. Instituti integrisanih unvierziteta imaju takav položaj. Njihov položaj ima karakteristike dvostrukog pravnog režima: statusna pitanja se ravnaju prema mjerodavnom zakonu o visokom obrazovanju, a zvanja i način rada prema zakonima o naučnoistraživačkoj djelatnosti. Rad univerzitetskih instituta tek treba istražiti.

Naučni radnici nisu dovoljno brojni, niti zastupljeni u strukturi radne snage.[112] Ipak, njihov najveći broj je koncentrisan na univerzitetima.[113] Zbog tog je treći značajan element snage inovacionog sistema dobar naučnonastavni kadar. Na formalnom nivou, kvalitet nastavnog kadra diktiraju odredbe o uslovima za izbor akademskog osoblja u Okvirnom zakonu o visokom obrazovanju u BiH[114] i način njihova adopcije zakonima nadležnih političko-teritorijalnih jedinica. Uporedni pregled pokazuje da u domaćem zakonodavstvu nema većih odstupanja od okvirnih odredbi Ta činjenica je s jedne strane refleksija objektivno nezadovoljavajućih uslova u kojima univerziteti rade, a sa druge strane može da upućuje na nedovoljno razvijenu autonomiju

---

110 Kremić & Trifković, 2020:21 tabele 2-8

111 O pravnom statusu instituta u Bosni i Hercegovini vidjeti Trifković, 2020b: 45. Regulativa u entitetu FBiH je izložena na str. 145 – 147, a u entitetu RS na str. 203 – 206. Za Entitet RS vidjeti i čl. 47. i 64. Zakona o visokom obrazovanju RS.

112 Trifković, 2020b: 42: godine 2015. oni su u u FBiH činili 0,47%, a u RS 0,36& ukupnog broja zaposlenih.

113 Prema *Agencija za statistiku Bosne i Hercegovine. Nauka, tehnologija i digitalno društvo, Statistika Istraživanje i razvoj 2019* od 2883 zaposlenih u istraživanju i razvoju godine 2019., njih 2271 je radilo u visokom obrazovanju. Od toga je istraživača bilo 1871, a tehničkog i ostalog osoblja 400. Zabrinjava podatak da je više od polovine istraživača (970) bilo angažovano sa radnim vremenom kraćim od punog radnog vremena.

114 Vidjeti članove 28 - 35.

univerziteta koja vodi mirenju sa minimalnim standardima. Neposredan sintetički izraz djelovanja svih faktora SWOT matrica na institucionalnom planu može biti i globalno vrednovanje bosanskohercegovačkih univerziteta. Trenutno ga moramo prikazati prema *Webometrics* rangiranju,[115] navodeći samo opšti plasman: 1. UNSA – 1675; 2. UNBL – 2658; 4.UNTZ – 3694; 5. IUS – 3786;. 7. SVM – 4748; 8. UNZE – 5129 itd. Značajno je da se među prvih 10 univerziteta u Bosni i Hercegovini nalaze i četiri privatna univerziteta; 3. International University of Sarajevo – 3557; 6. IU Burch – 3979 ; 9. European University Brcko – 6109 i 10. SSST – 6166.

Iz dosadašnjih izlaganja je vidljivo da je bosanskohercegovačko visoko obrazovanje kao sistem, uz uvažavanje dejstva objektivno uslovljenih slabosti i sjajnih individualnih i institucionalnih dostignuća, tek počelo da planski radi na prihvaćanju kriterij izvrsnosti. Zbog toga se na ovu priliku našeg inovacionog sistema moramo posebno osvrnuti. Približavanje naučno-istraživačkih ustanova Evropskom prostoru istraživanja podrazumijeva razvijanja izvrsnosti u istraživanju, odnosno prepoznavanja ustanove kao centra izvrsnosti u istraživanju. Jedan od mehanizama koji je uspostavljen na evropskom nivou je dodjeljivanje nagrade ili loga „Izvrsnost u istraživanju".[116]Evropska komisija dodjeljuje ovaj logo kao javno priznanje istraživačkim institucijama koje razvijaju procese ujednačavanja politika zapošljavanja i razvoja karijera istraživača sa Poveljom i Kodeksom za istraživačke institucije[117]. Institucije koje dobiju pravo da koriste ovaj logo pokazuju predanost da implementiraju pravedan i transparentan proces zapošljavanja i unapređivanja istraživača. Da bi institucija dobila ovaj logo, koji se evaluira u redovnim ciklusima kroz unutarnje i vanjske procese, potrebno je izraditi Strategiju ljudskih resursa za istraživače (HRS4R) sa Akcionim planom, te ova dva dokumenta kao obavezna usvojiti na najvišim akademskim tijelima univerziteta. U ovom trenutku, samo tri univerziteta u Bosni i Hercegovini imaju pravo da nose logo „Izvrsnost u istraživanju". To su Univerzitet u Banja Luci od aprila 2015. godine, Univerzitet u Istočnom Sarajevu od 2017. godine i Univerzitet u Sarajevu od 2019. godine. Poređenja radi, u Republici Hrvatskoj šest sveučilišta i osam naučnih instituta ima ovaj logo, dok su se u Srbiji četiri univerziteta kvalifikovala za ovu nagradu. Na prvi pogled se može činiti da ovaj logo nije direktno povezan sa izvrsnim istraživanjima. Ipak, uvidom u elemente Povelje i Kodeksa jasno je da Evropska Komisija izvrsnost u istraživanju

[115] Consejo Superior de Investigaciones Científicas (2021).
[116] Evropska Komisija. (2021).
[117] European Comission. (2019).

veže za angažovanje izvrsnih naučnika , stvaranje okruženja u kojem oni mogu slobodno i društveno odgovorno raditi i udruživati svoje napore na stvaranju promjena baziranih na kvalitetnim istraživanjima.

IV. Zaključci

1. SWOT analiza je u Bosni i Hercegovini široko prihvaćena kao instrument opšteg i sektorskog strateškog planiranja, uključujući i razvoj inovacionog sistema. Njena primjena u entitetu FBiH je je postala i pravno obavezna. Vjerovatno će uskoro steći isti status i u entitetu RS. Te činjenice zahtijevaju intenzivno bavljenje metodološkim pitanjima SWOT analize.
2. Inovacioni sistem u Bosni i Hercegovini djeluje u nepovoljnom unutrašnjem socijalnom, ekonomskom, političkom i pravnom okruženju. Državni izdaci za istraživanja i razvoj se suštinski smatraju troškom, a ne investicijom. Zbog toga tretman istraživanja i razvoja u SWOT analizama pripremljenim za opšte strateške dokumente ne odgovara potencijalima inovacionog sistema za ostvarivanje razvojnih ciljeva.
3. Donošenje strategija razvoja inovacionog sistema je u Bosni i Hercegovini zanemareno. Samo država Bosna i Hercegovina, entitet Republika Srpska i Kanton Sarajevo imaju važeće strategije i SWOT analize u ovoj oblasti. Ovakvo stanje je pouzdan pokazatelj nezadovoljavajućeg odnosa politike prema inovacionom sistemu, faktor produbljivanja unutrašnjeg jaza u znanju i nagovještaj pogoršavanju položaja Bosne i Hercegovine u međunarodnoj konkurenciji.
4. Upoređivanje naše SWOT analize inovacionog sistema, urađene na osnovu skorašnjih istraživanja, sa SWOT matricama iz dokumenata opšteg i sektorskog strateškog planiranja pokazuje značajnu podudarnost između njih. Razlike postoje naročito u izboru pojedinih elemenata svakog faktora, tretmanu finansiranja kao slabosti sistema, zastupljenosti tehnološkog razvoja i uticaja međunarodne suradnje na poboljšanje stanja inovacionog sistema.
5. U svim SWOT matricama su relativno dobro stanje visokog obrazovanja i ljudskog kapitala najvažnije snage inovacionog sistema. Ovakva unisonost ne postoji kod ostalih faktora.
6. Sve urađene SWOT matrice pokazuju da postojeći inovacioni sistem u Bosni i Hercegovini nije ni dovoljno razvijen, niti interesno, ciljno, normativno i funkcionalno povezan u mjeri koja bi od njega načinila

odlučujući faktor kretanja prema društvu i ekonomiji znanja. Samim tim naš inovacioni sistem ne omogućava nacionalnoj privredi prelazak iz faze efikasnijeg korištenja sirovina u fazu proizvodnje dobara zasnovane na znanju

7. SWOT analiza inovacionog sistema u Bosni i Hercegovini pokazuje da je on činilac izrazito sporog i na različite načine ograničenog društvenog i ekonomskog napretka, što u globalnoj konkurenciji objektivno znači stagnaciju, donosno relativno nazadovanje u razvoju.

Prilog 1

Tabela br. 1: Elementi inovacionog sistema u SWOT matricama razvojnih dokumenata

R. br.	Faktori SWOT analize	Elementi pojedinih faktora SWOT analize	Skraćeni naziv dokumenta i stranica
1	2	3	4
1,	**SNAGE**		
1.1.		Visok kvalitet obrazovanja u oblasti matematike i prirodnih nauka	SO za BiH, 31
1.2.		Stabilna dostupnost naučnika i inženjera, kvalitetan univerzitetski nastavni kadar	SO za BiH, 31; SR SBK, 31
1.3.		Saradnja između univerziteta i industrije u oblasti istraživanja i razvoja	SO za BiH, 31; SR ZDK, 236
1.4.		Kvalificirani stručni kadrovi u raznim privrednim i društvenim oblastima	NSP TK, 226; SR SBK, 30; SR ZDK, 238; SR BPK, 44
1.5.		Rasprostranjenost upotrebe interneta	SO za BiH, 31
1.6.		Dinamičan i konkurentan IT sektor	SR FBiH, 151
1.7.		Akreditiran i razvijen sustav visokog obrazovanja	SR ŽP, 49; ISR USK, 111; SR SBK,31; SR ZDK, 236; SR KS 296; SR HNŽ, 113
1.8.		Razvijene organizacije za podršku poduzetništvu	SR ZDK, 236; SR ŽZH 56
1.9.		Zakonski okvir za djelovanje u naučno-istraživačkom radu	SR KS, 297
1.10.		Zaštićene oznake zemljopisnog podrijetla	SR ŽZH 56
2.	**SLABOSTI**		
2.1.		Tehnološki usmjerena preduzeća napuštaju BiH zbog nedostatka visokokvalifikovane radne i istraživačke snage	SR BiH, 7
2.2.		Nizak nivo dodatne vrijednosti u izvoznim proizvodima; nedovoljno razvijena kreativna industrija	SO za BiH, 31; SR ZDK, 236; K 10, 31
2.3.		Nizak nivo tehnologije, marketinga, istraživanja i razvoja u preduzećima, naročito onih za zeleni rast i malim i srednjim preduzećima	SO za BiH, 31; SR ŽP, 49; SR HNŽ, 113
2.4.		Nedovoljan nivo ulaznih SDU i tehnoloških transfera	SO za BiH, 31

R. br.	Faktori SWOT analize	Elementi pojedinih faktora SWOT analize	Skraćeni naziv dokumenta i stranica
1	2	3	4
2.5.		Nedostaci u zaštiti intelektualne svojine	SO za BiH, 31; SR FBiH, 152;
2.6.		Nepostojanje strateškog okvira za razvoj digitalne ekonomije	SR FBiH ,151; SR ŽP, 49
2.7.		Nedovoljna uključenost privrede u istraživačko-razvojne aktivnosti univerziteta	SR FBiH, 152; SR HNŽ, 111; SR ŽZH 57
2.8.		Nepostojanje zakonskog i strateškog okvira i loša koordinacija inovacionog sistema; nedovoljna koordinacija u upravljanju razvojem; nedosljedna primjena zakona o naučnoistraživačkoj djelatnosti.	SR FBiH, 152 ISR USK, 111; SR ZDK, 239; SR HNŽ, 111
2.9.		Nepoticajna poreska politika za razvoj	SR FBiH, 152
2.10.		Smanjen prirodni priraštaj stanovništva i odlazak u inostranstvo, naročito mladih	SR ŽP,49; SR ZDK, 236; SR ZDK, 241; SR KS, 300; K 10, 32
2.11.		Nedovoljno ulaganje u kampus i obrazovnu infrastrukturu	NSP TK, 226
2.12.		Nedovoljan broj naučnoistraživačkih centara i centara za sticanje praktičnih vještina	NSP TK, 226
2.13.		Nedostatak savremene opreme u svim oblastima	NSP TK, 226-227; SR ZDK, 238
2.14.		Nedovoljno promovisanje i poticanje, inovacija, istraživanja i razvoja	SR HNŽ, 110
2.15.		Slaba povezanost javnog, privatnog i visokoškolskog sektora	SR HNŽ, 110; SR ŽZH 57
2.16.		Nepostojanje mehanizma motivacije državnih službenika za razvojne poslove	SR ŽZH 57
3.	**PRILIKE**		
3.1.		Direktna strana ulaganja (u moderne tehnologije)	SR BiH, 9;
3.2.		Zamah četvrte industrijske revolucije i genetike. Upotreba tehnologija koje ne štete okolišu	SR FBiH, 154 SR SBK, 32
3.3.		Saradnja privrede, akademske zajednice i vlade u istraživanjima *(Triple helix)* i pametna specijalizacija	SR FBiH, 155; SR KS, 300
3.4.		Razvoj STEM obrazovanja	SR FBiH, 155
3.5.		Globalni lanci vrijednosti i mogućnost pametne specijalizacije	SR ŽP, 51
3.6.		Razvoj naučno-tehnoloških parkova	NSP TK, 226

R. br.	Faktori SWOT analize	Elementi pojedinih faktora SWOT analize	Skraćeni naziv dokumenta i stranica
1	2	3	4
3.7.		Korištenje EU fondova za NI i IR rad	SR KS, 299
4.	**PRIJETNJE**		
4.1.		Odljev kadrova (odlazak obrazovanih i mladih) posebno u globalno deficitarnim strukama, npr. medicinskoj	SR BiH,8 ISR USK, 112; NSP TK, 226 i 228; SR HNŽ, 111; SR BPK 45
4.2.		Prijetnja marginalizacije bh. privrede, nauke i društva; ulaganje u zastarjele tehnologije	SO za BiH, 32; SR ZDK, 242-243
4.3.		Neuspješnost u privlačenju direktnih stranih ulaganja i transferu tehnologije	SO za BiH, 32
4.4.		Nedostatak prenosa novih znanja i stručne pomoći od naučnih institucija posebno u poljoprivredi i adaptaciji na klimatske promjene	SR ŽP, 51
4.5.		Destimulativna poreska i carinska politika	ISR USK, 112
4.6.		Nedovoljni kapaciteti NI i IR centara	SR SBK, 32
4.7.		Slaba institucionalna podrška NI aktivnostima	SR ZDK, 240
4.8.		Nizak stepen saradnje naučno-istraživačkih institucija i privrede	SR ZDK, 240

Legenda:

1. SR BiH – „Strategija razvoja Bosne i Hercegovine, Radni dokument“, Vijeće ministara, 2010.[118]
2. SO za BiH – „Strateški okvir za Bosnu i Hercegovinu“, Vijeće ministara, 2015.[119]
3. SR FBiH - „Strategija razvoja Federacije Bosne i Hercegovine“, Vlada FBiH, 2020.[120]
4. SR ŽP – „Strategija razvija Županije Posavske 2021 -2027“, Županija posavska, 2021.[121]
5. ISR USK – „Integrirana strategija razvoja Unsko-Sanskog kantona“, Vlada USK, 2014.[122]
6. NSP TK - „Nacrt strateške platforme razvoja Tuzlanskog kantona“, Vlada TK, 2015.[123]
7. SR SBK – „Strategija razvoj Srednjobosanskog kantona za period 2016 – 2020“, 2016.[124]
8. SR ZDK – „Strategija razvoja Zeničko-dobojskog kantona za period 2021 – 2027, Nacrt“, ZDK kanton, 2020[125].

[118] Bosna i Hercegovina. Vijeće Ministara. (2010).
[119] Bosna i Hercegovina. Vijeće Ministara. (2015).
[120] Federacija Bosne i Hercegovine. Vlada Federacija Bosne i Hercegovine. (2020).
[121] Federacija Bosne i Hercegovine. Županija Posavska. (2021).
[122] Federacija Bosne i Hercegovine. Unsko-sanski kanton. (2014)
[123] Federacija Bosne i Hercegovine. Tuzlanski Kanton. (2015).
[124] Federacija Bosne i Hercegovine. Srednjobosanki kanton. (2016).
[125] Federacija Bosne i Hercegovine. Zeničko-dobojski kanton. (2020).

9. SR KS – „Strategija razvoja Kantona Sarajevo, Nacrt – proširena verzija“. KS – Zavod za planiranje razvoja, 2020.[126]
10. SR HNŽ – „Strategija razvitka Hercegovačko-neretvanske županije za period 2021. – 2027. – Nacrt strateške platforme „ Vlada HNŽ, 2020.[127]
11. SR BPK – „ Strategija razvoja Bosansko-podrinjskog kantona Goražde za period 2016.- 2020. godine“, 2015[128]
12. SR ŽZH – „Strategija razvoja Županije Zapadnohercegovačke 2021 – 2027“, ŽZH, 2020.[129]
13. K 10 – „Strategija razvoja kantona 10 z a period 2016 – 2020. godina, Nacrt“ 2015[130]

[126] Federacija Bosne i Hercegovine. Kanton Sarajevo. (2020).
[127] Federacija Bosne i Hercegovine. Hercegovačko-neretvanska županija. (2020)..
[128] Federacija Bosne i Hercegovine. Bosansko-podrinjski kanton Goražde. (2015)
[129] Federacija Bosne i Hercegovine. Županija Zapadnohercegovačka (2021).
[130] Federacija Bosne i Hercegovine. Kanton 10. (2015).

Prilog br. 2

Tabela br. 5: SWOT matrica inovacionog sistema u Bosni i Hercegovini razrađena prema faktoru snage i njegovim elementima

Razrada elementa faktora snage sažete SWOT matrice: Uspostavljen državni okvir za inovacioni sistem			
R.br.		**R.br.**	
1	**2**	**3**	**4**
1.	**Snage**	**2.**	**Slabosti**
1.1.	Donesen je Okvirni zakon o osnovama načnoistraživačke djelatnosti i koordinaciji unutrašnje i međunarodne naučno-istraživačke saradnje (Sl.gl. BiH /09)	2.1.	Država BiH je nadležna za međunarodne odnose inovacionog sistema, ali nema efikasne ustavne i zakonske instrumente za ispunjavanje dogovorenih obaveza i prava unutar zemlje.
1.2.	Sporazum o stabilizaciji i pridruživanju EU otvorio mogućnosti za pristup ERA	2.2.	Pretpostavka nadležnosti nižih političko-teritorijalnih jedinica za sve poslove koji nisu izričito ustavom dati višoj političko-teritorijalnoj jedinici
1.3.	Donesena državna strategija razvoja NID	2.3.	Izostavljanje opšteg i parcijalizacija posebnog interesa za inovacioni sistem prema teritorijalnoj nadležnosti za donošenje zakona u ovoj oblasti.
1.4	Donesen Okvirni zakon o visokom obrazovanju u BiH (50/07 i 59/09)	2.4.	Po iznosima i strukturi apsolutno nedovoljno i neadekvatno budžetsko finansiranje funkcionisanja inovacionog sistema, praćeno izostankom poticaja i povlastica za istraživanje i razvoj.
1.5.	Uspostavljena međuzavisnost naučnog i nastavnog rada na univerzitetima	2.5.	/
1.6.	U toku je završetak stvaranja usaglašenog sistema strateškog planiranja u BiH	2.6.	/
3.	**Prilike**	**4.**	**Prijetnje**
3.1.	Završetak zakonskog uređivanja sistema nauke donošenjem novih zakona u šest kantona koji to nisu učinili nakon potpisivanja Dejtonskog mirovnog sporazuma.	4.1.	Legalna mogućnost nižih političko-teritorijalnih jedinica da ne koriste svoje nadležnosti i time umanje efekte nastojanja države u međunarodnoj naučnoj i tehničkoj saradnji
3.2.	Donošenje 11 nedostajućih strategija razvoja inovacionog sistema (devet kantona, FBiH, Distrikt Brčko)	4.2.	Autarhična primjena principa decentralizovanog i policentričnog planiranja razvoja inovacionog sistema
3.3.	Razvijanje mehanizama povezivanja Ministarstva civilnih poslova BiH i subjekata inovacionog sistema u stvaranju i ispunjavanju oblika međunarodne saradnje.	4.3.	Ustavno-pravne i političke teškoće u djelovanju FBIH na harmonizaciji pravne i strategijske regulative inovacionog sistema

3.4.	Pojačavanje međunarodne razmjene i cirkulacije naučnoistraživačkih kadrova	4.4.	Produbljivanje unutrašnjeg jaza u znanju iz objektivnih razloga (različit stepen razvijenosti kanona, npr.), političkih stavova i kulturološke situacije (stav prema društvu i ekonomiji znanja, npr.).
Razrada elemenata faktora snage sažete SWOT matrice: Ujednačena struktura inovacionog sistema			
R.br.		**R.br.**	**Slabosti**
	Snage		
1	**2**	**3**	**4**
1.1.	Ujednačena sistematizacija poslova u inovacionom sistemu. Institutska i univerzitetska zvanja su izjednačena, a uslovi za izbor veoma slični	3.1.	Nedovoljno učešće naučnika i istraživača u ukupnoj populaciji i u radnoj snazi
1.2.	Visokoškolsko obrazovanje je dio EHEA i funkcioniše na ujednačen način	3.2.	Postoje male razlike u uslovima za izbor nastavnika, istraživača i naučnih i saradnika, ali one imaju značajan efekt na mobilnost radne snage unutar inovacionog sistema u državi
1.3.	Postoji sedam vrsta subjekata inovacionog sistema u velikoj mjeri ujednačenog statusnog režima	3.3.	Iz ugla optimalnog funkcionisanja inovacionog sistema, svaka od sedam vrsta subjekata ima svoje specifične statusno-pravne slabosti
1.4	Specifična pravna rješenja o inovacionom sistemu unutar političko-teritorijalnih jedinica se mogu harmonizovati bez narušavanja jedinstva bilo kojeg podsistema	3.4.	Nedovoljna produktivnost naučnog osoblja
1.5.	/	3. 5.	Inovacioni sistem nije prioritet politike u zakonodavnom, planskom, strategijskom i finansijskom pogledu
1.6.	/	3.6.	Apsolutno nedovoljna izdvajanja za nauku i sasvim neadekvatan sistem finansiranja
1.7.	/	3.7.	Ne postoji sistemski pristup naučnoj etici kao kontrolnom mehanizmu društvenog karaktera i uslovu za odobrenje pojedinih projekata
1. 8.	/	3.8.	Nezainteresiranost državne uprave za funkcionisanje i za učešće u radu inovacionog sistema.
2.	**Prilike**	**4.**	**Prijetnje**
2.1.	Donijeti nepostojeće i harmonizirati važeće zakone o inovacionom sistemu	4.1.	Legalna mogućnost nižih političko-teritorijalnih jedinica da na svom području ne unapređuju i ne harmoniziraju legislativu inovacionog sistema
2.2	Donijeti nepostojeće i harmonizirati važeće podzakonske akte o inovacionom sistemu	4.2.	Suprotnost između postojanja državne nadležnosti za međunarodne odnose inovacionog sistema i nepostojanja ovlaštenja i instrumenata za implementaciju međunarodnih aranžmana unutar države

2.3.	Povećanje iznosa i poboljšanje metodologije i budžetskog finansiranja, poboljšanje strukture finansiranja po subjektima i izvorima	4.3.	FBiH ima nadležnost za zakonsko uređivanje ekonomskih i privrednih odnosa, ali ne i za uređenje inovacionog sistema
2.4.	Usklađivanje politike direktnih stranih ulaganja sa strategijom i politikom inovacionog sistema	4.4.	Nepostojanje velikih privrednih organizacija koje bi bile nosioci razvoja inovacionog sistema u ekonomiji, ali i u državi

Razrada elemenata faktora snage sažete SWOT matrice: Dobro stanje ljudskog kapitala			
R.br.		**R.br**	
1	**2**	**3**	**4**
1.	**Snage**	**2.**	**Slabosti**
1.1.	Dobar zdravstveni sistem	2.1.	Nedovoljno ulaganje, države prvenstveno, u sve komponente ljudskog kapitala, a posebno u javno zdravstvo
1.2.	Obrazovni sistem usklađen sa evropskim standardima	2.2.	Postojanje unutrašnjeg jaza u znanju. Ljudski kapital u svim dijelovima države nije podjednako razvijen niti ima iste razvojne uslove.
1.3.	Još uvijek dobro stanje ljudskog kapitala koje se manifestuje objektivnom sposobnošću bosanskohercegovačke privrede da na međunarodno tržište plasira složene izvozne proizvode	2.3.	Nedovoljna koncentracija sopstvenog ljudskog kapitala u samostalnim institutima i privrednim subjektima
1.4	U inovacionom sistemu dominiraju istraživači sa titulom doktora nauka	2.4.	Nepovoljan odnos između broja istraživača i drugih zaposlenih u istraživačkim organizacijama
3.	**Prilike**	**4.**	**Prijetnje**
3.1.	Povećanje obuhvatnosti dobnih i stručnih grupa zaposlenih odgovarajućim vidom cjeloživotnog obrazovanja	4.1.	Dalja devalvacija znanja, vještina i kompetencija u društvenom sistemu, u pod-sistemu politike posebno.
3.2	Povećanje domaće potražnje za institutskim znanjem i uslugama	4.2.	Nedovoljno brz rast informaciono-komunikacionih vještina i kompjuterske pismenosti stanovništva.
3.3.	STEM obrazovanje ponovo uključiti u državnu obrazovnu politiku	4.3.	Pad nataliteta, starenje stanovništva i emigracija
3.4.	Jačanje dijelova sistema javnog zdravstva relevantnog za održavanje i razvoj ljudskog kapitala	4.4.	Odliv pameti
2.5.	Planskim akcijama uklanjati razlike između deklaratornog i stvarnog odnosa prema ljudskom kapitalu.	4.5	/

Razrada elemenata faktora snage sažete SWOT matrice: Ujednačeno i stabilizirano visoko obrazovanje			
R.br.		**R.br.**	
1	**2**	**3**	**4**
1.	**Snage**	**2.**	**Slabosti**
1.1.	Potpisane i primijenjene najvažnije konvencije koje definišu EHEA	2.1.	Univerziteti su največim dijelom orijentisani na održavanje nastave. Ne postoje istraživački univerziteti.
1.2.	Donesen i primijenjen Okvirni zakon o visokom obrazovanju u BiH (Sl.gl. BiH 59/07 i 59/09). Entitet RS i svi kantoni u Entitetu FBiH usvojili svoje zakone u ovoj oblasti.	2.2.	Mali broj centara izvrsnosti i u političko-teritorijalnim jedincima u kojima su zakonski uređeni.
1.3.	Povoljna struktura univerziteta	2.3.	Veoma ograničena saradnja sa privredom
1.4.	Jedinstvo nauke i nastave postavljenu kao princip i veliki dijelom ostvareno u praksi	2.4.	Nezadovoljavajući plasman svih domaćih univerziteta na međunarodnim rang listama
1.5.	Izučavaju se sve naučne i umjetničke oblasti	2.5.	Nedovoljni kapaciteti za transfer tehnologija
1.6.	Relativno dobar naučnonastavni kadar	2.6.	Ograničena sposobnost angažiranja najboljih kadrova iz privrede i diplomiranih studenata
1.7.	Postojanje instituta kao istraživačkih jedinica, pretežno na javnim univerzitetima.	2.7.	Nedefinirana politika suprotstavljanja odlivu pameti
3.	**Prilike**	**4.**	**Prijetnje**
3.1.	Ubrzano zapošljavanje stručnjaka deficitarnih struka, naročito mlađih.	4.1.	Spor razvoj autonomije visokoškolskih ustanova
3.2.	Utvrditi politiku i obezbijediti sredstva za sistematičnu međunarodnu saradnju i cirkulaciju kadrova	4.2.	Održavanje sadašnje strukture prihoda visokoškolskih ustanova. Kod javnih to znači dalju dominaciju budžeta, a kod privatnih – školarine. Stagnacija prihoda od istraživanja i razvoja je opasna i po univerztitete i po društvo
3.3.	Donijeti strategiju i operativne dokumente za formiranje centara izvrsnosti.	4.3.	Tendencije samoizolacije i provincijalizacije univerziteta.
3.4.	Planski pristup mjerama za povećanje objavljivanja u časopisima koje prate indeksne baze podataka i za popravljanje ranga naših univerziteta, javnih naročito	4.4.	Zadržavanje sadašnjeg nivoa ulaganja u opremu i načnoistraživačke projekte i istrajavanje na sistemu nedovoljnog sufinansiranja nabavki i istraživanja
3.5.	Donijeti opštu i strategije visokoškolskih ustanova za saradnju sa privrednim subjektima	4.5.	Zadržavanje sadašnjeg nivoa ulaganja u opremu i načnoistraživačke projekte i istrajavanje na sistemu nedovoljnog sufinansiranja nabavki i istraživanja

Prilog 3.

Tabela br. 6:"Pregled objavljenih radova u Scopus bazi prema granama nauke i univerzitetima"

OBLAST	UNIVERZITETI/SVEUČILIŠTA								**SUMA**	%
	UNSA	UNBL	UNTZ	SVEM	UIS	UNZE	UNMO	UNBI	Σ	RADOVI
Medicina	2085	353	461	375	178	72	17	0	3541	19,9%
Inžinjerstvo	1264	494	341	116	202	101	63	0	2581	14,5%
Kompjuterske nauke	963	307	213	81	157	43	74	0	1838	10,3%
Poljoprivreda i biološke nauke	471	347	65	101	101	0	17	0	1102	6,2%
Društvene nauke	458	135	149	136	78	25	23	0	1004	5,6%
Matematika	461	200	70	37	82	27	10	0	887	5,0%
Fizika i astronomija	442	184	75	24	82	39	2	0	848	4,8%
Biohemija, genetika i molekularna biologija	360	166	66	85	52		1	0	730	4,1%
Nauka o zaštiti okoline	273	147	90	38	58	11	7	0	624	3,5%
Hemija	188	120	58	41	96	17	2	0	522	2,9%
Nauka o materijalima	130	174	40	31	75	54	8	0	512	2,9%
Hemijsko inžinjerstvo	231	77	62	27	71	20	2	0	490	2,8%
Energija	194	96	84	10	79		5	0	468	2,6%
Umjetnost i humanističke nauke	170	50	62	81	12	22	10	0	407	2,3%
Biznis, menadžment i računovodstvo	173	57	25	25	23	9	9	0	321	1,8%
Farmakologija, toksikologija i farmaceutika	145	70	12	17	11	1	0	0	256	1,4%
Nauke o Zemlji i planetama	83	62	55	22	19	3	1	0	245	1,4%
Zdravstvene studije	88	25	42	41	43	2	3	0	244	1,4%
Donošenje odluka (interdisciplinarno područje)	106	35	11	4	30	8	9	0	203	1,1%
Ekonomija, ekonometrija i finansije	111	35	17	12	18		5	0	198	1,1%
Fiziologija	79	39	30	22	7	2	0	0	179	1,0%
Veterina	105	25	4	16	5	1	1	0	157	0,9%

OBLAST	UNIVERZITETI/SVEUČILIŠTA								**SUMA**	%
Imunologija i Mikrobiologija	79	12	11	18	7	0	0	0	127	0,7%
Neuroznanost	52	13	18	5	3	0	0	0	91	0,5%
Sestrinstvo	50	8	15	6	4	3	1	0	87	0,5%
Stomatologija	43	11		9	20	1	0	0	84	0,5%
Mutidisciplinarna područja	36	15	6	4	7	0	2	0	70	0,4%
	8840	3257	2082	1384	1520	461	272	0	**17810**	
% PO UNIVERZITETU	49,6%	18,3%	11,7%	7,8%	8,5 %	2,6%	1,5%			

Zahvala

Autori žele da se zahvale gospodinu Saši Madackom, diplomiranom komparativisti i diplomiranom bibliotekaru, na velikoj pomoći u obezbjeđivanju i sintezi podataka vezanih za broj visokoškolskih institucija u Bosni i Hercegovini i naučnoistraživačkih radova u SCOPUS bazi.

Literatura

Agencija za razvoj visokog obrazovanja i osiguranje kvaliteta Bosne i Hercegovine . Lista akreditiranih visokoškolskih ustanova u BiH. Preuzeto s http://hea.gov.ba/akreditacija_vsu/Default.aspx, 10. 5. 2021.

Agencija za statistiku Bosne i Hercegovine. Demografija i socijalne statistike. Statistika obrazovanja – Visoko obrazovanje u školskoj 2019/2020. godini, Saopćenje (God. XV, Broj 2), Sarajevo, 30. 10. 2020.

Agencija za statistiku Bosne i Hercegovine. Nauka, tehnologija i digitalno društvo, Statistika Istraživanje i razvoj 2019, Saopćenje, God. IX (br. 1), Sarajevo, 12. 2. 2021.

Babić, M. (2021). Od Srbije čekamo da nam izbroji vakcinisane. Oslobođenje [Digital Edition]. 25. 5. 2021. Preuzeto s https://www.oslobodjenje.ba/vijesti/bih/od-srbije-cekamo-da-nam-izbroji-vakcinisane-658782, 25. 5. 2021.

Bosna i Hercegovina. Centar za informiranje i priznavanje dokumenata iz oblasti visokog obrazovanja Bosne i Hercegovine. (2021). *Lista visokoškolskih ustanova*. Preuzeto s http://www.cip.gov.ba/images/pdf/ListaVSU/Lista_VSU.bos.pdf, 10. 5. 2021.

Bosna i Hercegovina. Okvirni zakon o osnovama naučno-istraživačke djelatnosti i koordinaciji unutrašnje i međunarodne naučno-istraživačke saradnje Bosne i Hercegovine *Službeni glasnik Bosne i Hercegovine* br. 43/09.

Bosna i Hercegovina. Okvirni zakon o visokom obrazovanju u Bosni i Hercegovini. *Službeni glasnik Bosne i Hercegovine* br. 59/07.

Bosna i Hercegovina. Ustav Bosne i Hercegovine. [Aneks IV Opšteg okvirnog sporazuma za mir u Bosni i Hercegovini]. Preuzeto s https://www.ustavnisud.ba/public/down/USTAV_BOSNE_I_HERCEGOVINE_bos.pdf

Bosna i Hercegovina. Vijeće Ministara Bosne i Hercegovine (2016). Strategija razvoja znanosti u Bosni i Hercegovini 2017-2022: revidirani okvirni dokument. Preuzeto s http://www.vijeceministara.gov.ba/akti/prijedlozi_zakona/?id=29796, 20. 6. 2016.

Bosna i Hercegovina. Vijeće Ministara Bosne i Hercegovine (2020). Srednjoročni program rada Vijeća ministara BiH 2021–2023. Vijeće ministara Bosne i Hercegovine. Sarajevo. Preuzeto s https://www.ekonsultacije.gov.ba/legislationactivities/downloaddocument?documentId=1013796, 11. 6. 2021.

Bosna i Hercegovina. Vijeće Ministara Bosne i Hercegovine. (2014). Odluka Vijeća ministara BiH o postupku srednjoročnog planiranja, praćenja i izvještavanja u institucijama Bosne i Hercegovine. *Službeni glasnik Bosne i Hercegovine* br. 62/14.

Bosna i Hercegovina. Vijeće Ministara Bosne i Hercegovine. Direkcija za ekonomsko planiranje. (2015a). Strateški okvir za BiH. Direkcija za ekonomsko planiranje. Sarajevo. Preuzeto s http://www.dep.gov.ba/naslovna/DEP%20Strateski%20okvir%20za%20BiH.pdf, 2. 4. 2021.

Bosna i Hercegovina. Vijeće Ministara Bosne i Hercegovine. Direkcija za ekonomsko planiranje. (2015b). Strategija razvoja Bosne i Hercegovine. Direkcija za ekonomsko planiranje. Sarajevo. Preuzeto s http://www.dep.gov.ba/razvojni_dokumenti/razvojna_strategija/Archive.aspx?langTag=bs-BA&template_id=140&pageIndex=1, 11. 6. 2021.

Bosna i Hercegovina. Vijeće Ministara. (2010). Strategija razvoja Bosne i Hercegovine, Radni dokument. Preuzeto s http://dep.gov.ba, 11. 6. 2021.

Bosna i Hercegovina. Vijeće Ministara. (2016). Odluka Vijeća ministara o sistemu koordinacije procesa europskih integracija u Bosni i Hercegovini *Službeni glasnik Bosne i Hercegovine* br. 72/16 Preuzeto s http://vijeceministara.gov.ba/home_right_docs/default.aspx?id=23422&langTag=hr-HR, 11. 6. 2021.

Bosna i Herceogovina. Vijeće Ministara. (2015). Strateški okvir za Bosnu i Hercegovinu. Preuzeto s http://dep.gov.ba/naslovna/DEP%2'strateski%20okvir%20za%20BiH.pdf, 11. 6. 2021.

Božac, M.G. (2008). SWOT analiza i TOWS matrica – sličnosti i razlike. *Ekonomska istraživanja*. Vol. 21 (br. 1), str. 20–23.

Consejo Superior de Investigaciones Científicas (2021). *Ranking Web of Universities - Bosnia and Herzegovina*. Preuzeto s https://webometrics.info/en/Europe/Bosnia%20and%20Herzegovina%20, 11. 6. 2021.

Cvitković, I. [ur.] (2017). *Demografske i etničke promjene u BiH*, Akademija nauka i umjetnosti Bosne i Hercegovine, Sarajevo.

Čičić, M. [ur.] (2020). *Studija o emigracijama Bosne i Hercegovine*. Akademija nauka i umjetnosti Bosne i Hercegovine, Sarajevo.

Emirhafizović, M. i Zolić, H. (2017). Dobna struktura i reprodukcija stanovništva Bosne i Hercegovine. [ur.] Cvitković, I. *Demografske i etničke promjene u BiH*, (str. 11-54). Akademija nauka i umjetnosti Bosne i Hercegovine, Sarajevo.

European Comission. (2019). The European Charter for Researchers: The Code of Conduct for the Recruitment. Office for Official Publications of the European Communities. Luxembourg. Preuzeto s https://www.unsa.ba/sites/default/files/inline-iles/EU%20Povelja%20i%20Kodeks%20za%20istrazivace_BOS.pdf, 11. 6. 2021.

Evropska. Komisija. (2021). EURAXESS - Researchers in Motion. Preuzeto s https://euraxess.ec.europa.eu/, 11. 6. 2021.

Federacija Bosne i Hercegovine. Bosansko-podrinjski kanton Goražde. (2015) Strategija razvoja Bosansko-podrinjskog kantona Goražde za period 2016–2020. godine, Preuzeto s Http:// www. zzpr.gov.ba/bs/docs/25/4/kantonalni zzh.ba/images/PDF/Strategije/Strategija%20razvoja%20Zupanije%20Zapadnohercegovacke%202021-2027-RADNA%20 VERZIJA.pdf -strateski-dokumenti, 11. 6. 2021.

Federacija Bosne i Hercegovine. Federalni zavod za programiranje razvoja. *Uredbe*. Preuzeto s https://www.fzzpr.gov.ba/bs/docs/35/8/uredbe

Federacija Bosne i Hercegovine. Federalni zavod za programiranje razvoja. *Kantonalnoi strateški dokumenti*. Preuzeto s https://fzzpr.gov.ba/public/bh/strateski-dokumenti/kantonalni-strateski-dokumenti, 11. 6. 2021.

Federacija Bosne i Hercegovine. Federalno ministartsvo obrazovanja i nauke (2010). Strategija razvoja nauke u Federaciji Bosne i Hercegovine za period 2011 – 2021. Federalno ministarstvo obrazovanja i nauke. Mostar.

Federacija Bosne i Hercegovine. Hercegovačko-neretvanska županija. 2020).. Strategija razvitka Hercegovačko-neretvanske županije za period 2021. – 2027. – Nacrt strateške platforme. Preuzeto s https://www.vlada-hnz-k.ba/sites/default/files/17.11.strateska_platfroma_hnk_2021_2027_nacrt_mm_1.pdf, 11. 6. 2021.

Federacija Bosne i Hercegovine. Kanton 10. (2015). Strategija razvoja kantona 10 za period 2016 – 2020: Nacrt. Preuzeto s https://www.fzzpr.gov.ba/bs/docs/25/4/kantonalni-strateski-dokumenti, 11. 6. 2021.

Federacija Bosne i Hercegovine. Kanton Sarajevo. (2020). Strategija razvoja Kantona Sarajevo, Nacrt – proširena verzija. Preuzeto s https://zpr.ks.gov.ba/strategija-razvoja-kantona-sarajevo-2021-2027strateska-platforma-nacrt-prosirena-verzija, 11. 6. 2021.

Federacija Bosne i Hercegovine. Srednjobosanki kanton. (2016). Preuzeto s https://sbk-ksb.gov.ba/images/Strategija_razvoja_SBK_2016-2020.pdf, 11.6. 2021.

Federacija Bosne i Hercegovine. Tuzlanski Kanton. (2015). Nacrt strateške platforme razvoja Tuzlanskog kantona. Preuzeto s http://www.vladatk.kim.ba/Vlada/Novosti_2014/Nacrt_Strateske_platforme_razvoja_Tuzlanskog_kantona.pdf, 11. 6. 2021.

Federacija Bosne i Hercegovine. Unsko-sanski kanton. (2014). Integrirana strategija razvoja Unsko-sanskog kantona, Preuzeto s https://www.fzzpr.gov.ba/bs/docs/25/4/kantonalni-strateski-dokumenti, 11. 6. 2021.

Federacija Bosne i Hercegovine. Uredba o izradi strateških dokumenata u Federaciji Bosne i Hercegovine. *Službene novine Federacije Bosne i Hercegovine* br. 74/19

Federacija Bosne i Hercegovine. Vlada Federacija Bosne i Hercegovine. (2020). Strategija razvoja Federacije Bosne i Hercegovine. Preuzeto s http://fzzpr.dgov.ba/bs/pages/48/16/strategija-razvoja-federacije-bih-2021-2027, 11. 6. 2021.

Federacija Bosne i Hercegovine. Vlada Federacije Bosne i Hercegovine (2021). *Strategija razvoja Federacije Bosne i Hercegovine 2021-2027*. Vlada Federacije Bosne i Hercegovine. >Sarajevo. Preduzeto s http://www.sogfbih.ba/sites/default/files/javni_dokument/2021-05/Strategija%20razvoja%20FBiH%202021.%20-%202027..pdf, 11. 6. 2021.

Federacija Bosne i Hercegovine. Zakon o razvojnom planiranju i upravljanju razvojem u Federaciji Bosne i Hercegovine. *Službene novine Federacije Bosne i Hercegovine* br. 32/17.

Federacija Bosne i Hercegovine. Zeničko-dobojski kanton. (2020). Strategija razvoja Zeničko-dobojskog kantona za period 2021 – 2027: Nacrt. Preuzeto s https://www.zdk.ba/component/k2/item/download/5098_caae7a6c7e858099211e354ca553e6ec, 11. 6. 2021.

Federacija Bosne i Hercegovine. Županija Posavska. (2021). Strategija razvija Županije Posavske 2021-2027. Županija posavska. Preuzeto s http://www.zupanijaposavska.ba/wp-content/uploads/2020/11/FINALNI-NACRT-V2-Strategija-razvoja-Zupanije-Posavske-10-11-2020-2_compressed.pdf, 11. 6. 2021.

Federacija Bosne i Hercegovine. Županija Zapadnohercegovačka (2021). Strategija razvoja Županije Zapadnohercegovačke 2021 – 2027. Preuzeto s http://www.eui-zzh.ba/images/PDF/Strategije/Strategija_razvoja_ZZH_za_razdoblje_2021_-_2027_godine.pdf , 11. 6. 2021.

Federalni zavod za statistiku. (2020). *Projekcije stanovništva Federacije Bosne i Hercegovine 2020 – 2070*. Federalni zavod za statistiku. Sarajevo. Preuzeto s https://fzs.ba/wp-content/uploads/2020/12/PROJEKCIJE-STANOVNI%C5%A0TVA-FBiH-2020_2070_bos.pdf, 11. 6. 2021.

Federalni zavod za statistiku. (2020). Statistički bilten Visoko obrazovanje 2019/2020, broj 306, Sarajevo.

Federalni zavod za statistiku. Visoko obrazovanje u Federaciji Bosne i Hercegovine u 2020./2021. Saopćenje (God. XIII, Broj 12.3), Sarajevo, 3. 3. 2020.

Fleisher, C. i Bensoussan, B. (2007). *Business and Competitive Analysis: Effective Application of New and Classic Methods*. Pearson Education. Upper Saddle River, New Jersey.

https://www.weforum.org/reports/the-global-competitiveness-report-2017-2018, 24. 3. 2021.

Kanton Sarajevo. Vlada kantona Sarajevo. Ministarstvo za obrazovanje, nauku i mlade Kantona Sarajevo (2017). Strategija razvoja obrazovanja i nauke Kantona Sarajevo za period 2018 – 2022. godine - (Nacrt). Ministarstvo za obrazovanje, nauku i mlade Kantona Sarajevo. Sarajevo. Preuzeto s https://skupstina.ks.gov.ba/sites/skupstina.ks.gov.ba/files/nacrt_strategije_obrazovanje.pdf, 11. 6. 2021.

Kanton Sarajevo. Vlada kantona Sarajevo. Ministarstvo za obrazovanje, nauku i mlade Kantona Sarajevo Standardi i normativi za obavljanje djelatnosti visokog obrazovanja na području Kantona Sarajevo. *Službene novine Kantona Sarajevo* br. 33/17

Kremić, E. I Trifković, M. [ur.] (2020). Harmonizacija sistema nauke u Bosni i Hercegovini: projekt = Harmonization of the science system in Bosnia and Herzegovina : project. Federalni zavod za statistiku = Institute for Statistics of the Federation of Bosnia and Herzegovina : Akademija nauka i umjetnosti Bosne i Hercegovine = Academy of Sciences and Arts of Bosnia and Herzegovina. Sarajevo.

Nikolić, R. (s.a.). SWOT analiza: šta je to i kako se primenjuje. [Digital Edition]. Preuzeto sa www.issu.com/bisera.kardula/docs/1913_m_chapter_3_swor_manual_r-niko, 27. 3. 2021.

Pašalić–Kreso, A. (2017). Obrazovanost stanovništva u Bosni i Hercegovini – Bosna i Hercegovina između najviše stope nepismenosti i najnižeg nivoa obrazovanosti“ [ur.] Cvitković, I. *Demografske i etničke promjene u BiH*, (str. 93-124). Akademija nauka i umjetnosti Bosne i Hercegovine, Sarajevo.

Radošević, S. (2011). Science-industry links in Central and Eastern Europe and the Commonwelth of Independent States: conventioanla policy wisdom faciong reality. *Science and Public Policy*. Vol 38 (br. 5), str. 365-378.

Radošević, S., i Lepori, B. (2009). Public Research Funding Systems in Central and Eastern Europe: Between Excellence and Relevance: Introduction to Special Section. *Science and Public Policy*, Vol. 36 (br. 9), str. 659-666.

Repbublika Srpska. Narodna skuppština Republike Srpske. Materijali za 16. Redovnu sjednicu. Preuzeto sa: http://www.narodnaskupstinars.net/sites/default/files/upload/dokumenti/materijali_za_sjednice/lat/Materijali%20za%2016.%20redovnu%20sjednicu.zip, 26. 4. 2021.

Republički zavod za statistiku Republike Srpske. (2020) .Statistički bilten 2019/2020, Banja Luka,

Republika Srpska. Ministartsvo za naučnotehnološki razvoj, visoko obrazovanje i informaciono društvo. *Strategije*. Preuzeto sa https://www.vladars.net/sr-SP-Cyrl/Vlada/Ministarstva/mnk/PAO/Strategije/Pages/default.aspx, 11. 6. 2021.

Republika Srpska. Vlada Republike Srpske (2017). Strategija naučnog i tehnološkog razvoja Republike Srpske 2017 – 2021. godine – Znanje za razvoj. Vlada Republike Srpske. Banja Luka. Preuzeto s https://www.vladars.net/sr-SP-Cyrl/Vlada/Ministarstva/mnk/Documents/PRIJEDLOG%20-%20%20strategije%20naucnog%20i%20tehnoloskog%20razvoja%20RS%202017-2021%20%286%29.pdf, 11. 6. 2021.

Republika Srpska. Zakon o naučnoistraživačkoj djelatnosti i tehnološkom razvoju. *Službeni glasnik Republike Srpske* br. 6/12, 33/14 66/18 i 84/19. Preuzeto s http://spu.ba/wp-content/uploads/2018/02/zakon_o_naucnoistrazivackoj_djelatnosti_i_tehnoloskom_razvoju.pdf, 11. 6. 2021.

Republika Srpska. Zakon o visokom obrazovanju. *Službeni glasnik Republike Srpske* br. 67/202

Schwab, K. (2017). *The Global Competitiveness Report 2017-2018*. [Digital Edition]. World Economic Forum. Cologny/Geneva. Preuzeto sa

Schwab, K. (2019). *The Global Competitiveness Report 2019*. [Digital Edition]. World Economic Forum. Cologny/Geneva. Preuzeto shttp://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf, 24. 3. 2021.

Statista (2021). *Number of novel coronavirus (COVID-19) deaths worldwide as of May 24, 2021, by country*. Preuzeto s https://www.statista.com/statistics/1093256/novel-coronavirus-2019ncov-deaths-worldwide-by-country/, 24. 5. 2021.

Steiner, C. [et. al.] (2010). Ustav Bosne i Hercegovine : komentar. Fondacija Konrad Adenauer e.V. Sarajevo.

Trifković, M. (2020a). Uticaj Dejtonskog mirovnog sporazuma na inovacioni sistem u Bosni i Hercegovini. *Dijalog*, 2020 (br. 3-4), str. 40-59. ISSN 0350-6177.

Trifković, M. (2020b). *Harmonizacija sistema nauke u Bosni i Hercegovini*. Akademija nauka i umjetnosti Bosne i Hercegovine. Sarajevo.

Trifković, M. [ur.] (2020c). Zadržavanje mladih u Kantonu Sarajevo: analiza determinanti i prijedlog strateških mjera“. Akademija nauka i umjetnosti Bosne i Hercegovine, Sarajevo.

Wikipedia (2021). *List of countries by GDP (PPP) per capita*. Preuzeto s https://en.wikipedia.org/wiki/List_of_countries_by_GDP_(PPP)_per_capita, 24. 3. 2021.

World Bank (2021). *World bank Data: Science and Technology*. Preuzeto s https://data.worldbank.org/topic/14, 26. 3. 2021.

World Intelectual Property Organization (2020). *Global Innovation Index. Bosnia and Herzegovina*. Preuzeto s https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020/ba.pdf, 24. 3. 2021.

Science System - a Factor of Stimulation or Limitation in Development

CONTENTS

PREFACE

The Academy of Sciences and Arts of Bosnia and Herzegovina (ANUBiH) continuously monitors and studies the development of science and the state of the innovation system in the country. The latest contribution to this process is the international conference “Science System - a Factor of Stimulation or Limitation in Development”, organized by the Department of Social Sciences.

Data from statistical institutes in Bosnia and Herzegovina, all available international studies and analyses, answers of Bosnia and Herzegovina to primary and supplementary questions on science from Chapter 25 of the European Commission, medium-term development plans of various levels of state organization and ANUBiH research results, including the latest “Harmonization of the Science System in Bosnia and Herzegovina”, show that scientific research and technological-development work in Bosnia and Herzegovina are stagnating in the absolute sense, and regressing in relative sense. The title of the conference is based on this conclusion. Our studies confirm that the main reasons for the unsatisfactory state of science and technological development in Bosnia and Herzegovina are the absolutely insufficient funding, and a polycentric and atrophied innovation system. The profile of this conference has been determined accordingly. It is not focused on the description of the situation, but on the policy and instruments for its change.

The contributions are oriented to the most important and most critical structural and functional elements of the innovation system – those that significantly affect the development of society and the knowledge economy. These factors were examined in order to identify key links between global and domestic development of the innovation system and the messages that Bosnia and Herzegovina can draw from global trends. To achieve this, selected aspects of the innovation system are highlighted, especially from the angles of economic policy and planning, organization, financing, law, ethics and scientometrics. Such procedure placed three groups of subjects into the focus of the conference: the state, universities and companies. Thus, the necessity of systematic application of the Triple Helix approach in our country is highlighted.

The organizers of the conference hope that the scientific and professional public will especially benefit from the vast knowledge and experience that the authors summarize in their papers. In order to make the best use of this wealth, which was made available to us free of charge, enough time for discussion was left in the conference program. With the same goal, presentations, discussions and conclusions of the conference will be posted on the ANUBiH website. If this serves as an inspiration for new research and concrete changes in this area, the conference will fully fulfil its mission.

The Academy of Sciences and Arts of Bosnia and Herzegovina wishes to express its gratitude to the Federal Ministry of Education and Science, especially to mr. sc. Jasmin Brankovic, Assistant to the Minister of Science and Technology, not only for financing the conference and printing of the Proceedings, but also for understanding the difficulties caused by the COVID-19 pandemic to the organizers of this gathering.

On behalf of the working bodies that organized the conference and the publication of the Proceedings, I would like to thank all the employees of ANUBiH for their selfless commitment to the success of this project.

Sarajevo, October 2021

Academician Miloš Trifković, editor
Academy of Sciences and Arts of Bosnia and Herzegovina

DOI: 10.5644/PI2021.200.11

The limitations of scientific consensus

Key note address

*Dražen Prelec**

It is a pleasure and honour to contribute to the conference on "Science System — a Factor of Stimulation or Limitation in Development," organized by the Academy of Sciences and Arts of Bosnia and Herzegovina. One cannot overstate the importance and timeliness of the conference topic, which raises at least two distinct questions: The first 'external' question is how to measure the impact of scientific research on society as a whole; the second, 'internal' question is how the scientific system should be organized to maximize the production of genuine scholarship. From the program, it is evident that both questions will be discussed during the course of the day.

I should acknowledge at the outset that my research is not in the study of science per se. I have worked on decision making, behavioural economics, and, what is relevant here, on the development of mechanisms for eliciting and aggregating expert judgment, which in terms of this conference, makes me a 'meta-expert' if not a 'domain expert.' Expert or specialized judgment is, of course, at the heart of science, contributing to tension between scientists and the general public, which is asked to accept the judgments of the scientific community without necessarily understanding the supporting reasons or evidence. The lay public is asked simply to trust science.

The focus of my talk will be on methods for reaching a consensus judgment in situations where experts disagree. Such disagreement arises routinely in every discipline and institution. It is endemic to legal decision making, artistic judgments, and in certain areas of medicine, notably psychiatry. Within natural science it has both an internal and external aspect. At the every-day

* Professor in the Sloan School of Management, the Department of Economics, and the Department of Brain and Cognitive Sciences, Massachusetts Institute of Technology.
E-mail: dprelec@mit.edu.

level within the ordinary functioning of science, there are decisions about accepting articles for publication, funding grant proposals, or hiring and promoting individual faculty candidates. In such cases, equally qualified judges or panel members may reach different conclusions. How, then, should decisions be made? Should they be entrusted to a single ‘dictator,’ such as a journal editor or university president, or to a credentialed panel, as is typically the case in grant funding decisions? The challenge of reaching a consensus judgment also appears at the external level, when the discipline speaks to social problems and policy. The question then is what the discipline actually believes, for example about climate change or economic policy. Should that collective belief be computed by some kind of average of beliefs of card-holding professionals in the discipline?

We are touching here on an ancient problem of democratic voting, and the related questions of who is competent to vote on a particular question, and how votes should be combined to produce a decision. One could start with the ancient Greeks; I will only note two important more recent results, one mathematical and one empirical.

The mathematical result is Condorcet’s ‘jury theorem’ (Condorcet, 1785). Condorcet considered the accuracy of majority opinion on binary question, such as whether a proposition is True or False. The question is presumed to have an objectively correct answer, which no single person necessarily knows. Condorcet proved that if each voting individual has a better than 50% chance of being correct, then majority opinion becomes an increasingly likely indicator of truth as the number of voters increases, and becomes infallible as that number approaches infinity. This was an early proof of the law of large numbers.

More than a century later, the English scholar Francis Galton provided a small but elegant empirical demonstration, which proved even more influential (Galton 1907). Galton conducted a judgmental experiment in the natural setting of a country fair, where animals were being bought and sold. He asked people there to judge the weight of a single ox, or, more precisely, the weight of meat produced by the animal after it had been slaughtered. Galton reasoned that the accuracy of the median estimate would constitute a fair test of democratic decision making:

> “According to the democratic principle of ‘one vote one value’ the middlemost [median] estimate expresses the *vox populi*, every other estimate being condemned as too low or too high by a majority of the voters...”

Galton did not screen for expertise, and the people providing estimates were a diverse lot, some experienced with assessing the value of animals offered for sale and others mere passers-by. The experiment could thus be presented as a test of the democratic one-person one-vote principle. The result of the experiment was remarkable and perhaps a disappointment to Galton who was politically conservative. The median estimate matched actual weight almost exactly.

Galton's paper become the stimulus to what is now known as the 'wisdom-of-the-crowd' philosophy, which holds that algorithmic aggregation of opinions is superior to, and should replace credentialed experts. The utopian claims associated with this philosophy are well summarized in the best seller "The Wisdom of Crowds," by the journalist James Surowiecki:

> "Large groups of people are smarter than an elite few, no matter how brilliant — better at solving problems, fostering innovation, coming to wise decisions, even predicting the future (Surowiecki, 2005)."

The wisdom-of-the-crowd movement draws strength from two trends - one technological and one social-political. The widespread adoption of electronic communication devices has made it much easier to tap vast numbers of dispersed individuals, and, if needed, pay them for offering their opinions. We see this in the proliferation of online ratings systems and freely provided evaluations; we can all vote on all kinds of different question without much effort. Galton's vox populi is now heard everywhere, all the time. This is accompanied by increased mistrust of expertise in general, and in scientific expertise in particular.

However, the technological advances in communicating opinions did nothing to solve an underlying theoretical problem: Although it is obviously true that a large group of people has more information than any single individual, it is not obviously true that unfiltered majority opinion will correctly reflect that information. Majority opinion can certainly produce the wrong result if the best information is concentrated amongst a small number of individuals, while the majority holds incorrect beliefs. This is true in science as well, as new scientific developments are often greeted with scepticism even within the scientific community itself.

Before considering alternatives to majority opinion as a definition of truth, we should note that our culture possesses another powerful mechanism for eliciting and combining opinions from many individuals, namely markets and market institutions. In markets, these opinions are not expressed explicitly, but only implicitly through trading activity. That is, by investing in a market, investors are declaring that they have some information or insight that is not reflected in the current market price, but will be reflected at a later time, yielding a profit as a result.

Regarded as an instrument of collective decision making, markets have three interesting features. First, markets are procedurally democratic: Everyone can participate; a person does not need a degree or pass a test to be able to 'vote' in a market. However, unlike voting, the market verdict is not algorithmically democratic because the price does not reflect the average opinion, but the average weighted by how much different market participants are willing to invest. Those with deeper pockets have more influence. In theory at least, the market instrument should be exquisitely sensitive to expertise, as individuals with superior information will invest relatively more and have more impact on the price. Third, markets solve what economists call the 'incentive-compatibility problem,' that is, they provide incentives for individuals to reveal their honest opinions about future prices. This is not the case with voting or rating, where people can vote or rate dishonestly without any penalty.

Given these advantages, one might ask whether markets could have a role to play in the allocation of resources to scientific projects, evaluation of grant proposals, or editorial decisions in journals? Indeed, recent work has shown that a certain type of 'prediction market' is able to predict the reproducibility of scientific findings (Dreber et al., 2015). The market participants are able to intuit, to some extent, whether a published result is fragile or not credible.

It remains to be seen whether markets can play a larger role in scientific decision making. The crucial limitation of markets is that market securities must be defined with respect to a verifiable, public metric or event. In the paper just mentioned, the verifiable event is the outcome of an attempt to reproduce an experimental finding. The result will be known: Either the experimental result reproduces or does not reproduce. But many, if not most interesting scientific questions are not readily verifiable. This is certainly true in social sciences, where, for example, the 'truth' of a Keynesian approach to macroeconomics will never be resolved to everyone's satisfaction.

A similar problem appears if one were to attempt to use markets to make a grant funding decision. One can imagine a market where individuals would invest in proposals that are competing for funds. However, even if one could define a verifiable index for evaluating the ultimate performance of a research project, such an index could only be computed for proposals that were actually funded; unfunded proposals would not have determinate market value.

For these reasons some type of voting procedure remains the instrument of choice for reconciling opinions in science. As noted already, a major limitation of voting is its insensitivity to relative expertise. This problem cannot be solved by asking individuals to indicate their level of confidence and then weighting their answers by self-reported subjective confidence. People are simply not good in reporting confidence, and it is easy to imagine scenarios where experts are precisely the people who are relatively less confident (this would be the case when the information available to experts shatters confidence in a widely held consensus view).

In a recent paper my colleagues and I have proposed a solution to this problem, based on asking experts not only to give their personal judgment but also to predict the distribution of judgments that other experts, i.e., their 'peers,' will provide (Prelec, Seung and McCoy, 2017). The voting principle described in there is not the standard democratic principle of selecting the alternative that receives the most votes, i.e., the most popular alternative, but the different principle of selecting the alternative that receives the most votes relative to predictions. This is called the 'surprisingly popular' principle. The claims behind the theory are based on a mathematical model, but the main intuition can be conveyed through simple examples.[1]

As an elementary demonstration or 'proof-of-concept,' let us consider a simple factual question where most people provide the wrong answer. The following is an example of such a question: "Is the city of Philadelphia the capital of the US state of Pennsylvania?" Because Philadelphia is a familiar large city, and also plays an important role in US history, it seems like a natural candidate to be the state capital, and most people in the US believe that it is the state capital. However, the actual capital is the relatively unknown city of Harrisburg. Therefore, the Condorcet assumption fails and each voter has less than 50% chance of being correct on this question. The majority opinion is usually wrong, and, indeed, is guaranteed to be wrong in the large sample limit.

Here is how this problem can be fixed. The surprisingly popular principle does not endorse majority opinion, but instead compares the votes for each possible answer against predicted votes for that answer. In the Philadelphia case, even though only a minority of people (about 35%) provide the correct

[1] The surprisingly popular principle can also be used to provide incentives for honest judgments, in situations where honesty cannot be independently verified (Prelec, 2004).

answer “No”, this is more than the predicted votes for “No” which are about 25%. Therefore, the answer “No” will be declared as the correct answer according to the method, since 35% is greater than 25%.

It is worth pausing to consider why the predicted votes for “No” are fewer than the actual votes. This is because individuals who know that the correct answer is “No” also know that most people do not know the correct answer. Another way to express the intuition is that if Philadelphia were really the capital, then almost everyone would believe that to be the case, rather than only 65%. If the obvious answer is true, then it should be endorsed by almost everyone; if a significant minority disagrees with the obvious answer, then that answer is most likely false. Essentially, the surprisingly popular principle implements a handicapping system, where different answers are evaluated by comparing how much support they receive relative to the predicted handicap.

To provide a demonstration with more substantive interest, involving genuine domain expertise, we tested the method with art experts estimating the market value of modern artworks (Prelec, Seung & McCoy, 2017). From the standpoint of method, the challenge here is similar to one faced by a scientific panel of experts tasked to evaluate different research grant proposals. In both settings, the panel will be composed of people with different tastes and different levels of knowledge about individual artworks or proposal submitted for evaluation. In our study with modern art, we predicted and observed a specific type of failure of the democratic voting algorithm, namely, that it is too conservative. Even if a few experts do recognize an extraordinary talent, their opinions will generally be overcome by their colleagues who do not recognize it. It is important to understand this is not a problem of individual ignorance, but rather a problem of the voting method. An exceptional artwork has a better chance of being recognized by a single randomly selected panel member, than by the majority opinion of the entire panel. (One could say that these findings provide a kind of support for the practice of artistic patronage, where decisions are essentially delegated to a single aristocratic or wealthy individual).

It is plausible that the same problem arises within scientific panels or committees, because structurally the setting and the decision dilemmas are similar. Among the individuals who compose such panels, there will be differences in expertise in relation to specific proposals. Those who are relatively less familiar with a proposal are likely to default to a safe ‘average’ rating, which is the correct response at the personal level. This generates a bias against truly original proposals, whose merits are recognized by relatively few. In theory, the surprisingly popular voting principle will eliminate the bias, and provide more opportunities for new ideas to receive funding.

Such an experiment has not yet been done, and these proposals remain speculative. The challenges with implementing this method, and evaluating its performance relative to a traditional, majority opinion alternative, are not trivial. Nonetheless, we know enough about individual and collective decision-making biases to recommend a change in how things are done, in the hope of promoting ideas and projects that would not otherwise survive.

We have addressed so far the 'internal' question of improving resource allocation within science, but the same concerns and the potential remedies apply to the 'external' question of identifying and communicating the best answer to questions that society might pose to the scientific community. Mere scientific consensus is not a reliable indicator of the best answer in light of all scientific evidence, because evidence is not democratically distributed within the scientific community, which, like all human communities, is subject to conventions, fashion and prejudice.

Literature

Condorcet, J.-A.-N. de Caritat, marquis de. *Essai sur l'application de l'analyse à la probabilité des décisions rendues à la pluralité des voix*. Paris: Imprimerie Royale, 1785.

Dreber, A., Pfeiffer, T., Almenberg, J., Isaksson, S., Wilson, B., Chen, Y., Nosek, B.A., & Johannesson, M. Using prediction markets to estimate the reproducibility of scientific research. *Proceedings of the National Academy of Sciences*, 2015, *112*(50), 15343-15347.

Galton, F. Vox populi (the wisdom of crowds). *Nature*, 1907, *75*(7), 450-451.

Prelec, D., Seung, H. S., & J. McCoy. A solution to the single-question crowd wisdom problem. *Nature*, 2017, *541*(7638), 532-535.

Prelec, D. "A Bayesian truth serum for subjective data." *Science*, 2004, 306, 462-466.

Surowiecki, J. *The wisdom of crowds*. Anchor, 2005.

DOI: 10.5644/PI2021.200.12

Public R&D and Science – Industry Links in Economic Development: Implications for Bosnia and Herzegovina

Slavo Radošević[*]

Abstract: The paper presents the current understanding of the role of public R&D in economic growth and the science–industry links from middle-income economies like Bosnia and Herzegovina (BiH). In the second part, we present the conventional view on science–industry links which see these linkages primarily in terms of a one-way transfer of knowledge or its commercialisation from R&D to the business enterprise sector. Based on the comparative data, which also includes BiH, we show an alternative approach and argue about its relevance in the context of BiH. Our conclusion is that science–industry links (SIL) should support technology upgrading and not (or not only) R&D based growth.
In the next section, we present the current understanding of the role of public R&D in economic growth. Section two explores the role of public R&D in the catching up context, while section 3 explores specifically the role of science-industry links in catching up context. Section 4 proposes a 'Triple Helix' approach to science - industry linkages for catching up economies. We illustrate its features within the data for the central and east European economies. Finally, section 5 concludes with implications for BiH.

Key words: Research & Development; Science industry links, 'Triple Helix', Technology Upgrading

1.The role of public R&D in economic growth[1]

A conventional argument for public R&D investments and especially for public support to private R&D is based on the assumption that firms do not invest in R&D due to possible 'knowledge leakage'. As a result, firms have difficulties appropriating all benefits of R&D and, as a result, underinvest in R&D, which justifies public R&D or public support to private R&D.

[*] Prof, University College London. E-mail: s.radosevic@ucl.ac.uk

[1] This section partly draws on Radosevic S (2016) The role of public research in economic development, Chapter II.1 in EC, Science, Research and Innovation performance of the EU. A contribution to the Open Innovation, Open Science, Open to the World agenda, DG for Research and Innovation, European Commission, pp119-139.

The primary analytical evidence on the role of public R&D in economic growth is the econometric literature on returns to R&D. This literature can be divided into:

- estimates of private rates of return on R&D,
- estimates of social rates of return on R&D, and
- estimates of returns to public R&D

1.1. Estimates of private and social rates of returns

Measuring rates of return to R&D are based on the logic of production function, where R&D is treated as one of the inputs in addition to capital and labour. This approach dominates as it can give quantitative estimates of how much R&D contributes to the growth or what are returns to R&D investments.

Estimates of social rates of return on R&D are based on the assumption that returns from R&D do not accrue only to inventor but also to other firms in the same industry. This is because these firms are either connected through value chains (suppliers and buyers) or to competitors who can learn freely based on leaders' mistakes or imitate them. The social rate of return is then estimated by adding the private rate of return (the benefit to the firm that performs the R&D) to the sum of the returns on R&D performed by external agents, be it other firms or industries or countries.

There is agreement that private and social return rates to privately funded R&D are significant and positive in many countries. Most of them fall in the range between (10%)20% and (30%)50%. Social returns to R&D are substantial and exceed private returns by a considerable margin[2]. They exceed the private return by 50 to 100 per cent. Sveikauskas (2007) suggests that the private return to R&D is around 25 per cent, while the social return is 65 per cent.

At the macro level, the OECD (2003) study shows a clear positive linkage between private sector R&D intensity and growth in per capita gross domestic product (GDP) for OECD economies. However, there is no clear-cut relationship between public R&D activities and growth, at least in the short term (ibid). Authors point out that this is due to '*important interactions between public and private R&D activities as well as difficult-to-measure benefits from public R&D (e.g., defence, energy, health and university research)*

[2] For list of references to these sources see Radosevic (2016) The role of public research in economic development, Chapter II.1 in EC, Science, Research and Innovation performance of the EU. A contribution to the Open Innovation, Open Science, Open to the World agenda, DG for Research and Innovation, European Commission, pp. 119-139.

from the generation of basic knowledge that provides technology spillovers in the long run' (OECD, 2003)[3].

1.2. Estimates of returns on public R&D

Estimates of returns to public R&D are fraught with several methodological complexities. First, the direct effects of R&D are less important than its indirect effects, which occur when investments in the private sector complement results of public R&D. Second, not all public R&D should be counted as investments, as for much of public R&D it is not easy to attribute the rate of return. So, only a small proportion of the public R&D should be classified as an investment (Sveiruskas, 2007). Third, public R&D enables or makes possible further investments in R&D by the private sector. In that respect, it is pretty ambiguous to separate private from public investments as if they were independent of each other if public research establishes basic understanding and concepts while private R&D implements them. So, this dual nature of public R&D, whereby part of it does not have commercial aims while other parts create the basis for future commercial developments, makes it quite tricky to interpret estimates of returns from publicly funded R&D.

A stylised fact of econometric research is that rates of return on public R&D are lower or less significant than those on private R&D. For example, see Griliches, 1986; Levy and Terleckyj, 1989; Lichtenberg and Siegel, 1991; Mansfield, 1980; Nadiri and Mamuneas, 1994 and references cited in Hall et al. 2010, Sveiruskas, 2007 and Kokko et al. (2015)[4]. Explanations for these results are different. First, a conventional explanation is that private firms may be less efficient when using public funding to do R&D, or this funding may be far from market research. Second, government R&D is implemented in areas which are either far from the market (defence) or operate in a mixed-mode like health. Third, public R&D is not to generate direct benefits but indirectly by developing the basis for the R&D activities of firms and public organisations (universities, hospitals, etc). Fourth, it is often stated that public R&D is directed towards more risky areas, which should reduce the rate of return. However, when successful, returns on basic R&D are higher when compared to returns on applied or development R&D (Griliches, 1986; Link,

[3] Park (1995) also found private-sector R&D to be more important than public R&D in OECD-based growth regressions. See PARK, W.G. (1995), "International R&D Spillovers and OECD Economic Growth", Economic Inquiry, Vol. 33, pp. 571-91.

[4] For full list of references see Radosevic (2016) op cit.

1981; Mansfield, 1980). Fifth, there may be overinvestment by governments into S&T areas, which are 'overcrowded' and where returns are low. Also, we should bear in mind that there are significant differences in which industries rely on public science. For example, Marsili (2001) shows that contribution of academic research to industries measured by citations to scientific papers in patents can be very high, like in pharmaceuticals and computer industries. In other industries, this type of contribution is low but steady, mainly through the flow of students.

1.3. Classification of benefits of public research

Although the econometric approach dominates the assessment of effects of R&D, including public R&D, it is evident that the complexity of the relationship between public R&D and growth requires alternative approaches. We know that the links between public-funded R&D and industry are varied and indirect. Based on these assumptions Martin et al., (1996) and Martin and Salter (2001) (see also Martin and Tang, 2006) have developed a classification of benefits of public research, which shows the variety and complexity of its impacts. These benefits may also accrue from private research, although in probably somewhat modified form and scale. They distinguish the following types of benefits (p. 520):

1. Increasing the stock of useful knowledge;
2. Training skilled graduates;
3. Creating new scientific instrumentation and methodologies;
4. Forming networks and stimulating social interaction;
5. Increasing the capacity for scientific and technological problem-solving;
6. Creating new firms.

Increasing the stock of knowledge

Public R&D increases the stock of knowledge, which is available to firms. Publications represent an essential source of learning for firms in sectors like pharma, but it is knowledge, not only information, that is the most valuable to firms. Since public research is far away from the market, it stimulates and enables firms to focus on near-market research, thus being a complement rather than a substitute. This requires familiarity with publications and informal contacts, joint R&D and networking (Arundel et al., 1995).

Skilled graduates

Skilled graduates are in many industries seen as the primary benefit that flows to firms. They bring complex problem-solving skills, new methodologies and the capacity to perform R&D. Of course, this transfer varies across areas and is dependent on where the *critical* competencies in specific technology areas reside

New instrumentation and methodologies

Instrumentation actively drives scientific progress (De Sola Price and Bedini, 1967). Therefore, the development of new instrumentation and methodologies are an essential outcome of public R&D, especially in some sectors.

Networks and social interaction

Industries are also social communities within which academic networks can play a vital role and are an essential part of technology networking. Links with the academy are essential in industries, which are directly dependent on science. In other cases, where graduates are an important source of new knowledge, networking is a more informal type through alumni. In other sectors, networks are maintained mainly through exhibitions and conferences. Martin and Salter (2001) review literature that shows the intense localised nature of R&D collaborations, which are reflections of either geographical, cultural or institutional proximity.

Technological problem-solving

The problem-solving capabilities of the public R&D sector complement its role as a provider of general scientific knowledge. This expertise is embodied in individual contracts and collaborations with universities and PROs with individual firms and is very frequent in applied R&D areas.

Creation of new firms

The creation of new firms through spin-offs is seen as one of the significant or desirable benefits of public R & R&D. Despite all policy hype; this seems to be the much less significant benefit of public R&D (Brown and Mason, 2014).

There are wholly unrealistic expectations regarding the capacity of public R&D to generate patents, licensing income and research spin-offs based on a patent. Only a few universities worldwide have successfully transformed research into innovation, and the majority of revenue from these activities originated from very few universities[5].

2. Role of public R&D in the catching up context

In this section, we address the question: what is the relevance of literature on rates of returns of R&D for catching-up countries whose firms by and large operate 'behind technology frontier'?

First, research on estimated return rates implicitly assumes that firms' R&D capability is not an issue. However, this is not the case in catching-up economies where the percentage of permanently R&D active companies is significantly smaller. Second, equally, it is assumed that capabilities in the academic sector enable regular interaction with the business sector and that these interactions can be measured via R&D budgets. However, the academic sector may not be able to engage in interaction with the business sector for various reasons, including gaps between knowledge bases of public R&D organisations and enterprises. Hence, the absorptive capacity of the business sector cannot be taken for granted.

Our first point of departure for understanding the role of public R&D in development in catching up context is that its role should be seen in three sources of R&D and development: private R&D, public R&D and R&D from abroad. The relative importance of these sources varies across development. In the catch-up stage, foreign links are the key, but in post catch-up these are not sufficient, as they need to be supplanted by a variety of local linkages (Albuquerque et al., 2015).

A second departing point is that the role of public R&D can be understood only when considered in relation to firms' changing capabilities (Albuquerque et al., 2015). So, we need to consider the evolution of both local public R&D as well as of local firms. In addition to the capabilities of firms, we should also consider the "capabilities of universities" (Eun et al. 2006) or "academic

[5] For example, in Europe, 10% of universities account for 85% of the total income generated by inventions. UK universities make only 2-4% of their external income out of patenting and licensing, whereas much larger funding comes from contract research, collaborative research and professional education. In the United States, MIT generates 22 spin-offs a year, whereas the average number among 157 universities is 4 spin-offs. Source: OECD (2013) Commercialising Public Research. New trends and strategies, Paris

capabilities" (Liefner and Schiller, 2008) as they also evolve by becoming more diverse[6].

It is essential to look at the relationship between public R&D and the business sector in evolving context. *'As the capabilities of firms, universities, and public research institutes evolve, the nature, the channels, and the reasons for the importance of universities to firms change'* (Albuquerque et al., 2015)

We have learned from the historical accounts of public R&D that channels of interaction between public R&D and business have historical evolution (Albuquerque et al., 2015). Daniel Schiller and Keun Lee (2015) outline the pattern of changing relationships between academy and business. Initially, universities and PROs provide human resources, testing, and simple problem solving (e.g., consultancy and technical assistance). Later, universities and PROs become better equipped, and local firms may use their laboratories. Finally, they undertake research activities that substitute and complement research and development (R&D) by firms. There is a similar process on the side of firms. '*Initially, firms may only use university-trained human resources, later they may look for universities and PROs to solve technical problems, and as these problems become more complex, research issues may arise, and R&D joint projects may become part of the agenda (p.21)'* (Kruss et al., 2015)

Historical evidence shows that research at universities and public laboratories which interacts with firm capabilities is one of the significant drivers of catch-up processes (Mazzoleni and Nelson, 2007). However, R&D programs that effectively contributed to catch-up did not operate within "ivory towers" but were oriented to help solve problems and advance technology relevant to a particular economic sector. By and large, these were the applications-oriented sciences and engineering disciplines where science could directly interact with the problems and opportunities in agriculture, medicine and industry. Finally, in addition to universities, it was also public research organisations (PROs) located outside of the mainline university structure, in dedicated applications-oriented laboratories, which played an important role

Within this perspective, benefits of public R&D have a somewhat different ordering in the catching up context compared to technology frontier

[6] Liefner and Schiller (2008) define academic capabilities as *'the set of functional skills and organizational ability of a country's higher education institutions to carry out their extended role in the process of technological upgrading and learning (p.281)*'. The academic capabilities form part of country's absorptive capabilities or external dimension of firms' internal absorptive capabilities.

economies. The following sequence reflects the decreasing importance of different types of benefits in catching up or converging countries[7]:

1. **Training skilled graduates**; Training of skilled graduates is probably the most important benefit of public R&D, especially as firms are not enough advanced to offer the acquisition of required skills on their own[8].
2. **Increasing the capacity for scientific and technological problem-solving**;[9]
3. **Forming networks and stimulating social interaction**[10];
4. **Creating new scientific instrumentation and methodologies**[11];
5. **Increasing the stock of useful knowledge through contract research**[12];
6. **Creating new firms**[13].

3. Science-industry links in the catching up context

It is usually assumed that science–industry links are pretty undeveloped in the catching-up context like that of BiH. However, research in Albuquerque et al. (2015) and evidence from the EU disproves this (see Radosevic, 2016). First, evidence from innovation surveys in catching-up economies shows that innovative firms regard universities as highly important sources of information to a similar or even higher extent than in developed countries. For example, in the 2008 Brazilian innovation survey, 6.8% of innovative firms regarded universities as highly important sources of information. In a Community Innovation Survey conducted by the EC, this ratio was 4.3% (Albuquerque et al., 2015). Also, there is no significant difference between developed and developing countries in ranking by firms regarding the importance of sources of innovation. For example, the correlation in the importance of sources of

[7] In footnotes we provide suggestions for possible research projects which could try to depict the extent of these linkages via statistical indicators. Of course, the first best option would be to conduct dedicated survey on the extent of these benefits.

[8] This dimension can be proxied by WEF GCR data on quality of education as proxy for quality of training of skilled graduates

[9] This dimension could be captured by data on funding from BES of HES/GOV RD and data from innovation survey on sources of information for innovation – universities and PROs

[10] This dimension can be captured by data from innovation surveys on sources of information for innovation

[11] This dimension can be captured by data on investments in R&D

[12] This dimension can be captured by data on papers and patents from HES and PROs, if available

[13] This dimension can be grasped based on data on publicly funded venture capital

information for innovation between the US and India is 0.886 (table 5.6 in Albuquerque et al., 2015).

Evidence like this question the prevailing notion that in the catching-up countries public – business R&D links are missing or weak. We think that this myth is widespread as the relation between public R&D and the business sector has been reduced on the commercialisation of R&D. Indeed, from that perspective, links between science and business are weak in countries behind the technology frontier. However, this is quite a reductionist view on the role of public R&D. This view stems from the evidence in technology frontier regional contexts, which led to the Triple Helix movement. The underlying idea is that the nature of knowledge in new industries has changed so that it requires new forms of science–industry interactions where their roles are much more overlapping[14]. However, as rightly pointed out by Eun et al. (2006), these industries form the minority of the technology spectrum in catching-up economies. For evidence on CEE, see Radosevic et al. (2010).

Thus, the evidence shows the importance of non-R&D innovation activities and that innovation policy in many CEE countries is heavily biased towards the promotion of only R&D based growth. However, R&D investments by themselves may not lead to innovation for a variety of structural factors. First, R&D may be far from the market, and thus, although the R&D system can be internationally excellent, local industry may be unable to commercialise R&D outputs. Elsewhere this has been described as the gap between international excellence and local relevance (Radosevic, 2011)[15]. Second, R&D is often not the primary source of innovation, but innovation emerges through non-R&D innovation modes. Figure 1 depicts the economy as the locus of multiple modes of innovation broadly defined.

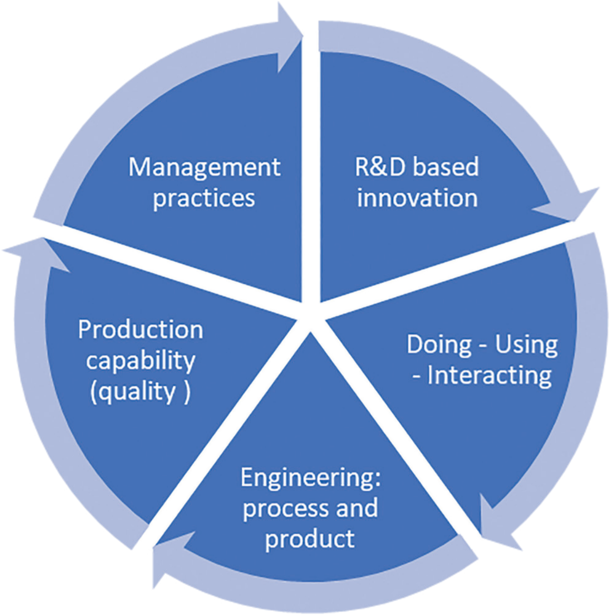
Innovation takes place not only based on R&D but also there's a variety of 'doing-using-interacting' type of innovations that are experience-based (Lorenz and Lundvall, 2006). Growth and productivity of the economy may rest on a variety of other activities which are not innovation activities in a narrow sense or are incremental innovations (product and process engineering improvements). Also, a variety of productivity-enhancing activities, such

[14] See Etzkowitz, H., Leydesdorff, L. (Eds.), 1997. Universities and the Global Knowledge Economy: A Triple Helix of University-Industry-Government Relations. Pinter, London.; Etzkowitz, H., 1998. The norms of entrepreneurial science: cognitive effects of the new university-industry linkages. Research Policy 27, 823–833.; Etzkowitz, H., Leydesdorff, L., 1999. "The future location of research and technology transfer". Journal of Technology Transfer 24, pp. 111–123.

[15] Radosevic (2011) op. cit.

as quality-related activities, and other activities like management practices focused on production may drive the growth of added value or productivity (Bloom and Van Reenen, 2010). However, these activities may often be much more critical for productivity growth, competitiveness and employment than R&D. Instead, R&D is often important as a promoter of absorptive capacity, i.e. as an activity that helps companies and the R&D sector to follow trends in R&D and enhance capacity to adapt imported technologies.

Figure 1. The economy as the locus of multiple modes of innovation



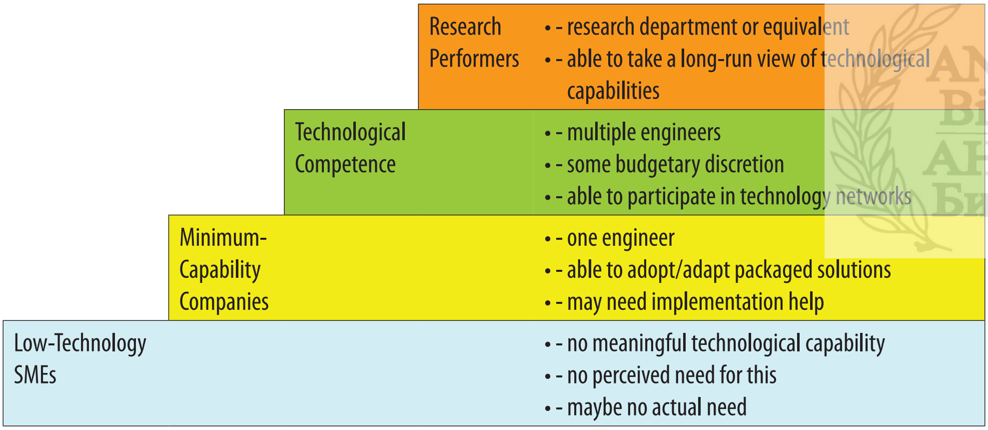
Source: Dominique Foray, Kevin Morgan and Slavo Radosevic (2018) The role of smart specialisation in the EU research and innovation policy landscape, EU Directorate-General for Regional and Urban Policy, Working Paper, Available at: http://ec.europa.eu/regional_policy/sources/docgener/brochure/smart/role_smartspecialisation_ri.pdf

The 'Doing – Using – Interacting' mode of innovation is important both in developed and less developed countries and yet it is a much-neglected mode. The productivity of economies like Serbia is driven much more by a variety of non-R&D activities. The three most important are: engineering, production capability and management practices. Unfortunately, data on these activities is sparse. Finally, even when companies innovate, most of their expenditures are about the acquisition of machinery and equipment.

It is important to recognise that these activities are mutually complementary and cumulative. Successful firms are those that couple R&D based and DUI modes of innovation. Developed production capabilities and engineering improvements (incremental innovations) are prerequisites for more ambitious innovation efforts. Improved management practices are also strongly correlated to levels of productivity of firms and economies. So, innovation policy cannot be reduced to R&D based innovation but needs to recognise and address the diversity of innovation modes and productivity-enhancing activities. Hence, the R&D policy needs to be complemented by measures that address a variety of other equally important sources of innovation and productivity growth.

The alternative way to conceptualise these issues is to assess the extent to which policy addresses the entire spectrum of firms' technology and production capabilities through the so-called 'competence staircase' or 'innovation ladder' (Figure 2). We can only assume that in BiH, these stairs are pretty steep, i.e. the share of research performers in BES is very limited, and the share of companies with technological competencies is also small.

Figure 2: Segmenting enterprises on the innovation ladder



Source: De Jager D. et al. (2002), Competence Centre Programme Estonia Feasibility Study, commissioned by the Division of Technology and Innovation, Ministry of Economic Affairs and Communications of the Republic of Estonia, Tallinn.

It is not surprising that we know much more about the R&D system and R&D based growth issues than about non-R&D innovation activities. Hence, there is a strong need to explore these activities as only when new data are available on these 'hidden innovation' activities, we will be able to legitimise and support policy activities. A standard 'horsework model' in this area which links R&D, innovation and productivity is the so-called CDM model which can be tested on the BiH BEEPS data or other data which could combine innovation survey data with other enterprises level data[16] (Box 1). This research would show what are limits of CDM model in the economies like BiH? Is innovation the sole driver of productivity? Which are other determinants of productivity? This would also be an opportunity to try to econometrically test alternative or modifications to this model, which is not based on R&D as the significant input but on variables like investments and which would be based on the synthetic indicator of technology upgrading based on a combination of questions from innovation surveys.[17] The results of this model would shed much more analytical light on the relevance of R&D to productivity than it is possible in this descriptive survey.

The second line of research should be based on a firm level survey and would consider the whole range of their innovation activities as depicted in figure 2.

Box 1: What is CDM Model?

A so-called CDM model is how economists explore the relationship between R&D, innovation, and productivity at the firm level. CDM model is based on a three-step sequence.

- In the first step, firms decide whether and how much to invest in R&D. Only if the net returns to this investment (which the analyst cannot observe, but firms know) are positive will they have positive R&D expenditure.
- In the second step, the model relates the given investment in R&D to innovation outputs, defined either as innovative sales or as the number of patents, using a knowledge production function.
- Finally, in the third step, CDM estimates the production function that describes the relationship between innovation output and productivity.

For a summary and application of the CDM model in the context of the CEE/CIS, see EBRD *Transition Report 2014: Innovation in Transition,* chapter 2, pp. 31-42.

[16] CDM name is coined from the initials of the three authors of the model: Crépon, B., E. Duguet and J. Mairesse (1998), “Research, Innovation, and Productivity: An Econometric Analysis at the Firm Level”, Economics of Innovation and New Technology, 7(3), pp. 115–156.
[17] For some of ideas that can be used in developing alternative variables see table 2.2, Golderbg et al (2011), Igniting Innovation. Rethinking the Role of Government in Emerging Europe and Central Asia, World Bank, Washington

4. 'Triple Helix' approach to science - industry linkages for the catching-up economies

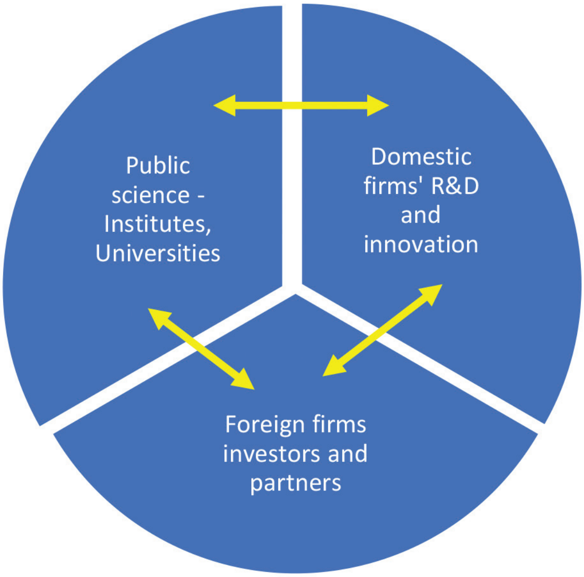
The conventional approach to science–industry links (SIL), which reduces these links to commercialisation of public R&D, is far too narrow and macroeconomically marginal for the catching-up economies. As pointed above, the role of public research organisations can be understood only in relation to firms' changing capabilities. This has been confirmed by a broader examination of these linkages in emerging economies (see Albuquerque et al., 2015). As firms' capabilities, universities, and research institutes upgrade, the nature of the linkages between universities and firms changes.

Also, in addition to the domestic industry-science linkages, we need to consider links between FDI and domestic firms and between FDI and domestic universities and research institutes. Why? In the catching-up economies, the main inflow of knowledge comes through FDI and trade relationships in supply chains (subcontracting) and exporting. Also, public research organisations can access international knowledge networks through international projects, including Horizon Europe or Erasmus exchange programs.

Domestic firms rely on foreign knowledge sources in licensing and reverse engineering or collaboration with customers and parent companies. However, as countries upgrade the importance of local sources of knowledge, including R&D, increases. Initially, local knowledge is used as a complement to the core technological knowledge from abroad. As countries upgrade, importance of domestic links increases.

So, the SIL should be seen in this context of firm and R&D system capabilities and their relationship with foreign partners. Figure 3 depicts in stylised manner the actual Triple Helix model in catching up economies which is of high relevance for countries like BiH.

Figure 3: Triple Helix model of innovation and science industry linkages in catching-up economies



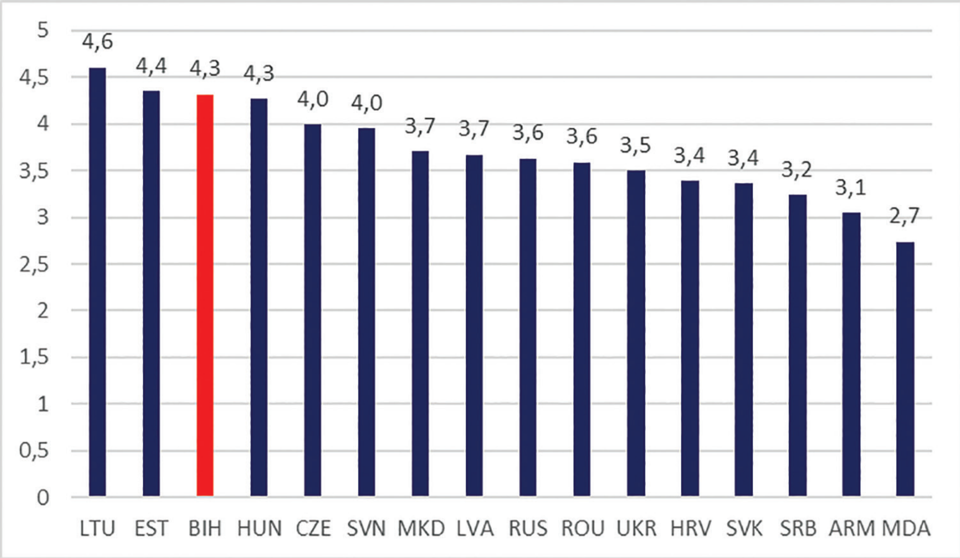
Source; Radosevic, 2021, Science industry links chapter: UNECE Innovation Capacity Report: Moldova, forthcoming

Figure 3 suggests that not only links between domestic firms and public research organisations matter, but even more so the links between domestic and foreign firms and links of universities with foreign firms and international sources of knowledge. As countries are upgrading, the nature of the relationship between science and industry is changing. In the initial stages, links with FDI are crucial, but as countries gradually upgrade, the relations between domestic firms and domestic R&D organisations become more important.

In continuation, we illustrate the strength and intensity of each of three helices in the case of the CEE economies, including Western Balkan.

A subjective assessment of the intensity of university-industry R&D collaboration through WEF Global Competitiveness Reports shows on a scale of 1-7 (best) a relatively high university-industry collaboration evaluation in BiH compared to other Western Balkan economies, Serbia and Croatia. How do we interpret this result? First, the individual indicator should be seen in the context of other indicators. Second, as pointed out earlier, the state of SIL can be understood only in the context of both firms' and 'academic' capabilities.

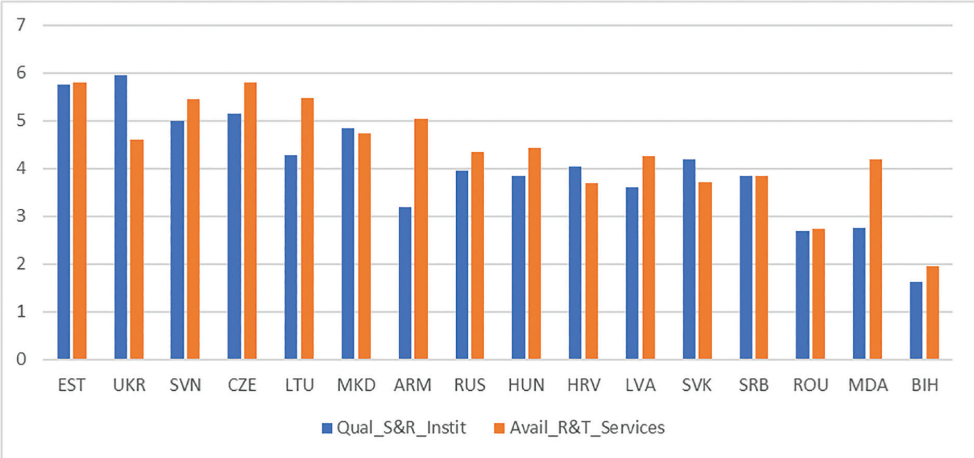
Figure 4: Assessment of University-Industry R&D Collaboration 2019 (scale 1-7)



Source: WEF GCR

Figure 5 shows that the quality of science and research services and their availability is relatively low. Moreover, it seems that it is the worst when compared to all comparators in figure 5. This may suggest that the collaboration is comparatively better - given the state of both academic and business sector capabilities - than in other Western Balkan economies. However, in economic jargon, this collaboration can be described as a ‘low-level equilibrium’ collaboration. In other words, it takes place at very low levels of both academic and business sector R&D and innovation activity. The following two figures support this hypothesis.

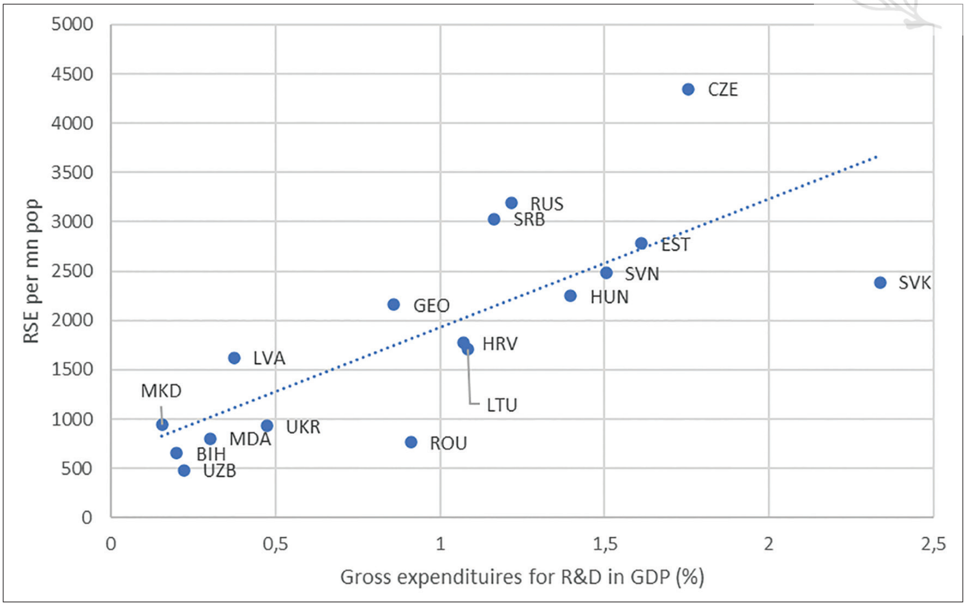
Figure 5: Quality and availability of R&D services



Source: WEF GCR

Figure 6 shows that the R&D intensity of the BiH economy is also the lowest among comparator economies. Its average R&D intensity of only 0.2% and 656 researchers per 1mn population indicate minimal investments, which are insufficient for adequate absorption of foreign knowledge, let alone for significant knowledge generation activities.

Figure 6: GERD expenditures in GDP and RSE per 1 mn pop 2019

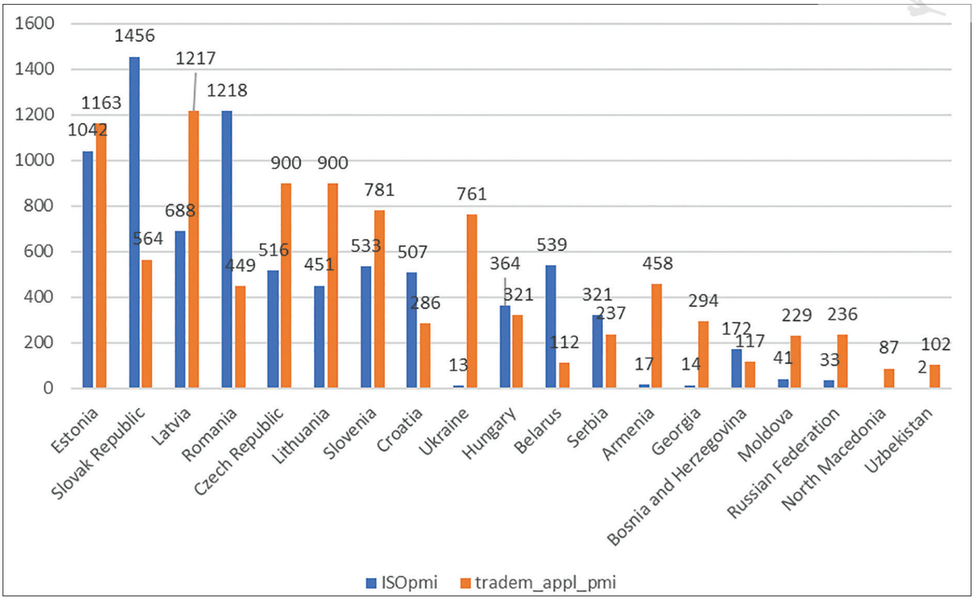


Source: Word Bank Development indicators database

The second pillar of the Triple Helix innovation model is the business enterprise sector. Given the overall very low R&D expenditures in BiH, we presume that the investment in the business sector is relatively marginal. This is further compounded by the dominance of small firms in economic structure, which as a rule do not have in-house R&D capacities, and by deindustrialisation in the post-socialist period. So, on this basis, we cannot expect on upstream side demand for R&D either internal (within the firm) or external (through extramural R&D). However, we may expect possible demand-pull coming from downstream activities in firms i.e. activities related to improved production capability, quality and product differentiation.

ISO9000 certificates and trademark applications per 1mn population are imperfect but valuable proxies for this type of activities. A density of ISO9900 certificates of 172 per 1 mn population places BiH in the bottom group of comparator economies. It is above the CIS economies, which are largely outside the global production networks, but is well below neighbouring and central European economies. This reflects very limited integration of BiH in the EU value chains where quality standards are one of the prerequisites. A situation is worse in terms of trademarks - a proxy of product differentiation on domestic and foreign markets. This may also reflect its economic structure in which there is a small share of consumer goods industries.

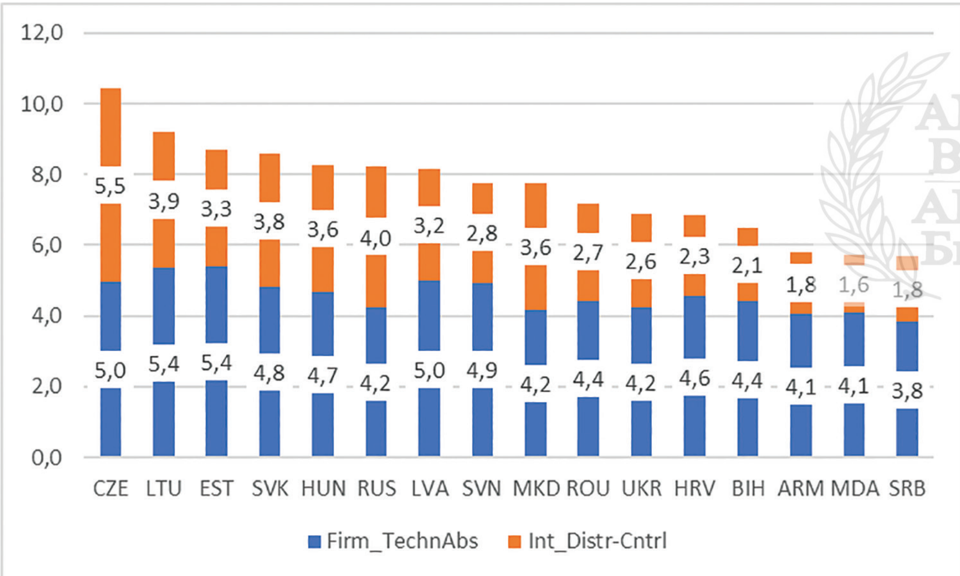
Figure 7: ISO900 certificates and trademarks per 1mn population 2015-19 avg



Source: ISO and WIPO Databases

A key feature of competent firms are their organisational capabilities, by which we understand how people and resources are brought together to accomplish work within the enterprise. An organisational capability emerges from a series of connected activities within the firm, not from any single activity. There are no agreed proxies of organisational capabilities. As imperfect proxies, we use here two components that may shed some light on their levels of development: firm technology absorption capacity and control of international distribution. Figure 8 shows the assessment of each of these components for BiH and comparator economies jointly. BiH is ranked in the group at the bottom end. Its firms have low capabilities to absorb new technologies and depend on foreign partners to access international distribution channels. Both features will strongly shape the extent and the nature of SIL.

Figure 8: Assessment of firm technology absorption capacities and control of international distribution channels (WEF GCR 2019):

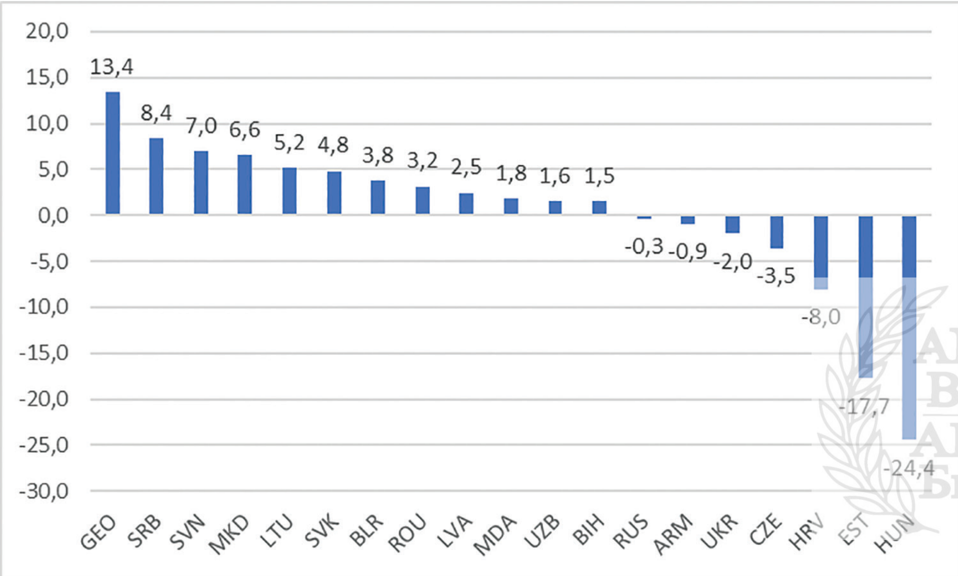


Source: WEF GCR

The third pillar of SIL in the catching-up economies is FDI, which is the primary source of new technologies and related knowledge. In an economy short of capital, new technology and limited access to foreign markets, foreign direct investments (FDI), subcontracting and other forms of knowledge are essential to technology upgrading, employment and export. Moreover, BiH is located close to central European economies, which is an excellent opportunity to join their industrial networks and get integrated into the EU supply chains.

If we use the share of net inflows in GDP as criteria, this potential for quick integration into the EU industrial networks has not yet been exploited. In relation to its comparators, BiH is in the group of economies 'discovered' by foreign investors post-2008. However, the overall share of inflows is still meagre (1.5% of GDP in the 2015-19 period).

Figure 8[18]: FDI net inflows 2014-19 avg in % of GDP



Source: World Bank Development Indicators database

An alternative route of acquiring foreign knowledge is purchasing foreign intellectual property rights through licences and other IPR (software etc.). This channel of knowledge acquisition is quite marginal in BiH and is at the level of 0.001% of GDP

In summary, our very unsystematic and quite imperfect evidence on three nodes of Triple Helix actors suggests that all three nodes are pretty weak, especially if we consider them in the conventional sense of R&D based SIL. There are significant limits of the traditional view of SIL, where the R&D sector operates as the primary source of knowledge and the business enterprise sector as a recipient. The key driver of the innovation process are enterprises,

[18] FDI net inflows are the value of inward direct investment made by non-resident investors in the reporting economy.

and the features of their innovation processes determine the extent and scope of cooperation with the R&D sector. This leaves us with the question: What is the most productive framing of the SIL in the catching-up economies, like BiH?

5. Science industry links: implications for BiH

Our conclusion on the above question boils down to one sentence: SIL should support technology upgrading and not (or not only) R&D based growth. Elsewhere, we developed at greater length the technology upgrading as the appropriate framework for measuring and conceptualising technology development in catching-up economies (see Radosevic and Yoruk, 2016, 2018, 2019; Radosevic, 2017; Bruno et al., 2021).

The majority of enterprises in EU new member states (NMS) as well as in Western Balkans (WB) countries are 'non-R&D innovators' (Arundel et al., 2008). Hence, to achieve growth and employment, the policy should not focus exclusively on encouraging R&D investment and supporting restructuring towards R & R&D-intensive industries. More than half of enterprises in CEE countries innovate without investing in R&D, and we can assume that this share is even higher in BiH. Instead, its policy focus should much more address factors of production capability (quality, productivity, skills, engineering, software, knowledge intensive services, etc).

Accordingly, WB countries should aim to build policies that will foster these processes. Question is whether mainstream S&T or innovation policy is a sufficient and necessary response to facilitate industry/technology upgrading in the WB region? We argue that mainstream innovation policy is a necessary but not sufficient ingredient to promote technology upgrading of WB economies. In these economies, R&D operates primarily as the factor of absorptive capacity rather than as the direct source of added value and employment.

The major challenge is how to kickstart industrial and technology upgrading, which is industry-specific. The knowledge base for such a process in the WB does not seem to be the major constrain. Parts of it already exist or are in the process to be generated through extensive foreign technical aid. For example, OECD (2010) study on sectoral competitiveness of several WB sectors has indicated upgrade paths for apparel, automotive suppliers and business process IT outsourcing (see below). The challenge is how to promote SIL, which can support these processes.

Patterns of industrial upgrading in Western Balkans in selected industries

Apparel: from only CTM (42%) services to the gradual introduction of Value Added services (OEM/OBM) + beyond imitation (design schools)
Automotive suppliers: to move out of subcontracting 'cost trap' towards improved quality standards, design and supply chain management skills
BPIT Outsourcing: from fragmented, diversified and local market-oriented firms towards the focus on core competencies (specialisation) and creation of BPITO champions

Source: Author based on OECD (2010)

References

Albuquerque, Eduardo Wilson Suzigan, Glenda Kruss, Keun Lee (eds) (2015) Developing National Systems of Innovation: University–Industry Interactions in the Global South, Edward Elgar, Cheltenham.

Arundel, A., C. Bordoy and M. Kanerva (2008), 'Neglected innovators: how do innovative firms that do not perform R&D innovate? Results of an analysis of the Innobarometer 2007 survey No. 215', INNO-Metrics Thematic Paper

Arundel, A., Van de Paal, G., Soete, L., 1995. PACE Report: Innovation Strategies of Europe's Largest Firms: Results of the PACE Survey for Information Sources, Public Research, Protection of Innovations, and Government Programmes. Final Report, MERIT, University of Limburg, Maastricht

Bloom, N. and Van Reenen, J. (2010) Why Do Management Practices Differ across Firms and Countries? Journal of Economic Perspectives, Volume 24, Number 1, Winter 2010, p.203–224

Derek de Sola Price and Silvio A. Bedini, (1967) "Instrumentation," in Technology in Western Civilisation, ed.

Eduardo Albuquerque, Wilson Suzigan, Glenda Kruss, Keun Lee (eds) (2015) Developing National Systems of Innovation: University–Industry Interactions in the Global South, Edward Elgar, Cheltenham.

Glenda Kruss, Keun Lee, Wilson Suzigan, and Eduardo Albuquerque (2015) Introduction, In Albuquerque et al (2015) op. cit.

Griliches, Z. (1986). "Productivity, R&D, and basic research at the firm level in the 1970s". *American Economic Review* 76, 141–154.

Jong-Hak Eun, Keun Lee, Guisheng Wu (2006) Explaining the "University-run enterprises" in China: A theoretical framework for university–industry relationship in developing countries and its application to China, *Research Policy* 35 (2006) 1329–1346

Lee, Jong Dong Lee, Slavo Radosevic, Dirk Meissner, Nick Vonortas) (eds) Technology Upgrading and Economic Catch-up, Oxford University Press

Levy, D., Terleckyj, N. (1989). "Problems identifying returns to R&D in an industry". Managerial and Decision Economics 1–2, 43–49.

Lichtenberg, F.R., Siegel, D.S. (1991). “The impact of R&D investment on productivity-new evidence using linked R&D-LRD data”. Economic Inquiry XXIX, 203–228.

Liefner, I., Schiller, D. (2008). Academic capabilities in developing countries – a conceptual framework with empirical illustrations from Thailand. *Research Policy*, 37, 276–293.

Lorenz, E. and Lundval, B. A. (2006) (eds) How European economies learn: coordinating competing models, Oxford University Press, Oxford.

Mansfield, E. (1980). “Basic research and productivity increase in manufacturing”. American Economic Review 70, 863–873.

Mazzoleni Roberto and Richard R. Nelson (2007) Public research institutions and economic catch-up, *Research Policy* 36 (2007) 1512–1528

Melvin Kranzberg and Carroll W. Pursell, Jr. (Oxford: Oxford University Press).

Meyer-Krahmer, F., Schmoch, U., 1998. Science-based technologies: university–industry interactions in four fields. Research Policy 27, 835–851.

Nadiri, M.I., Mamuneas, T.P. (1994). “Effects of public infrastructure and R&D capital on the cost structure and performance of US manufacturing industries”. *Review of Economics and Statistics* 76 (1), 22–37.

OECD 2003 The Sources of Economic Growth in OECD Countries, Paris

OECD 2003 The Sources of Economic Growth in OECD Countries, Paris

Radosevic S. (2017) Upgrading technology in Central and Eastern European economies. IZA World of Labor: 338 doi: 10.15185/izawol.338

Radosevic Slavo and Esin Yoruk (2016) Why Do We Need Theory and Metrics of Technology Upgrading?, Asian Journal of Technology Innovation, Volume 24, 2016 - Issue sup1, http://dx.doi.org/10.1080/19761597.2016.1207415

Radosevic Slavo and Esin Yoruk (2018) Technology upgrading of middle-income economies: A new approach and Results, Technological Forecasting & Social Change 129: pp. 56–75

Radosevic, S., M. Savic and R. Woodword (2010) *Knowledge based entrepreneurship in central and eastern Europe: results of a firm level based survey*, In Malerba, F. (ed) Knowledge-Intensive Entrepreneurship and Innovation Systems, Routledge, p.198-218

Radosevic, Slavo Deniz E. Yoruk and Esin Yoruk (2019) Technology Upgrading and Growth In Central and Eastern Europe, Chapter 8 in Social and Economic Development in Central and Eastern Europe. Stability and Change after 1990 Edited By Grzegorz Gorzelak, Routledge, London

Randolph Luca Bruno, Kirill Osaulenko and Slavo Radosevic (2021) Technology Upgrading in Emerging Economies: A New Approach to its Measurement, Results and Relationship to Mainstream Measures , In Lee et al, Oxford UNiversitry Press

Schmoch, U., 1997. Indicators of the relations between science and technology. *Scientometrics* 38: 1., 103–116.

Sveikauskas Leo 2007 R&D and Productivity Growth: A Review of the Literature, Bureau of Labor Statistics Working Paper 408

DOI: 10.5644/PI2021.200.13

Reforming Science Evaluation and Funding when Starting from a Low Performance Level

Key note address

Štěpán Jurajda[*]

The Challenge

Many post-communist countries recently enjoyed rapid economic convergence towards their Western European counterparts, but there has been surprisingly little convergence in scientific research performance. In 2015 only about 3% of the European Research Council's (ERC) Starting Grants originated from the EU's new members. As demonstrated by, e.g., Jurajda et al. (2016), the post-soviet countries of Europe are still lagging far behind in terms of high-quality academic output, in particular in social and medical sciences, which are critical for the quality of local governance on many policy levels. Post-communist countries' publication output is also heavily focused on quantity as opposed to quality. In short, bibliometric evidence implies that several fields of science in these countries are consistently unable to catch up to EU-15 (world-level) scientific standards.

Are there science policies that could be adopted to close this persistent gap? Several countries have recently experimented with science evaluation and funding systems that rely on quantitative measures such as (quality-weighted) publication or citation counts. Much of the experience from these reforms has been negative in that quantitative indicators often lead to opportunistic behavior aimed at maximizing indicators, not the quality of scientific output. The typical lesson from these experiments is to rely on peer review of scientific output. However, such peer review often must rely on local scientists and is therefore fundamentally problematic in fields of science where a given country lags far behind international standards. More broadly, the

[*] CERGE-EI, a joint workplace of Charles University in Prague and the Economics Institute of the Czech Academy of Sciences. E-mail: stepan.jurajda@cerge-ei.cz

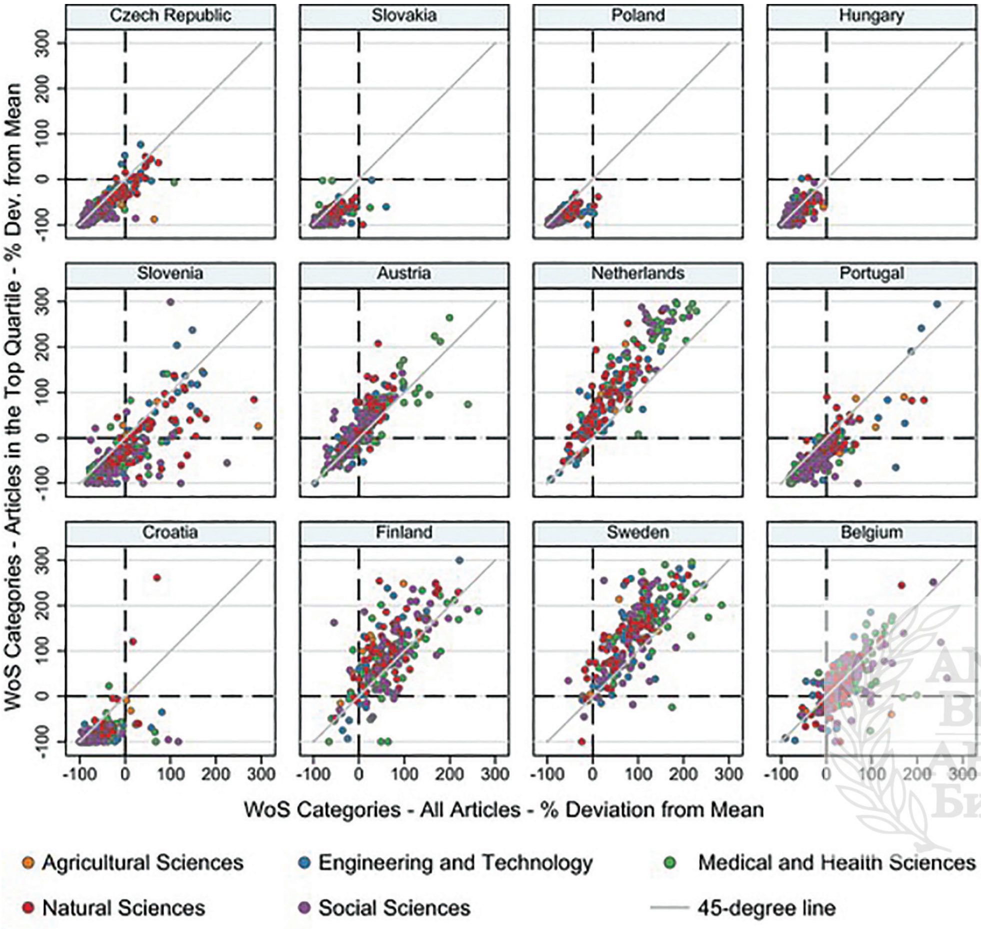
difficult question is how one can reform science funding and evaluation to help improve performance when entire national fields of science are lagging far behind international standards?

This is a difficult question in part because field-wide low performance levels typically combine with low funding levels and with internal democratic processes in academia to prevent reforms and rapid change. This note provides a stylized description of recent reforms of science funding and evaluation in the Czech Republic. It aims to illustrate these difficulties and offer some suggestions on how to break reform gridlocks by offering two-tier funding schemes. The discussion is in part based on descriptive evidence from the Czech Republic and on the relevant scientific literature covering other EU countries, but most of the views and recommendations offered here are those of a reformer involved in the process of proposing, adopting and implementing a reform of science funding and evaluation, i.e., they are not particularly scientific.

Persistently Low Relative Performance in Social Sciences

There is growing evidence that post-communist countries have not yet been able to close the gap in scientific performance vis-à-vis the EU-15 countries. Figure 1 (taken from Jurajda et al., 2017) presents a 2010-2014 bibliometric comparison based on the Web of Science (WoS) of publication performance across 226 scientific disciplines for six post-communist EU member states relative to six EU-15 countries of a comparable size. The graph contrasts each country to the average performance of the entire sample in terms of per capita article counts on the horizontal axis and in terms of per capita article counts in the most influential journals, as judged based on a journal belonging to the best quarter of journals according to the Article Influence Score (AIS), a journal citation impact indicator. Post-communist countries, with the exception of a few scientific disciplines mainly in Slovenia, still lag far behind their EU counterparts. It is also clear from these statistics that research in post-communist countries tends to focus relatively more on quantity rather than quality. The relative publication performance of post-communist countries in the WoS is particularly weak in social and medical sciences and relatively strongest in natural sciences and engineering.

Figure 1: A Web-of-Science Comparison of Publication Quantity and Quality



Source: Jurajda et al. (2017).

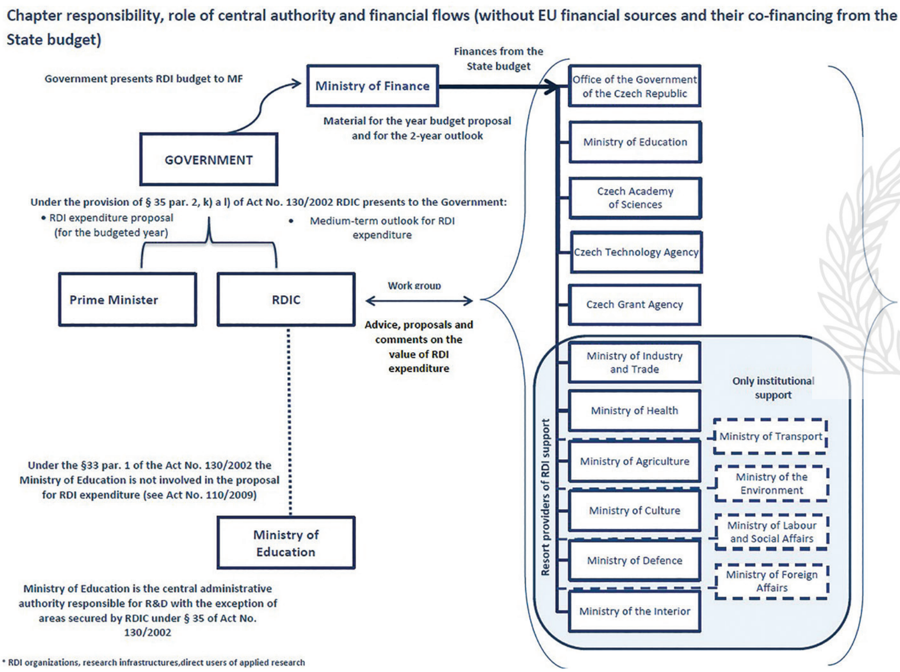
Science Funding in the Czech Republic: Basic Facts

How is the administration of Czech science organized? There is no ministry of research, and the entire Research and Development and Innovation (R&D&I) sector is coordinated by a hybrid executive-strategic R&D&I Council (RDIC) headed by the Prime Minister, an advisory body to the government, which proposes budgets and policies, including the distribution of funding to so-called 'providers' of funding.[1] Within basic research, the key

[1] The country has a number of strategic plans and policy documents, where the National Economic Strategy embeds the 2030 Innovation Strategy, which subsumes the National R&D&I Policy, which in turn subsumes the National Research and Innovation Strategy for Smart Specialization (RIS3) Strategy.

providers of institutional funding (block grants) are the Ministry of Education (which provides funding to universities) and the Academy of Sciences (which covers its institutes). The institutional funding sector has been subject to two funding reforms, which are discussed below. Among key providers of competitive program funding are the Czech Science Foundation ("Grant Agency of the Czech Republic"), which covers basic science, and the Technological Agency, which covers applied research and innovation. There are competitive funding programs provided also through several ministries (of industry, health, culture, etc.). Finally, there is a set of applied research institutes at specific ministries, e.g. a geology institute at the Ministry of Environment.

Figure 2: The Public Administration of Czech Science



Source: The Czech RDIC

How are these funding channels evaluated? The program-based competitive funding schemes are evaluated qualitatively by their respective providers, with the evaluation reports being submitted to the RDIC, which approves of program extensions or not. Institutional funding (basic research funding of block grants of universities and research institutes) has undergone two major reforms over the last decade. These reforms have occurred on the background of growing aggregate funding. The Czech Republic R&D expenditures (GERD) have grown substantially from 1.3% of GDP in 2010 to just under 2% in 2014, with a mild decline afterwards. This puts the Czech Republic's research funding intensity close to, but still below the EU-28 average. As we saw in Figure 1, the Czech Republic is lagging particularly far behind the EU-15 in Social Sciences. According to OECD statistics, the Czech Republic also features a particularly low share (of 6% in 2017) of GERD in Social Sciences and Humanities. The combination of low performance and funding is typical for social sciences in the region and may reflect the communist heritage.[2] In the Czech Republic, it is also a consequence of a recent funding and evaluation reform, which damaged social sciences for years to come.

Two Czech Reforms of Institutional Funding

Following a broadly criticized peer-review-based funding scheme operating in the 2000s, which relied on local low-quality panels for its evaluation, the Czech RDIC introduced a sweeping funding reform in 2008 based on quantitative bibliometric indicators. While other countries have experimented with formula-based funding schemes, this has been the first reform where all of institutional funding was based on formulas and not on any expert-administrator decision-making.

Since 2009, Czech academics began supplying all of their research output to a government's registry operated by the RDIC, which used the database of output to determine the distribution of about 1 billion Euro of research funding each year, roughly 50% of all research funding from the Czech government budget. The funding formula was based on the number of papers in the WoS published by a given research unit, with somewhat higher 'points' awarded to publications in journals featuring a higher Impact Factor (IF), and on the number of books and other types of publications, with each type of publication being assigned a fixed number of funding 'points'. The overall budget was then distributed in proportion to the distribution of these points to specific funding providers who used the same transparent scheme to distribute funding to universities, many of which used the same funding formulas to allocate funding to faculties and even individual departments. Crucially, the 'points' per type of publication were the same across all disciplines and fields of science.

[2] For a related discussion see Kovač et al. (2018).

Within three years, this system has achieved massive reallocation of funding from low-output to high-output workplaces and from fields of science where even the best scientists in the world publish only few papers a year (mathematics, economics) to fields of science where a typical scientist publishes several papers a year (e.g., chemical engineering). Some natural science faculties increased their overall funding multiple-fold within a short time period, to a significant extent at the expense of social science and humanities.

The speed of reallocation and the arbitrary nature of cross-discipline redistribution of scientific funding were so dramatic that, by 2013, a modified version of the funding scheme was introduced, which fixed aggregate budget shares of major fields of science (for example, social sciences) and led to massive rat-race competition within each field-specific budget based on the production of high quantity of output. While higher-IF output did receive more 'points' than lower quality output, this gap in 'point' reward was dwarfed by the gap in costs of production. Given how easy it was to generate new WoS journals and to increase their IF,[3] mass production of low quality output was the only way workplaces could keep their share of the field-specific budget. The rat race of mass production did not allow for funding increases for workplaces that focused on increasing the quality of their output. The situation was particularly dire in Social Sciences due to two factors: First, the overall budget of Social Sciences shrank due to the arbitrary reallocation of funding in the first three years of the reform, which intensified the rat race competition for funding. Second, many researchers in Social Sciences have never published in high-quality journals before the reform, which meant that mass production of low quality publications was the only way to compete for funding.[4]

The reform resulted in major reallocation towards higher-quality workplaces in natural sciences and in mass over-production of research output of low or zero scientific value in many fields - output that would not have been produced had it not been for the powerful transparent incentives set up by formulaic funding. In WoS Categories where such opportunistic behavior has been particularly strong, including several disciplines in technical fields and in social sciences, the Czech Republic now produces as many low-quality

[3] Three practices were chiefly used to inflate journal IFs: First, WoS Proceedings corresponding to local conferences cited locally published journals heavily. Second, some journals increased self-citation rates. Third, "citation consortia" of semi-bogus journals (several economics journals in the Baltics, for example) were involved in the practice of citing each other heavily within an implicit citation consortium.

[4] Some social science programs instructed their students to publish their master theses in near-predatory publishing houses such as Lambert Academic Publishing.

WoS articles (in the lowest 4th quartile of WoS AIS journal rankings) as would correspond to one fifth of such output of the entire EU-15. In one recent year, as a consequent of 'point' incentives, Czech economists produced more ISI Proceedings than all US economists; it is clear these have not systematically increased scientific knowledge in the field.

The composition of the RDIC changed around 2014 and the new Council introduced another major funding and evaluation reform in 2017. This second reform scrapped the formulaic funding scheme and replaced it with one that relies heavily on peer review, but disciplines peer review with bibliometric statistics. The new system only compares evaluated units within fields, not across fields, and it operates 5 modules (dimensions) of evaluation:

- M1 – Quality of Selected 10% of Results (peer review using external opponents)
- M2 – Research Performance (bibliometrics reviewed by discipline panels)
- M3 – Social Relevance (reported to 'provider')
- M4 – Viability (reported to 'provider')
- M5 – Strategy (reported to 'provider')

The first module focuses on peer-review evaluation of publications that fall outside of the WoS (where no impact measure is easily available) and on the evaluation of WoS output that may stand out in terms of its impact. The second module focuses on two statistics for each evaluated unit within a discipline: (a) its quality profile, where a high share of publications in lowest-ranked journals are deemed inappropriate, and (b) its share of high-quality output within a discipline relative to its share of funding (capacity) within a discipline. The capacity normalization step is yet to be fully implemented. Again, comparisons within M1 and M2 are performed within fields only. M1 and M2 performed annually at the national level (under the RDIC), then field-level grades are aggregated up to research-unit level (university, institute) by 'providers' who perform their own evaluation steps within the other three modules, which are operated in a 5-year cycle.

The WoS part of the bibliometric module M2 relies on the Article Influence Score to rank journals within 6 fields and 42 FORDs discipline categories (based on the OECD classification). WoS journals are segmented by AIS journals rankings into the 1st decile, and four quality quartiles. Panels write a discipline-wide report and then comment on the publication profiles of individual universities.

The funding reallocation achieved based on the new scheme thus far has been minimal, but the reform succeeded in that all providers now accept that their funding decisions should reflect the 'index funding' principle, where research units achieving higher marks in evaluations should receive higher growth rate of their institutional funding. This is a major improvement over the previous scheme, which reallocated all funding each year (based on the rule of three) proportionally to evaluation 'points' corresponding to the funding formula. This resulted in large year-to-year increases as well as drops in funding, something that any scheme of science funding should avoid.

Lessons: Reform Obstacles and Traps

The above-provided subjective review of the Czech reform experience fits well into the existing scientific literature studying incentive provision in scientific knowledge production.

The printing press of quantitative publishing incentives

There is a growing literature on how scientists' behavior is strongly affected by economic incentives (Stephan, 2012). Reformers aiming to provide incentives for high-quality science often argue that peer reviewing at journals and measures of journal quality (typically citation impact measures) provide an ideal external *quantitative* structure that can be used to allocate funding. This idea has led to several unfortunate unintended consequences in multiple countries.

Until the Czech reform of 2009 discussed above, Australia represented the only country that attempted to introduce simple bibliometric funding formulas to distribute major shares of research funding to universities. Butler (2003) reports on the effects of a simple funding formula used in Australia to fund university research, where no attempt was made to account for the quality of publication output. While such funding schemes were used since 1990, their budget shares were small (of the order of 5%). In 2001, however, the share of overall funding targeted to research and linked to a formula increased dramatically. Butler (2003) shows that with the introduction of the publication funding formulas, the number of publications in the bottom half of journals as ranked based on citation impact grew twice as fast as the number of articles in journals ranking in the top half, that such 'inflation' of low-quality research output occurred in almost all fields of science, and that it did not happen outside of the university sector in Australia, where the funding formula was not applied. While the Czech experience has thus far not been summarized in a scientific evaluation of this type, the stylized description provided above is in line with the Australian experience.

Italy is another example of a country that introduced bibliometric-based evaluations with likely negative consequences in terms of strategic behavior of scientists. Seeber et al. (2019) show that Italian academics react to quantitative citation metrics used in promotions by quickly increasing self-citations, with the increase being strongest for social scientists. In line with this finding, Baccini et al. (2019) point out that the extent to which citations to Italian publications come from within Italy also increases after the introduction of citation-based metrics in academic evaluations and Bagues et al. (2019) find that around 5% of Italian researchers - a high share - have published in journals classified by the scholarly librarian Jeffrey Beall as ‘predatory’.

Comparing apples and oranges

A particularly unfortunate feature of the Czech reform of 2008-2013 has been to award the same funding per article published in any field of science, despite the vast differences in publication practices across scientific disciplines. For similarly undesirable consequences of paying all researchers the same pay level across all disciplines, see Boyle (2008).

Inappropriate measures lead to unfortunate incentives

Whenever countries tie funding to the Impact Factor (IF) of journals where scientists publish, new journals appear that allow those scientists who cannot publish in high-quality outlets, to boost their ‘accounting’ output measures. Such journals can improve their IF by citations from locally organized conference proceedings, and they often do so. One way to avoid these printing-press incentives is to rely on the Article Influence Score (AIS) instead. The AIS is also an average per-article influence measure based on citations in the Web of Science (WoS), but it has several important advantages relative to the IF. It puts higher weight on citations from more prestigious journals, and it ignores citations to articles from the same journal, making it harder to manipulate. It is also important to avoid disadvantaging the humanities based on the fact that no such external quality proxy is available for books and non-WoS journals.

Another problem with restructuring funding allocation is that one wants to avoid unpredictable rapid changes in funding. A basic feature of the production of scientific knowledge is that high-quality teams (departments, schools) take years to build, but can be disrupted rapidly by temporary absence of adequate funding. This dictates that funding schemes do not introduce large year-to-year fluctuations in funding. Similarly, while competitive (i.e., grant) funding provides incentives for quality growth, when the share of competitive funding relative to institutional (block-grant) funding is too high, this also creates too much uncertainty that curbs the ability of ambitious workplaces to maintain an upward quality trajectory. In a typical environment, this is not a binding issue since status quo is usually preserved through internal academic democratic processes, but the Czech reform of 2009/10 shows that reform efforts can go too far. This means that reallocation of funding towards higher quality workplaces or individuals ideally should come from aggregate increases of additional funding, not at the expense of their competitors within the system.

Conclusions and Recommendations

The main lessons from the Czech reform can be summarized as follows: Growth in aggregate funding opens door to reforms, but without international-standards evaluations, progress is slow or none. Any evaluation exercises are to be performed strictly within disciplines. Formulaic 'transparent' incentives can backfire, making reliance on peer review critical, but this raises another key issue of who sets the composition of evaluation panels. International advisory boards can be helpful.[5]

One can formulate two recommendations based on these lessons: (i) Attempt to make as much of a commitment as possible to external non-formulaic evaluation benchmarks such as the number of awarded ERC grants by field. If local efforts do not make a difference on such external-benchmark front over the medium term, they are ultimately to be judged as not successful. (ii) Whenever there is any opportunity for public funding growth, divide funding into a main stable part, which is available to the existing scientific community with high level of predictability and continuity, and a structurally separate funding tier focused only on high-quality performance. This second tier can ideally rely in its funding allocation on evaluation and advisory

[5] In the context of the Czech Republic, the Czech Science Foundation sub-contracts some of its evaluations to the ESF – Science Connect. The RDIC has an International Advisory Board, which includes top-level Czech scientists working abroad. All Czech universities and some institutes of the Czech Academy of Sciences now have an International Advisory Board. Several Nobel laureates are now involved in some of these boards.

boards composed of scientists based at world-leading research institutions, including those from the diaspora.

A highly ambitious project within this second tier would be to establish a large excellence center such as the Austrian IST (see https://ist.ac.at/en/home/)[6]. More realistic perhaps is the establishment of person-centered large-grant programs (similar to the ERC competition but at a lower level of expectations and funding, examples include the EXPRO grants of the Czech Science Foundation, the *Lumina Quaeruntur* grants of the Czech Academy of Sciences, or the Dioscuri centers of the MPG network) as well as workplace-based funding schemes. One example, where support for internationally competitive undertakings is desirable at the workplace level (as opposed to person level) is doctoral studies. There are good-practice examples to follow when designing a competition for the best doctoral program in the nation in every field and supporting that program (and its faculty) generously (e.g., the LC centers of the Czech Ministry of Education in the 2000s or the large German *Exzellenzinitiative*). If such efforts prove to be too ambitious, any national evaluation that provides higher growth rate of funding to best-evaluated institutions based on strictly within-field comparisons, is likely to gradually make a difference as well.

References

Butler, L. (2003) “Modifying publication practices in response to funding formulas,” *Research Evaluation,* 12 (1), 39–46.

Baccini, A., De Nicolao, G., and E. Petrovich (2019) “Citation gaming induced by bibliometric evaluation: A country-level comparative analysis,” *PLOS ONE*, 14(9).

Bagues, M., Sylos-Labini, M., and N. Zinovyeva (2019) “A Walk on the Wild Side: ‘Predatory’ Journals and Information Asymmetries in Scientific Evaluations,” *Research Policy*, 48(2): 462–477.

Boyle, G. (2008) “Pay Peanuts and Get Monkeys? Evidence from Academia,” *The B.E. Journal of Economic Analysis & Policy*: 8(1), Article 21.

Jurajda, Š., Kozubek, S., Münich, D., and S. Škoda (2017) “Scientific publication performance in postcommunist countries: still lagging far behind.” *Scientometrics* 112, 315–328.

Kovač, D., Scrbec, N., and B. Podobnik (2018) “Does it Pay Off to Research Economics—A Tale of Citation, Knowledge and Economic growth in Transition Countries,” *Physica A: Statistical Mechanics and its Applications*, 505(1): 293-305.

[6] This may not require new buildings as it can correspond to a distributed center with its own governing board. More generally, while investment into buildings and laboratories (equipment) is often very important, the critical aspect of scientific progress is human capital and the ability to attract and keep promising researchers who then can help generate their equipment funding.

Seeber, M., Cattaneo, M., Meoli, M., and P. Malighetti (2019) "Self-citations as Strategic Response to the Use of Metrics for Career Decisions," *Research Policy*, 48(2): 478–491.
Stephan, P. (2012) *How Economics Shapes Science,* Harvard University Press.

DOI: 10.5644/PI2021.200.14

Impact of Intellectual Property Rights on the National Science System

Joseph Straus[*]

"Science, like nothing else among the institutions of mankind, grows like a weed every year. Art is subject to arbitrary fashion, religion is inwardly focused and driven only to sustain itself, law shuttles between freeing us and enslaving us."
K.B. Mullis (Nobel Laureate for Chemistry 1993)

Abstract: After using the 2020 developments of the COVID-19 vaccines as an example of successful cooperation between academia, industry and government for supporting research and translating its results into innovations assisted by patents, the article turns to the national science systems. First, it addresses the pioneering role of the 1945 "Science the Endless Frontier", the *Magna Carta of American Science* and its patent policy. Retraced are the subsequent US developments revealing a gradual turn from incentivizing knowledge and technology transfer from government funded institutions to industry by allowing it only in the form of non-exclusive licenses, to imposing the public research sector an obligation to commercialize its research results by allowing exclusive licenses and assignments of intellectual property rights to private business. This all by recognizing and preserving academic freedom and inquiry. Next, it pays attention to developments in countries where legislators followed overall the US model. Finally, the contribution discusses the intellectual property rights system in the light of the specific needs of academic researchers.

Key words: University-Industry-Government Relations – Intellectual Property Rights and National Science Systems

I. Introduction

Seldom, if ever in peace times, have events such as those characterizing the year 2020, in a more impressive way demonstrated the importance of the so-called "*Triple Helix*" *Alliance* for the wellbeing of the society of the globe. The notion of the "*Triple Helix*" *Alliance* stands for "a spiral model

[*] Dr. jur., Dres. jur. h.c., Professor of Law (University of Munich and University of Ljubljana), Emeritus Director at the Max Planck Institute for Innovation and Competition, Munich. Foreign Member, Academy of Sciences and Arts of Bosnia and Herzegovina E-mail: j.straus@ip.mpg.de

of innovation in terms of university-industry-government relations [is] required to capture the evolution of multiple linkages at different stages of the capitalization of knowledge”.[1] Only thanks to the successful and intensive university-industry-government interactions, it was possible, for the first time in history, to develop and put on the market new vaccines to fight the SARS 2 COVID-19 pandemic. The scientific and technological foundations for the vaccines of BioNTech-Pfizer, Moderna and Oxford-AstraZeneca, which were the first to receive marketing approval and enter the market, originate from the late 1980s-1990s.

First, the close international cooperation between publicly funded research institutions and biotech companies, relying on patents protecting their basic research inventions,[2] generated the first therapeutics based on the recombinant DNA technology, such as human insulin, erythropoietin (EPO), granulocyte-colony stimulating factors (GCSF) and others. Then, after some ten years, the intensive collaborative efforts within the Human Genome Project (HGP), an internationally supported public project (paralleled by Celera Genomics, a private effort), in 2001 culminated in the deciphering of the entire human genome.[3] Whereas the Oxford-AstraZeneca researchers introduce into their vaccine double stranded DNA of the Coronavirus spike protein gene using another virus (an adenovirus) as vector[4]- an approach developed in the 1990s - the BioNTech and Moderna vaccines store the instructions for building the spike protein in single-stranded RNA.

To end up with BioNTech-Pfizer and Moderna vaccines using messenger RNA as “vector”, a change of paradigm, induced by research work on mRNA

---

[1] Leydesdorff & Etzkowitz, Emergence of a Triple Helix of University-Industry-Government Relations, 1996:279-286, quoted from Leydesdorff & Etzkowitz, The Future Location of Research: A Triple Helix of University-Industry-Government Relations II, 1996: 20-25. For a detailed discussion of the Triple Helix as a model for innovation studies, cf. Etzkowitz & Leydesdorff, Universities and the Global Knowledge Economy: A Triple Helix of University-Industry-Government Relations, 1997:1-8 and Viale & Etzkowitz, Third Academic Revolution: Polyvalent Knowledge; The “DNA” of the Triple Helix, 2005, accessible under https://www.researchgate.net/publication/242406526_Third_academic_revolution_polyvalent_knowledge_theDNA_of_the_triple_helix - last visited February 9, 2021 and Leydesdorff, The Triple Helix: An Evolutionary Model of Innovations, 2000:243–255.

[2] Cf. e.g. Straus, Intellectual Property Rights and Bioeconomy, 2017:576-590 (pp. 580-582).

[3] Fraser, Editorial: A Genome to Celebrate, 2021:545; Jones & Cook-Deegan, Complicated Legacies: The Human Genome at 20, 2021:564-569.

[4] Cf. Corum & Zimmer, How the Oxford-AstraZeneca Vaccine Works, The New York Times of February 8, 2021 (https://www.nytimes.com/interactive/2020/health/oxford-astrazeneca-covid-19-vaccine.html - last visited February 9, 2021).

on both sides of the Atlantic, was necessary. However, while Katalin Karikó and Drew Weissman, the researchers who worked on mRNA at the University of Pennsylvania during the 1990s, have been praised as having been critical to the development of mRNA-based therapies,[5] since they published a paper in 2005,[6] the name of Ingmar Hoerr, the European early pioneer in mRNA research is nowhere mentioned. Ingmar Hoerr who started his Ph.D. work in mid 1990s was convinced that RNA could be a platform for developing a multitude of therapies, from prophylactic vaccines to immunotherapies. Unlike Karikó and Weissman who reduced the antiviral response of mRNAs uridines with the modified versions, called pseudouridine and 5-methyluridine, i.e. by nucleosides and received a patent for their use in 2012,[7] Hoerr stabilized the mRNA by sequence modification. Since 1999, Hoerr has filed numerous patent applications, e.g. on June 5, 2001, i.e. 20 years ago, for "Pharmaceutical Composition Containing a Stabilized mRNA Optimized for Translation in its Coding Regions".[8] Hoerr published his findings in 2000 in his doctoral thesis entitled "RNA Vaccine for the Induction of Specific Cytotoxic T-Lymphocytes (CTL) and Antibodies"[9] and together with his group in the European Journal for Immunology.[10] His discovery made it easy to use ribonucleic acid for the development of vaccines and immunotherapies. RNA vaccines can be produced in high amounts and have the same major advances as DNA vaccines but lack the potentially harmful effect of DNA integration into the genome. However, Ingmar Hoerr is not only the "seminal early mRNA pioneer", who has solved the problem of stabilizing the mRNA through a paradigm change.[11] Dr. Hoerr also stands for entrepreneurial spirit and a remarkable enduring

[5] Cf. Keener, Just the Messenger: A New Class of Therapeutic Instruct the body to make its own drugs, 2018:1294-1300; Gaveria & Kilic, A Network Analysis of COVID-19 mRNA Vaccine Patents, 2021:546-549; Fauci, The Story Behind COVID-19 Vaccines, 2021; Kolata, Kati Kariko Helped Shield the World From the Coronavirus, 2021.

[6] Karikó & Buckstein & Ni & Weissman, Suppression of RNA Recognition by Toll-like Receptor: The Impact of Nucleoside Modification and the Evolution Origin of RNA, 2005:165-175, with references to some of their earlier publications.

[7] According to Keener, *supra* No. 6, p. 1299.

[8] US Patent 10188748 B2 (A1) of January 29, 2019, claiming as the first priority June 5, 2001 (application published on December 12, 2002).

[9] Cf. Wikipedia under Ingmar Hoerr.

[10] Cf. Hoerr & Obst & Rammensee & Jung, In Vivo Application of RNA Leads to Induction of Specific Cytotoxic T-Lymphocytes and Antibodies, 2000:1-7.

[11] Kuhn emphasizes, "The scientific community is a supremely efficient instrument for maximizing the number and precision of the problem solved through paradigm change." (Kuhn, The Structure of Scientific Revolutions, 1970 (at p. 169)).

energy necessary to translate an important basic research discovery into a commercially marketable and society benefitting product, e.g. a vaccine. In 2000, Ingmar Hoerr founded the successful biotech company CureVac, based in Tübingen, now working in co-operation with GlaxoSmithKline on a vaccine effective also against the Brazilian, UK and South African COVID 19 mutants. In an article published in 2017, Hoerr not only described in detail the challenging foundation of the company, the struggle to persuade and bring together public and private investors to provide the necessary funding, etc., but also emphasized that "*valid preclinical data and ideally broad patents*" were essential for the success of the company.[12] It is difficult to understand that papers which report on CureVac's programs for mRNA-based influenza and malaria vaccines, supported by Bill & Melinda Gates Foundation, or about CureVac first clinical trial of an mRNA vaccine against prostate cancer undertaken already in 2008,[13] don't even mention Ingmar Hoerr, the founder of CureVac, or his seminal paper published in 2000!

When the development and marketing approval of a new vaccine, which requires tens of thousands of clinical tests and costs hundreds of millions or more Euros or Dollars, is at hand, universities, public research institutions and even successful biotech start-ups are in need of strong private and public allies. The financial risks are of such magnitude that even big pharmaceutical companies, as a rule, shy away from such endeavours if the government does not signal its readiness to support the project financially. In case of the development of Corona vaccines, even a pharmaceutical giant such as the US Company Merck & Co., despite the already effected investment, gave up its efforts because of the setbacks it experienced. The International Federation of Pharmaceutical Manufacturers Association (IFPMA) estimates that expenditures of the pharmaceutical manufacturers branch for developing Corona vaccines and their production from private funds will amount to more than 10 billion US $ by the end of 2021. However, public initial funding was also of key importance for the development of Corona vaccines. Without that funding, companies would have never taken up such a broad initiative. Most important by far was the funding provided by the US-Government's "Operation Warp Speed" action, which generated more than 12 billion US $. The EU was much more modest. It will spend no more than few hundred millions of Euros for that purpose. Crucial for the incredible speed for the Corona vaccines

[12] Cf. Hoerr, A Successful Founder off the Beaten Path, 2017:900-903 (at 902, emphasis added).

[13] Cf. e.g. Keener, *supra* No. 6, p. 1298, reporting on CureVac but entirely ignoring Hoerr.

development were not only the engagement of the best researchers and the financial support by government but also the prospect of a global market of an unprecedented size. Sales projected for 2021 are impressive: Pfizer (~ 15 billion US $), Moderna (~ 12 billion US $), BioNTech (~ 8 billion US $), CureVac (~ 5 billion US $) and AstraZeneca (~ 4 billion US $).[14]

The greatly appreciated and applauded success of the "*Triple Helix*" *Alliance*, which delivered the new vaccines to fight the Corona pandemic within an unbelievable one year, has, however, already been clouded. The reason being, the production capacities are lagging far behind the urgent demand, the enormous overall costs for the vaccination of the entire population, unaffordable for many if not most countries, and the prospect of profits which the vaccine producers, the beneficiaries of the multibillion initial public funding, can expect thanks to their patents. Not surprising, calls for compulsory patent pools, compulsory licenses, etc., to master the problems, and proposals for solving the problem by weakening patent protection followed.[15] Indeed, surprising, however, was the May 5, 2021 decision of the US President Joe Biden to support a temporary waiver of Covid-19 vaccine patents, which provoked not only great concerns of the pharma industry,[16] but has also been found neither appropriate nor productive by European leaders such as the German Chancellor Angela Merkel and the French President Emmanuel Macron.[17]

II. National Science Systems

(a) USA – The Pioneer

In 2020 the US celebrated the 75th anniversary of what is regarded as the "*Magna Carta of American Science*",[18] the Report "*Science the Endless*

[14] Cf. Benz & Feldges, Ein Turbo für die Impfstoff-Hersteller: Lässt sich die Produktion von Corona-Vakzinen Beschleunigen?, 2021 (https://www.nzz.ch/wirtschaft/corona-impfung-moeglichkeiten-zur-beschleunigung-der-produktion-ld.1599788 - last visited February 8, 2021).

[15] Cf. e.g. Abbott & Reichman, Facilitating Access to Cross-Border Supplies of Patented Pharmaceuticals: The Case of the COVID-19 Pandemic, 2020:535-561.

[16] Cf. e.g. Asgari & Mancini & Kuchler, Pharma Industry Fears Biden's Patent Decision Sets Dangerous Precedent, Financial Times, May 7, 2021, p. 3; Stacey & Williams, Biden's Diplomatic Victory Blunts Pharma Lobby, Financial Times of May 10, 2021, p. 4.

[17] Cf. e.g. Peel, EU Leaders .Confront US over Vaccine Patent Waiver Demands, Financial Times of May 8, 2021, p.2.

[18] Thorp, Editorial: Science has always been Political, 2020:227.

Frontier", which Vannevar Bush, Director of the Office of Science Research and Development, submitted to the President Harry Truman on July 25, 1945 (Report).[19] This Report was the result of a 1944 request of President Franklin D. Roosevelt, who requested answers/ideas to four questions. They all centered around how best the results of the research work which Bush's Office so successfully conducted "in the utmost secrecy and carried on without public recognition of any kind; but its tangible results can be found in the communiques coming in from the battlefronts all over the world.", could be profitably employed in times of peace. This meaning, "for the improvement of national health, the creation of new enterprises bringing new jobs, and the betterment of the national standard of living."[20]

As the Science Editor in Chief, Holden Thorp emphasizes, Bush's Report set out the rationale and structure of a system to fund science in the USA.[21] As regards the rationale, the Report pointed out that "Science can be effective in the national welfare only as a member of a team, whether the conditions be peace or war. But, without scientific progress no amount of achievement in other directions can insure our health, prosperity, and security as a nation in the modern world."[22] Therefore, the Government should accept new responsibilities for promoting the flow of new scientific knowledge and the development of scientific talent of our youth.[23] The Report recommended that a new agency for these purposes be established. That agency "should recognize that freedom of inquiry must be preserved and should leave internal control of policy, personnel, and the method and scope of research to the institutions in which it is carried on. It should be fully responsible to the President and through him to the Congress for its program."[24] As the result of this Report, President Harry Truman on May 10, 1950 established the National Science Foundation, designed on the principle that scientists themselves should determine the course of fundamental research.[25]

In the context of this contribution and in view of the ongoing debates on the impact of intellectual property rights, especially patents, on scientific progress and the translation of publicly funded research results to innovative

[19] https://www.nsf.gov/od/lpa/nsf50/vbush1945.htm - last visited February 3, 2021.
[20] President's Letter of November 17, 1944 (ibid p. 3, 4).
[21] Thorp, *supra* no. 11.
[22] The Report, p. 5.
[23] Ibid p. 7.
[24] Ibid p. 8.
[25] Cf. Gibson, Overseeing Innovation: 75 Years after Vannevar Bush's Impactful Report, Debate Continuous About Directing Science, 2020:258-259 (at p. 259).

products and processes, the following statements in the "Science the Endless Frontier" Report seem of enduring relevance.

> "The most important ways in which the Government can promote industrial research are to increase the flow of new scientific knowledge through support of basic research, and to aid in the development of scientific talent. In addition, the Government should provide suitable incentives to industry to conduct research, (a) by clarification of present uncertainties in the Internal Revenue Code in regard to the deductibility of research and development expenditures as current charges against net income, and (b) by strengthening the patent system so as to eliminate uncertainties which now bear heavily on small industries and so as to prevent abuses which reflect discredit upon a basically sound system. In addition, ways should be found to cause the benefits of basic research to reach industries which do not now utilize new scientific knowledge."[26]
>
> "V. Patent Policy. - The success of the National Research Foundation in promoting scientific research in this country will depend to a very large degree upon the cooperation of organizations outside the Government. In making contracts with or grants to such organizations, the Foundation should protect the public interest adequately and at the same time leave the cooperating organization with adequate freedom and incentive to conduct scientific research. The public interest will normally be adequately protected if the Government receives a royalty-free license for governmental purposes under any patents resulting from work financed by the Foundation. There should be no obligation on the research institution to patent discoveries made as a result of support from the Foundation. There should certainly not be any absolute requirement that all rights in such discoveries be assigned to the Government, but it should be left to the discretion of the director and the interested Division whether in special cases the public interest requires such an assignment. Legislation on this point should leave to the Members of the Foundation discretion as to its patent policy in order that patent arrangements may be adjusted as circumstances and the public interest require."[27]

As result of the patent policy integrated into the "Science the Endless Frontier" Report, the US universities and publicly funded institutions engaged themselves actively in patenting. They received numerous patents, however, hardly ever commercially exploited. Since patents issued on publicly funded research results could be neither exclusively licensed, nor assigned to private businesses, their translation into innovative products and processes did not take place. By the end of 1970s, of the 25.000 to 30.000 government owned

[26] Ibid, Summary (at p. 6).
[27] Ibid p. 30.

patents, less than 5% were licensed.[28] In order to overcome this economically unfavorable situation, in the 1980s the USA enacted several laws aimed at encouraging technology transfer of results from federally funded research undertaken at universities and academic research institutions. In 1980, the Bayh-Dole Act[29] introduced the possibility for private parties to retain patent rights via a "title in contractor" policy, i.e. small businesses and non-profit organizations, including universities could retain intellectual property rights to results from federally funded research. Also in 1980, the Stevenson-Wydler Act[30] required that federal agencies administrating research establish an Office of Research and Technology Applications (ORTA) at all government-operated or contractor-operated laboratories with an annual budget of more than US $ 20 Million. In 1986, the Federal Technology Transfer Act (FTTA)[31] amended the Stevenson-Wydler Act by shifting the emphases in federal policy from one permitting technology transfer to one requiring the agencies act vigorously in working with industry to commercialize federally funded research. In the so-called Cooperative Research and Development Agreements (CRADAs) exclusive licensing terms were also allowed.

This legislative intervention of the US lawmaker had manifold and far-reaching consequences. It has opened the way to fundamentally change the access to publicly funded research results since it not only encouraged, but in fact obliged universities and other publicly funded institutions to commercialize research results achieved by federal funds, i.e. make them proprietary as far as possible and, the Federal Government became a third player in the game. Although the overall social and economic impact of the Bayh-Dole Act and the other US legislative measures have often been questioned[32], the undeniable fact is that the US universities and federally funded research institutions since the 1980s have played a key role as generator of new knowledge, as well as its translator into innovations. The annual statistics published by the US Association of University Technology Managers (AUTM) have demonstrated this since long. Its 2018 Licensing Activity Survey reveals that its members created 825 new products, formed 1.080 start-ups, filed 17.087

[28] Cf. Straus, *supra* no. 2 (at p. 581).
[29] Public Law 96-517.
[30] Public Law 96-480.
[31] Public Law 99-502.
[32] Cf., e.g. Mowery & Nelson & Sampath & Ziedonis, The Growth of Patenting and Licensing by US Universities: An Assessment of the Effect of the Bayh-Dole Act of 1980, 2001:99-119; and as regards the critics Frangioni, The Impact of Greed on Academic Medicine and Patient Care, 2008:503-507.

new US patent applications, executed 9.350 licenses and options and received 7.625 US patents.[33] The total revenues of US universities from their licensing activities in 2018 amounted to US $ 2.94 billion. Assuming the average 2% royalty rate, the academic technology was responsible for sales of products amounting to some US $ 147 billion.[34] Statistics for the years 2015-2019 reveal that universities have been very active if not even dominating in biotech patenting. Among the top 20 academic centers ranked by number of issued biotech patents, except for one – University of Tokyo ranked 17th – all were American, with the University of California System (1.557 patents), Stanford University (658 patents), University of Texas System (531 patents), Massachusetts Institute of Technology (519 patents) and University of Pennsylvania (495 patents) in the top 5 ranks.[35] Patenting activities are, however, expensive. In 2018 alone, US universities spent more than US $ 425 million in patent related expenses.[36]

Patent statistics alone, however, do not yet represent a 'tangible outcome' of the increasing cooperation between federally funded research and industry since the adoption of the 1980s legislative measures. Most impressive in this regard are the aggregate data on the numbers of drugs developed from inventions, which Public Sector Research Institutions (PSRIs) had generated solely or jointly, protected by intellectual property rights specific to drugs, and subsequently transferred to a company through a commercial license.[37] These data reveal that, between 1991 and 2006, 153 drugs were developed (e.g. also approved by the Federal Drug Administration (FDA)), from PSRIs research results, including 22 developed from the National Institutes of

---

[33] AUTM 2018 Licensing Activity Survey: A Survey of Technology Licensing and Related Activity for US Academic and Nonprofit Research Institutions, p. 4 (https://autm.net/AUTM/media/SurveyReportsPDF/AUTM_FY2018_US_Licensing_Survey.pdf - last visited February 18, 2021).

[34] Cf. Dipanjan & Gupta & Turo, The Evolution of University Technology Transfer: By the Numbers, 2020 (https://researchgate.net/publication/340766806 - last visited February 20, 2021).

[35] Cf. for details Huggett & Paisner, Biotech Patenting 2019, 2020:921-922.

[36] According to Dipanjan & Gupta & Turo, *supra* no. 34.

[37] As defined by Stevens & Jensen & Wyller & Kilgore & Chatterjee & Rohrbaugh, The Role of Public-Sector Research in the Discovery of Drugs and Vaccines, 2011:535-541, at. p. 537. These authors emphasize that in most cases, the intellectual property was a patent or patent application, but that a few products have used proprietary biologic materials developed and licensed by the PSRI.

Health's Intramural Research Program (NIH-IRP),[38] for which patent applications were filed around 1985 (with one exception) and patents were granted between 1991 and 2007.[39] The therapeutic areas of those 153 drugs were oncology (40), infectious disease (36), cardiology (12), immunology (6) and others (59).[40] The remarkable impact that the drugs and biologics developed and patented by NIH alone had and still have on public health worldwide transpires from the fact that drugs and biologics still under license from NIH generated sales of US $ 4.7 billion in 2010. In addition, sales for drugs and biologics for which patents had expired (that were no long under NIH licenses) were about US $ 2.2 billion in 2010. Thus, the total worldwide sales in 2010 for inventions of the NIH Intramural Program alone amounted to at least US $ 6.9 billion.[41] The instrumental role that NIH patents have played in achieving such impressive and beneficial 'tangible' results should be obvious.

(b) Some Followers

(i) Japan

The US 1980s statutory moves, which firmly embedded publicly funded academic research into the national innovation strategy, have not only inspired economists to direct their attention to the industry-academia links,[42] but have

[38] Cf. Chatterjee & Rohrbaugh, NIH Inventions Translate into Drugs and Biologics with High Public Health Impact, 2014:52-58, Table 3 (at p. 54).

[39] Ibid, Table 1 (at p. 53). The main applicant was the National Cancer Institute with 12 patent applications, respectively patents granted (Table 1 (at p. 53)).

[40] Ibid, Table 3 (at p. 54).

[41] Ibid (at pp. 56-57).

[42] Here only a selection can be referred to: Collier, Alan, Australian Framework for the Commercialization of University Scientific Research, 2007:51-68; Eun & Lee & Wu, Explaining the "University-run Enterprises" in China: A Theoretical Framework for University-Industry Relationship in Developing Countries and its Application to China, 2006:1329-1346; Abetti, University Incubators as Agents for Technology Transfer and Economic Growth: Case Studies in USA, Ukraine and Finland, 2006:308-337; Rubenstein & Heisey & King, Public Sector Technology Transfer Through Patents and Licensing: The Case of US Agriculture, 2006:401-420; Steenhuis & Gray, The University as the Engine of Growth: An Analysis of How Universities can Contribute to the Economy, 2006:421-432; Walsh & Cohen & Cho, Where Excludability Matters, Material vs. Intellectual Property in Academic Biomedical Research, 2007:1184-2003; Chaves & Moro, Investigating the Interaction and Mutual Dependence Between Science and Technology, 2007:1204-1220; Woolgar, New Institutional Policies for University-Industry Links in Japan, 2007:1261-1274 and D'Este, & Patel, University-Industry Linkages in the UK: What are the Factors Underlying the Varity of Interactions with Industry? 2007:1295-1313.

worked also internationally as an ignition for activities of many legislators. Those activities were all aimed at designing national innovation policies by taking into account the important role which academic research has to play in that context.

The closest follower was *Japan*, where the Diet in 1995 passed the Science and Technology Basic Law, in 1996 adopted the First and in 2001 the second Science and Technology Basic Plan. By the latter, a new Science and Technology Council, attached directly to the Cabinet Office was set up.[43] In 1998, the Japanese Diet adopted the Act on the Promotion of Technology Transfer from Universities to Private Business.[44] In executing the Science and Technology Basic Law, in October 2003, Japan transformed its Science and Technology Corporation (JST) into Japan Science and Technology Agency (JST) as an independent administrative institution. The Agency's task is to strengthen the infrastructure for the promotion of science and technology and implement initiatives set out in the Basic Law.[45] In 2017, JST owned 3.604 patents worldwide and filed 75 patent applications.[46] At its website, JST offers selected technologies for licensing, thereby making all information on the respective patents/patent applications online accessible.[47] However, the results of the intense and long lasting efforts of the Japanese Government to promote university-industry cooperation aimed at incentivizing a smooth translation of academic research into innovative and marketable products and processes, so far achieved appear modest. The direct involvement of the government into the structure and functioning of universities, the limited acceptance of exclusive licensing of state funded research results to private business and the

[43] Cf. Edgington, The Japanese Innovation System: University-Industry Linkages, Small Firms and Regional Technology Centers, 2008:1-19 (at pp. 10 *et seq*). For policy initiatives promoting the university-industry ties in Japan see also Walsh & Baba & Goto & Yasaki, Promoting University-Industry Linkages in Japan: Faculty Responses to a Changing Policy Environment, 2008:39-54; and Holroyd, Reinventing Japan Inc.: Twenty-First Century Innovation Strategies in Japan, 2008:21–38.

[44] Act No. 52 of May 6, 1998 (English translation WIPO) (https://www.wipo.int/edocs/lexdocs/laws/en/jp/jp193en.pdf - last visited February 22, 2021). Cf. also Fujisue, Promotion of Academia-Industry Cooperation in Japan – Establishing the "Law of Promoting Technology Transfer from University to Industry", 1998:371-381.

[45] See https://www.jst.go.jp/EN/about/history.html - last visited February 20, 2021.

[46] See https://www.jst.go.jp/EN/about/jstdata.html - last visited February 20, 2021.

[47] See https://www.jst.go.jp/chizai/en/univ-ip/cips/licensing/details_01.html - last visited February 20, 2021.

fact that universities are not the direct beneficiaries of licensing income, may be a combined reason for that situation.[48]

As in the US, also in Japan, universities are particularly active in patenting in the area of life sciences. In June of 2008, the Kyoto University, where the researchers were very successful in the area of induced pluripotent stem cells (iPS) technology, established the company iPS Academia Japan, Inc., aimed at licensing the iPS-cell technology. Since January 2016, iPS Academia has the status of an official organization for technology transfer under the 1998 Law for Promoting University-Industry Technology Transfer.[49] In its portfolio, sourced not only from the Kyoto University rights but also from the rights of other Japanese Universities and even some foreign institutions, iPS Academia in 2012 had some 450 patent applications (some 125 patent families), among them some 200 on which patents were already granted by September 2016 in Japan, the USA, Europe and some other countries.[50] According to its licensing guidelines, iPS Academia allows the not-for-profit organizations free use of its intellectual property for educational purposes, provided no commercial aim involved. As regards commercial entities, they, as a matter of principle, can only acquire non-exclusive licenses at reasonable terms. Since the changes of the guidelines of October 2015, however, in exceptional cases, where non-platform technologies are involved, commercial entities can acquire exclusive licenses.[51] Until 2018, iPS Academia has granted 96 licenses to Japanese, 29 to US and 21 to European companies. Among them such pharmaceutical giants as Ajinomoto and Sumitomo from Japan and, e.g. Boehringer Ingelheim, Roche and Sanofi from Europe.[52] [53]

---

[48] For a detailed analysis of Japanese developments until 2003, cf., Kneller, University-Industry Cooperation and Technology Transfer in Japan Compared with the United States: Another Reason for Japanese Malaise? 2003:329-449 (at pp. 347-449).

[49] See http://ips-cell.net/e/about/outline.html - last visited February 21, 2021.

[50] See http://ips-cell.net/e/patent/ - last visited February 21, 2021.

[51] See http://ips-cell.net/e/license/policy.html - last visited February 21, 2021.

[52] See http://ips-cell.net/e/license/licensees.html - last visited February 21, 2021. Cf. also Straus, Patentierung und Kommerzialisierung im Bereich der Stammzellforschung, 2018:237-276 (at pp. 244-245).

[53] As Japan, Korea and Taiwan, in the late 1990s, adopted similar science and technology basic laws. They allowed institutions of higher education the ownership in government financed research results and opened the way for their decentralized licensing. Cf. Chang & Chen & Yang & Hua, Universities as Patent- and Licensing Income-Generating Institutions: A survey in Taiwan, 2008:290-309 (at p. 292).

(ii) China

Not much later than Japan, the *People's Republic of China*, on May 15, 1996 adopted the Law on Promoting the Transformation of Scientific and Technological Achievements, which entered into force on October 1, 1996. An important amendment of that Law followed by the Order No. 32 of the President on August 29, 2015, which entered into force on October 1, 2015.[54] As it transpires from its Article 1, the Law was developed for purposes of promoting the transformation of scientific and technological achievements into real productive forces, standardizing such transformation, accelerating scientific and technological progress, and promoting economic and social developments. Its 52 articles represent an all-encompassing and coherent legal framework aimed at successfully translating research findings also of "state-maintained research and development institutions and institutions of higher education", into innovative practice. These institutions can transfer their scientific achievements to enterprises or other organizations by assignment, license, investment as a trade-in and other means. They act based on own independent decisions, however, with prices to be determined by pricing in agreement, listing on the technology exchange market, auction, and other ways. In the case of pricing in agreement, they shall disclose the names of scientific and technological achievements and the proposed transaction prices in their entities.[55] In a number of provisions state defines measures such as to establish a public research and development platform, to provide technology integration,[56] support the development for the incubation of science and technology enterprise as scientific and technological enterprise incubator and university science parks.[57] Moreover, the Law sets forth that financial funds for the transformation of scientific and technological achievements be chiefly used as guidance funds, loan interest subsidies, subsidy funds, risk investments for the transformation,[58] and that the state shall, in accordance with the provision of relevant tax laws and regulations, implement tax preference for the transformation activities.[59]

[54] PKULAW.COM [CLI Code]: CLI.1.256285(EN). Some Chinese authors call this law "the newly revised 'Bayh-Dole Act'," cf. e.g. Wang & Xue & Shi, Characteristics and Logical Framework of Chinese Universities' Response to the Newly Revised 'Bayh-Dole Act', 2021.
[55] Articles 17 and 18.
[56] Article 31.
[57] Article 32.
[58] Article 33.
[59] Article 34. According to the Articles 36 and 38, the state encourage insurance institutions to develop insurance products "commensurate with the characteristics of the." The state shall also encourage venture capital institutions to make investments in the respective projects.

Under Article 43 of the Law, the income from the transformation, i.e. commercialization of research results, obtained by state-maintained R&D institutions and institutions of higher education, "shall be totally retained thereto and be mainly used for science and technology research and development, achievement transformation, and other relevant work, after rewards and remunerations are granted to people who have made significant contributions to the completion and transformation of job-related scientific and technological achievements." Article 45 regulates the distribution of the proceeds from "commercialization" and the reward of the employees for the so-called job-related achievements, who significantly contributed to the transferred achievements, and provides the following interesting solutions:

> "(1) Where a job-related scientific and technological achievement is assigned or licensed to others, not less than fifty percent of net income from assignment or license of such scientific and technological achievement shall be withdrawn.
> (2) Where a job-related scientific and technological achievement is used as a trade-in in investment, not less than fifty percent of shares or capital contributions formed from such scientific and technological achievement shall be withdrawn.
> (3) Where a job-related scientific and technological achievement is implemented independently or in cooperation with others, not less than five percent of business profits from the implementation of the scientific and technological achievement shall be withdrawn consecutively for three to five years after the transformation and successful production thereof.
> The method and amount of rewards and remunerations that state-maintained research and development institutions and institutions of higher education specify or agree upon with scientific and technical personnel shall comply with the criteria specified in item (1) to item (3) of the preceding paragraph.
> State-owned enterprises and public institutions shall, in accordance with the provisions of this Law, include the expenditures of rewards and remunerations granted to people who have made significant contributions to the completion and transformation of the job-related scientific and technological achievements into their total wages in the current year, but the said expenditures shall not be subject to the restriction of their total wages in the current year and shall not be included into their total wage base."

Empirical data about the results of this Chinese legislation are not available. However, statistics about patent applications filed by Chinese universities and public research institutions such as the Chinese Academy of Sciences (CAS) clearly reveal that they are very active. For instance, in the area of artificial intelligence technologies, Chinese organizations make up 17 of the top 20 academic players in the world, with CAS ranking 17th in the top 100 of all applicants. Statistics for AI related patent applications reveal in general, high activity of universities and public research institutions. Among the top 500 of all applicants, 167 are academic institutions, of which 110 Chinese.[60]

(c) Europe

Although Europe also took note of the Bayh-Dole Act and other related US legislative developments of the 1980s and despite suggestions made to follow the US example,[61] the European lawmakers, at the Community and the national level, until today resisted any Bayh-Dole type of legislation. Instead, they designed model agreements for industry-academic relationship. In its Recommendation 2008/416 of April 10, 2008 on the Management of Intellectual Property in Knowledge Transfer Activities, and Code of Practice for Universities and Other Public Research Organizations,[62] the Commission recommended that Member States, *inter alia*, ensure that all public research organizations (PROs) define knowledge transfer as a strategic mission. Further, encourage PROs to establish and publicize policies and procedures for the management of IP in line with the Code of Practice, support the development of knowledge transfer capacity and skills in PROs, raise the awareness and skills of students regarding IP, knowledge transfer and entrepreneurship, and promote the broad dissemination of knowledge, created with public funds. This all by taking steps to encourage open access to research results, while enabling, where appropriate, to protect related IP, etc.[63]

In its Knowledge Transfer Study, the EC Commission recognized that the European public research institutions were less effective in commercializing research results and generating invention disclosures, patent applications or license income as compared with the US counterparts. European publicly funded research institutions spent on average 3.3 times more research expenditures to earn € 1 Million in license revenues than the US publicly funded research institutions.[64] The Study found out that most European institutions

[60] Cf. WIPO Technology Trends 2019 – Artificial Intelligence, 2019:16-17; also Straus, Artificial Intelligence – Challenges and Chances for Europe, 2021:142-158 (at pp.146-147).
[61] Cf. Straus, The Present State of the Patent System in the European Union, 1997 (footnote 111 (at pp. 55 and 56) and Suggestion xiii (at p. 63)).
[62] Cf. EU Commission, OJ EC No. L 146, 2008:19.
[63] Cf. also Collins, European Tools up for Industry-Academic Collaborations, 2006:2-4, reporting on the so-called Lambert Agreement model contracts in the UK.
[64] https://ec.europa.eu/research/innovation-union/pdf/knowledge_transfer_2010-2012_report.pdf - last visited February 25, 2021, pp. 128-129.

involved in commercializing of academic research results were losing money, despite a vast pool of IP. Aimed at improving the efficiency of the transfer of intellectual property and technology by public sector research institutions into industry through R&D contracts, licensing and spin-outs, the Commission launched the Call Capacity-Building in Technology Transfer.[65] That Call resulted in the three years project Progress-TT – “Public Research Organization Growing Europe through best practice Solutions for Technology Transfer”. Yet, Europe is still far behind the United States as regards knowledge and technology transfer from academia to industry. Nonetheless, institutions such as Oxford University Innovation (OUI), Oxford Nanopore Technologies, and the University College London Business from the UK, the German Max Planck Innovation and the French CERN are examples of successful commercialization of research results of their institutions. Numerous patents, licensing agreements and start-ups witness that success.[66]

(d) Germany

Inspired by the US legislative developments, which have narrowed the academic freedom of publicly funded researchers and their employers to publish and freely disseminate their research, the German legislator, in 2002, fundamentally revised the respective provision of the Act on Employee’s Inventions.[67] Based on the constitutional right of freedom of science and research of Article 5 (3) of the German Basic Law (Grundgesetz - Constitution), Section 42 (1) of the Act declared that inventions made by professors, lecturers and scientific assistants, in their capacity as such, at universities and higher schools of science shall be free inventions. Meaning that they belonged to their inventors without any limitations and thus could have been published or filed for a patent at their discretion. The changed Section 42 of the Act now sets forth that inventions of employees of universities and other institutions of higher education are, as far as the entitlement to them is concerned, in principle subjected to the same rules provided for under the Act for inventions of all other employees. However, contrary to the general rule, this group

[65] https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/cbtt-1-2014 - last visited February 25, 2021.

[66] Cf. the ALLEA Statement “The Need for Intellectual Property Rights Strategies at Academic Institutions” (https://allea.org/wp-content/uploads/2019/11/The_Need_for_IPR_Strategies_at_Academic_Institutions_ALLEA_2019-1.pdf - last visited February 25, 2021), 2019:6-7, with further references.

[67] Federal Official Journal 2002 I, 2002:414.

of inventors has the right to disclose their "service inventions" within their teaching or research activities, provided they have timely (as a rule, 2 months in advance) notified their invention to the employer (Section 42 (1) no. 1). Moreover, in case the inventor decides not to disclose his invention in the course of his teaching and research activities, he is not obliged to notify the employer of his service invention at all. One further fundamental difference existing between service inventions of university personnel and those of all other employees concerns the reward the employer (i.e. university) has to pay to the inventor in case of exploitation of inventions he acquired. That reward has been fixed by the Statute at 30% of the income earned (Section 42 (4)), which is much higher than that calculated for other employee inventors. The Federal Government used several millions of Euros from the billions generated by auctions of the Universal Mobile Telecommunications System (UMTS) to finance the infrastructure necessary to enable universities to take up the knowledge and technology transfer task. 19 professional agencies for patenting and exploitation of publicly funded research were established and in 2002 started coaching 170 universities and 40 smaller research institutions.[68] How successful the so-called "exploitation offensive" of the Federal Government has been is difficult to assess. Recently, criticism of unsatisfied faculties about their share in proceeds, even indicating that some professors use a "dummy" as applicant to circumvent their statutory obligation and uphold their established industry ties, came to the light.[69]

In a decision of September 18, 2007,[70] the German Federal Supreme Court conceded, on the one hand, that the obligation of professors and other university personnel to defer for a certain period the publication of research results underlying an invention, does indeed affect the freedom of science, i.e. academic freedom. On the other hand, however, the Court held that the freedom of research and teaching does not require the ownership of exploitation rights in his research results attached to the professor. The Court, moreover, observed, that Article 5 (3) of the Basic Law does not only control individual rights but constitutes also a basic norm containing a value judgement regulating the relationship between science and the state. According to this basic norm, the state has to undertake appropriate organization and measures in

[68] Cf. the answer of the Federal Government of August 21, 2002 in the Bundestag (Federal Parliament), Drucksache 14/9874, p. 26.
[69] Cf. Technologietransfer kommt nicht in Schwung (unsigned), Handelsblatt of March 3, 2021, https://www.handelsblatt.com/politik/deutschland/verwertunsoffensive-der-bundesre...
[70] GRUR Int. 2008:251-254 (at 254) – Freedom of Publication.

the area of publicly funded research in order to leave the fundamental right to the free scientific activity untouched to the extent possible taking into account other legitimate tasks of scientific institution and constitutional rights of others involved. In this context, the Court clarified that the respective tasks must constitute legal values of constitutional ranking, but held that fundraising of the university, including from the pool of patentable inventions of its personnel, relates to the operational capability of the university having such constitutional ranking. The new rule introduced in 2002, according to the understanding of the Court, is taking into account the fiscal interest of the state, to enable universities to gain financial means from the exploitation of their inventions. It further emphasized that raising funds from inventions of universities' employees was, in principle, appropriate to strengthen the economy of the university. In view of the lack of a novelty grace period in the German Patent Act, the Court further observed that in order to secure the legitimate interests of the university, it was necessary for the legislator to introduce a rule preventing a premature disclosure of the invention. Further, that as long as universities were not expected or requested to give up basic research, or to perform it to a limited extent only, and concentrate on specific projects better suited for commercial exploitation, this does not shift the research mandate of the university from a purpose free basic research to a research aimed at an effective commercial use. Thus, this does not violate the constitutional right to freedom of research and teaching. Such a rationale, the Court held, however, could not be inferred from Section 42 of the revised Employees' Inventions Act.

III. Intellectual Property Rights

(a) General

According to Article 1 (2) of the International Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS) of 1994, which has introduced protection standards mandatory for all Member States of the World Trade Organization (WTO), the term 'intellectual property' covers patents, copyright and related rights, trademarks, industrial designs, geographic indications, layout designs (topographies) of integrated circuits and undisclosed information. The common characteristic of all of these rights is that they all relate to intangible ubiquitous results of human creative endeavor. In the context at hand, and of particular importance for research activities of the academic community, are patents and copyrights.

Patents relate to new, non-obvious and industrially applicable inventions,[71] i.e. instructions on how to solve technical problems by technical means. Discoveries as such do not constitute patentable subject matter. However, applied discoveries, i.e. concrete technical teaching, and not the theoretical explanation given for its functioning, are in principle patent eligible. For instance, Article 3 (2) of the 1998 Directive 98/44/EC of the European Parliament and the Council on the Legal Protection of Biotechnological Inventions[72] sets forth that: "Biological material which is isolated from its natural environment or produced by means of a technical process may be the subject of an invention even if it previously occurred in nature." This applies also to elements isolated from the human body, including the sequence or partial sequence of a gene (Article 5 (2) of the Directive).[73]

Copyrights relate to literary and artistic works, including every production in literary, scientific and artistic domains, whatever the mode or form of its expression may be. Copyright provides also protection for computer programs, whether in source or object code, as well as for compilations of data (Article 2 (1) of the Berne Convention for the Protection of Literary and Artistic Works of 1886 (last revised in 1971) in connection with Article 10 TRIPS).

Both patents and copyrights are exclusive rights limited in time. Patents, as a rule, are limited to 20 years calculated from the filing date.[74] The term of copyright protection is at least the lifetime of the author and 50 years after his death or, if calculated on the basis other than the life of a natural person, no less than 50 years from the end of the calendar year of authorized publication, or, failing such authorized publication, within 50 years from the making of the work, or 50 years from the end of the calendar year of making.[75] Apart

[71] Article 27 (1) TRIPS requires all WTO Member States to provide patents for any inventions, whether products or processes, in all fields of technology, provided that they are new, involve an inventive step (are 'non-obvious') and are capable of industrial application (are 'useful'). For details, especially for the exceptions allowed under Article 27 (2) and (3) TRIPS, see Straus, Implications of the TRIPS Agreement in the Field of Patent Law, 1996:160-215.

[72] OJ EC No. L 213/13 of August 30, 1998.

[73] For the specific problem of patenting human embryonic stem cells see Straus, Research, Exploitation and Patenting in the Area of Human Embryonic Stem Cells in Europe – A Case of Concern Causing Inconsistency, 2017:107-120.

[74] Article 33 TRIPS. In a number of countries, e.g. U.S.A., Japan and the Member States of the EU, in the case of pharmaceuticals and agrochemicals, an extension of the term based on a so-called Supplementary Protection Certificate (SPC) of up to 5 years can be achieved in order to compensate for the period of time necessary to get marketing approval.

[75] Article 7 (1) of the Berne Convention in connection with Article 12 TRIPS.

from the term of protection, the two categories of intellectual property rights most important to the academic world differ also in a number of other aspects, of which only the following should be mentioned: copyright does not require any formalities to come into being, but protects the author, in principle, only against 'copying' but not against independent creations. It also relates to the form of expression only, i.e. does not protect the content of the creation. Patents in most patent laws, require costly formal patent-granting proceedings with an examination of patentability requirements. Patents are 'blocking rights', i.e. they are also effective against independent inventors, who have either not applied for a patent or have done so only with a later priority.

As an instrument of economic policy, intellectual property rights provide incentives for and reward a broad range of useful human creativity. In particular, they play a key role as incentive for and safeguard of the risky investment in R&D. It is important to point out that intellectual property rights achieve their macro- as well as micro-economic effects only via market mechanisms, of which they form an important and even indispensable instrument. Not patents themselves, which secure their holders the exclusive rights of exploitation, reward inventors and inventions, but their success on the market place in competition with technical and economic alternatives. It is up to the intellectual property rights owners to seek such opportunities and to select the most promising ones.[76] Because of these mechanisms, inherent to the intellectual property system, only the 1980s US legislative actions could synchronize activities of the public sector research institutions with private R&D activities and optimally exploit their potentials. Although the importance of intellectual property rights, especially patents, for quite obvious reasons very much depends on the specific branch of industry, and is highest rated in the field of pharmaceuticals, it has become apparent and generally accepted that these rights constitute an efficient and indispensable incentive for research and innovation.[77]

---

[76] Cf. Beier, Significance of the Patent System for Technical Economic and Social Progress, 1980:563-584 (at p. 563).

[77] Cf. the comprehensive analysis by Sherwood, Intellectual Property Rights and Economic Development, 1990:67; Mansfield, Intellectual Property, Technology and Economic Growth, in Rushing, 1990:17-30; von Hippel, The Sources of Innovation, 1988:47; Mowery & Rosenberg, Technology and the Pursuit of the Economic Growth, 1989:72 and Cohen & Merrill, Introduction, 2003:3.

(b) Specific Aspects

For the impact the intellectual property rights, especially patents, have, or better should have on the work of academic researchers, it is essential that the intellectual property rights protection system adequately takes into account the needs resulting from their mission in the national innovation ecosystem.

As an important generator of patentable research results, the academe needs a legal environment in which it can optimally fulfill its primary mission, namely to generate new knowledge and to disseminate this knowledge widely in a timely manner, without losing proprietary rights in that knowledge. Thus, the patent system must broadly include into the subject matter eligible for protection all research results in the most advanced areas of science and technology. In other words, achievements in genomics, proteomics, stem cells technology, nanotechnology, computer implemented inventions, and e.g. in artificial intelligence technology, which meet the regular patentability requirements as a matter of principle should be patentable. Moreover, the patent system should provide for conditions in which the desired making available and disseminating research achievements does not automatically result in the loss of proprietary rights. Thanks to the mandatory publication of patent applications within 18 months from the filing/priority date and the requirement to disclose the invention in the patent application in a manner sufficiently clear and complete for it to be carried out by a skilled person, patents act decisively against secrecy in favor of early publication of research results and their dissemination. In order to prevent that any publication in a scientific journal, or any oral presentation in a conference, or public use of an invention, automatically results in a loss of any right to its exclusive exploitation, countries such as Australia, Brazil, Canada, Japan, the USA, and many others, provided in their patent laws for a so-called "grace period." The grace period rule provides for immunity against own publication of the applicant, if the application is filed within six or twelve months from the date of publication.[78] Unfortunately, the European Patent Convention (EPC) and the patent laws of all of its contracting parties adopted with the Article 55 EPC a narrow "grace period" providing for relief in case the disclosure occurred as result of an evident abuse in relation to the applicant or his legal predecessor. The repeated attempts of the European academic community, for instance represented by the Federation of European Academies of Sciences and Humanities

[78] Cf. Straus, Grace Period and the European and International Patent Law, Analysis of Key Legal and Socio-Economic Aspects, 2001.

(ALLEA),[79] to amend the novelty standard and bring it in line with the academe friendly standards of European counterparts, have been in vain.

As far as the position of academe as a user of patented inventions of third parties is concerned, patents should not constitute a serious obstacle for them to as far as possible freely access the latest achievements of science and technology and use them for educational, experimental and research purposes. By exempting from the effects of a patent, *inter alia*, acts done for experimental purposes relating to the subject matter of the patented invention and the use of biological material for the purpose of breeding or discovering and developing other plant varieties,[80] in Europe patent protection does not constitute an obstacle for further scientific and technological developments. For instance, the German Federal Supreme Court (BGH) and the German Federal Constitutional Court held that any experiment related to the subject matter of the patented invention pursuing the enhancement of knowledge, i.e. to obtain further research results, including finding further medical uses of a patented drug, eventually undertaken for commercial aims, does not infringe a patent.[81]

IV. Conclusions

The developments which started in the 1980s in the US, and those which followed in other countries, as reported also in Germany, clearly reveal an evolutionary change in the basic understanding of academic freedom to the extent to which the results of academic research are publicly financed. The underlying understanding being that imagination and creativity constitute important national resources and that the intellectual property rights system facilitates and permits the dissemination of research results to the public, as well as their translation in innovative products and processes. Moreover, that

[79] Cf. e.g. ALLEA Statement on Grace Period, adopted in a Conference on ‘Grace Period’ in Kiev (https://www.allea.org/wp-content/uploads/2015/08/Statement_Grace-Period_Kiev.pdf - last visited March 3, 2021), convened by ALLEA and the National Academy of Science of Ukraine (NAS.).

[80] Article 27 (b) and (c) of the Agreement on a Unified Patent Court, OJ EC 2013/C 175/01 of 20.6.2013. Although this Agreement due to the Brexit problems has not yet entered into force, national patent laws of EU Member States provide already such limitations of the effect of a patent.

[81] Cf. BGH Decisions of July 11, 1995, [1997] IIC 01, 103 – Clinical Tests, and of April 17, 1997, [1998] R.P.C. 423 – Clinical Trials II, and Federal Constitutional Court of May 10, 2000, [2001] GRUR 43 – Klinische Versuche.

an efficient management of publicly funded research results is in the public interest and involves intellectual property rights.

Thus, intellectual property rights play an important role in any national science system. However, even if optimally adapted to the needs of academic researchers, they are but one element among many, responsible for successful functioning of the national science system. The US "Science the Endless Frontier" Report made it clear already in 1947 that "Science can be effective in the national welfare only as a member of a team". In other words, together with other parts of the society. Apart from the indispensable financial support, the science system also needs adequate legal ramifications. Intellectual property system, being just one. The tax law, providing preferential treatment for investing in R&D and for proceeds generated by research results, and rational regulatory provisions dealing with safety, or ethics, being others. As the US legislation of the 1980s and its followers in Japan and China demonstrate, nurturing of national science systems is a demanding and complex task, which requires great efforts from all three parts of the "Triple Helix Alliance" to make it successful. To paraphrase the Nobel Laureate Karry Banks Mullis, the inventor of the patented polymerase chain reaction (PCR), one of the technological pillars of the rDNA technology, whose words introduced this contribution, the law should avoid to either "free," or "enslave" science. The law should nurture science in a balanced way between the two extremes. Karry Mullis is probably right that science "grows like a weed every year", but weed also needs some fertile soil. One should never ignore the wise words of Sir Charles Carter: *You cannot have a healthy science in a sick economy.*[82] Thus, a healthy economy is the soil the national science needs, and if properly nurtured, science can in return contribute to the health of the national economy.

Literature

Abbott, Frederick M. and Reichman, Jerome H. (2020). Facilitating Access to Cross-Border Supplies of Patented Pharmaceuticals: The Case of the COVID-19 Pandemic. JIEL, Vol. 23, p. 535-561

Abetti, Pierre A. (2006). University Incubators as Agents for Technology Transfer and Economic Growth: Case Studies in USA. Ukraine and Finland. Int. J. Technology Transfer and Commercialization, Vol. 5 (No. 4), p. 308-337

Act on the Promotion of Technology Transfer from Universities to Private Business Operators (Tentative translation) (1998) [Digital Edition]. Taken from https://www.wipo.int/edocs/lexdocs/laws/en/jp/jp193en.pdf

[82] Sir Carter, Conditions for the Successful Use of Science, 1983: 1295-1298.

Agreement on a Unified Patent Court, OJ EC 2013/C 175/01 (2013) [Digital Edition]. Taken from https://eur- lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2013:175:0001:0040:EN:PDF

ALLEA Statement on Grace Period (2013) [Digital Edition]. Taken from https://www.allea.org/wp-content/uploads/2015/08/Statement_Grace-Period_Kiev.pdf

ALLEA Statement "The Need for Intellectual Property Rights Strategies at Academic Institutions" (2019) [Digital Edition]. Taken from https://allea.org/wp-content/uploads/2019/11/The_Need_for_IPR_Strategies_at_Academic_Institutions_ALLEA_2019-1.pdf

Asgari, Nikou, Mancini, Donato Paolo and Kuchler, Hannah (2021). Pharma Industry Fears Biden's Patent Decision Sets Dangerous Precedent, Financial Times of May 7, 2021

AUTM 2018 Licensing Activity Survey: A Survey of Technology Licensing and Related Activity for US Academic and Nonprofit Research Institutions [Digital Edition]. Taken from https://autm.net/AUTM/media/SurveyReportsPDF/AUTM_FY2018_US_Licensing_Survey.pdf

Beier, Friedrich-Karl (1980). Significance of the Patent System for Technical Economic and Social Progress, IIC, Vol. 11, p. 563-584

Benz, Matthias and Feldges, Dominik (2021). Ein Turbo für die Impfstoff-Hersteller: Lässt sich die Produktion von Corona-Vakzinen Beschleunigen? [Digital Edition]. Taken from https://www.nzz.ch/wirtschaft/corona-impfung-moeglichkeiten-zur-beschleunigung-der-produktion-ld.1599788

Bush, Vannevar (1945). Science the Endless Frontier. [Digital Edition]. Taken from https://www.nsf.gov/od/lpa/nsf50/vbush1945.htm.

Carter, Charles (1983), Conditions for the Successful Use of Science. Science Vol. 219 (No. 4590), p. 1295-1298

Chang, Yuan-Chieh, Chen, Ming-Huei, Yang, Phil Y. and Hua, Mingshua (2008). Universities as Patent- and Licensing Income-Generating Institutions: A survey in Taiwan. Int. J. Technology Management, Vol. 42 (No. 3), p. 290 - 309

Chatterjee, Sabarni K. and Rohrbaugh, Mark L. (2014). NIH Inventions Translate into Drugs and Biologics with High Public Health Impact. Nature Biotechnology, Vol. 32 (No. 1), p. 52-58

Chaves, Catari V. and Moro, Sueli (2007). Investigating the Interaction and Mutual Dependence between Science and Technology. Research Policy, Vol. 36 (No. 8), p. 1204-1220

Cohen, Wesley M. and Merrill, Stephen A. (2003). Patents in the Knowledge Based Economy. Study of the National Research Council of the National Academies. The National Academic Press, Washington D.C.

Collier, Alan (2007). Australian Framework for the Commercialization of University Scientific Research. Prometheus, Vol. 25 (No. 1), p. 51-68

Collins, Luke (2006). European Tools Up for Industry-Academic Collaborations. Research Technology Management, Vol. 49 (No. 5), p. 2-4

Corum, Jonathan and Zimmer, Carl (2021). How the Oxford-AstraZeneca Vaccine Works [Digital Edition]. Taken from https://www.nytimes.com/interactive/2020/health/oxford-astrazeneca-covid-19-vaccine.html

D'Este, P. and Patel, Parimal (2007). University-Industry Linkages in the UK: What are the Factors Underlying the Varity of Interactions with Industry? Research Policy, Vol. 36, No. 8, p. 1295-1313

Dipanjan, Nag, Gupta, Antara and Turo, Alex (2020). The Evolution of University Technology Transfer: By the Numbers [Digital Edition]. Taken from https://researchgate.net/publication/340766806

EC Commission, Knowledge Transfer Study [Digital Edition]. Taken from https://ec.europa.eu/research/innovation-union/pdf/knowledge_transfer_2010-2012_report.pdf

Edgington, David W. (2008). The Japanese Innovation System: University-Industry Linkages, Small Firms and Regional Technology Centers. Prometheus, Vol. 26, (No. 1), p. 1-19

Etzkowitz, Henry and Leydesdorff, Loet (1997). Universities and the Global Knowledge Economy: A Triple Helix of University-Industry-Government Relations. Cassells Academic, p. 1-8

Eun, Jong-Hak, Lee, Keun and Wu, Guisheng (2006). Explaining the "University-run Enterprises" in China: A Theoretical Framework for University-Industry Relationship in Developing Countries and its Application to China. Research Policy, Vol. 35 (No. 9), p. 1329-1346

Fauci, Anthony S. (2021). The Story Behind COVID-19 Vaccines. Science, Vol. 372 (No. 6538), p. 109

Frangioni, John V. (2008). The Impact of Greed on Academic Medicine and Patient Care. Nature Biotechnology, Vol. 26, p. 503-507

Fraser, Claire M. (2021). Editorial: A Genome to Celebrate. Science, Vol. 371 (No. 6529), p. 545

Fujisue, Kenzo (1998). Promotion of Academia-Industry Cooperation in Japan – Establishing the "Law of Promoting Technology Transfer from University to Industry". Technovation, Vol. 18, (No. 6 – 7), p. 371-381

Gaveria, Mario and Kilic, Burcu (2021). A Network Analysis of COVID-19 mRNA Vaccine Patents. Nature Biotechnology, Vol. 39, p. 546-549

Gibson, Emily K. (2020). Overseeing Innovation: 75 Years after Vannevar Bush's Impactful Report, debate continuous about directing science. Science, Vol. 369 (No. 6501), p. 258-259

Hippel, Eric von (1988). The Sources of Innovation. Oxford University Press, Oxford

Hoerr, Ingmar, Obst, Reinhard, Rammensee, Hans-Georg and Jung, Günther (2000). In Vivo Application of RNA Leads to Induction of Specific Cytotoxic T-Lymphocytes and Antibodies. Eur J Immonol, Vol. 30 (No. 1), p. 1-7

Hoerr, Ingmar (2017). A Successful Founder off the Beaten Path. Nature Biotechnology, Vol. 35, (No. 10), p. 900-903

Holroyd, Carin (2008). Reinventing Japan Inc.: Twenty-First Century Innovation Strategies in Japan. Prometheus, Vol. 26 (No. 1), p. 21–38

Huggett, Brady and Paisner, Kathryn (2020). Biotech Patenting 2019. Nature Biotechnology, Vol. 38 (No. 8), p. 921-922

Jones, Kathryn M. and Cook-Deegan, Robert (2021). Complicated Legacies: The Human Genome at 20. Science, Vol. 371 (No. 6529), p. 564-569

Karikó, Katalin, Buckstein, Michael, Ni, Houping and Weissman, Drew (2005). Suppression of RNA Recognition by Toll-like Receptor: The Impact of Nucleoside Modification and the Evolution Origin of RNA. Immunity, Vol. 23 (No. 2) p. 165-175

Keener, Amanda B. (2018). Just the Messenger: A New Class of Therapeutic Instruct the Body to Make its Own Drugs, Nature Medicine, Vol. 24, p. 1294-1300

Kneller, Robert (2003). University-Industry Cooperation and Technology Transfer in Japan Compared with the United States: Another Reason for Japanese Malaise? U. Pa. J. Int'l Econ. L., Vol. 24 (No. 2), p. 329-449

Kolata, Gina (2021). Kati Karikó Helped Shield the World From the Coronavirus. The New York Times of April 8, 2021

Kuhn, Thomas S. (1970). The Structure of Scientific Revolutions, Second Edition, Enlarged, Vol. 2, No. 2, University of Chicago Press, Chicago/London

Leydesdorff, Loet and Etzkowitz, Henry (1996). The Future Location of Research: A Triple Helix of University-Industry-Government Relations II: EASST Review, Vol. 15 (No. 4), p. 20-25

Leydesdorff, Loet and Etzkowitz, Henry (1996). Emergence of a Triple Helix of University-Industry-Government Relations. Science and Public Policy, Vol. 23, p. 279-286

Leydesdorff, Loet (2000). The Triple Helix: An Evolutionary Model of Innovations. Research Policy, Vol. 29 (No. 2), p. 243–255

Mansfield, Edwin (1990). Intellectual Property, Technology and Economic Growth. Rushing, Francis W. and Ganz-Brown, Carol (eds.), Intellectual Property Rights in Science, Technology, and Economic Performance - International Comparisons (p. 17-30), Routledge, New York

Mowery, David C. and Rosenberg, Natan S. (1989). Technology and the Pursuit of the Economic Growth. Cambridge University Press, Cambridge

Mowery, David C., Nelson, Richard R., Sampath, Bhaven N. and Ziedonis, Arvids A. (2001). The Growth of Patenting and Licensing by US Universities: An Assessment of the Effect of the Bayh-Dole Act of 1980. Research Policy, Vol. 30 (No. 1), p. 99-119

OJ EC No. L 213/13 (1998) [Digital Edition]. Taken from https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:1998:213:0013:0021:EN:PDF

OJ EC No. L 146 (2008) [Digital Edition]. Taken from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32008H0416&from=EN

Peel, Michael (2021). EU Leaders Confront US over Vaccine Patent Waiver, Financial Times of May 8, 2021, p. 2

Report "A Missed Opportunity – The Patent Saga" [Digital Edition]. Taken from http://www.whatisbiotechnology.org/exhibitions/milstein/patents

Rubenstein, Kelly D., Heisey, Paul W. and King, John L. (2006). Public Sector Technology Transfer Through Patents and Licensing: The Case of US Agriculture. Int. J. Technology Transfer and Commercialization, Vol. 5 (No. 4), p. 401-420

Sherwood, Robert M. (1990). Intellectual Property Rights and Economic Development. Westview Press, Boulder

Stacey, Kiran and Williams, Aime (2021). Biden's Diplomatic Victory Blunts Pharma Lobby. Financial Times of May 10, 2021, p. 4

Steenhuis, Harm-Jan and Gray, Denis O. (2006). The University as the Engine of Growth: An Analysis of How Universities can Contribute to the Economy. Int. J. Technology Transfer and Commercialization, Vol. 5 (No. 4), p. 421-432

Stevens, Ashley J., Jensen, Jonathan J., Wyller, Katrine, Kilgore, Patrick C., Chatterjee, Sabarni and Rohrbaugh, Mark L. (2011). The Role of Public-Sector Research in the Discovery of Drugs and Vaccines. New England Journal of Medicine, Vol. 364 (No. 6), p. 535-541

Straus, Joseph (1996). Implications of the TRIPS Agreement in the Field of Patent Law. Beier, Friedrich-Karl and Schricker, Gerhard (Eds.), From GATT to TRIPS – The Agreement on Trade-Related Aspects of Intellectual Property Rights (p. 160-215.), Wiley VCH, Weinheim

Straus, Joseph (1997). The Present State of the Patent System in the European Union. Office for Official Publications of the European Communities, Luxembourg

Straus, Joseph (2001). Grace Period and the European and International Patent Law, Analysis of Key Legal and Socio-Economic Aspects. IIC-Studies, Vol. 20 C.H. Beck Publishers, Munich

Straus, Joseph (2017). Research, Exploitation and Patenting in the Area of Human Embryonic Stem Cells in Europe – A Case of Concern Causing Inconsistency. European Review, Vol. 25 (No. 1), p. 107-120

Straus, Joseph (2017). Intellectual Property Rights and Bioeconomy. JIPLP, Vol. 12 (No. 7), p. 576-590

Straus, Joseph (2018). Patentierung und Kommerzialisierung im Bereich der Stammzellforschung. Zenke, Martin, Marx-Stölting, Lilian and Schickl, Hannah (Eds.), Stammzellforschung: Aktuelle wissenschaftliche und gesellschaftliche Entwicklungen. (p. 237-276), Nomos, Baden-Baden

Straus, Joseph, Artificial Intelligence – Challenges and Chances for Europe (2021). European Review, Vol. 29 (No. 1), p. 142-158

Thorp, Holden H. (2020). Editorial: Science has always been Political. Science, Vol. 369 (No. 6501), p. 227

Viale, Riccardo and Etzkowitz, Henry (2005). Third Academic Revolution: Polyvalent Knowledge; The "DNA" of the Triple Helix [Digital Edition]. Taken from https://www.researchgate.net/publication/242406526_Third_academic_revolution_polyvalent_knowledge_theDNA_of_the_triple_helix

Walsh, John P., Cohen, Wesley M. and Cho, Charlene (2007). Where Excludability Matters, Material vs. Intellectual Property in Academic Biomedical Research. Research Policy, Vol. 36 (No. 8), p. 1184-2003

Walsh, John P., Baba, Yasunori, Goto, Akira and Yasaki, Yoshihito (2008). Promoting University-Industry Linkages in Japan: Faculty Responses to a Changing Policy Environment. Prometheus, Vol. 26 (No. 1), p. 39–54

Wang, Xiuqin, Xue, Lan and Shi, Dongbo (2021). Characteristics and logical framework of Chinese universities' response to the newly revised 'Bayh-Dole Act'. Studies in Science of Science [Digital Edition]. Taken from https://doi.org/10.16192/j.cnki.1003-2053.20201125.001 (only abstracts in English)

WIPO Technology Trends 2019 – Artificial Intelligence (2019) [Digital Edition]. Taken from. https://www.wipo.int/edocs/pubdocs/en/wipo_pub_1055.pdf

Woolgar, Lee (2007). New Institutional Policies for University-Industry Links in Japan. Research Policy, Vol. 36 (No. 8), p. 1261-1274

DOI: 10.5644/PI2021.200.15

The Crisis of Ethically Neutral Science

Mile Babić[*]

Abstract: Current crisis of morality in scientific and technical civilization leads us to a common ruin because modern science (which is free of morality) is inextricably linked to technology, and can therefore be called technoscience. As such, today it has a monopoly on knowledge of the world and therefore has the greatest power in history and is in tight collusion with the holders of power: the economy, politics, medicine, media, countries and multinational corporations. To have the greatest imaginable power (which, according to Kant, corrupts the freedom of mental reasoning), while being free from the morals that limit that power, means to turn the world into a world of the most modern barbarism and violence, destruction and self-destruction. Only morally responsible science is capable for future and it is the premise of a civilization capable of the future. Only responsible science can prevent science from turning into a comprehensive dogma. Therefore, science must be free from any ideology that depicts reality in black and white and thus produces vanity, hatred and violence. Global science requires a global ethos (global responsibility). Science cares about the truth that liberates us from lies and connects us into a single community. The fundamental ethical imperative *primum non nocere* ("first, do no harm") is valid everywhere and forever. Ethically responsible science requires a change in the consciousness of the individual and a rediscovery of the idea of brotherhood. No human action should undermine and destroy existing reality, but rather improve it.

Key words: science, crisis of ethically neutral science, global power, global responsibility, fundamental ethical imperative, new idea of brotherhood

Introduction

In the introduction to this paper, I will first present how Alexander Görlach argued that no one - neither people nor institutions - understood the gravity of the 2008 financial crisis in the United States because only the material side of the crisis was visible to everyone, while the spiritual (moral) was unnoticed. No one, therefore, noticed the spiritual (moral) cause of the crisis - the greatest one since the Great Depression (1929–1933). I will then show what contemporary, world-relevant thinkers have to say about how a deep moral

[*] Corresponding member of the Academy of Sciences and Arts of Bosnia and Herzegovina.
E-mail: dekan.babic@gmail.com

crisis (until the imminent disappearance of that same moral) came to be in all areas and levels of human life. At the same time, the question arises whether this is the end of the humanum, ie. the end of man? After that, it should be said that the world-renowned German moral philosopher Otfried Höffe today points out that every form of science must correspond to an appropriate form of ethics throughout history. Höffe distinguishes five stages in the development of science and its corresponding ethics. Finally, it should be emphasized that Günther Mack, a retired professor of experimental physics in Tübingen, Germany, argues that instead of science free of value (ie. morality and ethics) it is necessary to establish a science that will be responsible individually, institutionally and publicly - instead of the current paradigm of science free from morality to establish a paradigm of science capable for the future.

As an introduction to the topic, I refer to the statement of Alexander Görlach (linguist, theologian, visiting professor at Harvard and Cambridge, and professor of ethics and theology at Lüneburg, Germany) from his book *Homo Empathicus* (cf. Görlach 2019: 29), which states that no politician, no government and no supranational entity understood the gravity of the financial crisis of 2008 when Lehman Brothers went bankrupt in the United States. Everyone looked only at the material side of the novel crisis, and did not look for its spiritual cause which is called greed - one of the seven deadly sins according to Christian doctrine. No society can survive if the main vices (pride, greed, lust, envy, wrath, sloth), Görlach argues, determine the actions of its members, and he claims this referring to the text of Ralph Dahrendorf, a German-British sociologist, philosopher, economist and politician. (cf. Dahrendorf 2009), who in turn states that the economic system today destroys its own mentality assumptions. Dahrendorf reminds us that the first form of capitalism (the *Sparkapitalismus*, capitalism of savings) was based on Calvin's Protestant ethics, as evidenced by the great German sociologist Max Weber in his work *The Protestant Ethic and the Spirit of Capitalism*. Namely, Dahrendorf points out that the roots of economic thought lie in moral philosophy because a man who earns bases his agency on certain values. As an example, he cites Adam Smith, a Scottish economist and ethicist, who argues that the foundation of moral philosophy is man, not the market (not capital nor profit). In short, the modern economy has detached itself from morality and became more important than it. Dahrendorf analyses three forms of capitalism. In the first form (the capitalism of savings) ethic is respected, and in the second (*Konsumkapitalismus*, the capitalism of consumption) consumption is more important than fair work, while in the third (*Pumpkapitalismus*, the capitalism of debt) people live by spending money they borrowed from banks, which they have not earned and which remains without coverage. The main motto of debt capitalism is: Enjoy now, pay later. The depth and potency of the mentioned financial crisis consisted in the fact that the actors of the financial system absolutized their profits (they received large severance pays) and did not show any personal or systematic responsibility. No one has been sanctioned, because no state stood behind that financial system. It follows that the whole system therefore needs to be thoroughly reformed on the basis of core moral values (cf. Görlach 2019: 16–19, 21–36).

Crisis of morality in all fields and levels of human life

After the introduction, I present the views and claims of world-relevant thinkers about the crisis of morality and the predictable disappearance of morality from all areas and levels of human life and from all parts of culture, starting from science to art and religion. I rely on the following authors: Charles Taylor, Pascal Bruckner, Robert N. Bellah, Peter Sloterdijk, Hans Jonas, Edgar Morin, Hans Küng, Žarko Paić, Jürgen Habermas, Yuval Noah Harari, Otfried Höffe and Günther Mack.

A. Charles Taylor

World-renowned Canadian philosopher, professor emeritus, among other things known for his own contribution to moral philosophy. In his excellent book *Quellen des Selbst* [*Sources of the Self*] (Taylor 1994) he showed how two modern individualisms arose. The originator of the first (rational) individualism was René Descartes, and of the second (expressive) Michel de Montaigne. For Descartes, man is a pure mind, a disengaged mind, separated from the body. Such a mind has an instrumental relation to its own body and to the overall reality: it rules over everything and is responsible to itself. De Montaigne's expressive individualism seeks to express man's originality, uniqueness, and singularity. Such individualism is emotional, because it expresses man's aspirations and desires, ie. the peculiarity of person's feelings, but it suppresses moral ontology, which means that it makes morality impossible as a theory and as a practice. Both individualisms, according to Taylor, neglect the moral dimension of the human being and do not ask about the essence of the good life or about what makes human life worth living. Also, Taylor shows that both individualisms contain certain moral imperatives and norms, but they lack the ontological foundation of moral norms. Both individualisms are turned towards the human interior. Descartes emphasizes what is common for all people (the mind), and de Montaigne emphasizes what makes each person special.

In the book *Negative Freiheit?* [*Negative Freedom?*] (Taylor 1998) criticizes modern individualism and shows the fallacy of negative freedom. Namely, in a liberal society, freedom is understood exclusively as the independence of the individual from others, as the absence of external physical and legal obstacles. It should be said that in addition to external obstacles there are also internal ones. For internal obstacles, the highest judge is the entity itself, which excludes the possibility that its actions are judged by external entities. It follows that freedom thus understood cannot be realized, because the obstacles to the exercise and spread of such freedom are other people and law. In his book *Das Unbehagen an der Moderne* [*The Malaise of Modernity*] (Taylor 1995) he names three unpleasant phenomena in modernity. 1. The disappearance of the moral horizon, meaning and higher values. People once considered themselves integral parts of a more comprehensive cosmic order. Discrediting of this order is dubbed as the "disenchantment" of the world (*Entzauberung*, Max Weber). In this process, the world lost its magical power. Therefore, the first cause of malaise is individualism, which, according to many, is the highest achievement of modern civilization. Such individualistic (negative) freedom has been achieved by freeing ourselves from the older moral horizon, and now man lacks a sense of higher values, which are worth living and dying for. People today strive exclusively for "pathetic comfort" (*erbärmliches Behagen*, Friedrich Nietzsche). In this way man's life is impoverished because man is concentrated only on their *I*. 2. The second malaise of modernity is a phenomenon we call the primacy of the instrumental mind. The mind serves only as an instrument for finding the means that serve to achieve the set goal. Everything that exists is reduced to a means for use, so technology has a dominant role, which means that, for example, a patient is the object of processing for the medical profession, not a person: the patient is, therefore, a technical problem. 3. The third malaise is that individualism and the instrumental mind in political life lead people into mild despotism (Alexis de Tocqueville). It is a government that treats citizens gently and paternally and thus becomes the guardian of its citizens. This is taking place in an extremely centralized and bureaucratized political world.

Furthermore, in his book *A Secular Age* (cf. Taylor 2007), Taylor proves that in the new age evil is no longer in man - therefore, evil is no longer endogenous but exogenous. Namely, evil is now outside of man: in the system, in history, in structures, which is to say in reality outside man. In this way, man declared themselves sinless and harmless, and placed all evils into others: into members of other nations, religions, cultures, politics and civilizations. That sinless man today kills evil in other people without remorse. Innocent modern killers declare their murders of other people to be good deeds. These sinless people have killed millions upon millions of people in the name of the two most dangerous modern ideologies: in the name of nationalism (in the form of Fascism and Nazism) and in the name of communism (in the form of Stalinism and in the form of Chinese and South Asian variants of communism). Such a modern sinless man has become an immoral being, simply a being beyond good and evil: he has no sense of moral norm or moral obligation. Moral questions are simply absent from his consciousness. What used to be called moral philosophy or ethics is now called therapeutics. The famous "therapeutic turn" took place, which means that there is no evil in person, so they can never be guilty, but can only be mentally ill. Instead of a moral register, there is a therapeutic one today. It diminishes man's dignity, because man has become a mere object of therapeutic treatment. By rejecting the custody of religion (ie. the Church and the clergy), modern people wanted to affirm their dignity, but now they have fallen under the custody of therapeutics, where they are treated as objects and are silenced more than believers were once silenced in churches. If modern man is incapable of sin (evil), he is incapable of both freedom and responsibility, because sin (evil) arises from man's freedom, and from that freedom man's responsibility arises. This has produced the demise of ethic, which many Marxists had been talking about, and many scientists are talking about today.

B. Pascal Bruckner

French writer and one of the "new philosophers" known for his critiques of (not only) French society and French culture. In his book *The Temptation of Innocence* (cf. Bruckner 1997) he shows how it came to violence in the former Yugoslavia. People and whole groups, whole nations want to absolve themselves of responsibility in two ways: infantilism and victimization. These are the two symptoms of today's man and today's society. Infantilism consists in the fact that adult people and entire nations behave infantile, ie. as spoiled children: they do evil and do not feel guilty, but rather expect recognitions and rewards for the evil they have committed. Victimization is manifested in the fact that adults and entire nations consider themselves victims, who are incapable of evil. They allegedly endure other people's evils, and expect others to acknowledge their sacrifice.

C. Robert N. Bellah

An American sociologist internationally known for his work on the sociology of religion. In the co-authored book *Habits of the Heart* (Bellah et al. 1996), he criticizes two forms of American individualism, referring to the prominent French social philosopher Alexis de Tocqueville, who in 1830 called some aspects of American democracy individualism. Bellah proves that both American individualisms (utilitarian and expressive) rule in American society, and for both the individual is the primary reality, while society is secondary, ie. derived reality.

D. Peter Sloterdijk

World-renowned German philosopher, television presenter and essayist. In his three-volume work entitled *Sphären* [*Spheres*] (cf. Sloterdijk 1998; 1999; 2004), he argues that modern individualism is placental, because in the new age both individuals and systems function as sacred egoists. While criticizing individualism, Sloterdijk proves that the human being is a "bipolar being" from the very inception, because *the couple* represents a size more real than the individual.

E. Hans Jonas

A prominent American-Jewish philosopher, born in Germany, known for his works on Gnosticism and the ethics of responsibility. Long ago, in the book *Das Prinzip Verantwortung* [*The Imperative of Responsibility*] (cf. Jonas 1984), Jonas proved that science and technology had become the greatest threat to nature, man, and humanity. In the past, they promised salvation, and today they offer ruin, so they lead humanity to destruction and self-destruction. Related to the economy (especially the military) and the media, they have unprecedented power. That is why Jonas formulated a new ethical imperative, which reads: "Act so that the effects of your action are not destructive to the permanence of genuine human life on Earth" (Jonas 1984: 36)

F. Edgar Morin

French philosopher and sociologist, one of the most inspiring thinkers of today. In the book *Ethics* (cf. Morin 2008) he warns us that today's humanity may end up in barbarism instead of in true civilization and humanization. He points out that the relationship between science and ethics has become so inseparable that the term *technoscience* simply imposes itself on us today. The development of knowledge for the sake of cognition (it is the scientific imperative) has become inseparable from the mastery of nature (it is the technical imperative). It should be added that modern rule over external nature has also turned into rule over human nature. Science and technology in the service of economics (industry, transport and communications) and scientific research in the field of chemistry and genetics have introduced science into the world of profit. Thus, modern technoscience is the most powerful driver of society. Science explains the structure of atoms and genes and thus becomes a powerful means of destruction and manipulation in the hands of political forces. Scientists are deprived of power that is being concentrated in the hands of large companies and state powers. The atomic bomb has escaped the control of scientists. Science is present today in all areas and at all levels of human life, it has unlimited power, "but it is completely powerless to control its own power" (Morin 2008: 71).

G. Hans Küng

The most famous Catholic theologian, and also known as a philosopher, the founder of the dialogue between religions based on the principles of world ethos. In the book *Projekt Weltethos* [*Project World Ethos*] (cf. Küng 2006) he argues that the world ethos applies to all areas and to all levels of human life: politics, the economy, science, the media and other areas of public life. We need a global ethos that will apply to the whole world. Namely, the ethos frees us from all ideologies that portray reality in black and white and thus produce vanity, hatred and violence.

H. Žarko Paić

Croatian sociologist and philosopher, versatile intellectual. In the book *Identity Politics. The Culture as a New Ideology* (cf. Paić 2005) demands an approach to culture and ideology different from the current one because he wants “deideologisation of culture and deculturalization of ideology” (Paić 2005: 209). According to Paić, culture has become a universal ideology of global capitalism. The triad of *biopolitics of identity - the ideology of humanitarianism - genetic technology* determines the contemporary global capitalism. Culture, as a new ideology, includes science, religion and art. In the age of globalization, there has been a cultural turn, according to which culture becomes a new ideology of the new world order. Thus, contemporary culture justifies the development of global capitalism, and thus betrays its essence (autonomy, self-improvement, and integration). It should be mentioned that Paić wrote a five-volume work entitled *Technosphere* (cf. Paić 2018–2019), in which he asks whether a turn towards humanism is possible in the technosphere.

I. Jürgen Habermas

The famous German philosopher in his book *Glauben und Wissen* [*Faith and Knowledge*] (cf. Habermas 2001) points out that science today has a monopoly on knowledge about the world and that science has revolutionized our everyday knowledge. But modern science, in Habermas’s interpretation, has turned into bad philosophy because it abolishes the distinction between describing reality (which is the task of science) and justifying reality (which is the task of philosophy). Such science does not recognize man as a free and responsible being. In the book *Dialektik der Säkularisierung* [*The Dialectics of Secularization*] (cf. Habermas / Ratzinger 2011), he claims that our civilization is threatened by “secularization that is losing its course” (ibid.: 17), because sources of morality (especially solidarity) have dried up. Therefore, the constitutional state wants to preserve all the cultural sources “from which the sense of the norm and solidarity of citizens are fed” (ibid.: 33). If people are not aware of the moral norm that unconditionally binds them, they cease to be moral beings, ie. free and responsible beings; if they have lost their sense of solidarity and if the suffering of others does not affect them, they have become modern barbarians.

J. Yuval Noah Harari

Israeli intellectual, historian by profession, professor of history in Jerusalem. His book *Homo Deus. Eine Geschichte von Morgen* [*Homo Deus: A Brief History of Tomorrow*] (cf. Harari 2017) concludes by arguing that in the 21st century, censorship means (instead of a former ban) flooding people with irrelevant information. People then simply do not know what to draw their attention to, so they spend their time dealing with secondary aspects of some problem. In earlier times, power meant access to data, and today it means knowing what to ignore, knowing what to concentrate on in our chaotic world (cf. ibid.: 536). Harari announces changes at the beginning of the third millennium. He points out that hunger, disease and war can already be controlled by humanity. For the first time in history, more people die from overeating than from hunger; more people die from old age than from infectious diseases; there are more suicides than victims of crime, war and terrorism. At the beginning of our century, the average person is more likely to die from overeating at McDonald's than from drought, Ebola, and al-Qaeda attacks (cf. ibid.: 10). It is possible, according to Harari, for humans to become gods in three ways: through biotechnology, through cyborg technology, and through the production of inorganic living beings. Biotechnology starts from the realization that development begins from amoebae, through reptiles and mammals, to homo sapiens, and can go even further than homo sapiens. Cyborg technology will supply the organic body with artificial hands, eyes, and millions of nanorobots (cf. ibid.: 64). The third great project will be for mankind to appropriate to itself the divine power of creation and destruction, and to elevate homo sapiens into *homo deus*. So, according to Harari, all projects boil down to one project: to achieve divinity, but that divinity is understood more in terms of the Greek and Hindu gods, and less in terms of the almighty God of the Bible. Our descendants, Harari supposes, are likely to have their own traits, inclinations and weaknesses, but they will be able to love, hate, create, and destroy in a completely different way (cf. ibid.: 69).

If we look at human life as a whole, following Harari, all problems and developments will be overshadowed by three interrelated processes: 1. Turning science into a comprehensive dogma that claims that organisms are algorithms and that life is data processing; 2. Intelligence is separated from consciousness; 3. Unconscious but highly intelligent algorithms could soon know us better than we know ourselves. These three processes raise three key questions: 1. Are organisms really algorithms and is life really data processing?; 2. Which is more valuable - intelligence or consciousness?; 3. What will become of our society, our politics, and our daily lives if unconscious but highly intelligent algorithms know us better than we know ourselves? (cf. ibid.: 536–537).

K. Otfried Höffe

World-renowned German moral philosopher, specialist in the philosophy of Immanuel Kant. In the fifth chapter of his book *Die Macht der Moral im 21. Jahrhundert* [*The Power of Morality in the 21st Century*] (cf. Höffe 2014: 64–79) he gives an overview of the development of science and technology in five phases. If we consider the history of science, Höffe argues, we will see that the history of science (especially the history of nature research) shows what changes in science require a conversation with ethics, or rather, what kind of ethics they require. This approach has two advantages: it is not subject to the danger of moralizing that is far removed from reality, but begins with research and extends the ethics of research with known critical ethics and control ethics. If we look at the history of science in essential terms, we can distinguish five phases, each of which has its own characteristic relationship to ethics. In the Old East, it was, morally speaking, easy to deal with science. Medicine, astronomy, mathematics, and planned observation were in the service of human life, so conversing with ethics was superfluous. It can only be objected that the results of science served only a thin social stratum: the ruler, his family, the nobility, and high officials - in short, science there was humanitarian but unjust.

In the second phase, Höffe claims, the enormous progress in the Greek space was backed by an epistemic revolution focused on knowledge, ie. on the discovery of a logical order that had already been prepared in the ancient East. That revolution disempowers the myth in the name of the logos. Two aspects (two evolutionary shifts) of this revolution should be highlighted here. The scientific-theoretical shift deprives knowledge of the character of a recipe and makes it questionable so that it can be passed on through studying and learning. Knowledge is in the full sense determined by general concepts, reasons, causes, and laws. In order to realize the first aspect of the revolution, another aspect is needed, that is the intentional revolution, according to which research is free from benefits in two ways: it initiates a new kind of research ethic, an ethic that initiates and legitimizes research, and narrows the rank of today's predominantly humanitarian knowledge.

The science comprehends the highest and most general causes and reasons and strives for cognition for the sake of cognition. Just as a free man, unlike a slave, lives for himself, so, in the cognitive sense, free knowledge is sought for itself. This rank includes not only the First Philosophy, which we later called metaphysics, but also mathematics, astronomy, theoretical physics and biology. Research does not serve external interests or external obligations. The second epistemic revolution is associated with a moral revolution, with a moral evolutionary shift. The desire for knowledge belongs to the nature of man endowed with reason and therefore epistemic free research has a humane and at the same time moral rank. Such research meets the criteria of the ancient moral principle (*eudaimonia*), happiness to the greatest extent. In free research, man's rational nature is perfected and realized, and this is called happiness. Among the Greeks, epistemic free research of good has the highest moral rank. Whoever engages in philosophy or the study of nature leads a good life (*eu zen*) - a happy and prosperous life. This forms the core of the ethics of science and the ethics of research. Such ethics affirms science because it initiates and legitimizes research, affirms free research as the highest form of human life. A great proponent of such ethics was Aristotle, who does not deny the value of his father's medical vocation, but at the top of the hierarchy of science stand exclusively philosophy and science that is neither utilitarian nor humanitarian.

Aristotle did not neglect the multiplicity of nature, for he shows that even the lowest animals in their expediency have on them something worthy of admiration. This admiration for the infinite richness of nature points to a third epistemic evolutionary shift. Charles Darwin himself calls Aristotle one of the greatest, if not the greatest observer of nature. The Greeks made significant diagnostic and therapeutic advances in medicine. They made the second evolutionary shift: the solemn self-commitment of physicians. In it, they indicate another research ethic, even a control ethic. The Hippocratic physician subjects himself to two moral obligations. The first Hippocratic commandment contains the third reason that legitimizes and at the same time controls research. This is the first element of control morality: the well-being of the patient is the highest law (*salus aegroti suprema lex*). The second obligation sets a limit by prohibiting harm to anyone (*nil nocere*). Newer medical ethics adds a third to these principles: the command of enlightened consent.

In the third stage, according to Höffe, a conflict arises between the natural desire for knowledge and the knowledge that comes from divine Revelation. Here I wish to supplement the author with new insights. Namely, it should be noted that there was an exaggeration on both sides: both on the side of the natural mind, and on the side of faith (Revelation). Some wanted to reduce faith to knowledge and others knowledge to faith. Both are violent. The real solution lies in achieving harmony between reason and faith. New research into medieval philosophy and theology shows that the great Franciscan theologians and philosophers already had the primacy of practical (moral) intellect over speculative (theoretical). This is clearly stated in Roger Bacon, for whom moral philosophy is the pinnacle of philosophy, because practical intellect or free will is the intellect of freedom, from which responsibility arises. This reversed the hierarchical order of science that prevailed under Aristotle: theoretical, practical, and poiethical science. In Bacon, Johannes Duns Scotus and William Ockham, practical sciences take precedence over theoretical sciences (cf. Babić 2015: 67–86). In his history of philosophy J. Habermas proves that two Franciscan greats in the Middle Ages (Scotus and Ockham) were the originators of the modern paradigm, ie. of the modern way (*via moderna*), because they put crossroads for scientific, religious and socio-political modernity (cf. Habermas 2019: 761–851). Renowned researcher of medieval philosophy Ludger Honnefelder claims that the main characteristics of Scott's philosophy are intentionality, transcendence and morality. With his conception of freedom, Scotus establishes his ethical theory, which is beyond voluntarism and naturalism (cf. Honnefelder 2005).

In the fourth phase, Höffe shows how research developed in the early modern age, in contrast to antiquity and the Middle Ages. The seminal work of the prophet of scientific and technical civilization, Francis Bacon, *Instauratio Magna* or *Novum Organum* (1620) on the title page has a picture of a ship returning from its journey across the boundless ocean into the strait of the sea. This clearly indicates two evolutionary shifts characteristic of the new age: the ship frees itself from the ropes of the strait of the sea and thus symbolizes an intellectual emancipation that involves unlimited free will for knowledge. Contrary to the First Philosophy, which seeks the highest knowledge, the most general causes and reasons, a humanitarianly obligatory innovation now emerges: the adventure of discovery on the boundless ocean. In research, Bacon insists on empirical experiments. In this evolutionary step, Kant saw an epistemic revolution, which consisted in the fact that researchers do not observe nature passively, but actively process it. Researchers ask or invent precise questions for nature – hypotheses - and with the help of interventions, experiments, force it to answer. Both Bacon and Kant, however, ignore the moral consequences of such research, because research that affects the world of life imposes responsibility for such action, for the risks that arise from such intervention in nature. Bacon asks from scientists to learn to look at nature in a whole new way, as young children - to be free from preconception and prejudice. It should be said that small children live without preconception, but in a certain respect they act without thinking, ie. they neglect the negative consequences and overlook the costs of their venture.

For a long time, the new age tried to give the character of innocence to its innovations. It must be admitted that experiments such as Galileo's with the fall of the stone were innocent because they meet five conditions: 1. Experiments are conducted on a small scale; 2. They are conducted on inanimate matter; 3. The changes they cause in nature can be well estimated in advance; 4. They do not cause any major damage; 5. They cause only reversible damage. Bacon's third evolutionary shift is that he does not renew the ancient ideal of free research, because for him, research has a humanitarian purpose. In his scientific utopia *New Atlantis* (1627), the research republic sought remedies against hunger, plague and disease, under the motto: "Medicine instead of metaphysics". Therefore, in a humanitarian sense, research is limitless. In his work *Instauratio Magna,* Bacon argues that one cannot exaggerate when it comes to love in humanitarian research. Modern research is responsible for two things: 1. It is co-responsible for changing attitudes, ie. for a new utilitarian understanding of self and the world; 2. It is responsible for fulfilling its humanitarian promise. One of Bacon's first great supporters, René Descartes, assumed that "we might free ourselves from innumerable diseases, both of the body and the mind, and perhaps even from the infirmity of old age." A particularly extreme example of irrational expectations is offered by the Congress of leading molecular biologists held in London in 1962, which expected the liberation of the world from infectious diseases, life without suffering, and - thanks to organ transplants - endless life, which means improving genetic supply. Ethics as a critique of ideology rejects the implantation of omnipotence. Already Bacon himself criticized some biomedical research that wanted to play the role of God, who created the world in six days and rested on the seventh. Man cannot create nature from nothing (*ex nihilo*) like God, and cannot rest on the seventh day and look at what he has created as good. Man's desire for knowledge cannot be satiated (it is innate to humanity), and his interest in facilitating and improving human life remains constant. But human creation is never so good that it cannot be further perfected nor is secular paradise possible for man.

In the fifth phase of the development of science, Höffe shows that the latest research requires responsibility because it changes nature and because the consequences of research are irreversible, which means that the damage caused is impossible to repair. It is impossible to suppress radioactive radiation, which is also evident in atomic experiments. In his experiment, Galileo had to be careful only that no one was passing on the path on which the stone fell, and the stone itself could later be returned to the place from which it was taken. The framework conditions of research in early modern times were significantly violated in gene research. Here the basic elements of life are experimented with, and the consequences for the world outside the laboratory cannot be estimated. And the consequences can be fateful epidemics. Philosophical ethic cannot decide on the dangers that threaten us, but it can name responsibilities that are appropriate to such research while developing a control ethic and a risk ethic. We need to investigate the types of dangers that threaten us (completely unknown and therefore unpleasant) and the risks (that are manageable or not) by taking biological and physical precautions. Last but not least, one should ask about the price and the currency in which these experiments are paid for. Personal, social and even aesthetic costs should be taken into account. The risks should be determined not ahistorically, but only depending on the specific culture. Risk ethic refers not only to the personal character of morality, but also to the social measures that are needed, but must be flexible so as not to stifle the creativity of research. The international research community can be helpful in establishing internationally valid rules so that national legislators do not hinder their researchers.

Furthermore, in modern research, another evolutionary shift of the new age becomes important: the humanities. Until the 19th century, many prominent researches primarily served cognition. Thus, Newton's laws, Darwin's theory of evolution, quantum theory and the theory of relativity, and even the deciphering of DNA, were motivated by a pure desire for knowledge rather than humanitarian stimuli. Today, the opposite direction is dominant, as the era of sciences of life has come, from which higher benefits are expected. Deciphering the genetic code marks a structural change. It consists of a new order of theory and practice, because fundamental research can be transformed into a novel technology in a short time. The laws of Gregor Mendel, an Austrian priest and scientist, were already technically usable, and they offered only a theoretical upgrade to a long-practiced technique, the traditional cultivation of plants and animals. In molecular biology, the order is reversed: now theory precedes technique. Basic research almost creates possibilities of application which is sought to be exhausted as much as possible for the imperative of boundless improvement. However, more inter-research is needed, ie research into the foundations of application. Ethics is needed here as a critique of ideology. Whoever demands humanitarian gain from the inter-research of, for example, embryonic cells, is not only frivolous, but is also drawing a humanistically erroneous conclusion. Namely, they call for the possibility of helping patients, although they are still dealing with only preliminary work. In this case, the commandment applies: seriously ill patients and their relatives, who are clinging to the straw of salvation, must not be given any open promises. Even someone who can promise them new opportunities to help does not provide them any current help yet. Whoever conceals this difference draws another humanistically erroneous conclusion. A certain assessment of epistemic innovation is also frivolous. For example, if the human genome has been deciphered, the human being itself is not. At a time of boom in the sciences of life, philosophy and the humanities must not be forgotten. The benefits of medicine are welcome to all citizens, but they are the result of external research, ie. statutory insurance of patients, the welfare state in general, whose justification is subject to social ethics.

Molecular biology is moving towards the fifth evolutionary shift, which may have three perspectives: 1. In humans, molecular-biological relationships could be more complicated than relationships in the subhuman realm; 2. Health is an elementary good, so research has a humanitarian rank; 3. Only man has the rank of self-purpose, which we call human dignity, and therefore with regard to means there is a higher moral responsibility. Medically assisted fertilization offers itself as an example. Ethics first asks whether it is permissible to limit the power of destiny, then seeks arguments that speak for and against in the context of fertilization for the diagnosis of preimplantation. Finally, ethics distinguishes the question of what the legislator can extort, from the question of what is considered right and what friends and relatives advise in a given case. Thus, philosophical ethic distinguishes between the morality of rights (what we are obliged to do) and the morality of virtue (what we do beyond that which is commanded). In the name of the morality of virtue, the morality of rights must not be violated; no one's life should be ended in the name of the command to help another. In short, life must not be harmed (*nil nocere*).

L. Günther Mack

In his text entitled *Die Suche nach einem zukunftsfähigen Wissenschafts-Paradigma* [*The Search for a Paradigm of Science Capable of the Future*] (cf. Mack 1998: 308-329), Mack argues that science is a cultural activity whose formative power (*Machtförmigkeit*) is growing. The power of science, therefore, is growing in all areas of culture, society and politics, especially in the field of economics and the military industry. Feelings of fear of scientific and technological consequences are expanding, and range all the way to hostility towards science and technology. So far, the consequences of science and technology, as well as the consequences of their consequences, have been neglected. These are the problems of armaments (atomic, biological and chemical weapons), the ecological threat to humanity and disasters (climate change, the ozone depletion, deforestation and devastation, chemical plagues, species extinctions, etc.), information and genetic technology, population growth and economic, societal, social and political conflicts. This needs to be completely rethought and a shift in awareness needs to be initiated in order to reach a minimum consensus on the highest values and common goals. In this, the most important is change in the notion of science – a new paradigm of science that will replace the previous paradigm of science free of values, which was responsible neither for its applications nor for its consequences. Therefore, it was not possible to hold science accountable because it is obliged to pure knowledge and to find the truth, and because its applications in technology are not its business, even though those applications change the world, endanger everything and bring catastrophe. The discussion of ethics and the requirement that science and technology must be accountable for the present and future consequences of their ambivalent action is a symptom of a break. The impetus for changing the understanding of science comes from science itself, but also from beyond it. The crisis of science must not be seen as an isolated phenomenon because the crisis of morality is all-encompassing today. It affects all areas of the cultural and natural world (the world of life). We have been seduced by modern civilization thanks to its scientific and technical progress, but both the whole society and ourselves have been seduced.

Science today is to a large degree organized internationally, so its consequences are largely global. Therefore, the question of the paradigm of science capable of the future involves a discussion of world ethos. Science capable of the future is the premise of a civilization capable of the future. The reverse is also true. The question of the future of science is a question of a supradisciplinary kind. The cause of the crisis of science is the ethos of science that was focused on the internal management of science and the associated notions of freedom from values and about freedom of science. Namely, science had no relationship with its applications. Mack states that Robert K. Merton described "pure" science: knowledge is the common good (*donum commune*); scientific knowledge is valid for all people (it is, therefore, universal); it is not bound by any extrascientific ideologies or interests (disinterest); scientific knowledge is constantly subjected to critical re-examination by scientific methods and criteria. In this disinterest (freedom from external ideologies and interests) it is best seen that science understands itself as free from values (*wertfrei*). This therefore excludes extrascientific and supradisciplinary consequences of scientific activity. The principle of value-neutral science neglects the interdisciplinary and supradisciplinary dimensions of science. Science free of values in practice was more fiction than reality, because even Max Weber himself found it *difficult* to separate valuations from empirical constatations. One cannot speak of the disinterest of "pure", free and value-free science, because science and research in their real social character are inextricably linked and actively intertwined in the scientific-technical-economic complex. As an example, suffice it to mention that fundamental research in radiochemistry and atomic physics has unleashed revolutionary, politically subversive danger and power. This is also true of gene research, which leads to radical change. People from the economic, societal and political circles demand productive strength and competence to solve problems (actually benefit), and even the proponents of the value-free science thesis do not notice this.

The discrepancy between the self-limitation of science in the traditional ethos and the social orientation to practice belongs to the causes of the crisis, as science preserves its internal freedom, while the critical evaluation of its consequences comes from social instances, threatening the autonomy of science. Science and research, in addition to problem-solving competence, can also have the potential to produce problems. Therefore, science can no longer be justified by the principles of traditional ethos. One cannot speak only of the responsibility of scientists (individual ethics), but also of the responsibility of the scientific community in institutions and organizations. Sanctions are needed for scientists and institutions that act contrary to ethics. Today's moral crisis in science cannot be resolved within the current paradigm, so a new one needs to be established. New science should be open to other scientific disciplines (interdisciplinary) and to what transcends all scientific disciplines (transdisciplinary). A qualitative and quantitative expansion of its horizon is needed, which includes its responsibility. The contours of the science paradigm that will be capable of the future include the recognition of the value character of scientific cognition and action. Value is an integral part of science, which means that responsibility essentially belongs to scientific cognition and action. Not only is negative freedom required, but also positive freedom - freedom for higher values. Responsibilities include interdisciplinarity, transdisciplinarity and publicity of work.

Responsible scientific action is manifested in internal, institutional and public accountability, which includes assessing the consequences of research, especially when it comes to armaments, gene research and genetic technology. At that, it is important to determine the objectives of research, which will be in line with the personal and institutional ethos. And when in doubt - as Hans Jonas said - the prophecy of doom should be given priority. Scientific and technical responsibility also includes the appropriate teaching about it, then the institutional conditions, ethics commissions, people authorized to protect ethics, society and associations. The role of science in society and politics is to seek a fundamental ethical consensus, with society and politics. At the same time, scientific journalism is important, which will give the public qualified information, not sensations. What should we do? *Günther Mack asks at the end of his text and replies that th*is question goes beyond science. Mack quotes Leon Eisberg, an evangelical pastor who works with students, who says that the idea of fraternity in our time is a prerequisite for our survival. We need, therefore, to rediscover the idea of brotherhood.

Conclusion

From the above, I draw the following conclusion. Until the new age, man's cognition was mostly receptive and man was mostly a passive being. Therefore, injustices could be inflicted on man only by active forces: natural and higher forces. Namely, the active principle was more important than the passive one. It is only in the new age that human cognition becomes active, so man becomes the primary active being who changes nature (the world around him) and himself. This happened with the Copernican turn in the new age, when man, thanks to natural sciences and technology, mastered not only external nature, but also his own. In scientific-technical civilization, science has acquired a monopoly on knowledge of the world, and is now seeking to turn it into a comprehensive dogma. Only the power of morality can oppose it, which must be global because the power of science is also global.

Modern societies, according to Otfried Höffe, live off assumptions that they cannot guarantee on their own (cf. Höffeu 2014: 194). With this claim, Höffe relies on the claim of Ernst-Wolfgang Böckenförde, who long ago asserted that a libertarian secularized state lives off assumptions that it alone cannot guarantee (cf. Böckenförde 1991: 112). The assumptions we cannot live without are fundamental values: justice, truth, freedom, responsibility, equality and fraternity. The essence of the human being includes freedom and responsibility. If a man renounces freedom and responsibility, he renounces his own essence, ie. himself - he renounced his humanum, that which makes him a man.

We need a new understanding of science, which recognizes that freedom and responsibility are immanent to all human cognition and action. Freedom and responsibility are indivisible as science and technology are indivisible today. To change the notion of science requires a change in the consciousness of the individual. The secret is that this change cannot be forced by force and fear. Such change is possible only from freedom, and supreme freedom is positive freedom, the one that strives to achieve the highest values and the one that connects us with others in one community. Hannah Arendt argues that Johannes Duns Scotus, the greatest Franciscan medieval thinker, was also the greatest philosopher of freedom in Western thought and that only Kant could equate himself with him in unconditional devotion to freedom (cf. Arendt 1998: 376). Namely, Scotus proved that there are two inclinations in human free will: a tendency to self-interest and a tendency to justice. Both inclinations (aspirations) are free. The inclination of justice is innate freedom, according to which our will can want some good that is not directed at us, that is by which our will does not seek its own benefit, but that which transcends our benefit, our selfishness and egocentrism. The propensity for justice is more sublime than the propensity for one's own benefit, because to love justice for the sake of justice, for the sake of another, is a freer and more communicative act than the act of love for one's own benefit. Such an act of positive freedom frees us from egoism and connects us with other people and such freedom indirectly speaks of the idea of brotherhood, which is a prerequisite for the survival of humanity (cf. Babić 2012: 54–55; Duns Scotus 2012: 154–157).

For Scotus, natural action is necessary, but selfish, while only by free action that respects the other as the other, can we transcend natural necessity and selfishness. In his book *Reportatio Parisiensis Examinata* he argues that freedom can be proved a posteriori and that without freedom no virtues, no commandments, no warnings, no rewards, no punishments, no honours would be needed, and no human community would be possible. (neither political nor religious). Freedom is, therefore, a presupposition of politics, morality and soteriology. At that, Scotus has in mind the freedom that is free from egoism and that is communicative because it connects us into one community (cf. Babić 2019: XXI – XX; Duns Scotus 2005: 78–80). In short, true freedom is realized in morality and love.

References

Arendt, Hannah (1998). *Von Leben des Geistes. Das Denken. Das Wollen*, München/Zürich: Piper.

Babić, Mile (2012). „Sloboda kao *affectio commodi* i *affectio iustitiae* kod I. D. *Škota*“, u: Ivan Duns *Škot*, *Sloboda uzvišenija od nužnosti*, priredio, s latinskoga preveo, tumačenja dodao i bilješkama popratio Mile Babić, Zagreb: Naklada Breza, str. 53–55.

Babić, Mile (2019). „*Život* i djelo Ivana Dunsa *Škota*“, u: Ivan Duns *Škot*, *O principu individuacije*, priredio i preveo Mile Babić, Zagreb: Demetra, str. XI–XXV.

Bruckner, Pascal (1997). *Napast nedužnosti. Esej*, prevela Višnja Machiedo, Zagreb: Nakladni zavod Matice hrvatske.

Bellah, Robert N. et al. (1996). *Habits of Heart. Individualism and Commitment in American Life*, Berkeley/Los Angeles/London: University of California Press.

Dahrendorf, Ralf (2009). „Nach der Krise: Zurück zur protestantischen Ethik? – Sechs Anmerkungen“, u: *Merkur* 63/720, str. 373–381.

Duns Scotus, Johannes (2005). Pariser Vorlesungen *über* Wissen und Kontingenz. Lateinisch – Deutsch. Reportatio Parisiensis examinata I 38 – 44, herausgegeben, *übersetzt* und eingeleitet von Joachim R. Söder, Freiburg/Basel/ Wien: Herder.

Duns *Škot*, Ivan (2012). *Sloboda uzvišenija od nužnosti*, priredio, s latinskoga preveo, tumačenja dodao i bilješkama popratio Mile Babić, Zagreb: Naklada Breza.

Görlach, Alexander (2019). *Homo empathicus. Von Sündenböcken, Populisten und der Rettung der Demokratie*, Freiburg/Basel/Wien: Herder.

Habermas, Jürgen (2001). *Glauben und Wissen*, Frankfurt am Main: Suhrkamp.

Habermas, Jürgen / Ratzinger (2011). *Dialektik der Säkularisierung.* Über *Vernunft und Religion*. Freiburg/Basel/Wien: Herder.

Habermas, Jürgen (2019). *Auch eine Geschichte der Philosophie*. Band 1: *Die okzidentale Konstellation von Glauben und Wissen*, Frankfurt am Main: Suhrkamp.

Harari, Yuval Noah (2017). *Homo Deus. Eine Geschichte von Morgen*, München: C. H. Beck.

Höffe, Otfried (2014). *Die Macht Moral im 21. Jahrhundert. Annährungen an eine zeitgemässe Ethik*, München: C. H. Beck.

Jonas, Hans (1984). *Das Prinzip Verantwortung. Versuch eine Ethik für technologische Zivilisation*, Frankfurt am Main: Suhrkamp.

Küng; Hans (2006). *Projekt Weltethos*, München/Zürich: Piper.

Mack, Günther (1998). „Die Suche nach einem zukunftsfähigen Wissenschafts-Paradigma“, u: (ur.) Hans Küng, Karl-Josef Kuschel, *Wissenschaft und Weltethos*, München/Zürich: Piper, str. 308–329.

Morin, Edgar (2008). *Etika*, prijevod Vesna Pavković, Zagreb: Massmedia.

Paić, *Žarko* (2005). *Politika identiteta. Kultura kao nova ideologija*. Zagreb: Izdanja Antibarbarus.

Paić, *Žarko* (2018–2019). *Tehnosfera*. Zagreb: Sandorf – Mizantrop.

Sloterdijk, Peter (1998). *Sphären. Mikrosphärologie*. Band I: *Blasen*, Frankfurt am Main: Suhrkamp.

Sloterdijk, Peter (1999). *Sphären. Mikrosphärologie*. Band II: *Globen*, Frankfurt am Main: Suhrkamp.

Sloterdijk, Peter (2004). *Sphären. Mikrosphärologie*. Band III: *Schäume*, Frankfurt am Main: Suhrkamp.

Taylor, Charles (1994). *Quellen des Selbst. Die Entstehung der neuzeitlichen Identität*, *übersetzt* von Joachim Schulte, Frankfurt am Main: Suhrkamp.

Taylor, Charles (1995). *Unbehagen an der Moderne*, *übersetzt* von Joachim Schulte, Frankfurt am Main: Suhrkamp.

Taylor, Charles (1998). *Negative Freiheit? Zur Kritik des neuzeitlichen Individualismus*, *übersetzt* von Hermann Kocyba, Frankfurt am Main: Suhrkamp.

Taylor, Charles (2007). *A Secular Age*, Cambridge/Massatchusetts/London: The Belkamp Press of Harvard University Press.

DOI: 10.5644/PI2021.200.16

Financing research and development around the world, in Southeast Europe and in Bosnia and Herzegovina

Fikret Čaušević[*]

Abstract: This paper analyses the financing of research and development, starting from the global and regional contexts and moving on to the specifics of such investment in Bosnia and Herzegovina. The first section presents an analysis of the global context and of the 10 highest-investing countries, as well as a breakdown of the sources of such financing by sector. Based on the most recent data from UNESCO, which were for 2018 at the time of writing, South Korea and Japan invested most in research and development in relative terms, while the US and China did so in absolute terms. The second section contains a comparative analysis of investment in research and development by the countries of Central and Southeast Europe. This group is led by Slovenia, followed by the Czech Republic and Hungary. The third section is dedicated to the case of Bosnia and Herzegovina and certain factors affecting the country's very low level of spending on research and development. The fourth section presents a number of successful examples of investment by Bosnian companies in key branches of industry where the country has achieved above-average results for the Southeast European region, as well as very good export results, as measured by the Economic Complexity and the Product Complexity indices.

Key words: research and development (R&D), financing, world, Southeast Europe, Bosnia and Herzegovina, Economic Complexity Index.

JEL Classification: O30, O39

1. Global context

According to the UNESCO Institute for Statistics' (UIS) data for 2018 (the latest available), total research and development (R&D) spending worldwide, expressed in terms of purchasing power parity of USD ($PPP), was $1.7 trillion. As Table 1 shows, just ten countries accounted between them for GDP of $76.86 trillion ($PPP) or 59.5% of the global total calculated in terms of $PPP, but also for 84% of R&D spending in absolute terms. These were the USA,

[*] Corresponding member of the Academy of Sciences and Arts of Bosnia and Herzegovina. Professor of Economics and Finance. University of Sarajevo – School of Economics and Business. E-mail: fikret.causevic@efsa.unsa.ba

China, Japan, Germany, South Korea, France, India, Great Britain, Brazil and the Russian Federation, providing 1.5 times more of global research and development expenditures than their share in global GDP (in $PPP) would have warranted.

Table 1 – The top ten spenders on R&D in $PPP – 2018

Country	Total R&D expenditures in billions of $PPP	Shares of sectors in R&D expenditures (in %)		
		Business sector	Government	Universities
1. USA	476.5	71.5	11.4	13.1
2. China	372.3	77.3	15.8	6.9
3. Japan	169.6	77.7	8.3	12.6
4. Germany	109.6	67.6	14.6	17.7
5. South Korea	73.1	78.2	11.2	9.0
6. France	60.6	63.7	12.7	22.3
7. India	51.7	37.1	56.5	6.4
8. UK	43.8	65.1	7.3	25.8
9. Brazil	42.2	---	---	---
10. Russian Fed.	40.3	59.6	30.5	9.9

Source: UIS – UNESCO Institute for Statistics, at: http://uis.unesco.org/apps/visualisations/research-and-development-spending/ - accessed on 10/01/2021.

Taking each in turn, we see that the world's leading economic and technological power, the United States, had a share in global R&D spending that was considerably higher than its share in global GDP (28% compared to 15.9%). The same was true of China, the world's second-largest economy (21.9% compared to 16.8%).[1] The differences recorded for Japan and South Korea were even bigger, with shares in R&D spending 2.5 times their corresponding shares in global GDP (Japan: 10%, against 4%; South Korea: 4.3%, against 1.7%). These two countries were also the world leaders in relative investment in research and development (R&D expenditures as a % of GDP).

In South Korea, Japan, China, and the US, most R&D spending came from the business sector (on average close to 75% of all R&D expenditures in these four economies). In India, it was from government (56.5%). The United

[1] In 2018, China was the largest economy in the world in terms of GDP $PPP. To prevent any potential misunderstandings from the shares of world GDP assigned to the US (15.9%) and China (16.8%), please note that these shares are derived from GDP presented in terms of the purchasing power parity of the US dollar. On the other hand, when the countries' GDP are given in current prices and current US dollars for 2018, the US is the largest world economy (with a share of close to 21.2% of global GDP), and China the second largest (with a share of about 14.3% of global GDP).

Kingdom and France were the two countries with the highest university share in R&D spending. The most recent data (2019) indicates that the top ten corporate spenders on R&D were: Samsung (South Korea), Alphabet (USA), Volkswagen (Germany), Microsoft (USA), Huawei (China), Intel (USA), Apple (USA), Roche (Switzerland), Johnson & Johnson (USA), and Daimler (Germany),[2] investing a total of $122.2 billion (in USD from 2019) between them. This is approximately equal to the combined GDP of Slovenia, Bosnia and Herzegovina, and Serbia that year or almost a quarter of the combined GDP of all the low-income countries (the 28 poorest countries in the world).[3]

Table 2 shows the top ten spending countries in relative terms (R&D expenditures as % of GDP). It includes four countries from Table 1 (the largest spenders in absolute terms): South Korea, Japan, Germany, and the United States. The other members of the group are Finland, Switzerland, Sweden, Austria, Denmark, and Belgium. Slovenia is included in Table 2 as number 11, because although it is tied with Belgium for relative R&D spending, it nonetheless has fewer researchers per million inhabitants.

Table 2 - Top eleven spenders on R&D in relative terms – 2018

Country	R&D expenditures in % GDP	Number of researchers per million inhabitants
1. South Korea	4.3	6826
2. Japan	3.4	5328
3. Finland	3.2	7009
4. Switzerland	3.2	4468
5. Sweden	3.1	6875
6. Austria	3.1	4947
7. Denmark	2.9	7310
8. Germany	2.9	4320
9. USA	2.7	4205
10. Belgium	2.4	4528
11. Slovenia	2.4	4147

Source: UIS – UNESCO Institute for Statistics, available at: http://uis.unesco.org/apps/visualisations/research-and-development-spending/ - accessed on 10/01/2021.

World average R&D spending is 1.35% (as a % of GDP). The data in Table 2 show that South Korea is spending three times and the US twice the world average. Denmark leads by number of researchers per million inhabitants, followed by Finland, Sweden, and then South Korea. Slovenia is the leading

[2] Available at https://spendmenot.com/blog/top-rd-spenders/ (accessed on 26/12/2020).

[3] Data from the World Bank database website: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD (accessed on 26/12/2020).

country in transition by GDP per capita and was the first to become a member of the euro area. It is also the leading country in transition for R&D spending.

2. Regional context: Central and Southeast Europe

With R&D spending 1.9 times the world average, Slovenia leads the group of central and southeast European countries. Next is the Czech Republic, with approximately 1.5 times the world average, and then third-ranked Hungary, whose spending is close to the world average. Serbia heads the countries with R&D spending less than half the world average. The data on number of researchers per million inhabitants shows that Slovenia has 14 times more than Bosnia and Herzegovina (BiH) and 4.5 times more than Romania.

Table 3 - Countries of Central and Southeast Europe by R&D spending, in relative terms – 2018

Country	Spending on R&D as % GDP	No. of researchers per million inhabitants
1. Slovenia	2.4	4147
2. Czech R.	2.0	3402
3. Hungary	1.4	2673
4. Slovak R.	0.9	2715
5. Poland	0.9	2064
6. Bulgaria	0.8	1821
7. Croatia	0.8	1437
8. Serbia	0.7	1830
9. Romania	0.6	903
10. North Macedonia	0.5	837
11. Montenegro	0.4	671
12. Bosnia and Herzegovina	0.3	292
13. Albania	0.2	155

Source: UIS – UNESCO Institute for Statistics, available at: http://uis.unesco.org/apps/visualisations/research-and-development-spending/ - accessed 10/01/2021.

Ranking the central European and former Yugoslav countries by total R&D spending in $PPP puts Poland, the most populous country, in the lead (see Table 4). In 2018, its total spending on R&D was six times that of Slovenia. But Poland's population is 19 times Slovenia's, so the balance shifts back considerably in Slovenia's favour once we look at spending on a per capita basis, with Slovenia spending 3.1 times more per capita than Poland (753 compared to 241 $PPP). As already mentioned, the southeast European countries investing less than half of the world average are headed by Serbia (see Table 3). In

2018, Serbia's R&D per capita spending was 108 $PPP. This was 35% less than Croatia, but 48% more than Romania. It was still 3.1 and 3.2 times what BiH or Montenegro invested, respectively (on a per capita basis).

Table 4 – Total spending on R&D in Central European and former Yugoslav countries in $PPP – 2018.

Country	Total R&D spending in millions $PPP	Sectoral share in total spending (in %)		
		Business sector	Government	Universities
1. Poland	9,149	46.6	23.9	29.2
2. Czech R.	6,699	55.2	19.0	25.4
3. Hungary	3,408	71.5	13.7	13.5
4. Slovenia	1,506	77.4	12.2	10.4
5. Slovak R.	1,380	36.8	28.3	34.4
6. Serbia	756	29.6	24.5	45.9
7. Croatia	732	48.2	26.1	25.7
8. N. Macedonia	143	10.5	15.4	73.4
9. BiH	102	19.6	19.0	60.4
10. Montenegro	35	38.3	21.3	37.5

Source: UIS – UNESCO Institute for Statistics, available at: http://uis.unesco.org/apps/visualisations/research-and-development-spending/ - accessed on 10/01/2021.

Comparative spending on R&D in Central and Southeast Europe must be considered in the context of gross and per capita public debt and total and per capita GDP, with reference to the countries' respective starting positions on entering transition, given the impact all these variables have had, and continue to have on their overall capacity to finance, including to finance R&D funding opportunities. Slovenia was the only country of the former Yugoslavia to be fully spared direct involvement in the conflicts associated with the country's disintegration. It suffered no war damage and no break in production during the last decade of the last century. By contrast, BiH saw losses in human capital that, just in terms of the number of persons killed, were four times higher than the combined losses of all the other successor states.[4] What is more, the GDP BiH lost because of impeded production between 1992 and 1995 was equivalent to three times the country's total output in 1990, when its GDP was approximately DEM17 billion or $10.7 billion.[5] BiH's lost GDP during the 1992-1995 war for independence was thus $32 billion in 1990 US

[4] Available at https://hr.wikipedia.org/wiki/Raspad_SFRJ

[5] According to the Federal Bureau of Statistics of SFRY Yearbook for 1992. The data on GDP for 1990 in USD and DEM calculated according to the official and stable exchange rate of the Yugoslav dinar against the German mark (1DEM=7YUD).

dollars. The war left BiH with approximately 270,000 civilians and veterans with disabilities,[6] which has given rise to 25 years of total annual fiscal spending on them (from both entity budgets, i.e., the Federation of BiH and the Republika Srpska) of some 4.3% of GDP. This is approximately four times the corresponding fiscal burden to Croatia, the second most affected country by the break-up of the SFRY. In fact, no other country in transition has been burdened with anything like this type of expenditure, which has naturally improved their baseline for structuring budget expenditures, including for funding R&D activities.

Figure 1 – Comparative levels of per capita GDP and public debt for Central and Southeast European countries and Bosnia and Herzegovina (BiH=1.0; the left bar represents a country's level of GDP per capita, the right bar its level of public debt per capita)

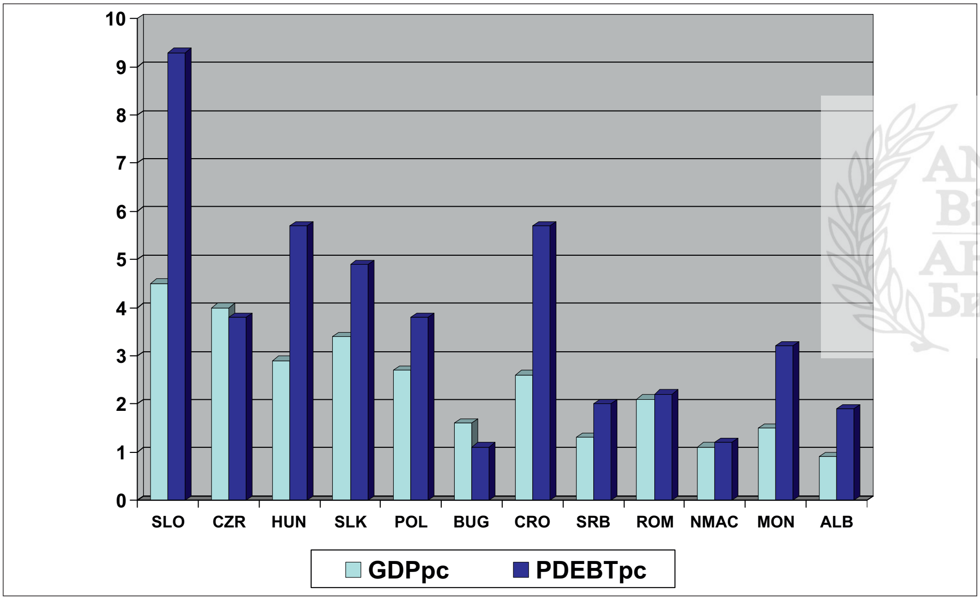


Figure 1 presents differences (for 2018) between central and southeast European countries and BiH in per capita GDP and per capita public debt. The only two countries with lower levels of public debt than BiH were the Czech Republic and Bulgaria. All the others have significantly higher levels of per

[6] Source: Žarko Papić (2008) "Socijalna inkluzija i filozofija razvoja," in Ž Papić and F. Čaušević, (eds) *Ekonomija ubrzanog razvoja*, Forum Bosnae 43/08, International Forum Bosnia, Sarajevo, pp. 256-283.

capita public debt, especially Croatia, Slovenia, Montenegro, and Albania, with levels compared to BiH that were 2.1 times the differences in per capita GDP.

3. Financing research and development in Bosnia and Herzegovina

How R&D in BiH has been financed since its independence has been directly determined by the administrative structure and, more particularly, the structure of fiscal federalism, set out in, or derived from the Dayton and Paris peace agreements (November/December 1995, respectively). The signing of the Paris Treaty (14 December 1995) was followed by confirmation of BiH's formal membership in the International Monetary Fund (on 14 December 1992), allowing the country to become a member of the World Bank Group (on 23 March 1996 the country's formal membership obtained on 23 February 1993 was confirmed). Eight days after accession to the World Bank Group, the BiH Priority Reconstruction Program began. It lasted four years. During 1996, the structure of fiscal federalism and, based on it, the powers and responsibilities of different levels of government to finance all three levels of education, science, research, and culture, were defined, as an integral part of the administrative restructuring package for BiH.

One consequence of the two entities having different administrative structures has been the different distribution of responsibilities for financing education and R&D. In the FBiH, for 25 years, funding for education and science has come largely from cantonal budgets (there are ten cantons in the FBiH). The cantonal budgets have therefore been responsible for financing all three levels of education, as well as for a certain proportion of R&D projects. The entity-level of government (the Budget of the FBiH) has also played a role in financing R&D, but not for financing any level of education in the FBiH. By contrast, in the RS, key responsibility for financing education and research lies with the entity government (the RS Budget) in cooperation with municipal/city authorities. In the "third part" of BiH, Brčko District, where approximately 3% of the population of the country lives, the District Budget is responsible for financing both.

According to the Federal Statistics Bureau (FBS), an average of 37 R&D projects were implemented each year between 2016 and 2018 at universities in the FBiH (i.e., not including the RS).[7] Of that number, most (20) were

[7] Academy of Sciences and Arts of Bosnia and Herzegovina, "Harmonizacija sistema nauke u Bosni i Hercegovini" –Federal Statistics Bureau, "Rezultati statističkog istraživanja,"

funded at a level of less than BAM 100,000. The state or BiH-level of government financed four R&D projects on average, while the cantonal level also funded four up to that value, while two more were on average financed by domestic or foreign non-governmental organizations and foundations. Of the R&D projects attracting funding of BAM 100,000 to 300,000, three were financed by the FBiH Budget and international organizations. There were on average two R&D projects each year with funding of between BAM 300,000 and 500,000 during the period, one funded from the FBiH Budget, the other by international organizations. There are a further three projects with funding of more than BAM 500,000 during these three years, one of them financed by the entity budget, one by the Sarajevo Canton budget, and one from international funds. Of the total of 37 projects in any given year, 31 were implemented at public universities, with six at private universities.

Thirty-nine research institutes were contacted for the FBS Survey. 18 responded. 134 of their 410 employees are researchers, implementing a total of 209 projects (approximately 70 per year), between 2016 and 2018. The largest block of those 209 projects, 103, involved providing consulting services/projects. Their R&D projects most relevant to developing BiH's export competitiveness and import substitution related to applied research and improving existing technology in the business sector. There were 52 such projects at the surveyed institutes, but the survey does not state the amounts spent on them.

The low value of R&D spending in BiH is clearly reflected in a document prepared for the RS Government by the RS Ministry for Scientific and Technological Development, Higher Education, and the Information Society, entitled *A Roadmap of Research Infrastructure in Republika Srpska (Bosnia and Herzegovina).*[8] It contains data on investment in equipment, according to which, a total of BAM 1,212,600 in funds for equipment was transferred from the RS Budget to 16 research institutions (institutes or university or faculty departments or research units in the RS) between 2010 and 2018. The average annual amount invested in research infrastructure (equipment) at all 16 institutions during that period was therefore BAM 134,733, which is BAM 8,420 per year per institution.[9]

Sarajevo, 2020, p. 19.

[8] Document available at: https://www.vladars.net/sr-SP-Cyrl/Vlada/Ministarstva/mnk/Documents/RIRS-RoadMap-SR.PDF

[9] Source: Ibid, p. 13. The data for the entire period (2010-2018) and yearly data are calculated using data from Table 1, p. 13 of the original document.

In September 2016, the BiH Council of Ministers prepared a strategic document on science development in BiH.[10] In the section that deals with financing R&D and covers 2017 to 2020, the plan was to increase investment for these purposes from BAM 101.2 to 189.6 million, followed by a further hike to BAM 268.2 million by 2022, with the entities contributing more or less in line with their share in overall GDP creation, 66.1% and 32.9% respectively, with the remaining 1% to come from Brčko District. For this to happen, spending on R&D would have to increase from BAM 66.9 to 177.4 million in the FBiH and from BAM 33.3 to 88.1 million in the RS between 2017 and 2022. Expressed as a percentage of national GDP, the planned increase in R&D expenditures was to have been from 0.35% (2017) to 0.80% (2022).[11] Effective spending on R&D in 2018 was lower than planned, with total spending in 2018, according to the UIS-UNESCO data presented above, just 0.3% of GDP. Planned expenditures in the entity budgets prepared at the end of 2020 for 2021 make it clear that total spending on R&D in BiH will not reach even 0.5% of GDP in 2021 or 2022, never mind the 0.75% planned.

How major scientific institutions of national importance have been financed is a remarkable paradox in R&D financing in post-war BiH. This paradox is a direct consequence of political fragmentation and unwillingness or, more correctly, obstruction on the part of the government (or part of the government) at entity and state levels to agree on financing national-level scientific and cultural institutions. There is no better example than how the Academy of Sciences and Arts of Bosnia and Herzegovina (ANUBIH) has itself been funded over the past 25 years. Namely, its survival is thanks exclusively to financing from the Sarajevo Canton budget. At no point in the past four years did the Academy's total annual revenues exceed BAM 1.8 million, and even this represented an increase on the twenty years previous to that. In fact, the ANUBIH's revenues peaked in 2019 at BAM 1.769 million, with planned revenues for 2020 of BAM 1.639 million.[12] This compares to total planned revenues for the Croatian Academy of Sciences and Arts of BAM

[10] The Council of Ministers of Bosnia and Herzegovina, "Strategija razvoja nauke u Bosni i Hercegovini – Revidirani dokument," Sarajevo, September 2016. At https://ekonsultacije.gov.ba/legislativeactivities/details/14-prijedlog-revidiranog-dokumenta-strategije

[11] Source: Ibid., p.62.

[12] The Academy of Sciences and Arts of Bosnia and Herzegovina. "Izvještaj o radu Akademije nauka i umjetnosti Bosne i Hercegovine za period od 1.jula 2017. do 31. decembra 2020. godine," Sarajevo, December 2020, p. 32.

19.79 million (HRK 76.192 million[13]) for 2020. Of this, 83% comes from the Budget of the Republic of Croatia.

The Annual Report of the Czech Academy of Sciences (CAS) for 2019 says it had 9672 employees, 3926 of them researchers, with a further 2014 employees in research institutes within the CAS holding university degrees.[14] The average monthly salary of these 9672 employees was $1,947, while researchers received $2,495 on average.[15] The average monthly salary for academics at the ANUBIH that year was $385. Per capita GDP was 300% more in the Czech Republic than in BiH, but the monthly salary of CAS researchers was 550% more than that of ANUBIH academics. Total CAS revenues for 2019 were $681.13 million, or CZK 15,461.74 million.[16]

4. Financing R&D in BiH and the country's economic complexity

According to UIS-UNESCO data, R&D spending in BiH was $PPP 102 million in 2018. Universities accounted for slightly more than 60% and the business sector for close to 20%, with the remainder (19%) funded by different levels of governments. University financing of R&D thus represented a greater share in Northern Macedonia and BiH than in the other former Yugoslav countries, while business sector funding was highest in Slovenia (above 77%) and Croatia (close to 50%). In BiH, the business sector accounted for just 19.6% of R&D expenditures in 2018, but, thanks partly to R&D investment and innovation by BiH companies in mechanical engineering and the automotive, metal processing, and wood processing industries, business results for 2015-2020 were nonetheless better than for neighbouring countries whose R&D expenditures were higher and, in some cases, significantly so.

At this point, we should look at how Western Balkan countries are ranked for business competitiveness purposes by the economic complexity and product complexity indices, a major measure of the effects of R&D spending and especially of applied research efficiency. According to the Observatory

[13] Source: The Croatian Academy of Sciences and Arts – available at: http://info.hazu.hr/upload/File/2020/ODLUKE-2020/PRORA%C4%8CUN-2021.pdf (accessed on 08/01/2021)
[14] Source: The Czech Academy of Sciences. "2019 Annual Report of the Czech Academy of Sciences", Prague, 2019, p. 45. Available at: https://www.avcr.cz/opencms/export/sites/avcr.cz/.content/galerie-souboru/vyrocni-zpravy/VZ-AV-CR-ENG.pdf
[15] Source: Ibid, p. 45 (amounts converted from CZK to USD at average USD/CZK exchange rate for 2019).
[16] Source: Ibid, p.48.

of Economic Complexity (OEC),[17] BiH's ranking under the Economic Complexity Index improved three places, from 44 in 2015 to 41 in 2019. Over the same period, Serbia's ranking improved two places (from 41 to 39), while Croatia stayed put at 37. This index is calculated on the basis of specialization in production and the complexity of production processes and indicated that there is very little difference between these three former Yugoslav countries in their ranking. Given the funds invested in R&D, whether overall or on a per capita basis, the BiH business sector's results in manufacturing have been above-average, not just for Southeast Europe but also for some countries of the southern EU (e.g., Greece, Portugal, Cyprus).

The most complex products made in and exported from BiH, as ranked by the OEC-published product complexity index, mostly come from the metal-working industries, the production of machinery and tools, and the automotive industry. More concretely, the product groups with the highest product complexity index include:

- the production of screws, bolts, nuts, rivets, and washers,
- interchangeable tools and dies for hand or power tools,
- gaskets and similar joints of metal sheets,
- parts and accessories for machine tools,
- knives, cutting blades, for machines and appliances,
- electrical machinery and equipment,
- machinery and appliances,
- vehicles and their parts.[18]

For a particularly good example of very successful and fruitful cooperation between universities, institutes, and the business sector related to improving the Bosnian economy's competitiveness and exports of more demanding products or indeed producing such products for domestic export-oriented companies, we may turn to Thermal Process Solutions (TPS) from Zenica. This company is owned by Jusuf Duraković, a lecturer at the Metallurgy Faculty of the University in Zenica. In 2019, TPS designed and produced devices for use in chemical and thermic processes in the automotive industry for the production of very high performance vehicles (Ferrari and Maserati).[19] TPS is in fact the only company making such equipment anywhere in what

[17] Data on OEC website: https://oec.world/en/rankings/eci/hs6/hs96 and https://oec.world/en/profile/country/bih

[18] Source: https://oec.world/en/profile/country/bih

[19] See https://www.bljesak.info/gospodarstvo/tvrtke/Zenicki-TPS-Proizveli-uredaje-za-obradu-dijelova-za-Ferrari-i-Maserati/290228

was once Yugoslavia and has sold its machinery to a Slovenian company making parts for the brands in question. TPS also produces an endogenerator for its Slovenian partner, a flow-through production line to harden paper fans, a key component in making filters, for Mann+Hummel BA, a company from Tešanj (again the automotive industry), and a chamber cementation furnace for SIM Technik, a company from Kotor Varoš. The company also cooperates very actively with NN and Graewe Tadiv, both from Konjic.

Procassa-Fischer from Jelah, near Tešanj, have also shown how, thanks to their accumulation and development of know-how, Bosnian companies can achieve excellent results based on their own investment in R&D, by integrating and deploying new technologies, within the branches of business they belong to. The company's director Mehmed Husaković, has achieved excellent results in just three years, working with engineering colleagues from BiH and business partners from Germany. In 2018, the company produced the first CNC machine in BiH, and in 2019 the first PLC press. Even if 2020 was overshadowed by the Covid crisis, the company nonetheless managed to promote its new product in late September of that year.[20] The product in question is a six-axle CNC machine.[21] The fact that this product integrates the "old" and "new" economies, viz. machinery with IT, only makes it even more significant for BiH's competitiveness. The newly minted six-axle CNC machine has been exported to Germany for use in the German automotive industry.

In late December 2020, a Sarajevo-based company Dizart promoted its own new five-axle CNC machine. The company applied for financial support for R&D projects provided by USAID WHAM. The machine will be used for training, as well as to finish materials for the European market. Dizart enjoys successful cooperation with the Sarajevo University's Mechanical Engineering Faculty, as well as with the Metalworking High Technical School in Sarajevo.[22] According to the director, the company exports more than three quarters of its total production to markets in England, Ireland, and Australia. Dizart is an exceptional example of a small company that has achieved outstanding results on the basis of modest financial resources and of excellent cooperation with the University of Sarajevo, and thus of the direct link possible between theory and practice.

---

[20] See Procassa-Fischer webpage, https://www.akta.ba/Firma/procassa-fischer-doo/279490

[21] Available on https://www.akta.ba/vijesti/novi-uspjeh-bh-pameti-nova-cnc-masina-najveca-na-balkanu/124096

[22] See BiznisInfo portal, https://www.biznisinfo.ba/sarajevska-kompanija-predstavila-novu-cnc-masinu-vlastite-proizvodnje/

During 2020, one of the "more unusual" examples illustrating Bosnian companies' flexibility and capacity was the news published in mid-December that a ventilator produced by the TMD Group from Gradačac had received MD-TEC certification in London.[23] The TMD Group had developed the prototype for this ventilator in cooperation with the University Hospital in Tuzla. During the 1970s and 80s, this company was part of the pre-war Famos group from Sarajevo and produced parts for vehicles and transport equipment. At the beginning of the present century, it was privatised by tender and began to focus again on producing parts for the automotive industry (for initial build), mostly for companies in Western Europe. The decades of experience and tradition in metalworking and metallurgy represented by such companies in BiH mean it is still possible to achieve excellent results on the basis of modest investment in innovation and adapt production for branches where they previously had no presence.

A particularly good example of successful cooperation between academic institutions and industry in the areas of innovative product development and more particularly of industrial design is how lecturers/teachers at the Academy of Fine Arts of the University of Sarajevo have been working together with Yield and MS&Wood, furniture manufacturing companies based in Sarajevo. Zlatko Tanović established Yield in 2007 and in 2013 began working closely with one of the most respected designers in furniture production in Southeast Europe, Salih Teskeredžić,[24] who teaches at the Academy. It was within the framework offered by Yield that Teskeredžić developed his own product and design brand called Gazzda. He has received a number of prestigious international awards for furniture design for these products. Nataša Perković,[25] a professor at the same Academy, designed a chair for MS&Wood which was awarded at a furniture trade fair in Germany. Avdo Avdagić won the highly prestigious German Design Award at the same trade fair for a sideboard he designed, also produced by MS&Wood.[26][27] Avdo Avdagić and Salih Teskeredžić work together closely on product development at one of the most successful companies in the furniture industry in Southeast Europe – Artisan

[23] See TMD Group webpage, https://tmd-group.ba/respirator-proizveden-u-gradaccu-certificiran-u-britaniji/

[24] Available on https://bigsee.eu/salih-teskeredzic-bosnia-and-herzegovina-big-see-visionary-2019/

[25] Available on https://www.archiproducts.com/en/designers/natasa-perkovic

[26] See: https://www.artisan.ba/en/designers/ado-avdagic

[27] Available on https://www.sarajevotimes.com/company-ms-wood-won-2-prestigious-german-design-awards-2018/

from Tešanj.[28] Another lecturer at the Academy to have achieved a regional and indeed European reputation over the past two decades, in his case in the field of graphic design, at his Sarajevo-based company Fabrika, is Bojan Hadžihalilović.

Nor have Bosnian companies in the fields of the "new economy,"[29] "the intangible economy", or the ICT-based economy, fallen behind their peers in the Western Balkans or, in some cases, even IT companies from Central and Eastern Europe more broadly. When Deloitte Central Europe published its 2019 list of the 50 fastest growing technology companies from Central and Southeast Europe (based on the growth rate in total revenues), the only company from the Western Balkans was a Bosnian company, the Ministry of Programming, whose revenues rose 813% during 2019. Founded in 2015, the company specialises in developing first-rate start-up companies in the sector. According to Deloitte, they have developed first-class services and products in data gathering and analysis, social networks, market development software, and software for discovering viruses. Google, McKinsey, and Rocket Internet have recognised three of the 35 start-up companies in which the Ministry of Programming has invested between 2015 and 2019 as world-class start-ups.[30]

Other highly significant companies from the IT sector to achieve regional and European reputations on the basis of years and indeed decades of investment in R&D include Lanaco and BS Telecom Solutions. In 2016, Lanaco became the first Bosnian company listed on the London Stock Exchange's ELITE programme, amongst the 50 most successful companies in Europe. The following year (2017), the company received a bronze medal at the SAP Quality Awards – SAP ERP for business transformation in central and eastern Europe.[31] Lanaco opened the Lanaco technology centre in Banja Luka in 2016 to promote investment and development of the sector, founding the ITivity Software Academy the following year. Lanaco has a presence throughout BiH, with offices in both Banja Luka and Sarajevo, and is first-rate example of an integrative economic approach to a knowledge-based Bosnian economy. BS Telecom Solutions is another example of an IT sector company

[28] See https://www.dnb.com/business-directory/company-profiles.artisan_doo_tesanj.f79f8c48dde194e74c0f035898df9cde.html

[29] For a recent discussion of the impact of the "new economy" (October 2020), see https://www.brookings.edu/research/whats-new-about-the-new-economy-it-economic-growth-and-productivity/

[30] Deloitte Central Europe: Deloitte Central Europe, "Deloitte Technology Fast 50 Central Europe", at https://www2.deloitte.com/ce/en/pages/about-deloitte/topics/technology-fast-50.html

[31] See LANACO web site - https://www.lanaco.com/nasa-prica/

with good references in the development of IT business solutions and a record of highly successful projects in the Czech Republic, Russian Federation, both entities of Bosnia and Herzegovina, and more recently, in neighbouring Serbia, who have shown that continuous investment in knowledge and innovation is the best path to a European reputation in the contemporary business world. Infobip BH Ltd Sarajevo, a subsidiary of the Croatian company Infobip from Vodnjan, is one of the most successful IT companies in BiH. The company has started the construction of a development campus, which should be completed in 2022 and will serve as the centre for MENA region.

According to the data set out in table 2 (see part two of the text above), in 2018, relative spending on R&D in the four industrially strongest economies of the former Yugoslavia, as a percentage of GDP, was: 2.4% in Slovenia, 0.8% in Croatia, 0.7% in Serbia, and 0.3% in BiH. In table 3, we presented the relative prominence of three sectors in the financing of R&D. The results for the business sector were: 77% for Slovenia, 48% for Croatia, 30% for Serbia, and 20% for BiH. Based on this data, we might conclude that business sector spending in these four countries, expressed as a percentage of GDP, for 2018, was: 1.86% for Slovenia, 0.38% for Croatia, 0.21% for Serbia, and 0.06% for BiH. Consequently, business sector spending on R&D in Slovenia was 35 times higher than in BiH, 8.9 times higher than in Serbia, and 4.9 times higher than Croatia. Total relative investment in R&D in Slovenia that year was eight times higher than in BiH, 3.4 times higher than in Serbia, and three times higher than in Croatia. These highly significant differences between Croatia, Serbia, and BiH in terms of business sector investment in R&D did not result in any major differences in their economic complexity indices or ranking, however. According to the latest rankings, BiH comes just two places after Serbia and only four places behind Croatia.

In other words, the effectiveness of R&D spending and innovative activities at the company level indicates that Bosnian companies achieved very good results with considerably less investment, which may be partially explained by capable management within the metalworking industry, mechanical engineering, the production of car parts, and the woodworking industry, and by the IT sector succeeding to innovate and commercially exploit their products and services, thus capitalising on a stock of knowledge and a tradition developed over decades in the first four industries and on being rather quick learners in the IT sector. A key element for explaining the significant achievement of dozens of Bosnian companies and Bosnia's high-ranking in terms of the Economic Complexity Index (among the top 28% of economies in the world), given the low degree of investment in R&D, on the one hand, and the effectiveness of resources invested in the business sector, on the other, is offered by the analysis given by Radošević of the sources of innovation in his paper.[32] Radošević points out, with reference to an earlier paper by Lorenz and Lundvall, that innovation doesn't just happen as a result of public sector investment in R&D, because it is essentially a consequence of "doing-using-interacting" work that draws on the productive and business experience of entrepreneurs and innovators. This aspect of the analysis of innovation and the relatively high degree of product complexity helps to explain the high ranking of Serbia, Croatia, and in particular Bosnia and Herzegovina, given their actual levels of public sector spending on R&D activities.

5. Conclusion

The analysis of global and regional experiences in financing R&D indicates that the world economies with the highest GDP or the highest GDP per capita account for more of global spending on R&D than of global GDP. South Korea is a very good example of a small open economy that has achieved exceptional technological results and global competitiveness across several industrial branches over the past three decades. The country is proof that targeted and effectively controlled planned investment in research and development can result in technological breakthrough onto global markets. The two largest economies in the world by GDP, the US and China, are also the two largest investors in research and development in absolute terms. The Scandinavian countries and the major Western European countries also offer good examples of the payoff from investment in research and development, but also the seeming need for such investment to be above-average vis-à-vis share in world GDP.

Global experiences and trends in financing research and development have been most successfully mirrored and applied in Central and Southeast Europe by Slovenia, the best performing country in transition in terms of per capita GDP. This country in transition and former member of the Socialist Federative Republic of Yugoslavia is not just the regional leader in relative investment in research and development, but number 11 in the world overall.

[32] Slavo Radoševič (2021) "Public R&D and Science – Industry Links in Economic Development: Implications for Bosnia and Herzegovina," London (June). Paper prepared for ANUBIH conference "System of R&D in Bosnia and Herzegovina" to be held on 5 November 2021, pp.8-9.

The approach taken by Slovenia and her national and economic policymakers and so the creators of her scientific and research development strategy has pushed this small country into 12th place worldwide in terms of the economic complexity index and into the group of countries with a very high human development index. The other central or south-eastern European countries with high levels of investment in research and development include the Czech Republic and Hungary, whose economies have experienced significant successes in the past decade.

Slovenia, of course, was the best placed of the former Yugoslav countries, while the other former Yugoslav countries have and continue to invest considerably less in R&D. Croatia and Serbia are well below the world average in investment for these purposes, while Bosnia and Herzegovina is the country with the second lowest level of investment in R&D in Central and Southeast Europe, after Albania, This very low level of investment in Bosnia and Herzegovina is at least in part a consequence of objective factors, but also in part due to the extremely misguided approach of government to organised investment in R&D and its importance for the future development of society, competitiveness, and export capacity. The most significant objective factor is Bosnia and Herzegovina's very different starting position on entering transition compared to the other countries in transition, and particularly the other countries of the former Yugoslavia, given the extremely heavy war-related destruction the country suffered, which was a multiple of the damages suffered by all other members of the former Yugoslavia combined. One consequence is that the BiH entities spend four times more on social security for civil victims of the war and disabled veterans than the other worst affected member of that former state.

On the other hand, there is really no excuse for a government that was unwilling to make room in the structure of available and, up until the Covid crisis, growing tax revenues for the goals of financing R&D which those same authorities set themselves in their own key development documents, ratified at all the various levels of government. One direct consequence of this approach has been the continued outflow of the best young scientists and researchers, generally to the countries of Western Europe, the UK, and the US. While the business sector in Bosnia and Herzegovina has not invested much in R&D, the business results achieved by companies in the metalworking industry, mechanical engineering, the automotive and woodworking industries, and in the ICT sector have helped put Bosnia and Herzegovina amongst the top 28% of countries in terms of the Economic Complexity Index. The talent, production-oriented knowledge, and capacity learned by employees in these industries by working or rather by innovating offer major scope for significantly improving the quality of life and of the economy in Bosnia and Herzegovina, but this proven potential may in the coming years and decades equally and with relative ease cease to be such a leading contributory factor to the Bosnian economy's surprisingly high-ranking in terms of the Economic Complexity Index, given the overall very modest level of investment in R&D, if those authorities and the economic-policy makers in Bosnia and Herzegovina do not radically change their attitude regarding the universal truism that investment in R&D is an extremely important precondition for improving both quality-of-life and the structure of the economy.

References

Academy of Sciences and Arts of Bosnia and Herzegovina. "Harmonizacija sistema nauke u Bosni i Hercegovini" – Federal Statistics Bureau, "Rezultati statističkog istraživanja", Sarajevo, 2020.

Academy of Sciences and Arts of Bosnia and Herzegovina. "Izvještaj o radu Akademije nauka i umjetnosti Bosne i Hercegovine za period od 1.jula 2017. do 31. decembra 2020. Godine", Sarajevo, December 2020.

Akta.ba - https://www.akta.ba/vijesti/novi-uspjeh-bh-pameti-nova-cnc-masina-najveca-na-balkanu/124096 ; https://www.akta.ba/Firma/procassa-fischer-doo/279490

Biznis.Info - https://www.biznisinfo.ba/sarajevska-kompanija-predstavila-novu-cnc-masinu-vlastite-proizvodnje/

Bljesak.info - https://www.bljesak.info/gospodarstvo/tvrtke/Zenicki-TPS-Proizveli-uredaje-za-obradu-dijelova-za-Ferrari-i-Maserati/290228

CountryEconomy - https://countryeconomy.com/countries/compare/

Deloitte Central Europe, "Deloitte Technology Fast 50 Central Europe", at:
https://www2.deloitte.com/ce/en/pages/about-deloitte/topics/technology-fast-50.html

Croatian Academy of Sciences and Arts (HAZU) – Academy financial planning documentation – at: http://info.hazu.hr/hr/o-akademiji/fin_planski_dok/

HAZU budget: http://info.hazu.hr/upload/File/2020/ODLUKE-2020/PRORA%C4%8CUN-2021.pdf

LANACO - https://www.lanaco.com/nasa-prica/

Radošević, Slavo (2021) "Public R&D and Science – Industry Links in Economic Development: Implications for Bosnia and Herzegovina," London (June). Paper prepared for ANUBIH conference "System of R&D in Bosnia and Herzegovina" to be held on 5 November 2021.

SpendMeNot - https://spendmenot.com/blog/top-rd-spenders/

The Brookings Institution - https://www.brookings.edu/research/whats-new-about-the-new-economy-it-economic-growth-and-productivity/

The Czech Academy of Sciences, "2019 Annual Report of the Czech Academy of Sciences," Prague, 2019, at:https://www.avcr.cz/opencms/export/sites/avcr.cz/.content/galerie-souboru/vyrocni-zpravy/VZ-AV-CR-ENG.pdf

The Observatory of Economic Complexity (OEC) - https://oec.world/en/profile/country/bih

The World Bank Database - https://data.worldbank.org/indicator/NY.GDP.MKTP.CD

TMD Group - https://tmd-group.ba/respirator-proizveden-u-gradaccu-certificiran-u-britaniji/

UIS – UNESCO Institute for Statistics: http://uis.unesco.org/apps/visualisations/research-and-development-spending/

Bosnia and Herzegovina Council of Ministers. "Strategija razvoja nauke u Bosni i Hercegovini – Revidirani document", Sarajevo, September 2016. At: https://ekonsultacije.gov.ba/legislativeactivities/details/14-prijedlog-revidiranog-dokumenta-strategije

Republika Srpska Government. Ministry For Scientific and Technological Development, Higher Education, and the Information Society, "Mapa puta istraživačkih infrastruktura u Republici Srpskoj (Bosna i Hercegovina) – Mapa puta istraživačkih infrastruktura u Republici Srpskoj", at:
https://www.vladars.net/sr-SP-Cyrl/Vlada/Ministarstva/mnk/Documents/RIRS-Road-Map-SR.PDF

DOI: 10.5644/PI2021.200.17

Role and importance of companies in shaping and functioning of the innovation system

Zijada Rahimić[*]

Abstract: By continuously strengthening research and development (R&D) activities and innovative capabilities, companies are achieving long-term sustainable competitive advantages in today's increasingly complex and uncertain markets. At the same time, by creating new knowledge, innovative application of existing knowledge and technologies, and facilitating their transfer, they contribute to building a knowledge economy and the country's competitiveness. One of the pillars of the knowledge economy is an effective innovation system, in which companies have a special place and role. The aim of this paper is to present and analyse the contribution of companies to the efficient functioning of innovation systems, to examine the relationship and impact of innovation and R&D expenditures on global competitiveness. The Global Innovation Index (GII) and the Global Competitiveness Index (GCI), in which innovation and sophistication represent one of the three categories of competitiveness, were used as a methodological framework for analysing the effects of innovation capabilities. The focus of the analysis was the relationship between innovation inputs and innovation outputs, as well as the relationship between the GII and GCI of Bosnia and Herzegovina, the countries of the Western Balkans and the group of selected countries of the European Union (EU). The research results show that there is a statistically significant relationship between innovation inputs and outputs. There are obvious differences in the strength of the link between the variables of innovation and competitiveness for the countries of the Western Balkans and for selected EU member states. It was also found that R&D expenditures significantly affect the value of the competitiveness index.

Key words: innovation system, knowledge economy, research and development, Global Innovation Index, Global Competitiveness Index

1. Introduction

In today's dynamic, uncertain environment characterized by globalization, extremely fast development of information and communication technologies, and the increasingly rapid obsolescence of knowledge, innovation and knowledge are especially important for building and maintaining a competitive position. In the modern economy, knowledge and innovation are key factors

[*] Prof Dr, Faculty of Economics, University of Sarajevo.
E-mail: zijada.rahimic@efsa.unsa.ba

in the long-term sustainable survival and development of enterprises.[1] The generation and use of knowledge plays a key role in the creation of national wealth in knowledge-based economies, which represent the modern paradigm of competitiveness of national economies. In that sense, the purpose of this paper is to point out the importance of innovative abilities and R&D activities of companies for achieving their competitive advantages, for building and functioning of innovation systems and strengthening the competitiveness of the national economy. The subject of research are the concepts of innovation systems, and ways of measuring innovation performance and competitiveness. The aim of the paper is to present and analyse the contribution of companies to the functioning of innovation systems, to examine the relationship between innovation inputs and outputs, innovation and global competitiveness, as well as the strength of the impact of R&D expenditures on economic competitiveness.

Following the defined subject and set research goals, the paper is structured so that after the Introduction, the characteristics and importance of innovations and innovation systems are presented as one of the pillars of the knowledge-based economy in achieving competitive advantages. Special attention in this, the second part of the paper, is focused on the role of companies in the functioning of innovation systems. Then, various indices are listed, which aim to showcase and compare the results of innovation and global competitiveness of an economy with a focus on the presentation of the Global Innovation Index (GII) and the Global Competitiveness Index (GCI). Using these indices, an empirical research was conducted and the results of the analysis for BiH, the countries of the Western Balkans and selected EU countries are presented. Finally, the conclusion presents the basic findings based on the results of theoretical and empirical research, and emphasizes the importance of companies for the effective and efficient functioning of innovation systems.

2. Innovation system as one of the pillars of knowledge economy

Constant changes, as a key characteristic of today's environment, are reflected, among other things, in the transition of classical industry to the technological era, ie in the fact that industries based on natural resources have been replaced by the so-called brainpower industries. The most developed

[1] Jovičić J. & Petković S. (2016). Inovacije kao faktor konkurentnosti privrede s osvrtom na Bosnu i Hercegovinu, Obrazovanje za preduzetništvo, 6(1), 2016, p. 102.

countries of today have achieved their success precisely by switching from a capital-intensive to knowledge-intensive economy.[2] The generation, dissemination and effective use of knowledge play a key role in the creation of national wealth in these economies. Thus, the knowledge-based economy became the dominant economy of the twenty-first century.

The pillars of the knowledge-based economy include: human resources, modern and adequate information infrastructure, an effective innovation system and an institutional regime. The innovation system in a broader sense represents a functional unit of all public and private entities and institutions that directly participate in the creation of new knowledge through fundamental, applied and development research, innovative application of existing knowledge and technologies and facilitating their transfer within the country and in international exchange.[3] In the context of the knowledge economy, it is important to point out the existence of partial coincidence and functional complementarity between the system of science on the one hand and the narrowly implied innovation system on the other, so that these terms are also used as synonyms.[4]

Having in mind the subject of research, the following segments will explain in detail the characteristics and importance of innovations and innovation systems in building the competitiveness of an economy, as well as the role of companies in the functioning of an innovation system. The most important indicators of innovativeness and competitiveness of an economy will also be presented.

2.1. Importance of innovations and innovation systems in achieving competitiveness of an economy

Innovation and innovation systems are becoming increasingly interesting to policy makers as means to achieving economic and social goals. Innovation is at the heart of the European Union's strategy because it provides "the best means of successfully addressing major societal challenges" (European

[2] Rahimić Z. & Kožo A. (2009). Building and Development of the Knowledge Based Economy in Bosnia and Herzegovina. Journal of Interdisciplinary Management Research, Vol. V, January 2009, p. 112.
[3] Trifković M. (2020). Harmonizacija sistema nauke u Bosni i Hercegovini, Academy of Sciences and Arts of Bosnia and Herzegovina, Centre for Systemic Research, volume 5/1, special editions, Sarajevo, p. 34.
[4] Trifković M.(2020), p. 40.

Commission, 2010).[5] It has also recently been pointed out that research, innovation and education are crucial for Europe in the transition to climate neutrality and digital leadership. European industry, economy and society are changing at the speed of light, representing a unique opportunity to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy that works for the people.[6]

The term innovation is often connected to technological changes, which include a new or innovative way of working or producing existing products or producing completely new products. However, all changes and all improvements within a company, but also in other spheres of life, can be covered under the concept of innovation.

R&D based knowledge is considered to be the most reliable source of innovation. However, other ways of acquiring and accumulating knowledge, such as "learning by doing" and "learning by using", are also extremely important. The perspective of practice conceptualizes the innovations located in the daily activities of organizing, learning and working. People create new knowledge as they work to solve problems they face in practice. In other words, knowledge, work and innovation are intertwined. In the knowledge economy, the creation of a knowledge base depends on the synergies achieved between the three main actors in an economy: the academia, the business community and the government.

Innovation is becoming an increasingly important factor in the fight to preserve and improve the competitive position of companies in the domestic and international market.[7] In the global economic context, innovation has become a fundamental and decisive pillar of a country's development and its potential success. More precisely, innovation is an instrument of country's economic security and a factor in improving international competitiveness.[8] The positive correlation between innovation and economic development has

---

[5] Schrempf B., Kaplan D. & Schroeder D. (2013). National, Regional, and Sectoral Systems of Innovation–An overview. *Report for FP7 Project" Progress". European Comission*, http://ec.europa.eu/europe2020/index_en.htm, p.3.

[6] Science, Research and Innovation Performance of the EU 2020, A fair, green and digital Europe, European Commission, https://ec.europa.eu/info/publications/science-research-and-innovation-performance-eu-2020_en

[7] Rahimić Z. (2006). Izgradnja konkurentskih prednosti preduzeća kroz njegova strateška opredjeljenja, Faculty of Economics Sarajevo, p. 275.

[8] Chuvakhina L.G., Terskaya G.A. & Buevich S.Y.(2018). Innovations as a factor of state's improved performance in the World Economic System,Revista Espacios, Vol. 39 (# 04) Year 2018.

been confirmed in numerous empirical and theoretical studies,[9] and it has been pointed out that increased innovation capabilities can lead to significant industrial development and the development of society in general.[10]

Increased awareness of the importance of innovation for economic growth has resulted in the development of the concept of a national innovation system (NIS). Special credit for the development of this concept is attributed to the British economist Christopher Freeman, who defines the national innovation system as a network of private and public sector institutions that initiate, import, modify and disseminate innovation through mutual interactions.[11] NIS can be viewed as a socio-economic system in which various actors communicate, such as companies, research and academic organizations, public administration, professional intermediaries and other formal and informal institutions. NIS uses all available resources in the country, such as human, financial, infrastructural and institutional resources. NIS can also be considered an intangible asset[12] that contributes to a country's economic growth, value creation and well-being.

The concept of national innovation systems is based on the assumption that the economic growth of a country, as a result of technological progress, does not depend so much on the size of R&D resources, but on the way of organizing and managing these resources at the national level. This attitude is especially important for small countries and developing countries, which, as a rule, do not have significant innovation capacity.[13] Therefore, the national innovation system should be thoroughly examined in the context of developing countries,[14] taking into account the capacity of knowledge production as well as the absorption capacity of end users, and the role of innovation policies.

---

[9] Kaynak S., Altuntas S. & Dereli T. (2017). Comparing the innovation performance of EU candidate countries: an entropy-based TOPSIS approach, Economic Research-Ekonomska Istraživanja, 30:1, pp. 31-54.

[10] Yongabo P. & Göransson B. (2020). Constructing the national innovation system in Rwanda: efforts and challenges, Innovation and Development.

[11] Freeman, C. (1995). The "National System of Innovation" in historical perspective. Cambridge Journal of Economics, 19 (1) 5–24., taken from Cvetanovic D. (2020)

[12] Gogodze J. (2016). Mechanisms and Functions within a National Innovation System, Journal of Technology Management&Innovation,Universidad Alberto Hurtado, Facultad de Economía y Negocios. Volume 11, Issue 4, pp. 12-21.

[13] Cvetanovic D., Cvetanović S. & Bogić D. (2020). Rastući značaj koncepta regionalnih inovacionih sistema za ekonomski i društveni razvoj, https://konferencija.komorapirot.com/44.RASTUCI%20ZNACAJ%20KONCEPTA%20REGIONALNIH%20INOVACIONIH%20SISTEMA%20ZA%20EKONOMSKI%20I%20DRUSTVENI%20RAZVOJ.pdf

[14] Yongabo P. & Göransson B (2020). Constructing the national innovation system in Rwanda: efforts and challenges, Innovation and Development, DOI:10.1080/2157930X.2020.1846886

The concept of efficiency of a national innovation system is directly related to the concept of productivity. An innovation system is considered to be efficient when it generates more innovation results with the same amount of innovation inputs, ie when fewer inputs are needed to create the same volume of innovation.[15]

The Oslo Manual (OECD, 2005) identifies four factors that affect the efficiency of the innovation process: framework conditions, science and technology institutions, transmission mechanisms, and company-specific innovative drives. The general framework conditions shape the activities of enterprises and their ability to perform innovative activities. The efficiency of science and technology institutions drives the accumulation of knowledge. Transmission mechanisms improve the flow of information and skills between stakeholders and ensure that innovative ideas reach the market. Finally, companies themselves need to identify and use the potential for innovation to strengthen the innovation process. The presented factors correspond to certain areas of intervention policies. The government is expected to create measures to address potential barriers and set priorities.[16] Generally, the state is considered to be the most influential factor in most national innovation systems, as it finances most of the fundamental research and development activities in the country.[17]

In addition to these factors, historical heritage can have a profound impact on the shape of national innovation systems.[18] Indeed, historical events and social norms in each country have had a major impact on the form of institutions, the articulation of priorities, and the results of innovation. However, thanks to the trend of continuous learning, the differences between national innovation systems observed in previous decades are less obvious today.[19] For

[15] Jankowska B., Matysek-Jędrych A. & Mroczek-Dąbrowska K. (2017). Efficiency of national innovation systems: Poland and Bulgaria in the context of the Global Innovation Index, Comparative Economic Research, De Gruyter, Warsaw, Vol. 20, issue 3, pp. 77-94.

[16] OECD (2013). Triple Helix partnerstva za inovacije u Bosni i Hercegovini, Razvoj privatnog sektora – Priručnik za politike, Sarajevo, p. 17. and OECD (2005), Oslo Manual: Guidelines for collecting and interpreting innovation data, issue 3, OECD, Paris.

[17] Melaas A. & Zhang F. (2016). National Innovation Systems in the United States and China: A Brief Review of the Literature, The Center for International Environment&Resource Policy, Tufs University.

[18] Radošević S. (2002). Regional innovation systems in Central and Eastern Europe: Determinants, organizers and alignments. J. Technol. Transf. 2002, 27, 87–96. Taken from: Mosurović Ružičić M., Miletić M. & Dobrota, M. (2021). Does a National Innovation System Encourage Sustainability? Lessons from the Construction Industry in Serbia. Sustainability 2021, 13, 3591, p. 5.

[19] Fatma A. (2018). Overview of the Japanese Innovation Systems vs. the American Innovation System. J Glob Econ 6: 312.

example, Japan's innovation system is based on "alternative energy technology" or energy efficiency, and the dominant concept in the United States is "innovation ecosystem."

Innovation systems can operate at national, regional or international level. Regardless of the level, the observation dimension of the innovation system emphasizes the importance of producing and using new knowledge in creating value.[20] In the process of production and dissemination of knowledge, the engagement of all actors, trust and loyalty among the actors and a supportive environment are considered particularly important.[21]

2.2. The role of companies in the functioning of an innovation system

Initial research into national innovation systems, in the early 1990s, aimed to measure companies' innovation performance through the development of new products, as well as their ability to absorb innovative technologies.[22] It was during this period, at the end of the 20th century, that the company's success was based on innovative ability due to the growing uncertainty and turbulence of changes in the environment, unlike in the 60's when the company's goal was to increase production, or 70's when focus was on reducing production costs, and the 80's when companies aimed to achieve high quality. The innovative capabilities of companies contribute to achieving and maintaining their own competitive advantages, as well as the country's competitiveness. Starting from the fact that market dynamics and market uncertainty will increase in the future, it can be said that companies should strive to strengthen their R&D activity, ie to strengthen innovation capabilities. The R&D activity of a company depends not only on the capabilities of the company but also on factors from the external environment. Among them, the attitude of the government (state) towards scientific research, the strong connection between scientific research institutions (universities and institutes) with economic entities, the speed of technological transfer and the rate of obsolescence of technologies, which is related to the type of business. Therefore, recent research has focused on the specific roles of other actors within the innovation

---

[20] Schrempf B., Kaplan D. & Schroeder D. (2013). National, Regional, and Sectoral Systems of Innovation–An overview. *Report for FP7 Project" Progress". European Comission*.

[21] Chaminade, C. & Lundvall B. (2019). Science, Technology, and Innovation Policy:Old Patterns and New Challenges. Oxford: Oxford University Press.

[22] Melaas A. & Zhang F. (2016). National Innovation Systems in the United States and China: A Brief Review of the Literature, The Center for International Environment&Resource Policy, Tufs University.

system, such as the role of government in creating incentives and the role of universities in conducting research.[23] In this sense, it is interesting to note that the EU supports industry research and innovation, as two thirds of investments in R&D and private sector development generates 80% of EU exports.[24]

The Conceptual Model for Analyzing Industry-Science Relations[25] is considered a tool for raising the competitiveness and technological performance of companies using the knowledge available in public research. The goal of promoting the relationship between industry and science is to ensure that public investment in higher education spills over to businesses and makes that investment economically productive. The model of the relationship between industry and science is considered to be the result of activities of actors in the "knowledge market", which is characterized by high asymmetry of information between participants and low market transparency, high transaction costs of knowledge exchange, restrictions on financing production and knowledge exchange due to financial markets reluctant to risk and with short-term orientations. The performance of the industry-science relationship is influenced first by the characteristics of the main stakeholders (companies and public scientific institutions) through supply and demand in the national knowledge market, secondly by framework conditions such as infrastructure, legislation and regulations and institutional settings, and thirdly by the intensity of mutual communication between industry and science.

Innovation can be encouraged by applying the Triple Helix model, i.e. cooperation between the academic and business community and the local government.[26] Coordinated activities of all three stakeholders and efficient communication enable the achievement of synergetic effects and the creation of higher value.[27] In theory and practice, there are three more models of knowledge creation and innovative creativity. Thus, the Quadruple Helix model is based on the Triple Helix model and adds the society based on culture and

---

[23] Melaas A. & Zhang F. (2016).

[24] https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation_en

[25] Polt W., Rammer Ch., Schartinger D., Gassler H. & Schibany A. (2001). Benchmarking Industry-Science Relations in Europe – the Role of Framework Conditions, Science and Public Policy 28 (4), August 2001., pp. 247-258.

[26] Leydesdorff L. & Strand Ø. (2013). The Swedish System of Innovation: Regional Synergies in a Knowledge-Based Economy, Journal of the American Society for Information Science and Technology.

[27] OECD (2013). Triple Helix partnerstva za inovacije u Bosni i Hercegovini, Razvoj privatnog sektora – Priručnik za politike, Sarajevo, p. 17. and OECD (2005), Oslo Manual: Guidelines for collecting and interpreting innovation data, 3.issue, OECD, Paris.

media and civil society as the fourth spiral. The Quadruple Helix is associated with the media, the creative industry, culture, values, lifestyle, art. The five-fold Quintuple Helix adds as a fifth spiral - the natural environment. The Quintuple Helix can be proposed as a framework for a transdisciplinary (and interdisciplinary) analysis of sustainable development and social ecology.[28]

Special emphasis in the process of creating innovation is placed on the phenomenon of industrial clusters, which contribute to the quality of the business environment and are an important factor in improving competitiveness.[29] In literature, "industrial clusters" along with the concepts of "innovative milieus" and "self-learning regions",[30] can be found under the common name of spatial innovation systems. Spatial innovation systems[31] include (encompass) interconnected enterprises in specific sectors, together with relevant suppliers and the service sector, as well as a number of supporting institutions, including universities, institutes, laboratories, professional associations and agencies. This is especially important for small businesses, as they have fewer resources and opportunities for internal research of their own. Interaction with other small and micro companies facilitates access to new knowledge, which becomes a source for their innovation.[32]

The existing foundations of cooperation within the innovation system can be supplemented by advocating a culture of opening scientific and innovation processes, i.e. open innovation and open science.[33] The new paradigm of openness will therefore not replace the existing foundations of cooperation,

---

[28] Ješić J. (2015). Model četverostruke spirale (Quadruple Helix Model) kao osnova nacionalnog inovacionog sistema, doktorska teza, Univerzitet Edukons Fakultet poslovne ekonomije Sremska Kamenica, Novi Sad.

[29] Porter M. & Stern, S. (2002). National innovative capacity. In K. Scwab, M. Porter, & J. Sachs (Eds.), The global competitiveness report 2001–2002, 102–118. New York, NY: Oxford University Press.

[30] Puljiz, J. (2009). *Faktori regionalnog razvoja i regionalnih nejednakosti u Republici Hrvatskoj*. Doctoral dissertation, Faculty of Economics, University of Split, Split, p. 40.

[31] Despotović D. & Cvetanović S. (2017). The theoretical explication of the factors of regional growth and the economic convergence (divergence) of the region, Economic Horizons, May - August 2017, Volume 19, Number 2, 111 – 125.

[32] Rigg C., Coughlan P., O'Leary D. & Coghlan D. (2021). A practice perspective on knowledge, learning and innovation – insights from an EU network of small food producers, Entrepreneurship & Regional Development.

[33] Hetze P. & Meyer M. (2018). Was bringt die Oeffnung von Wissenschaft und Innovation? Stifterverband Bildung. Wissenschaft.Innovation, Berlin and Warnke P. et al. (2016). Opening up the innovation system framework towards new actors and institutions, Fraunhofer ISI Discussion Papers - Innovation Systems and Policy Analysis, No. 49, Fraunhofer ISI, Karlsruhe.

but will complement them, which will enable companies to more easily and quickly transform into Knowledge-Creating Companies[34] and Learning Organizations. With such a business approach and strategic commitment, these companies manage to build a long-term sustainable competitive advantage, intensify cooperation with universities, and contribute to the efficiency of innovation systems, faster economic growth and competitiveness of the country.

2.3. Indicators of economy's innovativeness

Today, we are witnessing an explosion of research that attempts to show and compare the results of innovation in the broadest sense.[35] Various organizations and researchers have developed a number of complex indicators to measure innovation at the state level.[36] The most comprehensive insight into the innovation capacity and innovation performance of an individual country is provided by: 1. Global Innovation Index (GII), 2. Bloomberg Innovation Index, and 3. European Innovation Scoreboard. In addition to the above indices, which are exclusively focused on innovation, there are indices that deal with broader topics such as competitiveness, but also in part with innovation, e.g. Global Competitiveness Index (GCI). The results of examining the content[37] of the Global Competitiveness Index, the Human Development Index, the Knowledge Economy Index, the European Innovation Scoreboard indicate that these indices provide very similar information.[38] Below is a brief description of the specifics of the two indices which were used in the empirical research: the Global Innovation Index (GII) and the Global Competitiveness Index (GCI).

---

[34] Vukotić S., Zakić N. & Ćurčić N. (2017). Menadžment znanja i upravljanje inovacijama kao izvor poslovnog uspeha i konkurentske predosti preduzeća, Fourth scientific-expert gathering POLITEHNIKA 2017, pp. 436-442.

[35] Adam F. (2014). *Measuring National InnovationPerformance – the Innovation Union Scoreboard Revisited.* Slovenia, Ljubljana: Springer.

[36] Gogodze J. (2016). Mechanisms and Functions within a National Innovation System Journal of Technology Management & Innovation © Universidad Alberto Hurtado, Facultad de Economía y Negocios. Volume 11, Issue 4, p. 12.

[37] Wojciech N. (2016). Composite Indexes Economic and Social Performance: Do They Provide Valuable Information, Foundations of Management, Vol. 8, pp. 167- 174.

[38] Kaynak S., Altuntas S. & Dereli T. (2017). Comparing the innovation performance of EU candidate countries: an entropy-based TOPSIS approach, Economic Research-Ekonomska Istraživanja, 30:1, 31-54.

The Global Innovation Index was created in collaboration between two business schools, "Cornell - SC Johnson College of Business" and "INSEAD - The Business School for the World", and UN's World Intellectual Property Organization - WIPO. Recognizing the key role of innovation as a driver of economic growth and prosperity, the GII includes indicators that go beyond traditional metrics of innovation. This index has linked the economic indicators that affect the country's innovation by combining them into a specific framework.

The analysis of innovation activity according to GII is composed of seven pillars of innovation grouped into two sub-indices: innovation input (III-Innovation Input Index) and innovation output (IOI-Innovation Output Index).[39] Innovation input is actually an infrastructure that enables innovation, develops an innovation culture and encourages innovative behaviour. These include: institutions, human capital and research, infrastructure, market sophistication, and business sophistication. The end result of innovation is presented in innovation output, which includes two sub-indices: knowledge and technology outputs and creative outputs. The essence of the report is reflected in the ranking of innovation capabilities and results of world economies, and in the presentation of the strengths and weaknesses of a particular country. GII enables economies to analyse their innovation performance, create appropriate innovation policies and set priorities in taking measures to strengthen innovation activity. In addition, it acts proactively, e.g. GII 2020 explores new methods of financing innovation in the post-COVID world, which are urgently needed at a time when the global economic situation is significantly aggravated by the consequences of the global pandemic.

The Global Competitiveness Index developed by the World Economic Forum (WEF) is used to rank countries based on an analysis of 12 pillars of competitiveness grouped into three sub-indices (basic factors, factors of efficiency gains and innovation and sophistication factors). Countries whose economy is based on basic factors according to the global competitiveness index are at the first level of development. Maintaining competitiveness at this level of development depends primarily on well-functioning public and private institutions (pillar 1), well-developed infrastructure (pillar 2), a stable macroeconomic environment (pillar 3) and a healthy workforce that has acquired at least primary education (pillar 4). At the second level of development are countries that achieve more efficient production processes and

[39] Bilas V., Bošnjak M. & Novak I. (2019). Inovacijska izvedba zemalja članica Europske unije, Oeconomica Jadertina 1/2019., pp. 34-44.

growing product quality. At this stage, the growth of competitiveness is influenced by higher education and vocational training (pillar 5), efficient market of goods (pillar 6), efficient labour market (pillar 7), developed financial market (pillar 8), technological readiness (pillar 9) and market size (pillar 10). Finally, at the third level are countries whose economies are based on innovation or the rapid adoption of innovative technologies. At this level, the growth of competitiveness is conditioned by factors of high business sophistication (pillar 11) and innovation (pillar 12). There are also groups of countries that are in transition between the first and second, or the second and third levels. For years, Bosnia and Herzegovina has been in the group of countries whose economies are based on efficiency, along with Albania, Macedonia, Montenegro and Serbia. Of the countries in the region, only Croatia is in the group of countries in transition from an efficiency-based economy to an innovation-based economy.[40]

The World Economic Forum has been measuring the competitiveness of national economies since 1979 and publishes an annual Global Competitiveness Report. The last change in the methodology was carried out during 2018, when a new method of calculating the GCI 4.0 index was introduced, and according to the same the Global Competitiveness Report for 2019 was prepared. Therefore, in the empirical part of this paper, the GII for the period 2008-2018 will be used to conduct an analysis of the impact of innovation on the competitiveness of selected countries.[41]

3. Results of the empirical research

In accordance with the set goals of the research, a comparative analysis was conducted of the Global Innovation Index (GII), the Innovation Input Index (III), the Innovation Output Index (IOI) combined, and relative to seven variables listed in section 2.3.[42] Chart 1 shows the said variables for BiH, the countries of the Western Balkans (Albania, BiH, Montenegro, Northern Macedonia and Serbia) and selected EU countries, namely: Austria, Bulgaria, Greece, Croatia, Hungary, Germany, Romania and Slovenia. Then, a regression-correlation analysis between innovation inputs and innovation outputs

[40] CPU-Centre for Policy and Governance, Competitiveness of Economy in BiH and the Region 2014-2018.

[41] https://tcdata360.worldbank.org/indicators/gci?indicator=632&viz=line_chart&years=2007,2017&indicators=944

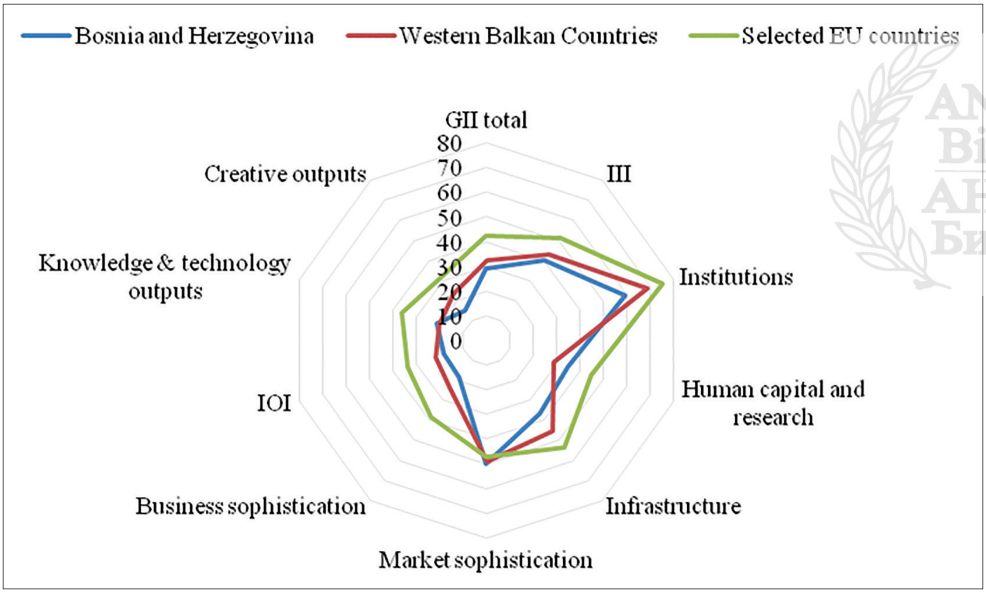
[42] https://www.globalinnovationindex.org/analysis-indicator

was performed,[43] and a regression-correlation analysis between innovativeness and global competitiveness. The aim was to examine the relationship between R&D expenditure and innovative activities and the competitiveness of the economy.

3.1. Comparative analysis of innovation performance of BiH and selected countries

Based on the data on the values of GII, III, IOI, as well as their basic components for Bosnia and Herzegovina, the countries of the Western Balkans and the selected EU member states, a graphic presentation no. 1 was created. It presents the relationship between the analysed innovation variables, which reflect the innovativeness of selected countries.

Figure 1. Comparative analysis of innovation variables



Source: Authors' calculation based on GII data for 2020
https://www.globalinnovationindex.org/analysis-indicator

The differences are clearly noticeable, i.e. lower values in innovation performance between BiH, the Western Balkans and selected EU member states

[43] Cvetanović S., Despotović D., Mladenović I. & Jovović D. (2014). The analysis of innovation in Western Balkan countries in 2012, Economic Research-Ekonomska Istraživanja, 27:1, 830-846.

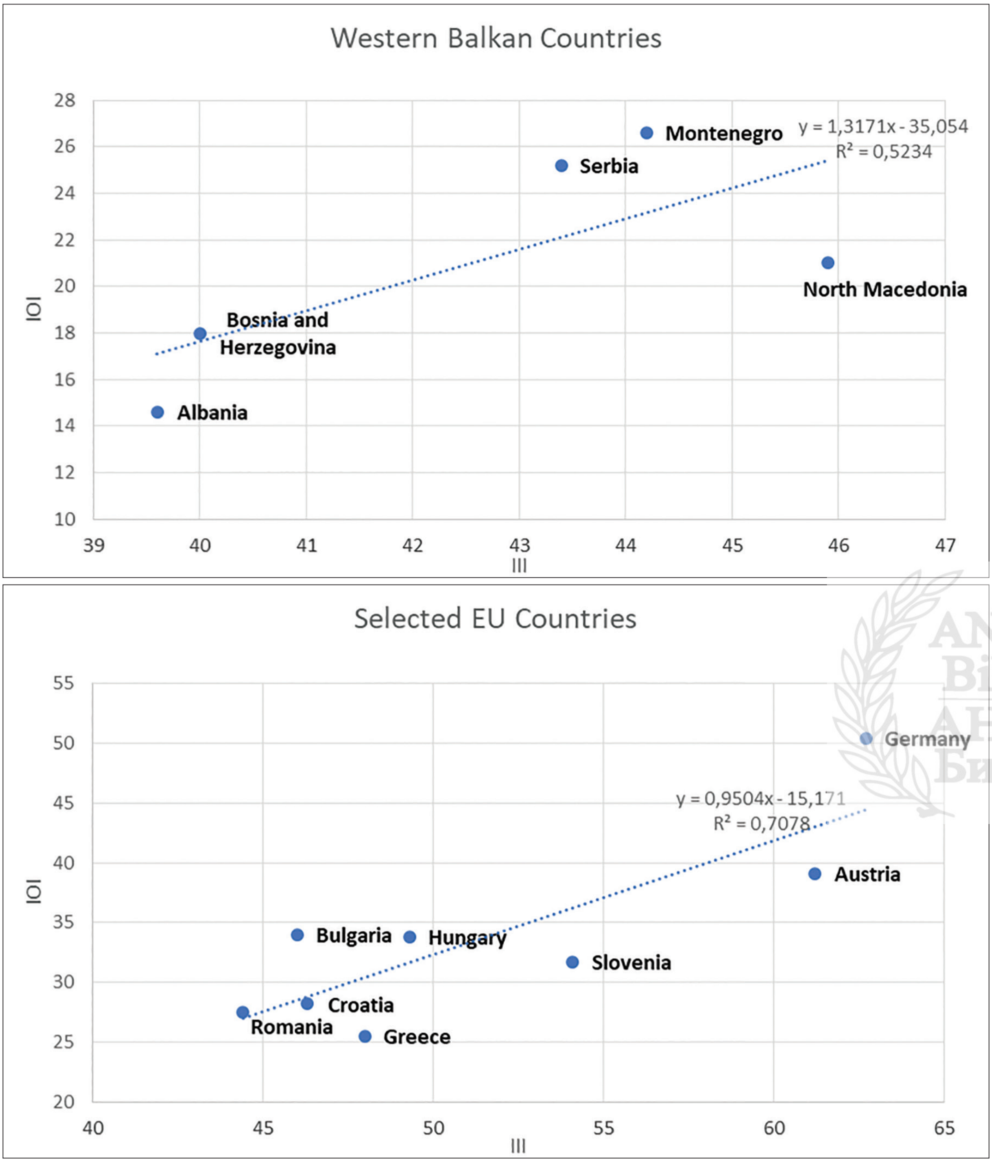
with the exception of the market sophistication dimension. BiH has high results compared to the countries of the region in the dimension of human capital and research, and is slightly better in terms of market sophistication and knowledge and technology outputs.

According to the 2020 Report of the Global Innovation Index, Bosnia and Herzegovina ranked 74th out of 131 countries, while in 2019 it was ranked 76th. The Global Innovation Index (GII) lists the following areas in 2020 as relative strengths: Human Capital, Market sophistication, Knowledge and technology outputs. Bosnia and Herzegovina achieves below-average results for its income group in four pillars: Institutions, Infrastructure, Business sophistication and Creative outputs. Even more precisely, we can list some identified particularly pronounced weaknesses in the context of our research, namely: Ease of starting a business (130th place), Innovation linkages (123rd place); Knowledge absorption (128), University/industry research collaboration (124).

3.2. Correlative analysis of innovation and competitiveness indexes

In addition to the comparative analysis of innovation variables, regression-correlation analyses were performed, namely: analysis of correlation, relationships between III (Innovation Input Index) as an independent variable and IOI (Innovation Output Index) as dependent variable for the countries of the Western Balkans and selected EU countries in 2020, and analysis of the relationship between innovation and competitiveness (GII as independent variable and GCI as dependent variable). The standard way to show the relationship between two variables is a scatter chart. In addition to the scatter chart, the results of regression-correlation linear models are presented in the figures. The representativeness of regression models is expressed by the coefficient of determination (R2), and based on that value the strength of the linear relationship, presented through regression models, is interpreted (as a share of explained variability, due to changes of independent variable, in the total variability of the dependent variable).

Figure 2. Scatter chart and regression-correlation model for III and IOI for the countries of Western Balkans and selected EU countries

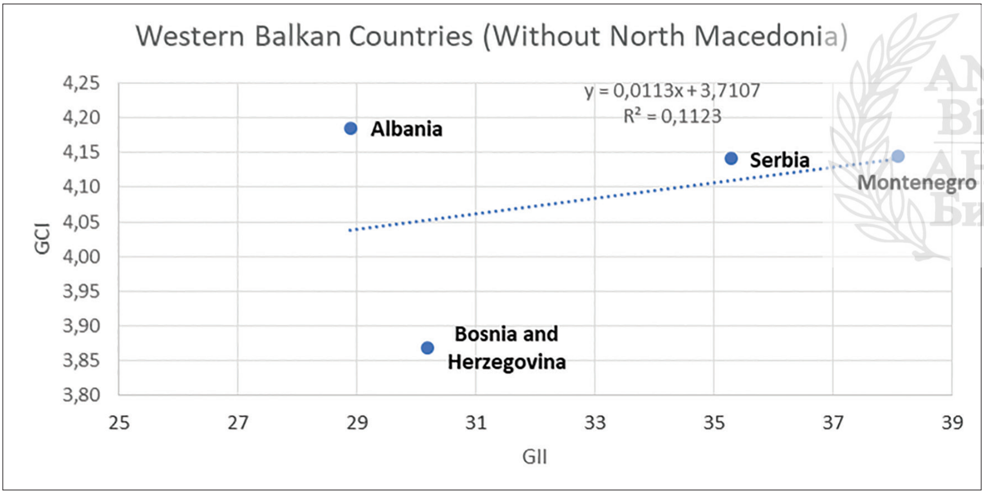


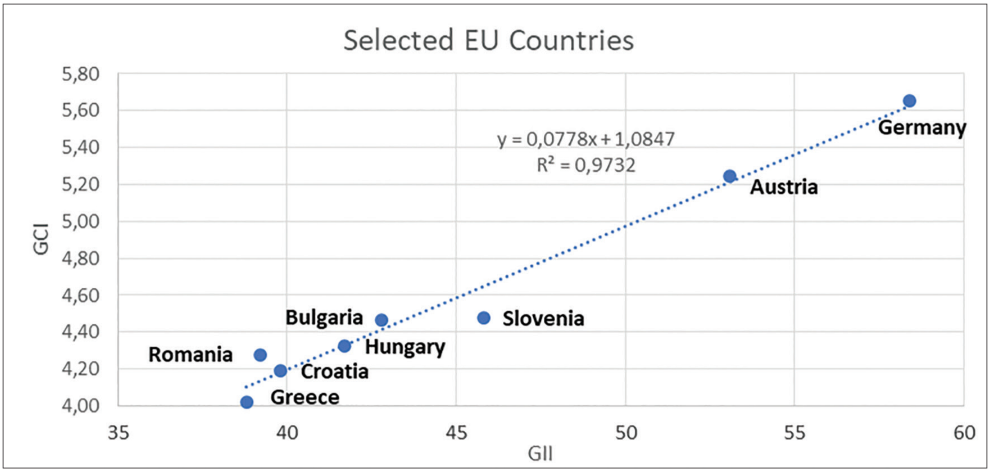
Source: Author's calculation based on GII data for 2020
https://www.globalinnovationindex.org/analysis-indicator

Figure 2. shows two separate scatter charts between III and IOI variables for the countries of the Western Balkans and for selected EU countries. The linear model indicates a relationship of moderate strength (52.3%) in the countries of the Western Balkans, while in selected EU countries the same model indicates a statistically more significant relationship between III and IOI, with a strength of 70.7%.

In order to find the answer to which extent does innovation affect the competitiveness of selected countries, i.e. to determine the strength of the link between innovation and competitiveness, we used data, GII Reports from 2017 and GCI from 2018. We considered it unjustified to take indicators from the same year, because the soonest one can expect impact of innovative and R&D activities on a country's competitiveness is no earlier than in the following year.

Figure 3. Scatter chart and regression-correlation model for GII and GCI for countries of the Western Balkans and selected EU countries





Source: Author's calculation based on GII data for 2017 and GCI for 2018 https://www.globalinnovationindex.org/analysis-indicator and https://tcdata360.worldbank.org/indicators/gci?indicator=632&viz=line_chart&years=2007,2017&indicators=944

Figure 3. presents data pairs of GII and GCI[44] variables for the countries of the Western Balkans and selected EU countries. It is obvious that in selected EU countries there is a strong direct linear correlation, as well as a statistically significant impact of GII on GCI (97.3%). On the other hand, the analysis of the relationship between GII and GCI at the level of the Western Balkans showed that there is no statistically significant impact of GII on GCI (11.2%).

In order to find answers to the extremely weak impact of innovation variables on competitiveness in the countries of the Western Balkans, below we have analysed certain variables from the GCI for the period 2008-2018 for all selected countries, namely the 12th Pillar - Innovation, and variables related to the investment of companies into R&D, the ability to innovate and cooperation of universities and industry in R&D. For all these variables, selected EU countries, primarily Germany and Austria, have far higher values and better rankings. For example, the largest allocations for R&D, shown as % of GDP in 2018, were recorded in Austria (3.17%) and Germany (3.09%), while between 1 and 2% of GDP is allocated by Slovenia (1.94 %), Hungary (1.55%) and Greece (1.18%). The lowest allocations were recorded in BiH

44 https://govdata360.worldbank.org/indicators/ha03bec65?indicator=41619&viz=line_chart&years=2017,2019

(0.20%), followed by Montenegro (0.37%), Romania (0.51%), Bulgaria (0.77%), Serbia (0.92%) and Croatia (0.97%).[45]

Nevertheless, the results of the analysis of the average annual rate of change over ten years show a different rate of movement. The fastest increase in GCI was achieved by Albania and Macedonia, on average the value of the index grew by 1.85% and 1.39%, respectively, while in Greece, Croatia, Hungary and Slovenia there was a slight decrease in the index. In BiH, the GCI is growing at an average annual rate of 0.96%. A similar situation is with the 12th pillar, Innovation, where the fastest growth was achieved by Albania, 4.30%, while BiH achieved an average annual growth of 0.81%. The answer can largely be found in the structure of exports and the structure of economic activity, i.e. the representation of certain industries in employment and turnover.[46]

To get a more comprehensive picture of the role of companies in the functioning of the innovation system, we analysed statistics for Bosnia and Herzegovina, namely: gross domestic expenditure on research and development, the share of total gross domestic expenditure on R&D in GDP, the number of employees in R&D, the number of published research papers and the number of units engaged in R&D for the period 2012-2019. Our focus was on indicators related to the business sector in relation to the public sector, higher education and the non-profit sector. The dominant representation of employees in R&D activities in higher education is noticeable in relation to the business sector, while their representation in the state sector is lower, and insignificant in the non-profit sector. According to the number of published research papers, higher education also dominates in relation to other observed sectors, while the number of units dealing with research and development has a smaller difference between sectors, but higher education is still ranked first. According to the research of innovative activities of companies in Bosnia and Herzegovina, which was conducted on a sample of 3,116 companies for the period 2016-2018, 35.6% carried out at least one innovative activity, while 64.4% of companies did not carry out innovative activities.[47]

---

[45] https://tcdata360.worldbank.org/indicators/GB.XPD.RSDV.GD.ZS?indicator=2013&viz=line_chart&years=1996,2017

[46] Matusiak M. & Kleibrink A. (ed.) (2018). *Supporting an Innovation Agenda for the Western Balkans: Tools and Methodologies,* Publications Office of the European Union, Luxembourg, doi:10.2760/48162, JRC111430.

[47] Agency for Statistics of Bosnia and Herzegovina, Science, Technology and Innovation – Innovation Activity of Enterprises, 2016-2018, Year IV, no. 1, Sarajevo, 30 April 2020, https://bhas.gov.ba/data/Publikacije/Saopstenja/2020/RDE_04_2016_Y2_0_BS.pdf

It is particularly interesting to analyse R&D allocations, where higher education again dominates in comparison to the business sector, followed by the government and non-profit sectors. Total gross domestic expenditure on R&D as % of GDP is around 0.20% in the period from 2015 to 2019. Half of that is focused on R&D in higher education. We find similar data in the Report of the European Commission, as well as that the estimated total amount of funds that the country allocates for research is still low, at the level of 0.3% of GDP. No progress has been made in providing reliable and comprehensive research and innovation statistics.[48] The budget funds of institutions that finance R&D activities are intended mostly for the higher education sector, 91.4%, followed by the state sector with 6.6% of budget funds. Other budget funds are intended for the non-profit sector, 1.6%, and the business sector 0.5%.[49]

The following table shows all previously processed indices (GII, GCI and GCI lag[50]) and R&D allocation indicators for Bosnia and Herzegovina in order to determine the correlation coefficient.

Table 1. Overview of GII, GCI and total gross domestic expenditure on R&D in BiH

BS	2013	2014	2015	2016	2017	2018
GCI BiH	3.93	4.02		3.71	3.80	3.87
Total gross domestic expenditure on R&D in BiH, in BAM	86,046,335	70,381,152	62,494,336	64,576,461	62,904,269	65,164,302
GII BiH	36.2	32.4	32.3	29.6	30.2	31.1
GCI BiH lag	4.02		3.71	3.80	3.87	

Source: Authors' calculation

The coefficient of linear correlation between expenditures for R&D and GCI is 0.8673, which means that the direct relationship between expenditures

[48] Bosnia and Herzegovina 2020 Report, 2020 Communication on EU Enlargement Policy, European Commission, Brussels 6 October 2020, https://ec.europa.eu/neighbourhood-enlargement/sites/near/files/bosnia_and_herzegovina_report_2020.pdf, p. 96.

[49] Agency for Statistics of Bosnia and Herzegovina, Science, Technology and Innovation – Government Budget Appropriations or Outlays for R&D, 2019-2020, Year VI, no. 1, Sarajevo, 21 December 2020, https://bhas.gov.ba/data/Publikacije/Saopstenja/2020/RDE_03_2019_Y2_0_BS.pdf

[50] Explanation for GCI lag – the data on the amount of allocations for R&D from one year and GCI of the following year were put in relation, e.g. expenditures from 2017 and GCI from 2018.

for R&D[51] and GCI for BiH in the observed period 2013-2018 has the strength of 86.73%. The similarity is also noticeable in the correlation coefficient of GII with GCI, which is 0.6381, which means that the direct connection between GII and GCI for BiH in the observed period has a strength of 63.81%. We can conclude that both correlation coefficients are high and relatively high, which means that there is a statistically significant relationship between R&D expenditure and GCI, and that R&D expenditure affects the value of the competitiveness index. A slightly weaker link between GII and GCI compared to the link between R&D and GCI indicates that the global innovation index includes more components, and a deeper analysis of the causes of these deviations would be useful and interesting.

4. Conclusion

Innovation and knowledge in today's dynamic and above all uncertain business environment are the key factors for achieving and maintaining the competitiveness of both companies and the national economy. The most developed countries of today have achieved their success precisely by switching from a capital-intensive to knowledge-intensive economy. One of the pillars of the knowledge economy is an effective innovation system in which companies, i.e. economic entities have a special place and role. By strengthening their R&D activities and innovation capabilities, companies contribute to the shaping and functioning of the innovation system. However, the R&D activity of a company depends not only on its capabilities but also on factors from the external environment such as the government's attitude towards scientific research, the relationship between scientific research institutions (universities and institutes) with businesses, the speed of technological transfer and knowledge obsolescence rate. Only by coordinating the activities of the business and academic community and the local government, i.e. by applying the Triple Helix model, synergistic effects can be achieved and higher value can be created.

The effects of innovation activity on the competitiveness of countries were investigated using the Global Innovation Index (GII) and the Global Competitiveness Index (GCI) on the example of Bosnia and Herzegovina, the Western Balkans and selected EU member states. At the same time, the analysis contributes to the assessment of the quality of their national innovation

[51] https://bhas.gov.ba/data/Publikacije/Saopstenja/2020/RDE_03_2019_Y2_0_BS.pdf budgetary allocations for R&D

systems. Based on the conducted analyses, it can be concluded that BiH and the countries of the Western Balkans achieve lower values in innovation performance, observed for the total GII, then for III (Innovation Input Index) and for IOI (Innovation Output Index). Of the seven variables of the global innovation index, the exception is the dimension of market sophistication where the countries of the Western Balkans do not lag behind (e.g. for BiH the value of this variable is 50.1 and for Austria it is 51.1). However, the value of GII for BiH is 29, compared to other observed countries only Albania has lower GII of 27.1. The highest GII values in 2020 were recorded by Germany (56.5), followed by Austria (50.1) and Slovenia (42.9).

The following conclusions are the result of an analysis of the correlation between III and IOI at the level of the Western Balkan countries and at the level of selected EU countries. The linear model determined the existence of a connection of medium strength (52.3%) in the countries of the Western Balkans, while in the selected EU countries the same model indicates a statistically significant connection between III and IOI, with strength of 70.7%. In the process of analysis of correlation between GII for 2017 and GCI for 2018, we found a strong direct linear correlation in selected EU countries, as well as a statistically significant impact of GII on GCI (97.3%), while at the level of the Western Balkans there is no statistically significant effect of GII on GCI (11.2%). Expenditures on R&D (% of GDP) and the R&D investments of companies can be singled out as the causes of the extremely weak impact of innovation variables on the competitiveness of the Western Balkan countries. The contribution of companies to the functioning of the innovation system can also be monitored through the number of employed researchers, the number of research units and the number of published papers. These indicators are presented for Bosnia and Herzegovina, and a correlation analysis was performed between R&D expenditures and GCI, as well as between GII and GCI, and the existence of a statistically significant relationship between R&D investments and GCI, as well as between GII and GCI were determined.

Based on the above, we can conclude that high innovation performance cannot be expected in an economy with a low percentage of R&D expenditures, and that low innovation represents a limiting factor of competitiveness. Therefore, companies need to develop innovation skills, and encourage R&D activities and continuous learning. With such a proactive approach and intensive cooperation with scientific research institutions, with the support of the government, they contribute to the effective and efficient functioning of innovation systems, competitiveness of the economy and long-term economic and social development.

References

1. Adam F. (2014). *Measuring National InnovationPerformance – the Innovation Union Scoreboard Revisited.* Springer. Berlin, Heidelberg.
2. Agencija za statistiku Bosne i Hercegovine (2020). *Nauka, tehnologija i inovacije – Patenti 2019*, Godina VI, broj 1, Sarajevo, 15. 10. 2020, https://bhas.gov.ba/data/Publikacije/Saopstenja/2020/RDE_02_2019_Y1_0_BS.pdf
3. Agencija za statistiku Bosne i Hercegovine (2020). *Nauka, tehnologija i inovacije – budžetska izdvajanja za istraživanje i razvoj, 2019.-2020.,* Godina VI, broj 1, Sarajevo, 21. 12. 2020., https://bhas.gov.ba/data/Publikacije/Saopstenja/2020/RDE_03_2019_Y2_0_BS.pdf
4. Agencija za statistiku Bosne i Hercegovine (2020). *Nauka, tehnologija i inovacije – Inovativne aktivnosti preduzeća, 2016-2018*, Godina IV, broj 1, Sarajevo, 30. 04. 2020.
5. Bilas V., Bošnjak M. and Novak I. (2019). Inovacijska izvedba zemalja članica Europske unije. *Oeconomica Jadertina* 1/2019., pp. 34-44.
6. Chaminade, C. and Lundvall B. (2019). *Science, Technology, and Innovation Policy:Old Patterns and New Challenges*. Oxford University Press. Oxford.
7. Chuvakhina L.G., Terskaya G.A. and Buevich S.Y.(2018). Innovations as a factor of state's improved performance in the World Economic System. *Revista Espacios*, Vol. 39 (# 04) Year 2018.
8. CPU-Centre for Policy and Gouvernance. *Konkurentnost ekonomije u BiH i regionu 2014-2018.* http://www.cpu.org.ba/media/35585/Konkurentnost-ekonomije-u-BiH-i-regionu-2014-2018.pdf (accessed on 10 June 2021)
9. Cvetanovic D., Cvetanović S. and Bogić D. (2020). *Rastući značaj koncepta regionalnih inovacionih sistema za ekonomski i društveni razvoj*, https://konferencija.komorapirot.com/44.RASTUCI%20ZNACAJ%20KONCEPTA%20REGIONALNIH%20INOVACIONIH%20SISTEMA%20ZA%20EKONOMSKI%20I%20DRUSTVENI%20RAZVOJ.pdf. (accessed on 10 June 2021)
10. Cvetanović S., Despotović D., Mladenović I. and Jovović D. (2014). The analysis of innovation in Western Balkan countries in 2012. *Economic Research-Ekonomska Istraživanja*, 27:1, 830-846, DOI: 10.1080/1331677X.2014.974920
11. Despotović D. and Cvetanović S. (2017). The theoretical explication of the factors of regional growth and the economic convergence (divergence) of the region. *Economic Horizons*, May - August 2017, Volume 19, Number 2, 111 – 125.
12. Dossou Y.L. and Khvatova T.Y. (2020). Analysis of innovative activity of companies in developing countries on the example of West African countries. *St. Petersburg State Polytechnical University Journal. Economics*, 13 (1) (2020) 79–90. DOI: 10.18721/JE.13107
13. European Commision (2020). *Science, research and Innovation Performance of the EU 2020, A fair, green and digital Europe.* Publication Office of the European Union. Luxembourg. https://ec.europa.eu/info/publications/science-research-and-innovation-performance-eu-2020_en. (accessed on 10 June 2021)
14. Fatma A. (2018). Overview of the Japanese Innovation Systems vs. the American Innovation System. *Journal of Global Economics,* 6: 312. doi:10.4172/2375-4389.1000312

15. Freeman, C. (1995). The “National System of Innovation” in historical perspective. *Cambridge Journal of Economics*, 19 (1) 5–24.
16. Gogodze J. (2016). Mechanisms and Functions within a National Innovation System. *Journal of Technology Management&Innovation*, Universidad Alberto Hurtado, Facultad de Economía y Negocios. Volume 11, Issue 4, pp. 12-21.
17. Hetze P. and Meyer M. (2018). *Was bringt die Oeffnung von Wissenschaft und Innovation?* Stifterverband Bildung. Wissenschaft.Innovation, Berlin.
18. http://ec.europa.eu/europe2020/index_en.htm, (accessed on 10 June 2021)
19. https://tcdata360.worldbank.org/indicators/GB.XPD.RSDV.GD.ZS?indicator=2013&viz=line_chart&years=1996,2017, (accessed on 10 June 2021)
20. https://bhas.gov.ba/data/Publikacije/Saopstenja/2020/RDE_03_2019_Y2_0_BS.pdf
21. https://bhas.gov.ba/data/Publikacije/Saopstenja/2020/RDE_04_2016_Y2_0_BS.pdf
22. https://ec.europa.eu/info/research-and-innovation/research-area/industrial-research-and-innovation_en, (accessed on 10 June 2021)
23. https://govdata360.worldbank.org/indicators/ha03bec65?indicator=41619&viz=line_chart&years=2017,2019, (accessed on 10 June 2021)
24. https://tcdata360.worldbank.org/indicators/gci?indicator=632&viz=line_chart&years=2007,2017&indicators=944, (accessed on 10 June 2021)
25. https://www.globalinnovationindex.org/analysis-indicator, (accessed on 10 June 2021)
26. Izvještaj o Bosni i Hercegovini za 2020, *Saopštenje o politici proširenja EU-a za 2020.* Evropska komisija. Brisel 6.10.2020, nezvanični prevod, https://europa.ba/wp-content/uploads/2020/10/Izvjestaj_za_BiH_za_2020_godinu.pdf (accessed on 10 June 2021)
27. Jankowska B., Matysek-Jędrych A. and Mroczek-Dąbrowska, K. (2017). Efficiency of national innovation systems: Poland and Bulgaria in the context of the Global Innovation Index. *Comparative Economic Research*, De Gruyter, Warsaw, Vol. 20, Iss. 3, pp. 77-94.
28. Ješić J. (2015). *Model četverostruke spirale (Quadruple Helix Model) kao osnova nacionalnog inovacionog sistema.* Doctoral thesis. Univerzitet Edukons Fakultet poslovne ekonomije Sremska Kamenica, Novi Sad.
29. Jovičić J. and Petković S. (2016). Inovacije kao faktor konkurentnosti privrede s osvrtom na Bosnu i Hercegovinu. *Obrazovanje za preduzetništvo*, 6(1), pp. 99-110.
30. Kaynak S., Altuntas S. and Dereli T. (2017). Comparing the innovation performance of EU candidate countries: an entropy-based TOPSIS approach. *Economic Research-Ekonomska Istraživanja*, 30:1, 31-54, DOI: 10.1080/1331677X.2016.1265895
31. Leydesdorff L. and Strand Ø. (2013). The Swedish System of Innovation: Regional Synergies in a Knowledge-Based Economy. *Journal of the American Society for Information Science and Technology*, DOI: 10.1002/asi.22895
32. Mandić S. and Trivunović D. (2020). Analiza konkurentnosti ekonomije Bosne i Hercegovine. *Jahorina Business Forum 2020*, pp. 511-520.
33. Melaas A. and Zhang F. (2016). *National Innovation Systems in the United States and China A Brief Review of the Literature.* The Center for International Environment&Resource Policy, Tufs University. Medford.
34. Mosurović Ružičić M., Miletić M. and Dobrota, M. (2021). Does a National Innovation System Encourage Sustainability? Lessons from the Construction Industry in Serbia. *Sustainability 2021*, 13, 3591. https://doi.org/10.3390/su13073591
35. OECD (2013). *Triple Helix partnerstva za inovacije u Bosni i Hercegovini.* Razvoj privatnog sektora – Priručnik za politike, Sarajevo.

36. OECD (2005). *Oslo Manual: Guidelines for collecting and interpreting innovation data.* 3. izdanje, OECD, Pariz.
37. Piljić J. (2018). Analiza konkurentnosti Bosne i Hercegovine i preporuke za jačanje konkurentnosti, Tranzicija/Transition. *Časopis za ekonomiju i politiku tranzicije/ Journal of economic and politics of Transition*, Godina XX, Vitez-Tuzla- Zagreb-Beograd-Bukurešt, No. 41.
38. Polt W., Rammer Ch., Schartinger D., Gassler H. and Schibany A. (2001). Benchmarking Industry-Science Relations in Europe – the Role of Framework Conditions. *Science and Public Policy*, 28 (4), pages 247-258, August 2001.
39. Porter M. and Stern, S. (2002). National innovative capacity. In K. Scwab, M. Porter, & J. Sachs (Eds.), *The global competitiveness report 2001–2002*, 102–118. Oxford University Press. New York.
40. Puljiz J. (2009). *Faktori regionalnog razvoja i regionalnih nejednakosti u Republici Hrvatskoj*. Doctoral dissertation, Ekonomski fakultet, Sveučilište u Splitu. Split, Republika Hrvatska. https://www.bib.irb.hr/393855
41. Radošević S. (2002). Regional innovation systems in Central and Eastern Europe: Determinants, organizers and alignments. *The Journal of Technology Transfer*, 27, 87–96.
42. Rahimić Z. (2006*). Izgradnja konkurentskih prednosti preduzeća kroz njegova strateška opredjeljenja.* Ekonomski fakultet u Sarajevu. Sarajevo.
43. Rahimić Z. and Kožo A. (2009). Building and Development of the Knowledge Based Economy in Bosnia and Herzegovina. *Journal of Interdisciplinary Management Research*, Vol. V, January 2009, pp. 111-122.
44. Rigg C., Coughlan P., O'Leary D. and Coghlan D. (2021). A practice perspective on knowledge, learning and innovation – insights from an EU network of small food producers. *Entrepreneurship & Regional Development*, DOI: 10.1080/08985626.2021.1877832
45. Schrempf B., Kaplan D. and Schroeder D. (2013). *National, Regional, and Sectoral Systems of Innovation–An overview*. Report for FP7 Project" Progress", progressproject.eu. https://www.progressproject.eu/wp-content/uploads/2013/12/Progress_D2.2_final.pdf
46. Trifković M. (2020). *Harmonizacija sistema nauke u Bosni i Hercegovini.* Akademija nauka i umjetnosti Bosne i Hercegovine, Centar za sistemska istraživanja, knjiga 5/1, posebna izdanja. Sarajevo.
47. Vukotić S., Zakić N. and Ćurčić N. (2017). Menadžment znanja i upravljanje inovacijama kao izvor poslovnog uspeha i konkurentske predosti preduzeća. *Četvrti naučno-stručni skup POLITEHNIKA 2017*, pp. 436-442.
48. Warnke P. et al. (2016). *Opening up the innovation system framework towards new actors and institutions.* Fraunhofer ISI Discussion Papers - Innovation Systems and Policy Analysis, No. 49, Fraunhofer ISI, Karlsruhe.
49. Wojciech N. (2016). Composite Indexes Economic and Social Performance: Do They Provide Valuable Information. *Foundations of Management*, Vol. 8, pp. 167- 174.
50. Yongabo P. and Göransson B (2020). Constructing the national innovation system in Rwanda: efforts and challenges. *Innovation and Development*, DOI:10.1080/2157930X.2020.1846886

DOI: 10.5644/PI2021.200.18

Influence of development of scientometrics on the outlook and functioning of the science system in the world and in individual countries[*]

Enver Zerem[**]
Suad Kunosić[***]

Abstract: The social significance and quality of scientific research largely depend on the usefulness of research results for the social and scientific community. The lack of funds and the desire to allocate funding to high-quality research projects make the assessment of the quality of research and the valorization of knowledge increasingly important. However, it is very difficult to apply criteria that can objectively assess scientific research, providing precise qualitative and quantitative data on which funding agencies could base their decisions. The product of scientific research is mainly information published in scientific journals. They are the basis for the dissemination of knowledge and the basic criteria for academic and scientific evaluation, fundraising for scientific research and career advancement. In addition to the evaluation of scientific publications, there is a wide range of other activities that reflect the scientific credibility of scientists, such as: number and quality of grants for scientific research projects, leadership in national or international academic societies, membership in editorial boards of reputable journals, doctoral dissertation mentorships and the like.
Although these activities are important and give credibility to the scientist, the relevant scientometric systems cover only publications, neglecting other criteria of scientific importance in evaluation for purpose of academic advancement of a scientist, as well as competitions for grants for financial support of scientific research. The reason for this is the fact that these activities, regardless of their importance, are very heterogeneous, with specific characteristics, and require very diverse parameters for evaluation. Therefore, there are no universal evaluation criteria for these activities and their quality is generally assessed individually, depending on the purpose of the assessment. Regardless of the shortcomings, university ranking systems are important comparative parameters for assessing the quality of scientific and educational value of universities.

Key words: internationally recognized criteria, academic community, education, ranking web of world universities

[*] This study is financially supported by the Federal Ministry of Education and Science, Federation of Bosnia and Herzegovina, as part of a scientific research project entitled “ The impact of the COVID-19 pandemic on scientific production, citations of scientists and ranking of universities in Bosnia and Herzegovina”

[**] Academy of Sciences and Arts of Bosnia and Herzegovina, Department of Medical Sciences; Cantonal Hospital “Dr. Safet Mujić” Mostar. E-mail: zerem@live.com

[**] Department of Physics, Faculty of Natural Sciences and Mathematics, University of Tuzla, Bosnia and Herzegovina. E-mail: kunosic@gmail.com

Introduction

There are only a few processes and events in the history of mankind that have transformed society and contributed to the common good more than science. The knowledge gained through scientific research has saved billions of people from poverty, encouraged industrialization and mass communications of unprecedented proportions, eradicated many diseases and enabled man to leave his mark on the moon. Today, science is a large industry that produces new knowledge, usually aimed to solve certain problems or issues facing humanity. Like any other industry, science uses its tools and resources - scientists, funding and time - to create its products: scientific knowledge, which is presented through publications in the scientific literature.

During the 20th and in the early 21st century, financing of science was increasingly taken over by the governments and public funds of rich countries and international corporations. The most important public funds and other organizations that finance most scientific research are also the main potential beneficiaries of the results of scientific research, which should be translated into general social progress, and ensure the profit and sustainability of foundations. This is precisely the reason why most of the financial resources are invested in research that should bring benefits to the military industry and competitive advantages in the economy. The realization that investments in biomedical research have been translated into concrete practical progress in several medical disciplines, has achieved strong social support for the investment of public funds in order to support biomedical science.

Large investments in science are mainly focused on basic scientific research, which undoubtedly results in an increase in the knowledge base. However, the research results obtained through basic scientific research are often not comparable with the expected speed of application of these results in practical improvements in industry, social progress and public health. Delayed results in the application of scientific research carry risks of undermining the confidence in science, have negative implications for the financing of scientific research and a relative slowdown in scientific innovation. It is often necessary to conduct additional, so-called, translational research that would enable the transfer of knowledge gained through fundamental research to its practical application.

It should be noted that fundamental (basic) scientific research has a very important essential meaning and social value in the production of new information that enhance the overall human science, and is useful even when it does not have a direct tangible outcome in the applied activities. It is also logical to assume that all basic scientific research has a degree of probability of generating tangible results in practice, although such outcomes can be unpredictable and distant both in time and content of application (for example, the theory of general relativity, scientifically proven in 1916, brought a useful outcome for the public good only at the end of the 20th century).[1]

However, despite the essential societal value of the knowledge achieved by fundamental scientific research, it is clear that public agencies and financial funds support scientific research with outcome-oriented goals, including health benefits and disease prevention, promotion and innovation in industry and economy, and increasing profits and return on investment. Precisely because of this, great competition has developed among service providers (universities and scientific institutes) who compete for grants that support scientific research projects. All universities, and often scientific institutes, are institutions that, in addition to their scientific research, have an important role in the education and training of new staff. The educational activity of universities is also financed in a high percentage from public funds and state budgets.[2]

The work of the academic staff a few decades ago was much easier than today. University teachers were obliged to deal with teaching and other forms of student education. Some of them worked on scientific research projects that did not have an imperative of an outcome or a deadline for completion. For example, university teachers in Great Britain had a contract that required them to deal with teaching, religion, and give at least four lectures during the academic year. They also had a general obligation to engage in scientific research work, but without precise criteria for evaluating the research results, nor a deadline for completing the research. Yet, even in such a relaxed atmosphere, with no pressure on scientists and no major investment in infrastructure and research, the hard work of innovators and the inquisitive minds of scientists have made some epochal discoveries (e.g. Sir Godfrey Hounsfeld, the discovery of computed tomography).[3] With the arrival of Margaret Thatcher as prime minister, new rules for university teachers were introduced in the academic community of Great Britain, and later in the whole of Europe: five-year renewable contracts according to precisely agreed goals and conditions for contract renewal, according to criteria based on scientometric parameters.

[1] Ashby, 2003:1–42; Bowen &Casadevall, 2015:11335-40.
[2] Horton, 1998:892.
[3] Hounsfield, 1973:1016-22

The new contracts for university staff introduced by Prime Minister Margaret Thatcher were not greeted with enthusiasm in the academic community, not only by unambitious university teachers but even by eminent scientists and inventors of epochal discoveries. For example, Max Perutz, co-discoverer of the haemoglobin structure (with John Kendrew), vigorously argued that discoveries like theirs could not have been made under the new principles of treating science with short-term contracts, because a particular invention requires almost two decades of development after the initial discovery before it enters routine application in practice.[4] Numerous scientists have argued that negative pressures on scientific institutions and scientists, and time constraints on research, can contribute to the relative slowdown of scientific innovation and lead to the neglect of the educational / teaching component in university work. Unlike the definition of output-input based efficiency, evaluating previous research results of research by scientists and scientific institutions who are applying for grants is much more complicated.

However, in absence of studying and monitoring the outcomes, it is not possible to find out whether society's investment in research pays off in relation to inputs, and the efficiency and effectiveness of scientific institutions, as well as the practical significance of scientific innovations compared to research investments, cannot be assessed. Monitoring scientific inputs, results, and outcomes can be used to assess the productivity of research institutions and can be useful in assessing future reforms and policy changes. To be applicable. the system of quality indicators should be as simple and rational as possible in terms of providing the necessary information for adequate assessment of the quality of research. Depending on the context of use, it is possible to distinguish different aspects of quality. The quality of research indicates the usefulness of research results for the scientific community within one or more scientific disciplines. Social quality, which is gaining in importance, indicates the usefulness of research results for a wider group: government, economy and industry, institutions of culture and civil society. In real practice, the quality of scientific research is determined by independent experts - peer-review - on the basis of international scientometric parameters. Depending on the purpose, the peer-review can be supported and supplemented by other quality indicators that cannot be expressed by scientometric parameters (received grants, participation in editorial boards of scientific journals, position in the academic community, mentoring in scientific projects and doctorates, etc.).

[4] Kendrew&Perutz, 1948:375-98.

Quality Assessment Criteria for s Scientific Research

The social significance and quality of scientific research largely depend on the usefulness of research results for the social and scientific community. The lack of funds and the desire to allocate funding to high-quality research projects make the assessment of the quality of research and the valorization of knowledge increasingly important. However, it is very difficult to apply scientific criteria that can objectively assess scientific research, providing precise qualitative and quantitative data on which funding agencies could base their decisions.

The key question, which has always remained elusive in science and education, is on the basis of which criteria this quality is measured, and how to ensure the fulfilment of standards so that all provide adequate quality of output competencies. Since scientific research work can be measured and evaluated far more exactly through innovations, patents, and publications, in relation to educative and other activities represented in higher education, these parameters often appear as predetermining measurements in evaluating the quality of higher education.[5]

The quality of scientific research and the overall scientific production evaluated through innovations, patents and publications are mostly influenced by: GDP, percentage of allocations from GDP for scientific research, international criteria for valorization of scientific research, conditionality of academic progress and scientific valorization and international scientific communications.

The product of scientific research is mainly information published in scientific journals and they are the basis for the dissemination of knowledge, as well as the basic criteria for academic and scientific evaluation, raising of funds for scientific research and career advancement. It is true that, in addition to the evaluation of scientific publications, there is a wide range of other scientific activities that also reflect the scientific credibility of scientists, such as: number and quality of grants for research projects, leadership in national or international academic societies, membership in editorial boards of reputable journals, service in national committees for expert examination of state-sponsored scientific research projects, mentorships in doctoral dissertations, the number of expert and thematic articles in the so-called lay press and the like.[6]

[5] Dixon, 2009: 847-50; Zerem, 2017: 107-9; Zerem & Kunosić, 2018: 133-4
[6] Miles, 1991:643-5; Zerem, 2013:128.

Although these activities are important and give certain weight to the scientific credibility of a scientist, the relevant metric scientific systems cover only publications and omit other criteria of scientific importance, which would make sense to use in assessing the academic advancement of a scientist and in competitions for grants for financial support of scientific research. The reason for this is the fact that these activities, regardless of importance, are very heterogeneous, as each of them has specific characteristics and requires different parameters for evaluation. Therefore, there are no universal evaluation criteria for these parameters of scientific importance, and their value is generally estimated individually, depending on the purpose of the assessment.[7]

Ranking of Universities and Attitude Towards Ranking in Countries in our Region

The competition to take a prestigious place on the world ranking list of top universities is increasingly heating up and taking on the characteristics of a battle for status and various kinds of domination of the most developed countries in the world. Significant financial resources are being invested in the formation of various international university ranking lists. Relevant university ranking lists consider various parameters, but for most universities (with the partial exception of the first 100) the number of publications and the impact that these publications achieve through citation are of the greatest importance in ranking.

The most prestigious ranking lists of universities in the world publish their results once or twice a year. In academic communities, as well as in the media of the countries of the region, these results are given great importance and they are followed very actively, sometimes fervently, and sometimes even too emotionally in relation to the rationality expected from members of academia. Some universities from the countries of the region – primarily the Universities of Ljubljana, Belgrade and Zagreb – have made significant progress in recent years on international rankings. The academic communities in these countries are constantly evaluating and finding opportunities for the advancement of their universities on the ranking lists, and the media analyse and compare the results of their universities with the results of other universities in the world and especially in the region.

[7] Marušić&Marušić, 1999:1713-14; Zerem, 2014:248-51; Zerem, 2018:147-8.

The situation in Bosnia and Herzegovina is, however, paradoxical. Contrary to the long-standing, in our public already established axiom opinion that we are the best, all our universities are either not ranked on international lists at all or are ranked significantly below universities of similar rank in the region. As far as the public knows, no founder (political mentor) of our universities has asked that improving the position on international rankings be a condition in assessing the success of the university they are the founder of, nor did any university set that as a goal at the beginning of a year. In such an atmosphere at the university and in society, how can one find enough strength to strive for true (globally recognized) values, and strength that could improve our universities on the world quality rankings?[8]

Why Rank Universities?

In an effort to make the traditional education system more open and flexible, there is a noticeable step towards its decentralization, not only territorial, but also more functional, as well as strengthening the autonomy in education and training. In a decentralized education system, governance is implemented through goals and outcomes that promote equality and reproduce a common value base.

In that process, the position of higher education is especially complicated, because scientific research is an inevitable part of it, and without that part, higher education remains uninventive and unable to justify its purpose. Since scientific research, through innovations, patents and publications, can be measured and evaluated much more accurately in relation to educational and other activities represented in higher education, these parameters often appear as predetermining metrics in evaluating the quality of higher education. Opponents of this way of evaluating universities note that in this way teaching in fact is not evaluated, but rather only scientific work, so this way of ranking universities does not reflect all parameters of university quality, especially those that reflect the modernity and quality of programs, teaching and professors. However, most agree that these irregularities apply only to low-ranking universities where a relatively small number of publications can cause statistical “artifacts”, while the publication of a large number of significant scientific publications, which is a characteristic of high-ranking universities, requires adequate quality in other segments of activity as well.[9]

[8] Zerem, 2013:128; Zerem, 2014:248-51.
[9] Petković, 2013; Zerem, 2014:248-51.

Global rankings are often subject to criticism and outrage, especially from those who are dissatisfied with the position of their universities in ranking and evaluation at various levels, but the fact is that, so far, no possible alternatives to this trend have been offered. It is therefore logical to conclude that, despite constant changes and evolution in the design of academic quality rankings, as well as other shortcomings, analyses of ranking systems show that they are becoming part of the reality and work of thousands of universities worldwide. Comparable information on higher education institutions, their teaching and research programs, should make it easier for students and researchers to choose where and what to study and where to work. Better information would also help policy-makers at the institutional, national and European levels to develop a future strategy for higher education. The current, largely one-dimensional rankings do not meet these purposes because they tend to focus on specific aspects of research and on entire institutions rather than on individual programs and disciplines. This approach requires new forms of management and programming of scientific research and educational work. The main goal in this direction is to establish an efficient and flexible system of accreditation of providers / organizers of educational services and certification of acquired knowledge and skills.[10]

Existing University Ranking Systems

The ranking of universities should include criteria such as: education, research, quality of teaching staff, international cooperation and funding (finances) that universities achieve through their work. Relevant criteria are those that can be expressed quantitatively, such as: number of enrolled students, percentage of graduates, the ratio of teachers to students, number of doctoral dissertations, awards for both teachers and students and “alumni” students, citations, number of papers published on SCI or SSCI lists, number of patents, number of international journals published by the university or faculty, number of foreign authors in those journals, website and available web services, university libraries, equipment of laboratory and classroom space, etc. Important metrics of university quality are also revenues from tuition fees, funding from state funds, funding from EU funds, etc. One of the very important criteria is international cooperation where an analysis would be performed on the number of foreign students studying at the university as well as the number of students who went to study at other universities (student mobility). Also,

[10] Petković, 2015.

for the overall evaluation of the work of a university, the number of visiting professors at the university is important, as well as the number of professors elected at that university who have been elected as visiting professors at other universities.

Although the number of university ranking systems is increasing every year, there are four most significant and most representative lists, which rank universities around the world using different parameters and scoring methods. The most important ranking lists of universities are: the Shanghai Ranking, the Times Higher Education Supplement - THES, WEBOMETRICS ranking and SCImago ranking.[11]

The Shanghai Ranking

The Academic Ranking of World Universities (ARWU) was first published in June 2003. Shanghai Jiao Tong University School of Education, China, updates this list every year. ARWU uses six objective indicators to rank universities, including the number of alumni and professors who have won Nobel Prizes and medals in specific fields, the number of highly cited researchers in journals who are cited in the Thomson Scientific database (now the "Clarivate Analytics Journal List"), the number of articles published in the journals "Nature" and "Science", the number of articles indexed in the Science Citation Index - Expanded and in the Social Sciences Citation Index, and the per capita effect in relation to the size of the institution. Each year, ARWU ranks more than 1,000 universities and publishes the top 500 online.

The Times Higher Education Supplement – THES

The Times Higher Education Supplement (THES) has ranked universities since 2004. THES ranking is based on four criteria that are considered to represent the quality of university work, namely: high-quality research, high-quality teaching, high employment rate of graduates and a good "international image". The problem with this way of ranking is some of the criteria that are objectively difficult to measure, such as the criterion of high-quality teaching.

[11] Hall,1998:1230; Klaic,1997:88-98.

WEBOMETRICS ranking

Ranking Web of World Universities is an initiative of the Cybermetrics Lab – a research group of the Center for Humanities and Social Sciences (CCHS), part of the National Research Council - CSIC in Spain. The Cybermetrics Laboratory ranks universities based on quantitative analysis of content on the Internet and the web, especially those related to teaching processes and academic communication. With these rankings, the webometrics team wants to further motivate researchers around the world to publish more and better scientific content on the web, and to make them available to colleagues and others interested people around the world. The ranking of world universities "Webometrics" was officially launched in 2004 and is updated every 6 months (data are collected in January and July and are published one month later).

SCImago Ranking

SCImago is a research group that deals with IT analysis in various fields. It consists of the Institute for Politics and Public Affairs of the National Research Council of Spain (CSIC), the SCImago Institute and several universities (University of Granada, Carlos III University of Madrid, University of Extremadura, University of Alcala de Hanares and University of Porto). SCImago Institutional Ranking - SIR is a global ranking list that ranks institutions from the RDI sphere (universities, colleges, institutes, research centres, hospitals, business companies, etc.) that have at least 100 indexed publications annually. In the SIR ranking tables, higher education organizations and RDI institutions are ranked based on the total number of publications based on searches in the SCOPUS database.[12]

Ranking of Universities on Bosnia and Herzegovina

Universities and faculties in Bosnia and Herzegovina are increasingly more educational and less scientific institutions, and symbolize the 'mix' of secondary and higher education, without becoming either one in the original sense of the word. Before the last war 1992-1995, there were 4 public universities in BiH (Sarajevo, Tuzla, Mostar and Banja Luka). In that period, the faculties and universities of Bosnia and Herzegovina were mostly created from already existing scientific institutions (usually institutes), which had been engaged in

[12] Brennan-Krohn, 2011.

scientific research work for years before that. The faculties were founded in a logical way by which the institutes, as already respectable scientific institutions, acquired an educational role, and in that way grew into faculties for that specific scientific field.

What happened to our academic community during and after the last war? If the war could have been an excuse for certain shortcomings in the initial post-war years, it can hardly be an excuse for us 25 years after the war. Why, in the meantime, have we not been able to restore the position and importance to higher education that it deserves? The shortest answer to this question would be: We have failed to introduce criteria, which would turn the uncontrolled-growing quantity of higher education institutions into quality.[13]

Thus, during 2002, there were 43 higher education institutions in the education system of Bosnia and Herzegovina in the rank of universities / colleges or independent faculties (10 public universities / faculties and 33 in private ownership), and in 2012 there were 25 universities with 177 faculties in BiH, 10 academies and 4 religious study faculties. Since then, the number of higher education institutions in our country has been constantly growing. However, this uncontrolled growth of the number of higher education institutions is not even remotely accompanied by an increase in scientific production, which would be logical to expect from so many universities and faculties. Scientific research work, and scientific publications as its most relevant evaluation confirmation, are the basic driving energy of higher education. Without that driving energy, our higher education has become a severely ill patient whose "blood turns to water" (or where science is replaced by politics), reduced to a mere educational component conducted by incompetent protagonists.

If we are to apply the ranking lists described in this article (Shanghai Ranking, The Times Higher Education Supplement - THES, SCImago ranking, Webometrics list) to our universities, it should be noted that our universities are ranked only on the Webometrics list. The other three lists directly rank only the top one thousand universities and none of our universities are represented on them. Webometrics list ranks virtually all registered universities (over 30,000 universities and colleges) twice a year (January and July), based on educational and scientific criteria. These criteria are continuously evolving and are changing to a lesser extent, but, in essence, the components (educational and scientific) which are the basis of Webometrics ranking remain.

[13] Zerem, 2013:128; Zerem,2014:248-51

Figure 1 shows the ranking of the most successful universities in BiH from 2014 to 2021, with cross-sections for both annual rankings (January and July). The University of Sarajevo is the only one of our universities that is positioned on the Webometrics list among the 2000 best universities (between 1500 and 2000 places) in the world, except in July 2015 and 2018, when it was positioned below the 2000th position. The fact is that the University of Sarajevo is our best ranked university, but it is also a fact that it is ranked lower compared to all public universities in Slovenia, Croatia (except the University of Osijek) and Serbia. Also, it is noticeable on the chart that it stagnated in the observed period, not showing a tendency of progress that would put it in a position to be ranked on other ranking lists. Such a modest position of our largest university, with by far the largest resources and budget, has had a negative impact on the development of science, our other universities and higher education in our country.

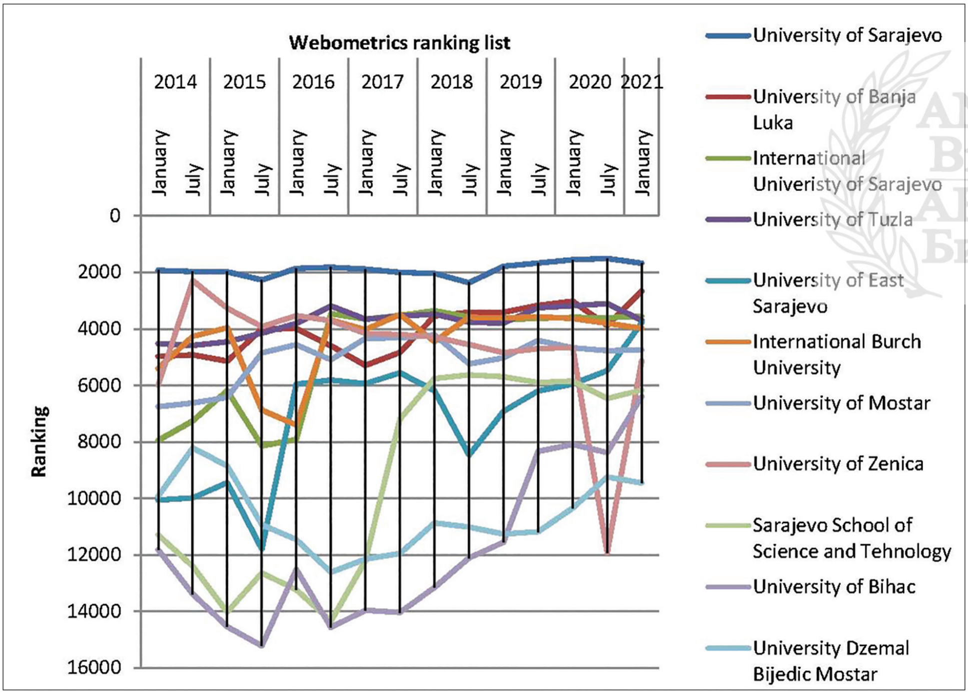


Figure 1. Overview of the most successful universities in BiH according to the Webometrics ranking list for the period 2014–2021.

The University of Banja Luka is the second-ranked university in our country on the most recent ranking list (January 2021), and along with Sarajevo, our only university ranked among the 3000 most successful universities. In the analysed period (since 2014), the University of Banja Luka shows a gradual growth and from 4977th place it reached 2658th place, and in the ranking of BiH universities it rose from fourth to second place.[14] The University of Tuzla was the second-ranked university in BiH until the end of 2016, after which it was positioned between 3500 and 4000th place on the overall Webometrics list and moved from second to fourth place among BiH universities. Other public universities in BiH were ranked below the 4000th place on the Webometrics list in the analysed period, with occasional short-term upward trends (Zenica in 2014), which were more the result of adjusting to the current criteria of the Webometrics list than of continuous objective quality. The graph shows that the largest nominal progress in the analysed period was achieved by the University of East Sarajevo (rose by 6270 positions) and the University of Bihać (rose by 5412 positions). Although their success, focusing only on numbers, is impressive, if we observe the positions of these universities against the trend of changing criteria on the Webometrics list shown in Table 1, which are not in favour of small universities, we should remain reserved regarding further progress of these universities on the Webometrics list.

Among the private universities in BiH, the International University of Sarajevo is the best positioned one, and is also the third best positioned university in BiH. This university presents the fact that staff selection and collaboration with a more powerful umbrella university is a good recipe for solid success in the competition of our universities. International Burch University operated in a similar manner, with similar results, until 2016. After 2016, the International Burch University had certain staffing problems which is reflected in their drop on the ranking list.

In the ranking for January 2021, the ranking methodology used by Webometrics was changed so that only 3 criteria were used for the ranking of universities (Table 1). Figures 2, 3 and 4 show the ranking of our most successful universities according to each of the three criteria separately. These figures show some facts that more objectively present the quality of work of our universities. The most obvious fact is that, according to the “Impact Rank” criterion, two private universities (European University of Brcko and European University Kallos) that have the same owner are ranked first and third in the competition of our universities. At the same time, according to the “Openness Rank” and “Excellence Rank” criteria, neither of these two universities is ranked in the top 10 in the comparison of BiH universities.

[14] Kunosić, S., Čeke, D., Zerem, E, 2019; Čeke&Kunosić, 2021.

These facts certainly require a more detailed analysis, but even without the analysis it can be said that there is a great interest of some private universities for faster progress on the ranking lists which is not in line with their realistic quality, as well as that there is insufficient interest of some other, primarily public universities for the same.

Table 1. Webometrics university ranking methodology (January edition, 2021)

INDICATORS	MEANING	METHODOLOGY	SOURCE	WEIGHT
PRESENCE		This indicator has been discontinued		
VISIBILITY	Web contents Impact	Number of **external networks** (subnets) linking to the institution's webpages (normalized and then the maximum value is chosen)	*Ahrefs Majestic*	**50%**
TRANSPARENCY (or OPENNESS)	Top cited researchers	Number of **citations** from **Top 210 authors** (excl. top 20 outliers)	*Google Scholar Profiles*	**10%**
EXCELLENCE (or SCHOLAR)	Top cited papers	Number of **papers** amongst the top 10% most cited in each one of the all 27 disciplines of the full database Data for the five year period: **2015-2019**	*Scimago*	**40%**

With their new methodology Webometrics has harmonized the weight percentages between educational and scientific criteria. Apart from that, Webometrics is continuously raising the impact of scientific criteria which affect the ranking of universities in the whole world. The change in criteria has also significantly influenced the positions of some universities in BiH, as evident from Figures 2, 3. and 4.

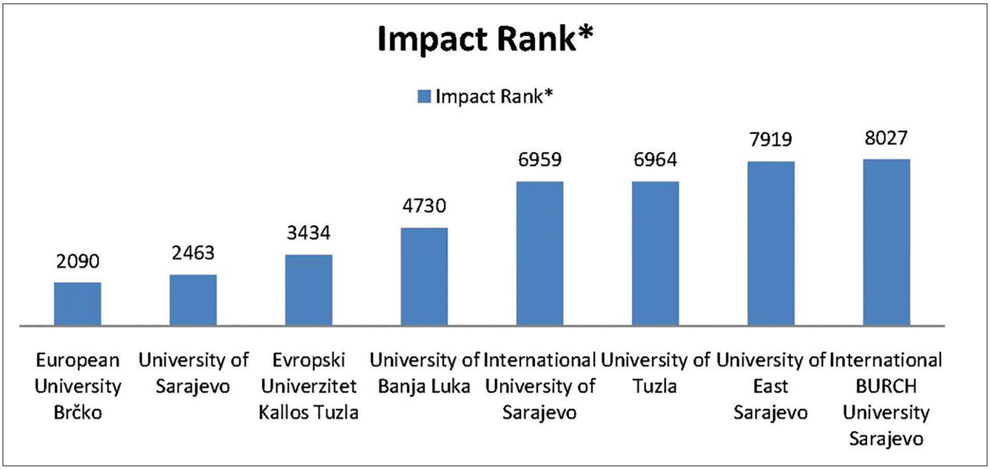


Figure 2. Overview of the most successful universities in BiH according to the "Impact Rank" criterion for January 2021.

According to the “Impact Rank” (Figure 2) best position is the European University Brčko, and among the 8 top ranked in this category are 4 private universities. It is noticeable that public universities in BiH have a lot of room for improvement according to this ranking criterion, which objectively offers the quickest and easiest progress on the ranking lists.

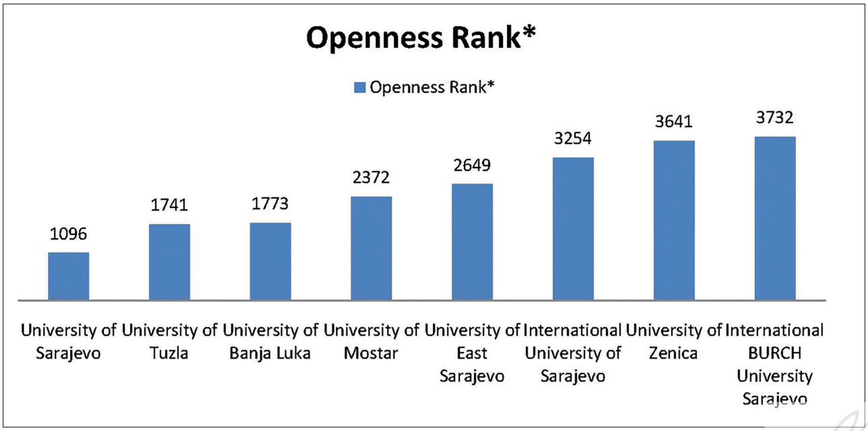


Figure 3. Overview of the most successful universities in BiH according to the “Openness Rank” criterion for January 2021.

In contrast to the previous “Impact Rank” criterion, the “Openness Rank” criterion which is based on the number of citations from the google scholar and represented in Figure 3, there is visible advantage of public universities, with universities that have the most employed scientists leading the group.

Figure 4. Overview of the most successful universities in BiH according to the “Excellence Rank” for January 2021.

The most important scientific criterion, “Excellence Rank”, which represents 40 percent of the total score on the Webometrics ranking, shows that the positions of the top three universities in BiH according to this criterion are identical to the top three positions of BiH universities on the overall Webometrics list (Figures 1 and 4).

In the SJR: Scimago report for the period 1996–2019 (Figure 5), Bosnia and Herzegovina ranks 95th in the world according to the number of published scientific articles, but with a lower citation rate than Macedonia, which has a smaller number of published articles. The best positioned regional countries on the list are Croatia, which is on the 50th position, Slovenia (52nd) and Serbia (53rd). Slovenia has the largest number of citations and the largest H index in relation to all other countries that emerged after the breakup of Yugoslavia.

Rank	Country	Doc	Citable doc	Citations	Self-citat	Citat per doc	H index
50	Croatia	113256	107688	1146885	197804	10,13	282
52	Slovenia	101460	96022	1490029	224168	14,69	310
53	Serbia	101388	95763	989159	184758	9,76	247
95	Bosnia and Herzegovina	13884	12961	94225	9735	6,79	103
97	Macedonia	12815	12117	133726	12137	10,44	121
123	Montenegro	4717	4474	32182	5984	6,82	64

Figure 5. Analysis of the number of articles, citations, H index according to SJR: Scimago report for period 1996-2019.

However, when the analysis of the number of documents and citations per capita is made (Figure 6), Bosnia and Herzegovina is in last place among the successor countries of the former Yugoslavia, both in terms of the number of documents and the number of citations. The data presented in Figures 5 and 6 clearly indicate that in the post-war period Bosnia and Herzegovina lagged behind the most in important parameters that present the state of science in a particular country or community.

Number of Articles per population	
Slovenia	0,049
Croatia	0,026
Serbia	0,014
Montenegro	0,008
Macedonia	0,006
Bosnia and Herzegovina	0,004

Number of quotations per population	
Slovenia	0,713
Croatia	0,268
Serbia	0,141
Montenegro	0,064
Macedonia	0,052
Bosnia and Herzegovina	0,027

Figure 6. Number of articles and citations per capita, according to the SJR: Scimago report for period 1996-2019.

Why have we failed to control this sudden increase in the number of faculties, universities and scientists, and to harmonize it with the realistically expected scientific production that was supposed to follow it and be its necessary corrective factor?

Objective causes should be mentioned first. All university centres in Bosnia and Herzegovina, at the very beginning of the war (but also during the whole war and later), were left without a significant number of staff, who until that moment were the bearers of activities at those universities. It was necessary to replace those staff with other teachers in order to maintain the functioning of the university in wartime conditions. It is normal and expected that these replacements in wartime conditions, very often, were not adequate. However, after that, a decisive mistake was made. The academic community had failed to oppose propaganda and the creation of the general climate that dictated abandonment of the established and universal international scientific criteria in the academic community in favour of introducing local criteria that are only appropriate for a country in wartime. With the introduction of local criteria, the war-isolated academic community became a target of local politics, which began with the increasingly frequent 'insertion' of its own staff who, according to the new criteria, fully met the conditions. This led to the weakening of the influence of science, as the basic driving force of academia, and the strengthening of the influence of politics in our higher education institutions.

A part of the answer is contained in the Dayton setting of the position of education, including higher education in our country, where the work and even the establishment of new higher education institutions are decided on by entity, and in the Federation even by cantonal political structures. These structures have shown complete incompetence to decide on such sophisticated problems, without understanding the essence of the functioning of higher education. This also applies to areas such as Sarajevo, Banja Luka, Tuzla and Mostar, which were university centres even before the war. On the other hand, the small cantons, which had previously barely maintained the secondary education system, were given the right to establish universities and became real "El Dorados" for private colleges of uncontrolled and dubious quality and for local strongmen eager for university fame. Some cantons opened several private colleges and even universities, before even passing the Higher Education Act. Therefore, those institutions practically worked at their own discretion, void of any legal or even essential control regulations.[15] All of the above has led to a real flood of scientific titles and teaching titles that are in no way correlated to real scientific production[16]. In this way, students get the wrong message at the beginning, so they do not identify with teachers who have achieved scientific achievements, but focus on obtaining scientific titles without science and on the fastest possible career advancement without objective indicators of scientific excellence. The question is whether it is now even worth introducing some standards in higher education at all, because we have already fabricated staff according to the current criteria who will be active at least until 2040.[17]

Perspectives and Final Considerations

The social significance and quality of scientific research largely depend on the usefulness of research results for the social and scientific community. The lack of funds for scientific research and the desire to allocate funding to high-quality research projects make the assessment of the quality of research and the valorization of knowledge increasingly important.

However, in science and education there has always been an open question: which criteria can objectively assess the quality of work of higher education institutions and thus ensure the fulfilment of standards that provide adequate quality of resulting competencies. Since scientific research through innovations, patents and publications can be much more accurately measured and evaluated, compared to educational and other activities of universities, these parameters often appear as predetermining measures in evaluating the quality of higher education.

[15] Zerem, 2014:248-51

[16] Zerem, E., Kunosić, S., Imširović, B., & Kurtčehajić, A. 136-142.

[17] Zerem, 2013;38:128; Zerem, 2014:248-51.

In the current situation, when in no segment of our higher education there is a sufficient level of knowledge, commitment and determination to take systemic measures to improve the quality of our higher education institutions, it is difficult to say what measures should be taken to improve this situation so that our universities would advance on the ranking lists. It is clear that numerous shortcomings can be found in the criteria for forming university ranking lists, but the ranking systems, whether we like it or not, are becoming part of the reality of the existence and work of thousands of universities in the world.

The fact is that investments in scientific research work affect the improvement of scientific production. However, without the introduction of internationally recognized scientific criteria in the evaluation of scientific research, and the coordination of academic progress in accordance with the criteria, even the current miserable investment in science is essentially a useless waste of taxpayers' money. The second, no less important reason for such state of our higher education and science, is its fragmentation and the lowering of competencies over them to the entities and cantons, which are completely incompetent for that role. The existence of an effective regulatory institution at the level of Bosnia and Herzegovina, which would establish unique criteria in higher education at the state level with the possession of competencies and mechanisms for effective supervision of their implementation, would contribute to improving the situation in science and higher education.

References

1. Ashby, N. (2003). Relativity in the Global Positioning System. Living Rev Relativ. Vol. 6(1):1. DOI: 10.12942/lrr-2003-1
2. Bowen, A., Casadevall A. (2015). Increasing disparities between resource inputs and outcomes, as measured by certain health deliverables, in biomedical research. Proc Natl Acad Sci U S A. 112(36):11335-40. DOI: 10.1073/pnas.1504955112.
3. Brennan-Krohn, Z. The Bologna Process in Bosnia-Herzegovina: Strengthening, Re-Branding, or Undermining Higher Education? In: 1st International Conference on Foreign Language Teaching and Applied Linguistics (FLTAL), Sarajevo/Bosnia and Herzegovina, 5-7 May 2011.
4. Dixon, A.K. (2009) Publishing and academic promotion. Singapore Med J. 50(9):847-50.
5. Hall, T. (1998) The haunted forest: a ghost story. Lancet 352:1230. DOI: 10.1016/S0140-6736(05)60578-8.
6. Horton, R. Publication and promotion. A fair reward. Lancet. 352:892. DOI: 10.1016/S0140-6736(05)60578-8
7. Hounsfield, G.N. (1973) Computerized transverse axial scanning (tomography). 1. Description of system. Br J Radiol 46:1016-22. DOI: 10.1259/0007-1285-46-552-1016

8. Kendrew, J.C., Perutz, M.F. (1948). A comparative X-ray study of foetal and adult sheep haemoglobins. Proc R Soc Lond A Math Phys Sci 194:375-98. DOI: 10.1098/rspa.1948.0087.
9. Klaic, B. (1997). Analysis of scientific prodictivity in Croatia according to the Science Citation Index, Social Science Citation Index, and Arts & Humanities Citation Index for the 1980-1995 period. Croat Med J. 38:88-98.
10. Kunosić, S., Čeke, D., Zerem, E.: Advantages and disadvantages of the webometrics ranking system. In: Kunosić, S., Zerem, E., (eds.) Scientometrics Recent Advances (2019). https://www.intechopen.com/books/scientometrics-recent-advances/advantagesand-disadvantages-of-the-webometrics-ranking-system
11. Čeke D and Kunosić S. (2021) Analiza kvalitete naučno-istraživačkog rada bazirana na citiranosti naučnih radnika i rangiranosti univerziteta u Covid-19 vremenu u Bosni i Hercegovini. Quality 2021 (S.Brdarević, S. Jašarević, editors)", ISSN 1512-9268, Neum, B&H, 17-19 June 2021., pp. 17-22
12. Marušić, A., Marušić M. (1999). Authorship criteria and academic reward. Lancet 353:1713-14.
13. Miles, K.A., Hayball, M., Dixon, A.K. Colour perfusion imaging: a new application of computed tomography. Lancet 1991; 337:643-5. DOI: 10.1016/0140-6736(91)92455-b.
14. Petković,B., Petković,D., Ćatić, R. (2013). Kako povezati sistem osiguranja kvaliteta u visokom obrazovanju sa aspekta postojećih sistema rangiranja univerziteta. Naučnostručni skup sa međunarodnim učešćem "QUALITY 2013", Neum, B&H, 06. – 08. juni 2013. 154 Posebna izdanja ANUBiH CC, ODN knjiga 18, str. 135-154
15. Petković, B., Pehlić, I., Ćatić, R. Petković, D. Analiza spremnosti BH visokoškolskih organizacija za procese međunarodnih rangiranja rangiranja. Naučno-stručni skup sa sa međunarodnim učešćem "QUALITY 2015", Neum, B&H, 10. – 13. juni 2015.
16. Zerem, E. (2013). Right criteria for academia in Bosnia and Herzegovina. Lancet. 382:128. DOI: 10.1016/S0140-6736(13)61565-2
17. Zerem, E. (2014). Academic community in a developing country: Bosnian realities. Med Glas (Zenica). 11:248-51.
18. Zerem, E. (2017). The ranking of scientists based on scientific publications assessment. J Biomed Inform. 75:107-109. DOI: 10.1016/j.jbi.2017.10.007.
19. Zerem, E. (2018). The ranking of scientists. J Biomed Inform. 79:147-148. DOI: 10.1016/j.jbi.2018.02.007
20. Zerem, E.; Kunosić, S. (2018) The ranking of scientists: Computational calculation of Z-score. J. Biomed. Inform. 81: 133–134. DOI: 10.1016/j.jbi.2018.04.002.
21. Zerem, E., Kunosić, S., Imširović, B., & Kurtčehajić, A. (2021). Science metrics systems and academic promotion: bosnian reality. Psychiatria Danubina, 33(suppl 3), 136-142.

DOI: 10.5644/PI2021.200.19

Difficulties in Advancement of Science and Shaping the System of Science and University as a Carrier of Technological Development in Bosnia and Herzegovina

Dejan Milošević[*]
Benjamin Fetić[**]

Abstract: The primary function of the university, in addition to education, is scientific research. At Bosnia and Herzegovina universities, the scientific research has been neglected. There are two basic reasons for that. The first is insufficient financial investment in science and research, and the second is an underdeveloped awareness of the importance of scientific research work, both in the society of Bosnia and Herzegovina and in universities themselves. This paper indicates what needs to be done to overcome this latter difficulty. In addition, the possibilities for improving science and shaping the science system at universities in Bosnia and Herzegovina to make them research universities were analysed. Scientific research work builds on research and development work, technological development, cooperation with the economy and the development of science and technology parks. These activities are even less represented at universities in Bosnia and Herzegovina than scientific research work. This paper shows the ways how to overcome these difficulties, so that research universities become carriers of the technological development of Bosnia and Herzegovina.

Key words: Bosnian-Herzegovinian universities, science, research, development, technology

Introduction

There are eight public universities in Bosnia and Herzegovina, six in the Federation of Bosnia and Herzegovina entity in five cantons (University of Sarajevo, University of Bihać, Džemal Bijedić University in Mostar, University of Mostar, University of Tuzla and University of Zenica) and two in the Republika Srpska entity (University of Banja Luka and University of East Sarajevo). There's also a total of eighteen private universities in Bosnia and Herzegovina - nine of them in the Federation of Bosnia and Herzegovina,

[*] Full member of the Academy of Sciences and Arts of Bosnia and Herzegovina. Full professor at the Faculty of Science, University of Sarajevo. E-mail: milo@bih.net.ba
[**] Assistant professor at the Faculty of Science, University of Sarajevo.
E-mail: benjamin.fetic@pmf.unsa.ba

seven in the Republika Srpska and two in the Brčko district. In addition, sixteen independent colleges and privately owned high schools operate in Bosnia and Herzegovina. Unfortunately, there are no data which show to which extent these institutions are engaged in scientific research.[1] No public or private university has units that have been declared centers of excellence. The connection of these institutions with the economy was assessed as insufficient (Trifković, 2020).

Scientific research projects are classified as fundamental, applied or research-development (Trifković, 2020). In addition to education, scientific research is a basic function of the university. Unfortunately, scientific research at the universities of Bosnia and Herzegovina has been neglected. This can be shown by analyzing the position of Bosnian-Herzegovinian science and Bosnian-Herzegovinian universities in world rankings. Within the project "Harmonization of the Science System in Bosnia and Herzegovina" (Trifković, 2020) of the Academy of Sciences and Arts of Bosnia and Herzegovina, it was shown that the main reason for unsatisfactory state of science in Bosnia and Herzegovina is its polycentric and atrophied organization. The proposed measures for improving the state of science are based on the harmonization of the science system through the legislation of the relevant political-territorial units. It was pointed out that, in addition to harmonizing existing and passing new laws, it is necessary to revise existing strategies, strengthen and modernize appropriate public administration capacities, separate budget funding for research and technological development activities from funding for the teaching component of higher education, and significantly increase allocations for science, in relation to the current 0.1% of gross national income, determine priorities in international cooperation and form science councils.

Most of the above proposed measures to improve the position of science are "top-down" type, i.e. it is envisaged that decisions are made at a higher level (e.g. change of law, adoption of strategies) with the expectation that this will lead to the desired changes. Unfortunately, the reality of B&H society is that laws are interpreted differently and strategies are not implemented. Authorities do not understand how important science is for society. There is no state ministry of science because, according to the Constitution of Bosnia and Herzegovina, education, together with scientific research, is the responsibility of the cantons in the Federation of Bosnia and Herzegovina, and of the

[1] See: *Answers to the Questionnary of the European Commission – Chapter 25 – Science and research*, The Directorate for European Integration of the Council of Ministers of Bosnia and Herzegovina, DEI | Answers to the Questionnaire. (November 2, 2020)

Republika Srpska entity. Legislation depends on the levels of government, so only partial solutions are made. There is no policy of the competent institutions for the return of the top students who left Bosnia and Herzegovina for the purpose of education. The personnel policy of universities is inadequate, i.e. it practically does not exist. This paper points out the possibility of a different approach. The "bottom-up" approach should gradually lead to a change in the awareness of the government and individuals about the importance of science and scientific research for the development of Bosnian-Herzegovinian society. It is necessary to create a critical mass of scientists who are really engaged in scientific research, which can be measured by exact indicators established by international standards and criteria, such as the number and quality of published papers monitored by the Web of Science Core Collection database, h-index and the like.

After this introduction, in the following chapters we will first present the exact indicators of the position of Bosnian-Herzegovinian science and Bosnian-Herzegovinian universities in the world. The obtained results are based on the analysis of carefully selected world rankings. After that, we will present the Strategy for the Development of Scientific Research/Artistic Research at the University of Sarajevo and the Regulation on Rewarding Academic and Scientific Research Staff of the University of Sarajevo based on the results of scientific/artistic work as examples of "bottom-up" measures to improve science in Bosnia and Herzegovina. We will also present the results of the analysis of the number and citations of papers affiliated with the University of Sarajevo. The remaining part of the paper presents data on institutes, research centers, technology parks and patents in Bosnia and Herzegovina. The weaknesses of the data collection system on scientific research work were pointed out. Funding and problems of realization of employment of scientists and researchers were considered immediately before the conclusions with which this work ends.

The Position of Bosnian-Herzegovinian Science in the World

The position of a country's science in the world is determined by the contribution of that country's scientists to scientific production expressed by the number and importance of scientific publications. There are different ranking lists of countries.[2]

[2] Academic ranking, Agency for science and higher education, Zagreb, 2019 (brochure printed as a part of the SKAZVO: https://skazvo.azvo.hr/images/stories/dokumenti/24_Bro%C5%A1ura_Akademska_rangiranja.pdf).

For example, Nature index[3] is a database based on papers published in a selected group of 82 high quality journals. Since the number of such papers published by Bosnian-Herzegovinian authors is negligible, we decided to analyze the data available on The SCImago Journal & Country Rank portal.[4] The analysis of publishing and citing in over 34 thousand titles according to a specific algorithm (Guerrero-Botea & Moya-Anegón, 2012) ranked 239 countries. The order for 2019 is: China, the United States, Great Britain, India, Germany, Italy, Japan, France, Canada, the Russian Federation, Australia, Spain, etc. Table 1 shows the position of Bosnia and Herzegovina based on published scientific papers according to the SCImago Journal & Country Rank in the period from 1996 to 2020. The ranking of countries in our environment is also stated. The conclusion is that we are significantly behind compared to Serbia, Croatia and Slovenia, but that we are better than Macedonia, Montenegro and Albania. Considering the pre-war development of these states, this result is expected. It is interesting to note that, unlike the surrounding countries, the position of Bosnia and Herzegovina on this ranking list has improved over the recent years. However, the difference of over thirty places on the world ranking list in relation to Serbia, Croatia and Slovenia is too big and can be attributed to the poor attitude of B&H authorities towards science and scientific research, as well as insufficiently developed awareness of academia members about the importance of scientific research.

Table 1. Ranking of Bosnia and Herzegovina and the countries in its vicinity in the period 1996-2020 according to the SCImago Journal & Country Rank portal. (June 1, 2021)

Country	1996-2020	2015	2016	2017	2018	2019	2020
B&H	96	92	92	92	93	92	92
Serbia	52	50	51	51	54	54	56
Croatia	50	52	53	53	55	59	58
Slovenia	53	53	55	55	59	60	60
Macedonia	97	93	95	95	95	98	101
Montenegro	122	118	112	111	114	112	114
Albania	118	107	117	126	116	118	119

[3] https://www.natureindex.com/

[4] https://www.scimagojr.com. This portal uses database information Scopus® (www.scopus.com; Elsevier B.V.: www.elsevier.com).

Position of Bosnian-Herzegovinian Universities on the Webometrics List

In the last few years, the management of the University of Sarajevo has made a significant effort to advance the position of the university in the world rankings. This is especially true for Webometrics ranking that includes all universities in the world. Namely, the academic staff of the University of Sarajevo publishes negligibly small number of papers in top scientific journals, so the University of Sarajevo is not ranked at all on prestigious world rankings such as the Shanghai list. When ranking by Webometrics, four criteria are used according to Table 2.

Table 2. Ranking criteria according to Webometrics.

INDICATORS	METHODOLOGY	SOURCE	WEIGHT
PRESENCE	**Web domain size** of the institution (with subdomains) – also includes the number of documents placed on the domain and sub-domains as *rich* text, pdf.	Google	5%
VISIBILITY	**Visibility** (number of external networks (subnets) linking to the institution's webpages.	Ahrefs Majestic	50%
TRANSPARENCY (or OPENNESS)	**Number of citations from top 10 authors** of institution at Google Scholar (citations from the second to the tenth ranked author are collected, while the number of citations of the first is not added).	Google Scholar Citations	10%
EXCELLENCE (or SCHOLAR)	**Number of published papers** among 10% of the most cited papers in 26 disciplines over a period of five years.	Scimago	35%

According to the Webometrics list from July 2020, the order of universities from our region is as follows (in parentheses is the ranking in the world): 1. Ljubljana (314), 2. Belgrade (441), 3. Zagreb (590), 4. Novi Sad (934), 5. Split (1098), 6. Maribor (1118), 7. Niš (1397), 8. Rijeka (1420), 9. Sarajevo (1508). Among the first 2000 universities are also: Skopje (1556), Kragujevac (1750), University of Montenegro (1915) and Osijek (1993). As expected, the universities in Ljubljana, Belgrade and Zagreb are far ahead of the University of Sarajevo, which is the best-ranked university in Bosnia and Herzegovina. According to tradition and pre-war position, the University of Sarajevo should be in the rank of the University of Novi Sad, and ahead of the Universities of Split, Maribor, Niš and Rijeka. Other universities in Bosnia and Herzegovina are ranked below the 3000th place (see Table 3). Thus, it is clear that the universities in Bosnia and Herzegovina, which should be the bearers of science and scientific research, are ranked far below expectations. This gap is even larger if only the criterion of scientific excellence is taken into account (the criterion of "excellence" contributes 35% according to Table 2; compare the last column in Table 3). The reasons for this failure of Bosnian science are listed in the Introduction.

Table 3. Ranking list of the first 14 universities in Bosnia and Herzegovina according to Webometrics.

Ranking	World	University	Presence	Impact	Openness	Excellence
1	1508	University of Sarajevo	905	1979	1209	2214
2	3107	University of Tuzla	1228	5553	1870	4011
3	3604	International University of Sarajevo	1120	6976	3472	4064
4	3800	International BURCH University Sarajevo	3767	7529	3762	4011
5	3882	University of Banja Luka	970	5861	5819	3383
6	4767	University of Mostar	940	12342	2531	4942
7	5478	University of East Sarajevo	1871	20450	2883	4011
8	6463	Sarajevo School of Science &Technology	17018	12688	4394	5379
9	6732	European University „Kallos" Tuzla	11938	4117	5593	6626
10	6881	European University Brčko	10345	3724	5819	6626
11	8378	University of Bihać	9031	13550	5018	5902
12	9240	University „Džemal Bijedić" Mostar	7267	11634	4329	6626
13	10866	International University Travnik	12903	8983	5819	6626
14	11916	University of Zenica	3519	23196	3706	5681

We note that the latest position of the University of Sarajevo in the 1508th place in the world is the best so far. This is the result of hard work on increasing the presence and visibility of the web assets of the University of Sarajevo (creation of a new website) and the requirement for academic staff and researchers to register on Google scholar.[5] This can be seen by the fact that the University of Sarajevo is ranked much better in terms of presence (905) and transparency (1209). This was achieved in a relatively short period of time. The University of Sarajevo lags behind in terms of the influence criterion (1979) (this criterion carries 50% of the ranking; simply put, when calculating this criterion, all external links that the university's web domain receives from third parties are taken into account). These results indicate that it is possible to improve the position of science in Bosnia and Herzegovina using the "bottom-up" approach. In addition to the University of Sarajevo, it is planned

[5] https://scholar.google.com/

to improve the position of other universities.[6] It is obvious that the University of Sarajevo lags behind the most in terms of excellence (2214), which contributes 35% to the overall ranking. Improving excellence can only be achieved through long-term measures. This, of course, includes the "top-down" measures mentioned in the introduction. Examples of long-term "bottom-up" measures are the Strategy for the Development of Scientific Research/ Artistic Research at the University of Sarajevo and the Regulation on Rewarding Academic and Scientific Research Staff of the University of Sarajevo based on the results of scientific/artistic work discussed in the following parts.

Strategy for Development of Scientific Research/ Artistic Research Work at the University of Sarajevo

The Council for Science and Arts of the University of Sarajevo is an expert and advisory body of the Senate of the University of Sarajevo appointed by the decision of the Senate of December 28, 2016. The basic document relevant to this paper is the Strategy for the Development of Scientific Research / Artistic Research at the University of Sarajevo, which was adopted on September 22, 2017 at the Senate session, at the proposal of the Council.[7] This strategy envisages that excellent research and publication of quality works are especially encouraged and rewarded. The second chapter of this strategy (2. Creating criteria of scientific excellence and relevance) in the section "New criteria for academic promotions and incentives for outstanding researchers" states that: "Scientific papers should include papers published in scientific journals represented in the WoSCC database (Web of Science Core Collection). When drafting the Regulation on election to academic titles, which will establish a scoring system for the evaluation of scientific papers as a condition for election to academic titles, pay special attention to JR (Journal Citation Reports) and SJR (SCImago Journal Rank indicator) and, accordingly, classify scientific journals according to their importance in their field (e.g. in the so-called quartiles Q1, Q2, Q3 and Q4)."

In the conclusion of the Strategy for the Development of Scientific Research / Artistic Research at the University of Sarajevo, it was emphasized that the key elements for the implementation of this strategy are:

---

[6] Milošević, D. The role, significance, promotion and popularization of science in B&H: Example of the University of Sarajevo, lecture, University „Džemal Bijedić" Mostar, December 24, 2019; contacts with colleagues from the University of Tuzla, etc.

[7] Strategy | University of Sarajevo (unsa.ba)

„– formation of registers of scientific / artistic works, researchers / artists, projects and infra-structure,
– activation / establishment of a center for research and development of the University of Sarajevo (and within it a science and technology park),
– new criteria for promotion to academic titles and incentives for excellent research,
– reforms and improvement of doctoral studies as an important segment of scientific research and general development of the academic community,
– rationalization of the existing scientific research infrastructure and planned procurement of crucial equipment.“

The above mentioned registers have not yet been formed. The UNSA Research and Development Center has been established but has not yet been activated. Criteria for incentives for outstanding researchers have been adopted and outstanding researchers have been awarded for results in 2017, 2018 and 2019. Criteria for promotion to academic titles has yet to be drafted and adopted. New rules for doctoral studies have been adopted. For the rationalization of the existing scientific research infrastructure and the planned procurement of crucial equipment, it is necessary to first form a register and make an appropriate analysis based on it.

Regulation on Awarding the Academic and Scientific Research Staff of the University of Sarajevo on the Basis of the Results of Scientific / Artistic Work

As another example of "bottom-up" improvement of the quality and position of science, we will cite the Regulation on rewarding academic and scientific research staff of the University of Sarajevo based on the results of scientific / artistic work.[8] The Senate of the University of Sarajevo has adopted this Regulation at the 19th session held on May 29, 2018. Prior to this adoption, an analysis of papers published in 2017 with the affiliation of the University of Sarajevo according to the Web of Science Core Collection database was conducted. Based on the results of that analysis, the Regulation is designed to achieve the most equal evaluation of the contribution of scientists from different fields. Tables 4, 5 and 6 present the results for 2017, 2018 and 2019.[9] For each group of sci-

[8] https://www.unsa.ba/o-univerzitetu/propisi/pravilnik-o-nagradivanju-akademskog-i-naucnoistrazivackog-osoblja

[9] The data in the given tables were processed by the Service for Scientific Research of the University of Sarajevo.

ences and each organizational unit, the number of papers published in journals accompanied by a certain quartile (Q1, Q2, Q3 and Q4) is presented.[10]

Table 4. List of the number of published papers and points for 2017 by groups and organizational units of the University of Sarajevo according to the Regulation on rewarding.

GRUPACIJA	Organizaciona jedinica/institucija	WoS Docs	Docs in JIF Journals	Docs in Q1 Journals	Docs in Q2 Journals	Docs in Q3 Journals	Docs in Q4 Journals	Docs other than JIF	Q1 (10)	Q2 (7)	Q3 (4)	Q4 (2)	UKUPNO BODOVA
Društvene nauke	Ekonomski fakultet	25	13	3	5	3	2	12	30	35	12	4	93
	Pravni fakultet	1	0	0	0	0	0	1	0	0	0	0	1
Humanističke nauke	Filozofski fakultet	6	3	0	2	1	0	3	0	14	4	0	21
	Pedagoški fakultet	2	2	0	0	1	1	0	0	0	4	2	6
Medicinske nauke	Fakultet zdravstvenih studija	1	1	1	0	0	0	0	10	0	0	0	10
	Farmaceutski fakultet	10	10	2	2	0	6	0	20	14	0	12	46
	Medicinski fakultet	40	38	6	12	18	2	2	60	84	72	4	222
	Stomatološki fakultet	8	4	0	4	0	0	4	0	28	0	0	32
	Veterinarski fakultet	12	12	6	2	3	1	0	60	14	12	2	88
Prirodno-matematičke i biotehničke nauke	INGEB	10	10	0	3	5	2	0	0	21	20	4	45
	PMF	103	97	22	10	32	31	6	220	70	128	62	486
	Poljoprivredno-prehrambeni fakultet	14	14	3	6	0	5	0	30	42	0	10	82
	Šumarski fakultet	14	13	5	3	1	4	1	50	21	4	8	84
Tehničke nauke	ETF	9	9	1	2	2	4	0	10	14	8	8	40
	Fakultet za saobraćaj i komunikacije	2	2	1	0	0	1	0	10	0	0	2	12
	Građevinski fakultet	11	11	2	2	0	7	0	20	14	0	14	48
	Mašinski fakultet	10	10	0	2	0	8	0	0	14	0	16	30

Table 5. List of the number of published papers and points for 2018 by groups and organizational units of the University of Sarajevo according to the Regulation on rewarding.

GRUPACIJA	Organizaciona jedinica/institucija	WoS Docs	Docs in JIF Journals	Docs in Q1 Journals	Docs in Q2 Journals	Docs in Q3 Journals	Docs in Q4 Journals	Docs other than JIF	Q1 (10)	Q2 (7)	Q3 (4)	Q4 (2)	UKUPNO BODOVA
Društvene nauke	Ekonomski fakultet	27	8	1	3	3	1	19	10	21	12	2	64
	Fakultet političkih nauka	5	2	0	0	2	0	3	0	0	8	0	11
	Fakultet sporta i tjelesnog odgoja	21	7	0	0	0	7	14	0	0	0	14	28
Humanističke nauke	Filozofski fakultet	11	7	2	5	0	0	4	20	35	0	0	59
	Katolički bogoslovni fakultet	1	0	0	0	0	0	1	0	0	0	0	1
	Pedagoški fakultet	11	1	1	0	0	0	10	10	0	0	0	20
Medicinske nauke	Fakultet zdravstvenih studija	2	2	1	0	1	0	0	10	0	4	0	14
	Farmaceutski fakultet	60	19	2	4	7	6	41	20	28	28	12	129
	Medicinski fakultet	51	27	3	9	8	7	24	30	63	32	14	163
	Stomatološki fakultet	3	0	0	0	0	0	3	0	0	0	0	3
	Veterinarski fakultet	36	35	17	4	12	2	1	170	28	48	4	251
Prirodno-matematičke i biotehničke nauke	INGEB	22	22	1	0	10	11	0	10	0	40	22	72
	PMF	124	88	18	30	26	14	36	180	210	104	28	558
	Poljoprivredno-prehrambeni fakultet	41	36	3	14	9	10	5	30	98	36	20	189
	Šumarski fakultet	27	19	3	5	4	7	8	30	35	16	14	103
Tehničke nauke	Arhitektonski fakultet	1	1	1	0	0	0	0	10	0	0	0	10
	ETF	33	27	2	6	10	9	6	20	42	40	18	126
	Građevinski fakultet	24	16	3	1	2	10	8	30	7	8	20	73
	Mašinski fakultet	32	10	0	3	3	4	22	0	21	12	8	63
Umjetnost	Muzička akademija	2	2	0	0	2	0	0	0	0	8	0	8

[10] The quartile ranking is based on the impact factor (IF) of the journal according to the Journal Citation Reports (JCR) published by Clarivate Analytics each year. Information can be obtained through the Web of Science Core Collection. Q1 joins the best journals (ranked in the top 25%), Q2 corresponds to 25-50%, Q3 - 50-75%, and Q4 the last 75-100% of journals according to IF.

Table 6. List of the number of published papers and points for 2019 by groups and organizational units of the University of Sarajevo according to the Regulation on rewarding.

SAVJET ZA NAUKU I UMJETNOST UNIVERZITETA U SARAJEVU													
UTVRĐENA LISTA RADOVA I BODOVA PO ORGANIZACIONIM JEDINICAMA U SKLADU SA PRAVILNIKOM O NAGRAĐIVANJU (2019. GODINA)													
OJ lista za nagrade													
								BODOVANJE					
GRUPACIJA	Organizaciona jedinica/institucija	WoS Docs	Docs in JIF Journals	Docs in Q1 Journals	Docs in Q2 Journals	Docs in Q3 Journals	Docs in Q4 Journals	Docs other than JIF	Q1 (10)	Q2 (7)	Q3 (4)	Q4 (2)	UKUPNO BODOVA
Društvene nauke	Ekonomski fakultet	36	22	9	7	5	1	14	90	49	20	2	175
	Fakultet političkih nauka	5	1	0	1	0	0	4	0	7	0	0	11
	Fakultet sporta i tjelesnog odgoja	10	2	1	0	1	0	8	10	0	4	0	22
	Fakultet za kriminalistiku, kriminologiju i sigurnosne studije	2	1	1	0	0	0	1	10	0	0	0	11
	Pravni fakultet	1	0	0	0	0	0	1	0	0	0	0	1
Humanističke nauke	Filozofski fakultet	18	1	1	0	0	0	17	10	0	0	0	27
	Katolički bogoslovni fakultet	1	0	0	0	0	0	1	0	0	0	0	1
	Pedagoški fakultet	10	2	0	0	0	2	8	0	0	0	4	12
	Institut za historiju	2	0	0	0	0	0	2	0	0	0	0	2
Medicinske nauke	Fakultet zdravstvenih studija	5	4	1	0	1	2	1	10	0	4	4	19
	Farmaceutski fakultet	46	26	2	0	10	14	20	20	0	40	28	108
	Medicinski fakultet	108	87	28	6	20	33	24	280	42	80	66	492
	Stomatološki fakultet	4	0	0	0	0	0	4	0	0	0	0	4
	Veterinarski fakultet	19	17	2	1	1	13	2	20	7	4	26	59
Prirodno-matematičke i biotehničke nauke	INGEB	26	26	2	0	4	20	0	20	0	16	40	76
	PMF	131	105	8	35	28	34	38	80	245	112	68	543
	Poljoprivredno-prehrambeni fakultet	36	24	5	6	3	10	12	50	42	12	20	136
	Šumarski fakultet	42	30	12	0	0	18	12	120	0	0	36	168
Tehničke nauke	ETF	41	28	15	4	3	6	13	150	28	12	12	215
	Fakultet za saobraćaj i komunikacije	3	1	1	0	0	0	2	10	0	0	0	12
	Građevinski fakultet	29	16	6	1	0	9	13	60	7	0	18	98
	Mašinski fakultet	52	19	1	5	11	2	33	10	35	44	4	126
Umjetnost	Akademija likovnih umjetnosti	1	0	0	0	0	0	1	0	0	0	0	1
	Muzička akademija	1	0	0	0	2	0	1	0	0	8	0	9

Analysis of the Number and Quotation of Scientific Papers Published With the Affiliation of the University of Sarajevo

In this part of the paper, we will analyze the number and citations of scientific papers with the affiliation of the University of Sarajevo (address of the institution "Univ Sarajevo") published in journals monitored by the Web of Science Core Collection database. Papers with the addresses: Int Univ Sarajevo, Burch Univ Sarajevo and SSST are excluded from consideration. Taking into account that the authors did not always take into account the affiliation of the University of Sarajevo (sometimes only the name of the faculty or department is stated), the obtained results cannot be considered complete. However, the results obtained in this way indicate a trend in the development of scientific work at the university.

Figures 1 and 2 show the number of published papers and their citations by years from 1949 to 2019. Four time periods/phases can be observed:

- From 1949 to 1972: This is the period of the beginnings of scientific work at the University of Sarajevo and the number of papers and citations of these papers is small.

– From 1973 to 1991: In this period there is already a good basis for scientific work and the number of published papers and citations is significantly higher than in the first period and is slightly increasing with age.
– From 1992 to 2004: This is a period of war and renewal of scientific potentials after the war. The number of publications has been reduced.
– From 2005 to 2019: After 2005, there was a sharp increase in the number of published scientific papers and the number of citations. This increase is significantly higher than expected and it would be useful to examine why this occurred. It is possible that this is related to the beginning of the Bologna Process, the introduction of internationalization and the improvement of international cooperation with other universities.

Figure 1. Number of published scientific papers with the affiliation of the University of Sarajevo by years (according to the Web of Science Core Collection for period from 1949 to 2019, accessed through the Max Born Institute in Berlin, 2020).

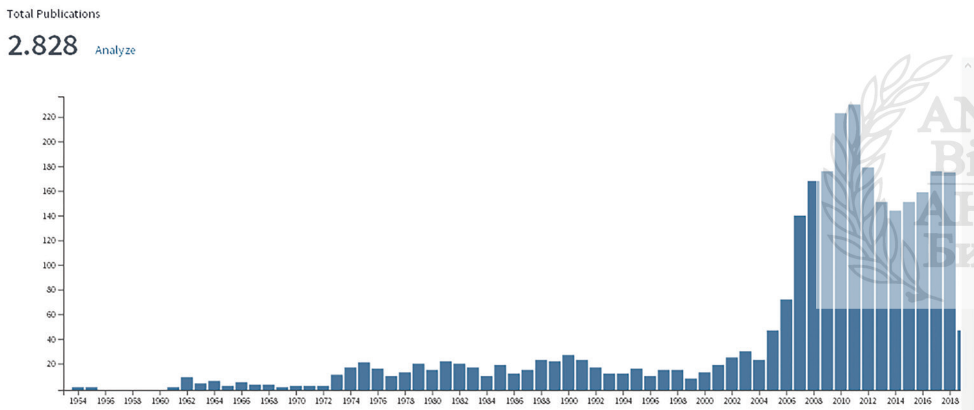


Figure 2. Number of citations for papers from Figure 1.

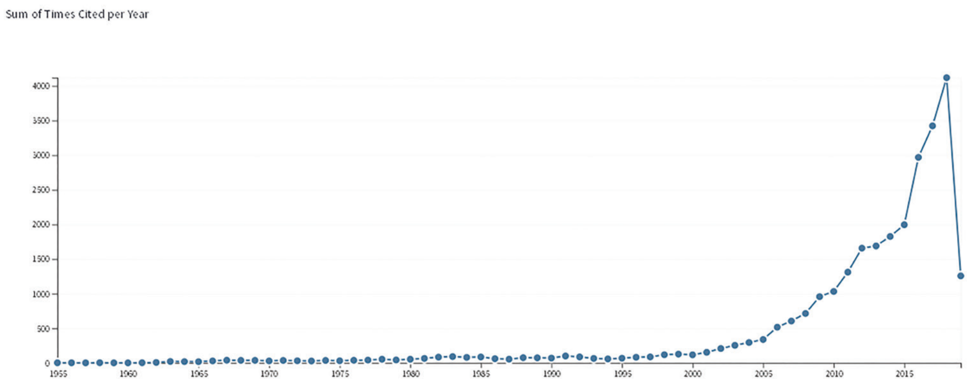


Figure 3 presents an analysis of the number and citations of papers affiliated with the University of Sarajevo according to the Web of Science Core Collection for the period from 1994 to 2020 (the subscription of the University of Sarajevo includes this period). We see that over 4000 papers have been published and that since 2007 the number of papers has risen sharply. After some stagnation in the period 2012-2014 the number of papers and their citation is constantly increasing. This analysis indicates that, despite the poor conditions in which scientific research takes place, our contribution to world scientific production is on the rise.

Figure 3. Number of published papers by years from 1994 to 2020.[11]

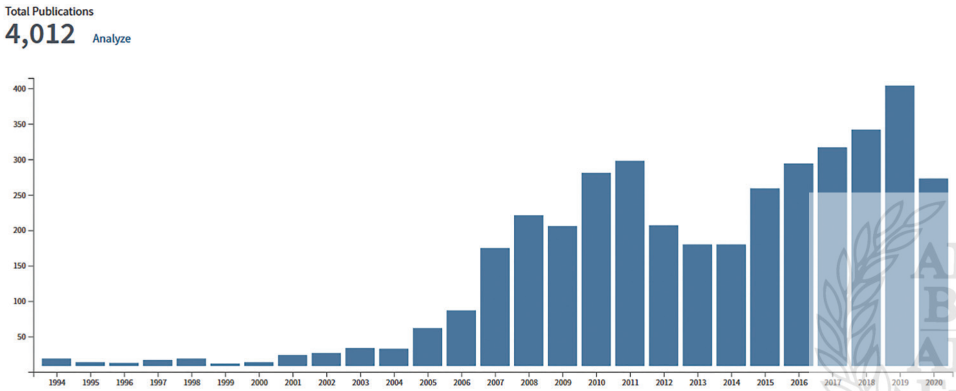
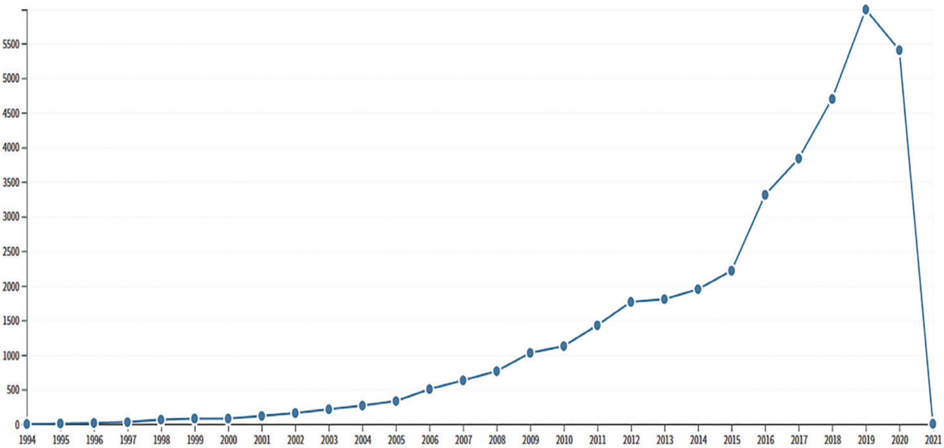


Figure 4. Number of citations per year for papers from Figure 3.



[11] Citation report WoSCC (2020, ORGANIZATION-ENHANCED: (University of Sarajevo) *NOT* TOPIC: (Int Univ Sarajevo) *NOT* TOPIC: (Burch). Indexes: SCI-EXPANDED, SSCI, A&HCI, ESCI).

Institutes, Scientific Research Centers and Technology Parks

According to the Answers to additional questions from the Questionnaire of the European Commission,[12] in the Federation of Bosnia and Herzegovina there are about 20 institutes within faculties or universities and a dozen institutes as independent legal entities. The terminology used ("about", "dozen") indicates the problem of the lack of a clear way of collecting basic data on institutes. How, then, can the position of these institutes be expected to improve? The information for Republika Srpska is somewhat more precise. There are a total of 30 institutes in this entity, of which 12 are at public universities, eight at private universities and ten are independent institutes.

In the mentioned Strategy for the Development of Scientific Research / Artistic Research at the University of Sarajevo, technology/science and technology parks are defined as organizations whose main task is to promote innovation and cooperative activity of entrepreneurs and research institutions with the potential to raise competitiveness. These organizations manage the flow of knowledge and technology between universities, research and development institutions and businesses. This enables the creation and establishment of companies based on innovations through spin-offs and start-up businesses. The primary task of such centres is to generate innovative solutions arising from the activities of scientific research entities (faculties, academies, institutes, laboratories, institutes, etc.) and to establish links and translate innovations into the business sector. There are currently four technology parks in the Federation of Bosnia and Herzegovina: Technopark in Zenica, INTERA in Mostar, BIT Centre in Tuzla and HUB 387 in Sarajevo. The question is to what extent these technology parks fit into the above definition of science and technology parks. In Republika Srpska, there is the Innovation Centre Banja Luka (ICBL), which supports the development of companies with the potential to offer the market commercial solutions in the form of products, services and business processes, based on knowledge and application of innovative and advanced technologies. The Ministry of Science and Technology maintains the Register of legal and natural persons engaged in technology development. Organizations for infrastructural support for technology development are: Foundation Innovation Centre Banja Luka, University-Entrepreneurship Centre Banja Luka, Business Incubator Gradiška, Technology Business Park

[12] See: Responses to the European Commission Questionnaire - Chapter 25 - Science and Research, Directorate for European Integration of the Council of Ministers of Bosnia and Herzegovina, DEI | Odgovori na Upitnik EK.

Banja Luka (since 2015 transformed into the business zone "Ramići-Banja Luka") and Technology Centre "LANACO" Banja Luka.

Among the mentioned institutes, scientific research centres and technology parks, there is no mention of the newly established Centre for Research and Development (R&D Centre) of the University of Sarajevo, as well as the public institution "Centre for Advanced Technologies in Sarajevo". For the implementation of the strategic goals of the mentioned Strategy for the Development of Scientific Research / Artistic Research at the University of Sarajevo, it is important to establish a Centre for Research and Development "which will contribute to establishing the University of Sarajevo as a leading institution in research, creation and implementation of scientific and development projects, as well as strengthening cooperation with the public, private and non-governmental sectors in our country. On the other hand, the application and implementation of the EU and other international projects, but also more intensive cooperation with the business sector will provide significant resources for financial and other support not only for applied but also for fundamental research and professional development and greater mobility of scientists and researchers. The establishment of such a centre will certainly enhance the integration of the University of Sarajevo into the European Higher Education Area (EHEA) and the European Research Area (ERA) and strengthen R&D cooperation internationally. The UNSA Research and Development Centre will be an integrated centre that will include three core areas:

- innovations, incubator and science / technology park through the "Open innovation" model which is an increasingly common model of organization and management of innovation, and includes R&D cooperation of all key stakeholders in order to create completely new products, processes and the like. In addition to adequate support for start-up projects, the R&D centre will also coordinate their implementation and commercialization of innovations through spin-off companies. This component implies significant involvement of young researchers and students;
- excellence and institutionalized approach to the development and transfer of best practices including support to UNSA teaching and research staff in the context of their professional development, research, education, intellectual property protection (spin-off), etc;
- EU and domestic projects: most of the implemented projects, whether international (EU) or domestic projects, depend on the individual engagement of individual researchers without any systemic support. Also, there is a disproportionate number of projects in which UNSA has the

role of a partner institution and not the role of coordinator or lead partner. By establishing the UNSA Research and Development Centre as an integrated mechanism of institutional support for project activities at our University, this ratio would be significantly improved, and a special contribution to the quality of written and implemented projects would be provided through multidisciplinary project teams and modern project portfolio management mechanisms and use of resources."

Statistical Data on Scientific Research Work. Patents

The Agency for Statistics of B&H publishes the announcement "Patents" as a result of processing data taken from the Institute for Intellectual Property of Bosnia and Herzegovina. Data were obtained according to defined tables and processed according to the given methodology. Table 7 shows the patents in the period 2010-2016. It is interesting to note that the number of foreign applicants is significantly higher than the number of domestic patent applicants. In addition, the number of patents is continuously declining. It is obvious that our society does not stimulate innovations and patents. In 2019, six patents were granted in the national procedure, of which only one was a domestic applicant and five were foreign applicants.[13]

Table 7. Patents granted in national proceedings, B&H 2010-2016.

	2010	2011	2012	2013	2014	2015	2016
Total	207	148	99	85	45	30	13
Domestic applicants	29	36	16	7	2	12	0
Physical persons	28	34	16	6	2	11	0
Legal persons	1	2	0	1	0	1	0
Foreign applicants	178	112	83	78	43	18	13
Physical persons	7	5	4	5	0	0	2
Legal persons	171	107	79	73	43	18	11

By analyzing the content presented on the website of the Agency for Statistics of Bosnia and Herzegovina[14] we concluded that the way of collecting statistical data on scientific research should be improved. For example,

[13] http://bhas.gov.ba/data/Publikacije/Saopstenja/2020/EDU_06_2018_Y1_0_BS.pdf
[14] www.bhas.gov.ba

according to the Agency for Statistics of Bosnia and Herzegovina,[15] the number of scientific papers published in higher education in 2018 in the field of natural sciences is 18. However, the actual number should be far higher. 18 papers were published by the Department of Physics of the Faculty of Science at the University of Sarajevo alone. According to Table 5, the Faculty of Science (PMF) and the Institute of Genetic Engineering and Biotechnology (INGEB) published 146 papers in natural sciences in 2018 (these papers were the basis for the awards and were registered in the Web of Science Core database). If other less significant databases are taken into account, the number of published works is much higher.

Financing and Problems of Realization of Employment of Scientists and Researchers

In this paper we do not analyze the problems of financing scientific research in Bosnia and Herzegovina, but we point out that, even if funds are obtained for scientific research jobs, the problem is the lack of mechanisms for the implementation of employment (requires the approval of the government or competent authorities, and they limit the number of jobs). Legislation and the "social atmosphere" need to be changed in parallel with the approval of funding for science. Taking into account the small number of young scientists and researchers in Bosnia and Herzegovina, it would be especially important to plan financial resources from the budget for providing scientific research to youth, i.e. employment of young assistants and researchers. At the same time, we should work on changing the personnel policy, developing international cooperation (with special emphasis on our scientific diaspora) and introducing special measures that would enable the return of the best students and scientists to Bosnia and Herzegovina.

Conclusions

In this paper, we have pointed out some of the possibilities of eliminating the difficulties encountered by the universities of Bosnia and Herzegovina in advancing science and shaping the system of science and scientific research. In the ranking of countries in the world according to The SCImago Journal & Country Rank portal, Bosnia and Herzegovina is currently ranked

[15] http://bhas.gov.ba/data/Publikacije/Saopstenja/2019/RDE_01_2018_Y1_0_BS.pdf

90th, and the best ranked university in Bosnia and Herzegovina according to Webometrics is the University of Sarajevo (1508th place). These results, if we take into account the specific constitutional and territorial organization of Bosnia and Herzegovina and the problems caused by the war and post-war transition, are not so bad. However, the lag in relation to the neighboring countries of Croatia and Serbia is too large and changes are necessary. Within the project "Harmonization of the system of science in Bosnia and Herzegovina" of the Academy of Sciences and Arts of Bosnia and Herzegovina, and in this collection of papers, the emphasis is on the harmonization of the system of science through the legislation of competent territorial units in Bosnia and Herzegovina. In this paper, the emphasis is on an alternative approach to improve the position of science and scientific research in Bosnia and Herzegovina. It is a "bottom-up" approach according to which universities, institutes and other bearers of the development of science and scientific research, as well as individuals engaged in scientific research, can do much to improve the position of science, without waiting for changes to existing and new laws. Examples of such an approach are the Strategy for the Development of Scientific Research and the Regulation on Rewarding Based on the Results of Scientific Research at the University of Sarajevo. In addition, using examples of statistical data on scientific research and patents (there is only one recognized domestic patent in Bosnia and Herzegovina in 2019), the need to improve the way of collecting statistical data on scientific research was pointed out. We hope that this paper and the above examples will serve as a guide on how the individual efforts and actions of the universities and institutes themselves can improve the position of science in Bosnia and Herzegovina.

References

Trifković, M. (2020). *Harmonization of the Science System in Bosnia and Herzegovina*. Academy of Sciences and Arts of Bosnia and Herzegovina. Special Editions. Volume CLXXXV. Systems Research Center. Volume 5/1. Sarajevo.

Guerrero-Botea, V. P. and Moya-Anegón, F. (2012). A further step forward in measuring journals' scientific prestige: The SJR2 indicator. *Journal of Informetrics*, Vol. 6, pp. 674–688. ISSN: 1751-1577

DOI: 10.5644/PI2021.200.20

SWOT Analysis of the Innovation System in Bosnia and Herzegovina

Miloš Trifković[*]
Dženana Husremović[**]

Abstract: The current global position of Bosnia and Herzegovina confirms the findings of previous research that in our country there is no single or at least harmonized and efficient innovation system, appropriate to the needs of the development of knowledge society and the knowledge economy. The first steps in determining the reasons for this situation are SWOT analyses of the position and role of the innovation system within the general strategic and sectorial research and technology transfer planning. The paper discusses the most important results of matrices obtained and compares them with the findings of our latest research. The first result is a concise SWOT matrix of the innovation system. The results of the elaboration of individual factors we present in a detailed SWOT matrix based on elements of strength. This matrix also showed that uniform and stabilized higher education is the most important element of the strength of the innovation system. Therefore, the paper specifically discusses characteristics of universities as subjects of the innovation system.

Key words: Bosnia and Herzegovina, knowledge society and economy, innovation system, SWOT analysis of innovation system, general development strategies, sectorial strategies of innovation system development, universities as subjects of the innovation system

I Introductory Notes

Innovation system and the global economic position of Bosnia and Herzegovina

Innovation system is a complex social subsystem created by the interaction of subjects in the processes of creation, application, distribution and dissemination of scientifically based knowledge in order to achieve goals set by society.[1] In par-

[*] Full member of the Academy of Sciences and Arts of Bosnia and Herzegovina. E-mail: iucomt@yahoo.com
[**] Ph.D., Faculty for Philosophy of University of Sarajevo, Vice-Rector for Education of University of Sarajevo. E-mail: dzenana.husremovic@ff.unsa.ba
[1] Trifković, 2020a: 41, see also Trifković, 2020b: 40-41.

allel, the basic elements of innovation systems at the national or supranational level are the same: resources, subjects and regulatory systems. The appearance of the elements, their mutual ties, the way of functioning of the overall innovation system and its relations with other subsystems depend on the historical and current, external and internal circumstances of each society. The same factors determine the system of goals. In modern conditions, the most general theoretical goal of the innovation system is the creation and further development of the knowledge society and knowledge economy as an instrument for raising individual and general well-being, primarily within the community. Hierarchically lower goals are determined according to the pragmatic requirement of raising the competitiveness of the national economy. Therefore, the tasks, structure, mode of operation and results of a particular innovation system ultimately depend on the structure of the state and the degree of overall development of society.[2] This pattern is also visible in the case of Bosnia and Herzegovina.

For the purposes of this paper, we may summarize the structure of the state to its legal system. A description and critical analysis of the constitutional and legal regulations and their unsatisfactory impact on the state of the innovation system of Bosnia and Herzegovina already exist.[3] Poor normative and actual regulation of the innovation system is both a consequence and a cause of unsatisfactory development of the Bosnian-Herzegovinian society, the state and the economy, as well as of the weak position of Bosnia and Herzegovina on the global playfield. There are plenty of arguments for such a view. In the global synthetic indices of development and competitiveness of countries over the last ten years, Bosnia and Herzegovina, as a rule, occupies a place in the lower half of the countries covered by the ranking[4] – with exception in

[2] For an extraordinary illustration of this thesis, instructive for B&H as well, see Radošević & Lepori, 2009: 659-666.

[3] On constitutional system of B&H see Trifković. 2020b: 83 – 95 and Trifković, 2020a: 44 – 48. For comparative overview of the most important legal provisions of all three levels of government in B&H see Trifković, 2020b: 109 – 120 and Trifković, 2020b: 173 – 186.

[4] One of the most general indicators of development is GDP per capita calculated according to the purchasing power parity (PPP). According to the World Bank ranking, in 2019 Bosnia and Herzegovina ranked 96th out of 189 countries. In the same year, the UN ranked B&H 95th out of 193 countries. According to Wikipedia, in 2021 B&H is ranked 92nd out of 141 countries. This is a better ranking than in 2016 (107) and 2017-18 (103). These data are indicative even when taking into account relevant objections to the WEF methodology, and changes in the ranking target and selection of indicators for 2019, according to Schwab, 2019. Cornell University Global Innovation Index (GII) and WIPO in 2020 rank B&H in 74th place among 131 countries, which is an improvement of two places compared to 2019

terms of human capital. No more favourable for us is the World Bank data on indicators of science and technology development in the period 2010-2018.[5] Their research shows that Bosnia and Herzegovina lags behind not only the world, Europe and Central Asia, but also the countries that emerged in the process of dissolution of Yugoslavia from its most underdeveloped republics.[6] Therefore, it is not surprising that the World Economic Forum in its 2017-2018 Competitiveness Report classified Bosnia and Herzegovina into the group of countries that base their development on efficiency in the use of resources, not on innovation.[7] Obviously, the process of intensive creation of a knowledge society and knowledge economy in our country is just beginning.[8]

The reasons for the unsatisfactory state of the innovation system and the poor results of the economic and social[9] competitiveness of Bosnia and Herzegovina are mostly of internal provenance and systemic character. They can be summarized as a development-inappropriate treatment of the country's innovation system. In other words, the innovation system of Bosnia and Herzegovina, within the society and the state it serves, operates in an unfavourable social, political, economic and legal environment. This situation requires an analysis of the state and possibilities of the innovation system to overcome the existing situation.

Methodological determinants

The current global position of Bosnia and Herzegovina confirms the findings of previous research that "in our country there is no single or harmonized

and four places according to the ranking for 2018. However, even with the aforementioned improvements in placements, B&H ranks 38th among 39 economies in Europe - a penultimate place according to the World Intellectual Property Organization, 2020.

[5] See World Bank data (2021).

[6] Trifković, 2020a: 55.

[7] Schwab, 2017:320.

[8] On conditions and issues of development which lead former socialist countries into the group of countries whose economy is driven by efficiency and innovation; see Radošević, 2011.

[9] Despite having only 3.5 million inhabitants, on 21 May, 2021, Bosnia and Herzegovina was ranked 45th on the world list by the absolute number of deaths from COVID 19 according to Statista (2021). In addition, data is available which reports that only 76,311 citizens in Bosnia and Herzegovina were vaccinated with the first dose by that date. Data on the number of vaccinated in the Republic of Croatia and the Republic of Serbia are still unknown, according to Babić, 2021.

and efficient innovation system, appropriate to social needs."[10] Therefore, the main problem of this paper is to identify the most important strengths and weaknesses, which, in conjunction with opportunities and threats, shape the innovation system in Bosnia and Herzegovina and determine its potential for the development of society as a whole. In the current situation, the main goal of the research must be to point out the elements of the innovation system that essentially determine its stagnation or development dynamics, and thus the movement of Bosnia and Herzegovina towards a knowledge society and knowledge economy. The primary hypothesis is: the current position of the innovation system is convincingly determined by weaknesses that limit not only its development, but also the development of Bosnia and Herzegovina. In accordance with the stated main assumption, the dominant subject of research will be the innovation system.

The presented methodological determinants impose an interdisciplinary approach to research. Procedures characteristic for economic, legal and political sciences dominate. The topic and the main problem of the paper require a brief review only of the specifics of the application of SWOT analysis.

Notes on how to use SWOT analysis

SWOT analysis is a method of strategic management that identifies and cross-examines current and future[11] internal strengths and weaknesses of a subject or social (sub)system, as well as opportunities and threats from the environment. It appeared in the seventies of the last century.[12] It was primarily used to determine company's market position, and then it was extended to other areas.[13] The increased domain of application of SWOT analysis and its derivative TOWS matrix has resulted in more and more frequent connection of these instruments with other methodological procedures of strategic environmental analysis.[14] Since 2017, in Bosnia and Herzegovina, SWOT matrix is predominantly tied to the PESTEL method.

In the application to the innovation system in general, and in Bosnia and Herzegovina in particular, the SWOT analysis shows some characteristics

[10] Trifković, 2020b: 69. This conclusion was, unfortunately, confirmed by the research of the actual state of innovation system in the territory of FB&H. See Kremić & Trifković, 2020.
[11] Fleisher & Bensoussan, 2007: 54-77 and Fleisher & Bensoussan, 2007: 87-103
[12] Ibidem
[13] Božac, 2008: 20-23
[14] Božac, 2008: 24 -27. and Fleisher & Bensoussan, 2015

conditioned by the subject of research. First, it has a macro character that requires that each of the four SWOT factors be determined while taking into account a large number of elements of domestic and international provenance. It is not always possible to draw a clear line between internal and external factors, between national and global, and between existing and emerging elements. Errors in each of the three domains are dangerous, especially in the operationalization of the international component of the strategy and the development of strategic scenarios for the development of the innovation system. Second, certain factors consist of a large number of generally complex elements, which imposes the need for their compression. Such procedure gives each element, as well as the SWOT analysis factor, a synthetic character. Increased compression measure creates a threat of impoverishment of the content of certain elements and factors. In the next step, a reductionist approach makes it difficult to determine the impact of the innovation system on the acceleration, stagnation or slowdown of the overall development of Bosnia and Herzegovina.[15] Third, almost none of the elements of any factor of the innovation system SWOT analysis in practice appear in pure form and with unambiguous effects. Therefore, determining the content of specific elements, their classification by factors of SWOT analysis and the measure of the impact on the innovation system is always to a significant extent a result of individual or group assessment. Therefore, the conclusion is that, even in the research of the innovation system, it is not possible to avoid the objection of subjectivism, which generally relativizes the value of the results of the SWOT analysis.[16] However, the advantages of SWOT analysis are such that, regardless of methodological problems, it is regularly used in designing of development strategies in Bosnia and Herzegovina.

[15] For warning against this threat see Nikolić, s.a. where it is stated that SWOT analysis "has a tendency to overgeneralize situation by classifying environment factors into the categories in which they don't necessarily fully fit."

[16] See Fleisher & Bensoussan, 2007: 94

II Swot Analysis of the Innovation System in Development Strategies in Bosnia and Herzegovina

Relationship of strategic development planning in Bosnia and Herzegovina towards SWOT analysis

The basic contradictions of the strategic development planning system in Bosnia and Herzegovina, including the development of the innovation system, have a constitutional character.[17] The first is the contrast between the uniqueness of the territorial,[18] economic and social space[19] of Bosnia and Herzegovina and the extremely large competencies of the lower levels of political-territorial organization in relation to higher levels. Its ultimate expression is the constitutional presumption that the lower levels of state organization have all the competencies that are not explicitly given to the higher political-territorial unit.[20] The second contrast is the limitation of the exclusive competencies of the state of Bosnia and Herzegovina and its institutions to a relatively small number of economic functions, which are predominantly of international character,[21] without the existence of internal mechanisms for independent realization of assumed obligations and rights with a foreign element. To illustrate the ultimate consequences of this contradiction, we cite the Decision of the Council of Ministers on the system of coordination of the European integration process in Bosnia and Herzegovina.[22] This act, by prescribing the methods of horizontal and vertical coordination, includes all lower levels of government of B&H in the decision-making on the issues of joining the European Union and thus de facto gives them the right to exercise

[17] Overview of constitutional solutions in Bosnia and Herzegovina, relevant to the innovation system, see Trifković, 2020b: 83. – 91.
[18] See art. I, par. 1 of the Constitution of Bosnia and Herzegovina
[19] See p. 4 of the Preamble and art. I. 4 of the Constitution of Bosnia and Herzegovina
[20] Art. 3, 1.a) of the Constitution of Bosnia and Herzegovina: "All governmental functions and powers not expressly assigned in this Constitution to the institutions of Bosnia and Herzegovina shall be those of the Entities." Evolution of constitutional law has modified the "constitutional reality" in this and other fields (see: Steiner, 2010: 529 and onward), but it did not change the basic model of the state's organization.
[21] Art. III.1 of the Constitution of Bosnia and Herzegovina. According to art. III. 5 The state shall assume responsibility for such other matters as are agreed by the entities. It should be noted that responsibilities assigned by this article in essence have a foreign-policy character.
[22] Bosnia and Herzegovina. Council of Ministers (2016)

state competencies in international relations.[23] These contradictions indirectly affect SWOT analyses for the purposes of strategic planning in our country.

Legal regulation of a uniform system of strategic planning in Bosnia and Herzegovina is nearing completion. In accordance with the constitutional competencies, at the state level, it takes place as planning of the institutions of Bosnia and Herzegovina.[24] Its basis is the strategic framework that includes documents from the B&H Presidency, the Parliamentary Assembly and the Council of Ministers Based on the established framework, a three-year, i.e. medium- and long-term work programs of the Council of Ministers,[25] are prepared through special methodology.[26] For the analysis of the environment, the Methodology Manual especially recommends the SWOT and PESTLE approach. The last publicly available "Strategic Framework for B&H" for the period 2016-2018 based the analysis of the socio-economic situation on the SWOT matrix.[27] It is therefore surprising that the sixth draft of the "Mid-Term Work Program 2021-2023" of the Council of Ministers from May 2020[28] does not use this methodology.[29]

The Law on Development Planning and Development Management in the Federation of Bosnia and Herzegovina from 2017[30] (LDP FB&H) created a unique system of development planning harmonized with the constitutional competencies of the entity and cantons. Ten regulations and one methodology for calculating the development index of local self-government units operationalize its application.[31] Most interesting for us is the Regulation on the Development of Strategic Documents in the Federation of Bosnia and Herzegovina.[32] According to its Article 17, the first step in developing a strategic platform is a situational analysis of the internal and external environment

[23] Accuracy of the stated conclusion is particularly confirmed by article 3 of the Decision: "Manner of decision making"
[24] Bosnia and Herzegovina. Council of Ministers (2014)
[25] See "Part two – mid-term planning", Bosnia and Herzegovina. Council of Ministers (2014)
[26] Bosnia and Herzegovina. Council of Ministers (2014)
[27] Bosnia and Herzegovina. Council of Ministers of Bosnia and Herzegovina. Directorate for Economic Planning, 2015:30 – 33.
[28] Bosnia and Herzegovina. Council of Ministers of Bosnia and Herzegovina (2020)
[29] Bosnia and Herzegovina. Council of Ministers of Bosnia and Herzegovina, (2010) included the document: "SWOT Analysis of the Development of Economy – Integrated", so we shall refer to it later.
[30] *Official Gazette of Federation of Bosnia and Herzegovina No. 32/17*
[31] See *Federation of Bosnia and Herzegovina. Federal Institute for Development Programming. Regulations (https://www.fzzpr/gov.ba/bos/docs/35/8/uredbe).*
[32] *Official Gazette of Federation of Bosnia and Herzegovina No. 74/19*

"in order to determine the real factors and potentials for the development of the area, or sector, and the limitations and obstacles." Thus, SWOT analysis, at least in the territory of Federation of Bosnia and Herzegovina (FB&H), has become a legally binding methodology. Practice has confirmed this conclusion. General strategic documents in the Federation of B&H, completed after the adoption of the LDP FB&H, regularly contain a SWOT analysis that includes elements of the innovation system.[33]

The basis for strategic development planning in Republika Srpska (RS) is Article 68, para. 1, item 8 of its Constitution, which obliges this entity to, among other things, regulate and provide "basic goals and directions of economic, scientific, technological… development". On that ground, in accordance with the regulations on the functioning of the Government and administrative bodies, a number of sectorial strategies were adopted. The Ministry of Technological Development, Higher Education and Information Society itself lists two adopted strategies and three action plans on its website.[34] In mid-April 2021, the National Assembly of the RS[35] published on its website the draft "Law on Strategic Planning and Development Management in the Republika Srpska". The proposed solutions point to a substantial similarity with the strategic planning system that exists in the FB&H entity.

With the adoption of the Law on Strategic Planning and Development Management in Republika Srpska, the professional principles of strategic planning will acquire a legal character throughout the country. Among the most important principles are: partnership of all levels of state government with local self-government units, vertical and horizontal coordination, synchronization of planning, complementarity of strategies, and efficiency and effectiveness of planning. The need to respect these principles will influence the way the SWOT analysis is made. First, SWOT analysis will become mandatory and will be used in conjunction with other strategic planning methodologies. Second, when concretizing the elements of each factor, creators of the analysis will have to respect the constitutional competence of the level of

[33] Federation of Bosnia and Herzegovina. Government of the Federation of Bosnia and Herzegovina (2021). According to art. 16 par. 5 of the Law on Development Planning, the final decision is made by the Parliament of FB&H. Overview of the state of works on development of cantonal strategies, mainly for the period 2021-2027 is on the Federal Institute for Development Programming web site (https://www.fzzpr.gov.ba/bs/docs/25/4/kantonalni-strateški-dokumenti)

[34] Republika Srpska. Government of Republika Srpska (2017)

[35] Republika Srpska. National Assembly of Republika Srpska. Materials for the 16th regular session

government for which the strategy is being worked out. Third, respect for the principles of strategic planning will certainly affect the choice of elements that make up each factor of SWOT analysis, the content given to the selected elements and the precision to the formulations that define the elements.

Elements of the SWOT matrix of the innovation system in strategic development documents in Bosnia and Herzegovina

The representation of the elements of the innovation system in SWOT analyses of general strategic development documents is an important indicator of the attitude of the bearers of planning and political decision-making in Bosnia and Herzegovina towards the knowledge society and knowledge economy. To determine the treatment of the innovation system in strategic plans, we examined SWOT analyses in a total of 13 preparatory materials, proposals and general development strategies, regardless of their legal validity. This research covers the entire territory of Bosnia and Herzegovina over - for our conditions - a relatively long period from 2010 to 2027. We have taken over the elements of the innovation system SWOT analysis which some documents, mostly newer, state according to the PESTEL method, regardless of the area in which they are located and the frequency of occurrence. The significance of an individual element was first determined in and of itself, and then in relation to other elements of the same and other factors of the SWOT analysis. In doing so, we had in mind that, due to the different competencies of individual subjects of strategic planning, content analysis in this case can be useful only to a limited extent. Attached Table 1: "Elements of the innovation system in SWOT analyses of development documents" offers total results. In essence, Table 1 is the SWOT matrix of the innovation system of Bosnia and Herzegovina, extrapolated from the existing documents of general strategic planning in the country. Despite all the methodological limitations, the tabular overview provides several basic conclusions about the position of the innovation system in Bosnia and Herzegovina. Following are the most important ones.

First, the factors of the extrapolated SWOT matrix of the innovation system have the following number of elements: strengths - 10, weaknesses - 16, opportunities - 7 and threats - 8. This confirms the dominance of weaknesses, characteristic of general strategic documents and sectorial strategies of innovation system development. Among the elements of strength, those concerning the system and quality of higher education dominate. It is interesting that all three levels of government agree on this element.[36] This places Bosnia and Herzegovina among the countries in which absolutely dominates state funding of science, almost exclusively through universities.[37] In weaknesses, leading are those of a systemic nature. Out of nine of them, four should be mentioned: insufficient legal and strategic framework, un-incentive tax and customs policy, weak connection between the public, economic and academic sector (the Triple Helix)[38], and insufficient copyright protection, etc.[39] Second place is occupied by four weaknesses related to technology.[40] Finally, population aging and the departure of young educated staff abroad is the third weakness. This process seems to affect the cantons more[41] than the FB&H and the State of Bosnia and Herzegovina. Of the seven opportunities, four have external provenance: foreign investment linked to new technologies, acceleration of the 4.0 industrial revolution, opportunities to engage in new value chains with smart specialization and the use of EU R&D funds.[42] Among the opportunities under the dominant control of domestic entities are: the development of STEM education, the acceleration of the Triple Helix process and the establishment of science and technology parks.[43] Among the threats, in the first place is the outflow of personnel abroad, especially from deficient professions. Although this threat is not broken down into several elements, it is commonplace in the strategic documents of cantons.[44] In the field of technology, the greatest threats are domestic or foreign investments in outdated technologies,[45] which is in itself a sign of underdevelopment of the economic system. The common denominator for all weaknesses in this matrix is the marginalization of the Bosnian-Herzegovinian economy and society. The

---

[36] See Table No. 1, items 1.1. -1.4.

[37] Radošević, (2011): Table 3 shows four basic institutional profiles (including Kazakhstan) of relationship of financing and implementation of research in former socialist countries. Bosnia and Herzegovina is not included in the table. Based on the known data, it can be considered that Bosnia and Herzegovina belongs to the third profile: the state is the biggest financier, and universities are the largest implementers of research.

[38] Since only five companies responded to the questionnaire, only as an illustration we shall cite that in the period 2016 – 2018 in FB&H only one of those companies received support from public funds for their scientific-research activities (Kremić & Trifković, 2020:36)

[39] See Table No. 1, items: 2.6, 2.9, 2.11 - 2.14 and 2.16.

[40] See Table No. 1, research items: 2.1. – 2.4 and 2.14

[41] See Table No. 1, item: 2.10

[42] See Table No. 1, items: 3.1., 3.2., 3.5. and 3.7.

[43] See Table No. 1, items: 3.4., 3.3. and 3.6.

[44] See Table No. 1, item: 4.1.

[45] See Table No. 1, items: 4.2. and 4.3.

largest group of threats is in the domain of knowledge transfer from science to economy. Four elements are identified in it: weak institutional support, insufficient capacity of specialized institutions, lack of specialized capacity and insufficient level of direct science-economy cooperation.[46]

The second group of conclusions refers to the contradictions within the derived SWOT matrix of the innovation system. Here are the most important cases. The first case is the contradiction between determining the stable availability of scientists and qualified personnel as an element of strength, while citing the weakness reflected in the fact that technology-oriented companies are leaving B&H due to lack of highly qualified research staff and workforce. Identification of the outflow of the most qualified personnel as a threat to the economic development of the state points to the same contradiction.[47] The second case is the mutual exclusion of allegedly good cooperation between universities and industry in the field of research and development, as an element of strength, and low level of added value in export products as a weakness of the whole system.[48] In the third case, the designation of a developed organization to support entrepreneurship as a strength contradicts the claim that the insufficient number of scientific research centres and centres for acquiring skills is a weakness of our innovation system.[49] Finally, the fourth case is the strength reflected in good cooperation between businesses and universities, which cannot be reconciled with the repeatedly pointed out weakness in these industry-university relations and shortcomings in the operationalization of the Triple Helix model.[50] Different powers, goals and policies of the creators of strategic documents can partly explain these contradictions. .[51] However, taken as a whole and related to opportunities and threats, the contradictions indicate insufficient harmonization of innovation subsystems and incoherence of the innovation system in Bosnia and Herzegovina.

The elements of the innovation system identified by the SWOT analysis as the basis for strategic planning reflect only a part of the actual attitude of development decision makers towards the innovation system. For a complete picture, it is necessary to identify the most important elements of the science

[46] See Table No. 1, items: 4.4 and 4.6. – 4.8.

[47] Compare items 1.2. and 1.4 with items 2.1., 2.2. and 2.10 from Table No. 1

[48] Compare items 1.3. with items 2.2. and 2.7. from Table No. 1

[49] Compare items 1.8 with item 2.12. from Table No. 1

[50] Compare items 1.3. and 2.15. from Table No. 1

[51] State of B&H and FB&H entity believe that the shortcomings in the protection of intellectual property are a weakness of the development and innovation system of B&H. Cantons don't even refer to this element (see Table No. 1, item 2.5)

and technology transfer system that are not in the extrapolated innovation system SWOT matrix. The third group of conclusions from Table 1 refers to these elements. The first significant set of problems that are not even mentioned relates to the legal regulations. The effects of the Framework Law on Scientific Research at the State level,[52] the consequences of the lack of a systemic law of this kind in the Federation of B&H entity, and the failure of six cantons to enact new laws on the innovation system are not qualified as a general strategic weakness or opportunity to achieve development goals. The internal knowledge gap is clearly not in the focus of strategic development planning. Another completely neglected area are the strategies for the development of the innovation system, as one of the pillars of the knowledge society and economy.[53] Their adoption is not prohibited even when the regulations are silent on this issue. Nevertheless, legislations of the state of B&H, the RS entity and four of the cantons[54] contain the obligation of the mentioned political-territorial units to adopt strategies for the development of the innovation system. Currently, instead of 14, there are only three strategies of the innovation system in different procedural status in the country, those at B&H level, in the RS entity and in the Sarajevo Canton. The Federation and three other cantons, which have introduced an obligation to adopt a sectorial strategy into their legislation, have not done so.[55] Regardless of the stated situation, the extrapolated SWOT matrix of the innovation system completely ignores the non-existence of strategies and the inaccuracy of those adopted. Third, the attitude towards the financing of the innovation system is a true test of understanding its role in fulfilling the development strategy. The development strategy of Bosnia and Herzegovina,[56] research[57] and theoretical works, all show that the situation in this area is completely unsatisfactory. The most important shortcomings are: absolutely unacceptable low allocations for these purposes (between 0.2% and 0.3% of GDP), the dominance of public budget (co)financing, fragmentation of already small funds, administrative

[52] The Framework Law on Basics of Scientific-Research Activity and Coordination of Internal and International Scientific-Research Cooperation of Bosnia and Herzegovina (see analysis of this Act in Trifković, 2020b: 95 – 102)
[53] Trifković, 2020b: 23 – 25 and 35 – 37.
[54] See Trifković, 2020b: 49-50
[55] On the legal regime of cantonal innovation system development strategies see: Trifković, 2020b:131 – 134
[56] "Strategy of Development of Science in Bosnia and Herzegovina 2017-2022 – revised framework document", Council of Ministers of B&H, 20 June 2016, p. 14-17
[57] Trifković, 2020b: 64, 127 and 192

allocation for purposes and projects, blurred funding of science at universities, time mismatch between project activities and funds inflow, insufficient state investment in equipment,[58] and the absence of customs and tax incentives. It is therefore surprising that the financing of the innovation system does not appear in any of the factors of the SWOT analysis of general development strategies. Instead, among the weakness elements of economic and financial character are those for which the political-territorial units are not directly responsible: low level of added value in export products, insufficient foreign direct investment and technology transfers, weak links between the industry and universities in the research field a small number scientific research centres and the lack of modern equipment in all areas.[59] Fourth, the consequence of keeping silent about the problem of innovation system financing is the complete ignoring of fundamental and development research as instruments for resolving numerous development weaknesses and threats, including those of technological nature.[60] Accordingly, even the accelerated formation of (independent) institutes strategies do not see as an opportunity offered by the innovation system. Finally, fifth, only the West Herzegovina Canton considers that the lack of mechanisms for motivating civil servants for development affairs is a threat to the development of the innovation system and the realization of development strategies.[61] Twelve other carriers of planning are avoiding this problem, thus relativizing their obligations under the public administration reform program. [62]

---

[58] Agency for Statistics of Bosnia and Herzegovina: "Report – Science, Technology and Digital Society: Research and Development 2019", subheading 2.1. states that of 39,728,000 BAM of gross assets invested in higher education, only 1,992,000 BAM was spent on investment costs, or 19.72%. In the same year, business sector had invested 25,647,000 BAM into research and development, 9.871.000 BAM or 38.44% in investments.

[59] See Table No. 1, items 2.2, 2.4, 2.7, 2.12 and 2.13. Of the 209 research projects, conducted between 2016 and 2018 by 18 institutes in the FB&H entity, 13 of them or 6.22% were fundamental research, and 13 or 6.22% were developmental research. At the same time, 103 consulting projects were conducted, or 49.28% of the total (see: Kremić & Trifković, 2020: 29).

[60] See Table No. 1, items 2.1.-2.4.

[61] See Table No. 1, item 2.16.

[62] Kremić & Trifković, 2020:9-15 offers plenty of data that supports our claims for the territory of FB&H. Of the 111 federal and cantonal ministries included in the research, 31 (27.93%) hasn't responded to the questionnaire at all, 36 (32.43%) stated they have no activities in the field of innovation system, and 44 (39.64%) filled the questionnaire. According to the systematization of workplaces in FB&H ministries, five employees deal with the issues of innovation system full time, and three more for half of worktime. In the cantonal ministries that have answered the questionnaire, the situation is however reversed. Six employees work for up to half of worktime, and only one works fulltime on the issues of the innovation

All three groups of conclusions based on the extrapolated SWOT matrix of strategic planning provide reasons for a pessimistic outlook: different levels of government, each within its scope, do not include in the development SWOT analysis elements of the innovation system that require additional financing or workload. There are efforts to, at least implicitly, share the consequences of such a policy with other subjects of the system. Obviously, state bodies are treating investing in research and development as a cost, not an investment. Thus, the hypothesis of the innovation system as a stepchild of political-territorial units can be considered proven. There are two final consequences of the existing approach to the innovation system: Bosnia and Herzegovina remains in the group of countries that base their development on the efficiency of raw material exploitation while slowing down the process of creating a knowledge society and economy.

SWOT analyses of innovation system in the strategies of science development in Bosnia and Herzegovina

There are currently four documents in Bosnia and Herzegovina on the development strategy for the innovation system for the period until 2022. These are: “Strategy for the Development of Science in Bosnia and Herzegovina 2017-2022 - Revised Framework Document”, version 01, dated 26 June 2016, by the Council of Ministers[63] (hereinafter: SRN B&H); “Strategy for the Development of Science in the Federation of Bosnia and Herzegovina for the Period 2011-2021 (Draft)”[64] (hereinafter: SRN FB&H), noting that the Parliament of FB&H did not consider this document ; “Strategy of Scientific and Technological Development of Republika Srpska 2017-2021 – ‘Knowledge for Development’”[65], proposal from April 2017, the Government of the Republika Srpska (hereinafter: SNTR RS) and the “Strategy for the Development of Education and Science of Sarajevo Canton for the period

system. Of the 44 ministries that have answered the questionnaire: in 4 federal and 19 cantonal ministries there is no strategy for scientific-technological development, nor is there work on any. Only one federal ministry noted that the prime minister and the competent minister from the government on a regular monthly basis consider the state of the innovation system and higher education, etc.

[63] *Official Gazette of B&H, No. 22/18*

[64] Federation of Bosnia and Herzegovina. FB&H Ministry of Education and Science (2010)

[65] Republika Srpska. Government of Republika Srpska (2017)

2018-2022 - (Draft)", Ministry of Education, Science and Youth of Sarajevo Canton, June 2017 (hereinafter: SRON KS).[66]

The formal-legal position of sectorial strategies of the innovation system is different. The SRN B&H has been adopted and is valid, the SRN FB&H is an abandoned document of unclear legal position, and the SRNT RS and SRON KS are in the draft phase. Regardless of the legal status of the documents, the data, analyses and conclusions they contain are professionally relevant, so we shall consider them. The goals and areas for which the strategies were written and their titles differ somewhat. The state level strategy views the innovation system as a whole, while the strategy of the RS pays the most attention to the technological component. Strategy of Sarajevo Canton divides attention between education and science.[67] Also SWOT matrices that individual strategies contain reflect differences in the subject and titles of aforementioned documents. We give the overview in tabular form.

Table No. 2: Structure of SWOT matrix in sectoral strategies of the innovation system in B&H

No.	Strategy document	Number of elements in factors of the SWOT matrix			
		S	W	O	T
1	2	3	4	5	6
1.	SRN B&H	7	24	14	11
2.	SRN FB&H	8	24	14	11
3.	SNTR RS	5	7	6	7
4.	SRON KS	7 (-3)	19 (-6)	13 (-4)	8 (-1)

The previous table requires some comments. First, only two elements of strength, three elements of weakness and two elements of opportunity from the SRN FB&H matrix are not included in the national SWOT analysis. Thus, the SWOT matrices of the state and the FB&H entity are practically identical, although they were made for different competencies and circumstances of the two political-territorial communities. Second, weaknesses dominate in all matrices. This feature is least pronounced in the RS entity. Third, SNTR RS summarized elements of each factor in the most consistent manner. And fourth, in line no. 4, which refers to the Sarajevo Canton, the numbers in

[66] Sarajevo Canton. Government of Sarajevo Canton. Ministry of Education, Science and Youth of Sarajevo Canton (2017). The Draft was withdrawn from the 44th session of Sarajevo Canton Assembly on 12 October 2018

[67] Ibidem

brackets indicate the elements of each factor that refer exclusively to the part of the educational process, without a factual impact on the innovation system. They must therefore be excluded from the analysis of the innovation system in this canton.

The science development strategy in Bosnia and Herzegovina is based on the principle of coordinated planning. It must "have a general character and represent the least common denominator of the interests involved."[68] Therefore, it is not surprising that the SRN B&H has the largest number of elements of each factor of the SWOT matrix. Their aggregation, regardless of the risks of generalization, requires the methodology of SWOT analysis and the need to compare the matrices of B&H and other levels of government. The results of grouping are given in tabular form. Brackets next to the numbers contain the ordinal numbers of individual elements in the matrix of B&H.

Table No. 3: "Aggregated SWOT matrix of the Science Development Strategy of Bosnia and Herzegovina"

No.	Aggregated elements	SWOT matrix of the Science Development Strategy of B&H			
		S	W	O	T
1	2	3	4	5	6
1.	Higher education	3 (1,2,3)	6 (2,3,10,12, 17, 24)	/	/
2.	Organization and infrastructure	1(6)	8 (4,8,9,16,20, 21)	2(2,3,)	/
3.	Economic-financial elements	/	4 (18,19,22,23)	4 (1,8,10,14)	3 (2,3,11)
4.	Political and cultural elements	/	3 (5,13,14)	2 (12,13)	8 (1,5,6,7,8, 9,11)
5.	International cooperation and foreign elements	1 (4)	3 (1, 6,15)	6 (4,5,6,7,9)	/
6.	Other	2 (5, 7)	/	/	/

Regardless of the errors inherent in the classification of polyvalent elements, the table above provides an opportunity for a large number of questions and comments. We shall stick to the essentials. First, the element of higher education is defined inconsistently: as opposed to the three elements of strength, there are as many as six elements of weakness. At the same time, it is surprising that there are no elements related to higher education in the factors of opportunities and threats. Second, the state of the organization and infrastructure of the innovation system is accurately identified. It shows

[68] Trifković, 2020b:101

the greatest number of weaknesses, as many as eight, and only two opportunities. It is notable that the funding shortcomings are clearly highlighted. Surprisingly, however, the negative consequences of the lack of funds have not been identified as threats. Third, the economic and financial shortcomings of the innovation system have been precisely identified. It is surprising that the "competitive price of scientific research work in B&H compared to abroad"[69] is cited as an opportunity, when it is known that this is one of the main reasons for the brain drain. In addition, seven of the 14 opportunities are in some way related to international competition, although domestic entities generally have a weaker position in it. Fourth, among political and cultural elements, following key weaknesses are rightly highlighted: long-term marginalization of science, demotivating egalitarianism, and opportunism in evaluating the results of scientific research. Among the threats, three elements have economic provenance,[70] and as many as seven have cultural provenance.[71] Checking the accuracy of the claim about the importance of cultural threats to the innovation system in B&H deserves special research. Fifth, elements that include international cooperation and other relations with the foreign element are most numerous in the opportunity factor. They make up six of the 14 elements, indicating distrust of domestic chances.

This entity's Law on Scientific Research and Technological Development regulates adoption of the strategy for the development of the innovation system in the Republika Srpska.[72] On that basis, the current five-year strategy of scientific and technological development was adopted, also dubbed "Knowledge for Development". After considering the important challenges, "Knowledge for Development" presents six basic strategic goals, which apply equally to all subjects and all segments of the innovation system.[73] In the field of science and innovation, each of them can have special manifestations. The strategy starts from the assumption that the institutional system is "a key precondition

[69] SWOT matrix in SRN B&H, opportunity No. 8

[70] SWOT matrix in SRN B&H states the following economic threats: 2- poor business awareness of capital owners; 3 – continuing marginalization of science at all levels; 9 – appearance of political interventions in science; 11 – expectation from the state to solve all brain waste and brain drain problems within the state and in diaspora.

[71] SWOT matrix in SRN B&H, cultural threats: 1 – lack of understanding of the importance of RTD for the development of the country; 4 – reluctance to change, fear of risk and failure; 6 – lack of lifelong learning culture; 7 – lack of understanding for the consequences of brain drain; 7 – avoidance of international competition and enclosure into national framework.

[72] *Official Gazette of Republika Srpska* 6/12, 33/14 66/18 and 84/19. For basic principles see Trifković, 2020b: 194 -195

[73] See ZNTR RS p. 26 – 42

for encouraging innovation",[74] and in determining the elements of individual factors, it insists on those that are common in all segments and subjects of the innovation system. The result of this approach is a SWOT matrix.[75] Its most striking methodological features are a small number of elements in each factor - a maximum of seven, and a clear content connection between the factors of strengths and opportunities, and weaknesses and threats.

For constitutional and legal-policy reasons, the FB&H entity has not passed a new law on scientific-research activities.[76] The attempt to adopt an entity strategy for the development of the innovation system has failed for the same reasons. Thus, the cantons remain the only bearers of strategic planning in this area. Their reaction to this task is uneven.[77] By 2020, all cantons had passed their own laws on higher education. These laws also regulate a part of the innovation system that takes place in higher education.[78] Only four cantons promulgated laws on scientific research, which regulate most of the relations of the innovation system: Sarajevo, Zenica-Doboj, Tuzla and Canton 10. These laws also regulated the adoption of a strategy for the development of scientific-research activities, i.e. the innovation system.[79] Of the six cantons that have not adopted new laws on scientific research, it would be too much to expect the development of medium-term strategies for the development of the innovation system. What is surprising is the lack of strategies for the development of the innovation system in the three cantons that have regulated this matter. This makes all the more important even a partial planning of this matter in general cantonal development strategies.[80]

The SWOT matrix contained in the Strategy for the Development of Education and Science of the Sarajevo Canton was adopted based on Art. 46, para. 1 of the Law on Higher Education of KS. This can probably explain the fact that this strategy covers the tasks of the competent cantonal ministry, and not the totality of the innovation system in the relevant area. The consequences

[74] ZNTR RS, p. 6
[75] ZNTR RS, p. 45
[76] See Trifković, 2020b: 106 – 107. Detailed situation analysis is available in Trifković, 2020a: 46 - 48
[77] See Trifković, 2020b: 107 -108
[78] See Trifković, 2020b: 169 -171
[79] See Trifković, 2020b:131 – 134
[80] Kremić & Trifković, 2020:11 suggests that employees in ministries in FB&H are not creators of strategy to a sufficient extent. Out of 14 employees, only two are "preparing the draft strategy". Two employees work on the preparation of foundations, five are working exclusively on administrative tasks, and five are "giving remarks and opinions".

are twofold. First, significant attention has been paid to the elements of higher education that can be only indirectly significant for the entire innovation system. We will omit them in the analysis. Second, the focus of the strategy is on the science created at the university. SWOT analysis does not even mention other open issues of the innovation system, technological development in particular. Accordingly, SRON KS finds the strength elements exclusively in higher education.[81] The weakness factor is the most extensive in this matrix as well. Of the 14 elements relevant to the innovation system, six of them concern personnel,[82] six relate to the organization of the functioning of the system,[83] and only two to the financing, and at that exclusively the financing of scientific staff and their scientific-research work.[84] The first six opportunities, traditionally, are seen in international cooperation, almost exclusively in the field of teaching. Cooperation with our scientific diaspora should take place according to the same concept.[85] Of the other elements of this factor, the Strategy mentions only "cooperation with the business community and the implementation of specific expert and applicative projects".[86] Threats are the most contradictory factor of this matrix. First, insufficient funding for scientific research and professional development of academic staff are both a weakness and a threat.[87] Furthermore, in accordance with the administrative provenance of SRON KS, the current "limited available sources of funding"[88] and "systemic uncertainty in terms of uncertain funding"[89] are only cited as future threats and not as a significant current weakness of the innovation system in Sarajevo Canton. Finally, the "inadequate image of universities and higher education institutions in the public"[90] is directly opposite to the strength of image and tradition in the Sarajevo region.[91] Among other elements of this factor, it is necessary to point

[81] SRON KS: 1 – image and tradition of higher education and scientific-research work; 2 – diversity of scientific groups and 3 – accredited higher education institutions.
[82] SRON KS: Weaknesses, items 2 – 7. It is interesting that weaknesses are identified in the lack of specific skills for writing domestic and international projects, lack of recognizability in realization of expert and applicative projects, lack of orientation and motivation, and in lack of publications in the Web of Science in relation to neighbouring countries.
[83] SRON KS: Weaknesses, items 1, 10,13, 15, 16 and 19.
[84] SRON KS: Weaknesses, items 8 and 9
[85] SRON KS: Opportunities, item 10
[86] SRON KS: Opportunities, item 9
[87] Compare SRON KS: Weaknesses, items 9 and 10 with Threats, items 13 and 14
[88] SRON KS: Threats, item 2
[89] SRON KS: Threats, item 1
[90] SRON KS: Threats, item 8
[91] SRON KS: Strengths, item 1

out the correctly perceived threat that non-existent or non-harmonized legal regulations, strategies and policies pose to the innovation system.[92]

III SWOT Analysis of the Current State of the Innovation System in Bosnia and Herzegovina

Latest research of the innovation system in Bosnia and Herzegovina and the manner of using their results

Six of the 13 documents of general strategic development planning and all three sectoral strategies for the development of the innovation system in B&H, which we examined in this paper, were published in the period 2015-2017. This means that the data on which the elements of individual factors of the SWOT analysis are determined and the strategies are created are at least four to five years old. These facts require that the SWOT analysis of our innovation system be done based on recent research, statistics and other data. Of the new sources, we used in particular the research conducted by ANUBiH independently or with other legal and natural persons,[93] new statistical reports and documents of entities that professionally deal with this area.[94]

Existing SWOT analyses have shown that the choice of elements of individual factors must not be based primarily on experience,[95] that the SWOT matrix cannot be reduced to a list of elements of each of its four factors and that the formulations of individual elements significantly affect their position in the matrix. Such actions in reality lead to: the omission of significant elements of certain factors, essential contradictions, the appearance of the same element within different factors and - ultimately - the manipulation of this methodology.

In order to avoid these pitfalls, at least partially, we first provide a concise SWOT matrix of the innovation system in B&H with a minimum number of the most important elements of each factor. Such a matrix is by definition general and only relatively accurate. Therefore, it must be elaborated, i.e. supplemented by concrete elements to the extent that makes the picture of the relationships clear, and makes the SWOT matrix an operational document of

[92] SRON KS: Threats, items 1 and 6
[93] Cvitković, 2017, Trifković, 2020b, Kremić & Trifković, 2020, Čičić; Trifković, 2020a: 39 -53;
[94] See part of the work on higher education as factor of strength.
[95] Fleisher & Bensoussan, 2007: 91-93, state that a lot of "insightful work" is needed to answer the questions in the right way and perspective.

strategic planning. We will do this by supplementing the factor of strength and its elements with the essentially related elements of other factors.

A concise and elaborated SWOT matrix of the innovation system in Bosnia and Herzegovina

The concise SWOT matrix relies on the elements of each factor that are necessary to obtain a relatively accurate macro view of the state of the innovation system in B&H. The extremely high level of generalization of the elements of each factor allowed only their partial linking in the matrix. An element of one of the factors that has no immediate counterpart in other factors - a poor funding system and the lack of ordered ethical rules, for example - acts equally towards all other factors.

Table No. 4: Concise SWOT matrix of the innovation system in Bosnia and Herzegovina

Factors			
No.		**No.**	
1	**2**	**3**	**4**
1.	**Strengths**	**2.**	**Weaknesses**
1.1.	Established state level framework for the innovation system	2.1.	Based on the assumption of the competencies of lower political-territorial units, a highly decentralized innovation system, which also means the passivisation of state bodies in this domain
1.2.	Same basic organizational structure of the innovation system	2.2.	Legal gaps and different legal solutions for a number of important issues of establishment and functioning of innovation subsystems of lower political-territorial units
1.3.	Good state of the human capital	2.3.	Declining birth rates, decreasing number of pupils and students, problems in STEM education, emigration, brain drain
1.4.	Harmonized and stable higher education	2.4.	Absolutely insufficient, dominantly budget funded and structurally inadequate financing of the innovation system, including higher education
1.5.	/	2.5.	Fragmented and incomplete ethical regulatory system in the field of scientific research on technology development
1.6.	/	2.6.	Partialized system of international cooperation, insufficient scientific productivity and unsatisfactory international ranking of domestic universities

3.	Opportunities	4.	Threats
3.1.	Strengthening of the interest of state bodies, ministries in particular, in filling legal gaps, work planning, functioning and use of the innovation system	4.1.	Neglect of competencies in the field of innovation system by state bodies and inert attitude of bodies of lower political-territorial units on improvement and better functioning of the innovation system
3.2.	Harmonization of legislation and bylaws, and adoption of harmonized development strategies	4.2.	Lack of legislation harmonization, retention of legal gaps in FB&H, insufficiency of strategies and further deepening of external and internal knowledge gap
3.3.	Systematic work on connecting higher education institutions, industry and state bodies in research and development of technologies	4.3.	Retaining the existing inappropriate level and quality of cooperation between universities and industry along with the stagnation of the system and practice of technology transfer, especially from abroad
3.4.	Adoption of a multidisciplinary strategy or program of preservation and development of human capital	4.4.	Maintaining the dominance of budgetary and bureaucratic financing of research and technology development, which results in the deterioration of B&H's global competitiveness
3.5.	/	4.5.	Lack of strategies and measures to increase the birth rate, reduce emigration and brain drain from B&H

The previous table shows that weaknesses dominate again. The ratio of threat and opportunity factors is 11:8, which confirms the general rule of thumb in this domain. In contrast, closer examination of the strength elements shows a significant deviation from the usual state. The four elements of strength are in fact the basic conditions for the existence of any social system, and not just a good innovation system. Paradoxically, it seems that the greatest strength of our innovation system is that its existence is – possible! This attitude requires further check by elaborating the condensed matrix according to the power factor elements. We did that in Table No. 5, which is found in Annex 2. It provides a relatively comprehensive insight into the set of factors that determine the real impact of strength factors, as well as the "systemic matching"[96] of the strength elements with elements of other factors.

The first two elaborated strength elements in the SWOT matrix from Table No. 5 are of political and legal nature. Their normative structure and the actual way of functioning is sufficiently known.[97] The third element of

[96] Fleisher & Bensoussan, 2007: 87-102

[97] For legal framework, see Trifković, 2020b: 95 – 106, and 168 – 188. In this paper we discussed development strategies. The answers of Bosnia and Herzegovina to the "Questionnaire of the European Commission", Chapter 25: "Science and research" contain official stance on innovation system issues. For the factors of weakness, which are related to the constitutional

strength, “Good state of human capital”, has a highly interdisciplinary character: demographic,[98] health, educational[99] and economic.[100] The resultant of action of various factors in this case gives contradictory result. The complexity of export products in the period 2010-2018 ranks Bosnia and Herzegovina between 33rd and 40th place, i.e. among “higher ranked countries”, indicating developed human capital. In contrast, in the matrix there is a clearly visible trend of deteriorating condition of all factors of human capital value.[101] It is very likely that negative demographic trends[102] will multiply the effects of weakness factor and accelerate the conversion of certain threats into current problems. This inevitably imposes the conclusion that a comprehensive study of the state of human capital in Bosnia and Herzegovina is necessary.

The analysed SWOT matrices without exception treat higher education as a strength factor. Higher education institutions are the most important creator of codified knowledge and scientific research staff in Bosnia and Herzegovina, so the quality of their work significantly affects other elements of other factors. Through these elements, higher education essentially determines the development capacity and the dynamics of the innovation system as a whole. Therefore, we will examine this element of the strength factor in more detail.

Harmonized and stable higher education

In terms of legislation, higher education is the most regulated element of the innovation system in Bosnia and Herzegovina.[103] It is fully and up-to-date

---

position of the state, also see Trifković, 2020a. Critique of the manner of financing of the innovation system is presented in this paper, in the part: *Elements of SWOT analysis of the innovation system in strategic development documents in Bosnia and Herzegovina.*

[98] Emirhafizović & Zolić, 2017: 11 – 54 conclude that the 1992 –1995 war in B&H and the social trends that followed it had “overturned all the demographic trends in the population of Bosnia and Herzegovina.”

[99] Pašalić – Kreso, 2017:93 - 124

[100] Global economic indices, which use different indicators to follow the state of human capital in Bosnia and Herzegovina, are not mutually harmonized. Still, results of the nine-year development, prepared by the World Bank, are humiliating for our country. See Trifković, 2020a: 53 -55

[101] See also Trifković, 2020a: 54

[102] See Institute for Statistics of FB&H (2020): 7, Image 1: “Comparative overview of the number of population 2019 -2070, Variant 1 and Variant 2”. There is basis to assume that the situation is similar in the Republika Srpska entity.

[103] Trifković, 2020b: 103-106, 168-172, 213-216

included in the EHEA through a system of international conventions and domestic legislation. Development planning is achieved through general and sectoral strategies. Regardless of the different levels of application of legal and strategic documents, the existence of planning acts has had a positive impact on social relations in this area. We will examine the real state of higher education as a key driving force of the innovation system by connecting the elements of its strength with other factors of the SWOT matrix.

The first element of the strength factor is the large number of various higher education institutions. Among them are public and private universities. Despite the uneven terminology and the different number of registered private institutions, the general picture is clear: there are eight (8) public universities and between 19 and 34 private higher education institutions.[104] The data that we will present later prove that domination by number does not mean domination by quality. Secondly, predominantly thanks to public universities, all scientific and artistic fields are studied at higher education institutions in Bosnia and Herzegovina. Educational needs and the economic situation have led to the fact that today we do not have universities predominantly oriented to a particular scientific field. The fact that the Framework Law prescribes that the status of a university requires having at least five study programs in at

[104] According to the records of accredited higher education institutions which are kept by the Agency for Development of Higher Education and Quality Assurance of Bosnia and Herzegovina, there are eight (8) public higher education institutions and twenty-four (24) private higher education institutions in Bosnia and Herzegovina. The list of higher education institutions kept by the Centre for Information and Recognition of Documents in the Field of Higher Education of Bosnia and Herzegovina (see Bosnia and Herzegovina. Centre for Information and Recognition of Documents in the Field of Higher Education of Bosnia and Herzegovina, 2021) includes eight (8) public higher education institutions and thirty-four (34) private higher education institutions, which is a difference of ten (10) private higher education institutions compared to the previous data source. Furthermore, statistical agencies collect data on higher education related to enrolled and graduated students, as well as engaged teachers, while the number of higher education institutions is not indicated. Finally, the Institute for Statistics of the Federation of Bosnia and Herzegovina in its higher education statistics indicates the existence of ninety-two (92) higher education institutions, of which seventy (70) are public, nineteen (19) are private and three (3) are religious higher education institutions. Unlike in the previous Report (03 March 2020 for the school year 2019/2020), the Statistical Bulletin of Higher Education for 2019/2020 states the existence of sixty-seven (67) public faculties, five (5) academies, three (3) religious faculties, seven (7) colleges, and eleven (11) private universities. In its Bulletin of Higher Education, the Institute of Statistics of Republika Srpska records the existence of twenty (20) higher education institutions, of which nine (9) universities and eleven (11) higher schools, without specifying the type of institution (public / private).

least three scientific fields studied at the institution also contributes to this.[105] The same social reasons did not facilitate the formation of research universities, the lack of which is one of the significant weaknesses of our innovation system.

An indirect conclusion on the diversification of educational and scientific research work can be made based on the distribution of student enrolment per certain areas. The analysis of data from the Institute for Statistics of FB&H and the Institute of Statistics of RS on the number of students enrolled in certain study programs classified in broader scientific and artistic fields shows that about 55% of all students study in the fields of social sciences, humanities and arts. About 28% of students are enrolled in STEM fields (basic sciences, technical field, electrical engineering and mathematics), 21% of students study in the field of medicine and health, while 4% of students are in the field of biotechnical sciences (agriculture, fisheries, forestry and veterinary medicine). Considering the structure of the economy and society, the dominance of social sciences is to be expected. However, these data undermine the thesis that the number of students in traditional STEM areas important for innovation and technical-technological development is unsatisfactory. The problem lies elsewhere: a large number of educated students in STEM and the medical field find jobs outside B&H relatively easily. Due to that, the limited possibility of hiring these experts within the country and the lack of a policy to prevent the brain drain are included in the key weaknesses of the innovation system. The fact that we educate a satisfactory number of students from the STEM field does not necessarily mean that all of them will contribute to the knowledge society and economy in Bosnia and Herzegovina. Solving the problem of staff training for other countries, however, lies outside the domain of the innovation system.

Another important indicator of scientific orientation in a country is the number of published scientific papers in certain fields. For reviewing the dominant research fields of the universities in Bosnia and Herzegovina, we took information from the *Scopus* database, which has a somewhat wider coverage of journals and a longer time span of indexed papers compared to the *Web of Science*.[106] The review covered seven public universities in Bosnia and Herzegovina, because the University of Bihać does not have any indexed

[105] Art. 10, p. 2, par. 2 of the Framework Law on Higher Education in Bosnia and Herzegovina

[106] Access to information is limited by a subscription contract between Clarivate Analytics and Elseviera with the University of Sarajevo as the bearer of the contract for access to databases (Scopus since 1951 to date; Web of Science since 1994 to date)

works under its affiliation. The categories shown in Table No.6, “Overview of published papers in the Scopus database by branches of science and universities from 1951 to 2021” (Annex 3), reflect the taxonomy of research fields and areas according to which articles are classified in the Scopus database. Analysis of Table No.6 provides a basis for several relevant conclusions. First, in the overall structure of papers classified by research areas, medical sciences are in the forefront, followed by engineering and computer science. From the available data on published papers, it can be seen that research in the field of medical and technical sciences are dominating at universities in Bosnia and Herzegovina, while natural-mathematical and biotechnical sciences take third place. This finding coincides with the data on STEM education that we have already presented. Social sciences and humanities do not have such an intensive production, but it should be taken into account that the subject of study in these disciplines is largely socially / nationally relevant, and not necessarily internationally interesting. Finally, it is understandable that the University of Sarajevo, as our oldest and largest higher education institution, has the best results. Nevertheless, policies and strategies for the development of higher education should contain levers for gradual and scalable approximation of the performance of public universities. The most important is the gradual reform of the financing system and the raising of allocations for higher education as part of the innovation system.

Another important strength element of higher education is the principle of unity of scientific-research work and teaching. And it has several manifestations. In the first place is the equal treatment of scientific-research and teaching activities in the employment contracts of academic staff. Examples are Standards and Norms for Performing Higher Education Activities in the Sarajevo Canton.[107] This bylaw primarily determines the conditions whose fulfilment is necessary for conducting activities.[108] They further specify that teachers and associates are obliged to actively engage in scientific research, or artistic activities for 20 hours per week. The rest of the working week is reserved for classes, exams and administration. However, the results of the research show that the relationship between scientific and teaching work in

[107] Sarajevo Canton. Government of Sarajevo Canton. Ministry of Education, Science and Youth of Sarajevo Canton. Standards and Norms for Conducting the Activities of Higher Education in the Territory of Sarajevo Canton (2017)

[108] Standards and Norms determine the minimum staffing, spatial and other material-technical conditions necessary for conduct of higher education activities and scientific-research/artistic-research work, in accordance with the Framework Law on Higher Education in Bosnia and Herzegovina and the Cantonal Law on Higher Education

practice is not yet balanced, and that teaching activities are dominant in relation to scientific work.[109] This weakness is certainly a consequence of changes in curricula, which impose on the existing teaching staff a moral obligation to increase the volume of pedagogical work. The integration of science and teaching is evident from the student's engagement in scientific research.[110] Another manifestation of the unity of scientific and teaching work concerns the students. Participants of the first cycle are most often involved in smaller research activities for teaching purposes, while second cycle students, as well as doctoral students, are independent researchers or members of project teams led by teachers at the level of organizational units, i.e. universities. Involving students in research increases their competencies needed for future independent research work and certainly contributes to increasing human capital in the field of science in Bosnia and Herzegovina. Finally, institutionalized forms of research work at universities are institutes.[111] In the legislation of the FB&H entity, an organizational unit of a legal person with the right to appear on the market independently has the status of an institute. The institutes of integrated universities have such a position. Their position has characteristics of a dual legal regime: the relevant law on higher education governs status issues, while titles and methods of work are governed according to the laws on scientific research. The work of university institutes has yet to be explored.

Scientists are not sufficiently numerous or represented in the workforce structure.[112] Yet, most of them are concentrated in universities.[113] Therefore, the third important strength element of the innovation system is a good scientific and teaching staff. At the formal level, the Framework Law on Higher Education in B&H[114] and the manner of its adoption in the laws of the competent political-territorial units dictate the quality of teaching personnel through provisions on the conditions for the election of academic staff in A comparative

---

[109] Kremić & Trifković, 2020:21, tables 2-7

[110] Kremić & Trifković, 2020:21, tables 2-8

[111] For legal status of institutes in Bosnia and Herzegovina see Trifković, 2020b: 45. Regulations in the FB&H entity are presented on pp. 145 – 147, and in the RS entity on pp. 203 – 206. For the RS entity, see also art. 47 and 64 of the Law on Higher Education of RS.

[112] Trifković, 2020b: 42: In 2015 they made 0.47% in FB&H, and 0.36% in RS of the total number of employed.

[113] According to the *Agency for Statistics of Bosnia and Herzegovina. Science, Technology and Digital Society, Statistics Research and Development 2019,* of 2.883 employees in research and development in 2019, 2.271 of them worked in higher education. Of that number 1.871 were researches, while technical and other staff made up 400. Worrying fact is that more than half of researchers (970) were engaged for less than full time working hours.

[114] See articles 28 - 35

review of internal legislation shows that there are no major deviations from the framework provisions. This fact is, on the one hand, a reflection of the objectively unsatisfactory conditions in which universities operate, and on the other hand, it may indicate an underdeveloped autonomy of universities that leads to settling with minimum standards. The direct synthetic expression of the action of all factors of the elaborated SWOT matrix at the institutional level can also be the global evaluation of the universities of Bosnia and Herzegovina. Currently we have to present it according to the *Webometrics* ranking,[115] stating only the general ranking: 1. UNSA – 1675; 2. UNBL – 2658; 4. UNTZ – 3694; 5. IUS – 3786; 7. SVM – 4748; 8. UNZE – 5129, etc. It is notable that among the top 10 universities in Bosnia and Herzegovina are four private universities; 3. International University of Sarajevo – 3557; 6. IU Burch – 3979; 9. European University Brcko – 6109 and 10. SSST – 6166.

From all that was presented so far, it is evident that higher education in Bosnia and Herzegovina as a system – taking into account the effects of objectively conditioned weaknesses and great individual and institutional achievements – has only just begun to work systematically on acceptance of the criterion of excellence. That is why we must pay special attention to this opportunity of our innovation system. Bringing scientific-research institutions closer to the European Research Area implies the development of excellence in research, ie the recognition of the institution as a centre of excellence in research. One of the mechanisms established at European level is the awarding of the prize or logo "Excellence in Research".[116] The European Commission awards this logo as a public recognition to research institutions that develop processes for harmonizing the employment and career development policies of researchers with the Charter and the Code for Research Institutions.[117] Institutions that are eligible to use this logo show a commitment to implementing a fair and transparent process of recruiting and promoting researchers. In order for the institution to receive this logo, which is evaluated in regular cycles through internal and external processes, it is necessary to develop a Human Resources Strategy for Researchers (HRS4R) with an Action Plan, and the highest academic bodies must adopt these two documents. At present, only three universities in Bosnia and Herzegovina have the right to carry the "Excellence in Research" logo. These are the University of Banja Luka since April 2015, the University of East Sarajevo since 2017 and the University of

[115] Consejo Superior de Investigaciones Científicas (2021)
[116] European Commission (2021)
[117] European Commission (2019)

Sarajevo since 2019. For comparison, in the Republic of Croatia six universities and eight scientific institutes have this logo, while in Serbia four universities have qualified for this award. At first glance it may seem that this logo is not directly related to excellent research projects. However, insight into the elements of the Charter and the Code makes it clear that the European Commission links research excellence to engagement of outstanding scientists, creating an environment in which they can work freely and socially responsibly, and pool their efforts to create change based on quality research.

IV Conclusions

1. SWOT analysis is widely accepted in Bosnia and Herzegovina as an instrument of general and sectoral strategic planning, including the development of the innovation system. Its application in the FB&H entity has become legally binding. It is likely to gain the same status in the RS entity soon. These facts require intensive consideration of the methodological issues of SWOT analysis.
2. The innovation system in Bosnia and Herzegovina operates in an unfavourable internal social, economic, political and legal environment. Allocations for research and development are essentially considered a cost, not an investment. Therefore, the treatment of research and development in SWOT analyses prepared for general strategic documents does not correspond to the potentials of the innovation system to achieve development goals.
3. Adoption of strategies for the development of the innovation system is neglected in Bosnia and Herzegovina. Only the state of Bosnia and Herzegovina, the entity of Republika Srpska and the Canton of Sarajevo have valid strategies and SWOT analyses in this area. Such situation is a reliable indicator of the unsatisfactory attitude of politics towards the innovation system, a factor of deepening the internal knowledge gap and a sign of the deteriorating position of Bosnia and Herzegovina in international competition.
4. The comparison of our SWOT analysis of the innovation system, based on recent research, with the SWOT matrices from the documents of general and sectoral strategic planning shows a significant correlation between them. Differences exist particularly in the choice of individual elements of each factor, the treatment of financing as a weakness of the system, the presence of technological development and the impact

of international cooperation on improving the state of the innovation system.

5. In all SWOT matrices, the relatively good state of higher education and human capital are the most important strengths of the innovation system. Such unison does not exist in other factors.
6. All conducted SWOT matrices are proof that the existing innovation system in Bosnia and Herzegovina is neither sufficiently developed nor sufficiently connected in terms of interests, targets, norms and function to the extent that it would make it a decisive factor in moving towards a knowledge society and economy. Therefore, our innovation system does not allow the national economy to move from the phase of more efficient use of raw materials to the phase of production of knowledge-based goods.
7. SWOT analysis of the innovation system in Bosnia and Herzegovina shows that it is a factor of exceptionally slow and in various ways limited social and economic progress, which in global competition objectively means stagnation, or relative regression in development.

Annex 1

Table No. 1: SWOT matrix of the innovation system extrapolated from development documents in Bosnia and Herzegovina

No.	Factors of SWOT analysis	Elements of individual factors of the SWOT analysis	Abbreviated titles of documents and pages
1	2	3	4
1,	STRENGTHS		
1.1.		High quality education in the field of mathematics and natural sciences	SO for BiH, 31
1.2.		Stable availability of scientists and engineers, quality university teaching staff	SO for BiH, 31; SR SBK, 31
1.3.		Cooperation between universities and industry in the field of research and development	SO for BiH, 31; SR ZDK, 236
1.4.		Qualified professional staff in various economic and social fields	NSP TK, 226; SR SBK, 30; SR ZDK, 238; SR BPK, 44
1.5.		Wide use of internet	SO for BiH, 31
1.6.		Dynamic and competitive IT sector	SR FBiH, 151
1.7.		Accredited and developed higher education system	SR ŽP, 49; ISR USK, 111; SR SBK,31; SR ZDK, 236; SR KS 296; SR HNŽ, 113
1.8.		Developed organizations to support entrepreneurship	SR ZDK, 236; SR ŽZH 56
1.9.		Legal framework for action in scientific research	SR KS, 297
1.10.		Registered geographical indications	SR ŽZH 56
2.	**WEAKNESSES**		
2.1.		Technology-oriented companies are leaving B&H due to a lack of highly qualified labour and research workforce	SR BiH, 7
2.2.		Low level of added value in export products; underdeveloped creative industry	SO for BiH, 31; SR ZDK, 236; K 10, 31
2.3.		Low level of technology, marketing, research and development in enterprises, especially those for green growth and small and medium enterprises	SO for BiH, 31; SR ŽP, 49; SR HNŽ, 113

No.	Factors of SWOT analysis	Elements of individual factors of the SWOT analysis	Abbreviated titles of documents and pages
1	2	3	4
2.4.		Insufficient level of incoming FDI and technology transfers	SO for BiH, 31
2.5.		Shortcomings in the protection of intellectual property	SO for BiH, 31; SR FBiH, 152;
2.6.		Lack of a strategic framework for the development of digital economy	SR FBiH ,151; SR ŽP, 49
2.7.		Insufficient involvement of businesses in research and development activities of the universities	SR FBiH, 152; SR HNŽ, 111; SR ŽZH 57
2.8.		Lack of legal and strategic framework and poor coordination of the innovation system; insufficient coordination in development management; inconsistent application of the law on scientific research	SR FBiH, 152 ISR USK, 111; SR ZDK, 239; SR HNŽ, 111
2.9.		Tax policy that isn't encouraging development	SR FBiH, 152
2.10.		Reduced natural population growth and migration abroad, especially of young people	SR ŽP,49; SR ZDK, 236; SR ZDK, 241; SR KS, 300; K 10, 32
2.11.		Insufficient investment in campus and educational infrastructure	NSP TK, 226
2.12.		Insufficient number of scientific-research centres and centres for acquiring practical skills	NSP TK, 226
2.13.		Lack of modern equipment in all areas	NSP TK, 226-227; SR ZDK, 238
2.14.		Insufficient promotion and encouragement of innovation, research and development	SR HNŽ, 110
2.15.		Weak links between the public, private and higher education sectors	SR HNŽ, 110; SR ŽZH 57
2.16.		Lack of a mechanism for motivating civil servants for development work	SR ŽZH 57
3.	**OPPORTUNITIES**		
3.1.		Foreign direct investments (in modern technologies)	SR BiH, 9;
3.2.		The momentum of the fourth industrial revolution and genetics; Use of technologies that do not harm the environment	SR FBiH, 154 SR SBK, 32

No.	Factors of SWOT analysis	Elements of individual factors of the SWOT analysis	Abbreviated titles of documents and pages
1	2	3	4
3.3.		Cooperation between the industry, academia and government in research (the triple helix) and smart specialization	SR FBiH, 155; SR KS, 300
3.4.		Development of STEM education	SR FBiH, 155
3.5.		Global value chains and the possibility of smart specialization	SR ŽP, 51
3.6.		Development of science-technology parks	NSP TK, 226
3.7.		Use of EU funds for S&R and R&D work	SR KS, 299
4.	**THREATS**		
4.1.		Outflow of personnel (departure of the educated and youth) especially in globally deficient professions, e.g. medical	SR BiH,8 ISR USK, 112; NSP TK, 226 i 228; SR HNŽ, 111; SR BPK 45
4.2.		The threat of marginalization of B&H economy, science and society; investing in outdated technologies	SO za BiH, 32; SR ZDK, 242-243
4.3.		Failure to attract foreign direct investment and technology transfer	SO za BiH, 32
4.4.		Lack of transfer of new knowledge and professional assistance from scientific institutions, especially in agriculture and adaptation to climate change	SR ŽP, 51
4.5.		Disincentive tax and customs policy	ISR USK, 112
4.6.		Insufficient capacities of S&R and R&D centres	SR SBK, 32
4.7.		Weak institutional support to S&R activities	SR ZDK, 240
4.8.		Low level of cooperation of R&I institutions and industry	SR ZDK, 240

Legend:

1. SR for BiH – "Strategija razvoja Bosne i Hercegovine, Radni document", Council of Ministers, 2010[118]
2. SO for BiH – "Strateški okvir za Bosnu i Hercegovinu", Council of Ministers, 2015.[119]
3. SR FBiH – "Strategija razvoja Federacije Bosne i Hercegovine", FBiH Government, 2020[120]

[118] Bosnia and Herzegovina. Council of Ministers (2010)
[119] Bosnia and Herzegovina. Council of Ministers (2015)
[120] Federation of Bosnia and Herzegovina. Government of the Federation of Bosnia and Herzegovina (2020)

4. SR ŽP – “Strategija razvoja Županije Posavske 2021 -2027”, Posavina Canton, 2021[121]
5. ISR USK – “Integrirana strategija razvoja Unsko-Sanskog kantona”, USK Government, 2014[122]
6. NSP TK – “Nacrt strateške platforme razvoja Tuzlanskog kantona”, TK Government, 2015[123]
7. SR SBK – “Strategija razvoja Srednjobosanskog kantona za period 2016 – 2020”, 2016[124]
8. SR ZDK – “Strategija razvoja Zeničko-dobojskog kantona za period 2021 – 2027, Nacrt”, ZDK Canton, 2020[125]
9. SR KS – “Strategija razvoja Kantona Sarajevo, Nacrt – proširena verzija”. KS – Development Planning Institute, 2020[126]
10. SR HNŽ – “Strategija razvitka Hercegovačko-neretvanske županije za period 2021. – 2027. – Nacrt strateške platforme”, HNŽ Government, 2020[127]
11. SR BPK – “Strategija razvoja Bosansko-podrinjskog kantona Goražde za period 2016.-2020. Godine”, 2015[128]
12. SR ŽZH – “Strategija razvoja Županije Zapadnohercegovačke 2021 – 2027”, ŽZH, 2020[129]
13. K 10 – “Strategija razvoja kantona 10 za period 2016 – 2020. godina, Nacrt”, 2015[130]

[121] Federation of Bosnia and Herzegovina. Posavina Canton (2021)
[122] Federation of Bosnia and Herzegovina. Una-Sana Canton (2014)
[123] Federation of Bosnia and Herzegovina. Tuzla Canton (2015)
[124] Federation of Bosnia and Herzegovina. Central Bosnia Canton (2016)
[125] Federation of Bosnia and Herzegovina. Zenica-Doboj Canton (2020)
[126] Federation of Bosnia and Herzegovina. Sarajevo Canton (2020)
[127] Federation of Bosnia and Herzegovina. Herzegovina-Neretva Canton (2020)
[128] Federation of Bosnia and Herzegovina. Bosnian-Podrinje Canton Goražde (2015)
[129] Federation of Bosnia and Herzegovina. West Herzegovina Canton (2021)
[130] Federation of Bosnia and Herzegovina. Canton 10 (2015)

Annex 2

Table No. 5: SWOT matrix of the innovation system in Bosnia and Herzegovina elaborated per elements of strength factor

Established state framework for the innovation system			
No.		**No.**	
1	**2**	**3**	**4**
1.	**Strengths**	**2.**	**Weaknesses**
1.1.	The Framework Law on the Fundamentals of Scientific Research and Coordination of Internal and International Scientific Research Cooperation was adopted (Official Gazette of B&H / 09).	2.1.	The state of B&H is responsible for the international relations of the innovation system, but it does not have effective constitutional and legal instruments for fulfilling the agreed obligations and rights within the country.
1.2.	The Stabilization and Association Agreement opens up opportunities for ERA accession	2.2.	Assumption of competencies of lower political-territorial units for all affairs that are not explicitly assigned by the constitution to a higher political-territorial unit
1.3.	Adopted state strategy for development of S&R activities	2.3.	Omission of general and fragmentation of special interest for the innovation system according to the territorial competence for passing laws in this area
1.4.	Adopted Framework Law on Higher Education in B&H (50/07 and 59/09)	2.4.	In terms of amounts and structure, absolutely insufficient and inadequate budget financing of the functioning of the innovation system, accompanied by the lack of incentives and benefits for research and development
1.5.	Interdependence of scientific and teaching work at universities has been established	2.5.	/
1.6.	Ongoing finalization of a harmonized strategic planning system in B&H	2.6.	/
3.	**Opportunities**	**4.**	**Threats**
3.1.	Completion of legal regulation of the science system by enacting new laws in six cantons that did not do so after the signing of the Dayton Peace Agreement	4.1.	Legal possibility of lower political-territorial units not to use their competencies and thus reduce the effects of the state's efforts in international scientific and technical cooperation
3.2.	Adoption of 11 missing strategies for the development of the innovation system (nine cantons, FB&H, Brčko District)	4.2.	Autarchic application of the principles of decentralized and polycentric planning of innovation system development

3.3.	Developing mechanisms for connecting the Ministry of Civil Affairs of B&H and the subjects of the innovation system in creating and fulfilling forms of international cooperation	4.3.	Constitutional-legal and political difficulties in the activities of the FB&H on the harmonization of legal and strategic regulations of the innovation system
3.4.	Strengthening international exchange and circulation of scientific-research staff	4.4.	Deepening of the internal gap in knowledge for objective reasons (e.g. different degree of development of the cantons), political attitudes and cultural situation (e.g. attitude towards the knowledge society and economy)
Harmonized structure of the innovation system			
No.		**No.**	
	Strengths		**Weaknesses**
1	**2**	**3**	**4**
1.1.	Uniform systematization of jobs in the innovation system. Institute and university titles are equal, and the conditions for election are very similar	3.1.	Insufficient participation of scientists and researchers in the total population and in the labour force
1.2.	Higher education is part of the EHEA and functions in a uniform manner	3.2.	There are small differences in the conditions for the selection of teachers, researchers and scientific associates, but they have a significant effect on staff mobility within the innovation system in the country
1.3.	There are seven types of subjects of the innovation system of a largely uniform status regime	3.3.	From the point of view of optimal functioning of the innovation system, each of the seven types of subjects has its specific status-legal weaknesses
1.4.	Specific legal solutions on the innovation system within political-territorial units can be harmonized without compromising the unity of any subsystem	3.4.	Insufficient productivity of the scientific staff
1.5.	/	3.5.	The innovation system is not a policy priority in legislative, planning, strategic and financial terms
1.6.	/	3.6.	Absolutely insufficient allocations for science and completely inadequate system of financing
1.7.	/	3.7.	There is no systematic approach to scientific ethics as a control mechanism of a social nature and a condition for the approval of individual projects
1.8.	/	3.8.	The lack of interest of the state administration in the functioning, and for participation in the work of the innovation system
2.	**Opportunities**	**4.**	**Threats**
2.1.	Adopt the lacking and harmonize existing laws on the innovation system	4.1.	Legal possibility of lower political-territorial units not to improve and harmonize the legislation of the innovation system in their area

2.2.	Adopt non-existent and harmonize valid bylaws on the innovation system	4.2.	The contrast between the existence of state competence for international relations of the innovation system and the lack of powers and instruments for the implementation of international arrangements within the state
2.3.	Increasing the amount and improving the methodology and budget financing, improving the structure of financing per subjects and sources	4.3.	The FB&H has the authority to legally regulate industry and economic relations, but not to regulate the innovation system
2.4.	Alignment of foreign direct investment policy with the strategy and policy of the innovation system	4.4.	The absence of large economic organizations that would be the bearers of the development of the innovation system in the economy, but also in the state

Good state of human capital			
No.		**No.**	
1	**2**	**3**	**4**
1.	**Strengths**	**2.**	**Weaknesses**
1.1.	Good healthcare system	2.1.	Insufficient investment, primarily by the state, in all components of human capital, and especially in public health
1.2.	Education system in line with European standards	2.2.	The existence of an inner gap in knowledge. Human capital in all parts of the country is not equally developed nor does it have the same development conditions
1.3.	Still good state of human capital, which is manifested by the objective ability of the Bosnian-Herzegovinian economy to place complex export products on the international market	2.3.	Insufficient concentration of own human capital in independent institutes and economic entities
1.4.	Researchers with the title of Doctor of Science are dominant in numbers in the innovation system	2.4.	Unfavourable ratio between number of researchers and other personnel in research organizations
3.	**Opportunities**	**4.**	**Threats**
3.1.	Increasing the coverage of age and professional groups of employees with the appropriate type of lifelong learning	4.1.	Further devaluation of knowledge, skills and competencies in the social system, especially in the policy sub-system
3.2.	Increasing domestic demand for institutional knowledge and services	4.2.	Insufficiently fast growth of information and communication skills and computer literacy of the population
3.3.	Reintegrate STEM education into state education policy	4.3.	Declining birth rates, population aging and emigration
3.4.	Strengthening the parts of the public health system relevant to the maintenance and development of human capital	4.4.	Brain drain

2.5.	Eliminate differences between the declaratory and the actual attitude towards human capital through planned actions	4.5.	/

Harmonized and stabilized higher education			
No.		No.	
1	2	3	4
1.	**Strengths**	**2.**	**Weaknesses**
1.1.	The most important conventions defining the EHEA have been signed and implemented	2.1.	Universities are mostly oriented towards teaching. There are no research universities
1.2.	The Framework Law on Higher Education in B&H was adopted and implemented (Official Gazette of B&H 59/07 and 59/09). The RS entity and all cantons in the FB&H entity have adopted their own laws in this area	2.2.	A small number of centres of excellence even in the political-territorial units in which they are legally regulated
1.3.	Favourable university structure	2.3.	Very limited cooperation with the industry
1.4.	The unity of science and teaching set as a principle and largely realized in practice	2.4.	Unsatisfactory placement of all domestic universities on international rankings
1.5.	All scientific and artistic fields are studied	2.5.	Insufficient capacities for technology transfer
1.6.	Relatively good scientific-teaching staff	2.6.	Limited ability to hire the best staff from the industry and among graduate students
1.7.	Existence of institutes as research units, mostly at public universities.	2.7.	An undefined policy of counteracting the brain drain
3.	**Opportunities**	**4.**	**Threats**
3.1.	Accelerated employment of professionals in deficit professions, especially younger ones	4.1.	Slow development of autonomy of higher education institutions
3.2.	Establish policy and provide funds for systematic international cooperation and staff circulation	4.2.	Maintaining the current revenue structure of higher education institutions. For the public institutions, that means further dominance of the budget funding, and for the private ones - tuition fees. The stagnation of R&D income is dangerous for both universities and society
3.3.	Adopt strategy and operational documents for the establishment of centres of excellence	4.3.	Tendencies of university self-isolation and provincialization
3.4.	Planned approach to measures to increase publication in journals that are followed by indexing databases and to improve the rank of our universities, especially public ones	4.4.	Maintaining the current level of investment in equipment and research projects and persisting in the system of insufficient co-financing of procurement and research
3.5.	Adopt the general strategy and strategies of higher education institutions for cooperation with business entities	4.5.	Maintaining the current level of investment in equipment and research projects and persisting in the system of insufficient co-financing of procurement and research

Annex 3

Table No.6: "Overview of published papers in the Scopus database per branches of science and universities"

FIELD	UNIVERSITIES								SUM	%
	UNSA	UNBL	UNTZ	SVEM	UIS	UNZE	UNMO	UNBI	Σ	PAPERS
Medicine	2085	353	461	375	178	72	17	0	3541	19.9%
Engineering	1264	494	341	116	202	101	63	0	2581	14.5%
Computer sciences	963	307	213	81	157	43	74	0	1838	10.3%
Agriculture and biology sciences	471	347	65	101	101	0	17	0	1102	6.2%
Social sciences	458	135	149	136	78	25	23	0	1004	5.6%
Mathematics	461	200	70	37	82	27	10	0	887	5.0%
Physics and astronomy	442	184	75	24	82	39	2	0	848	4.8%
Biochemistry, genetics and molecular biology	360	166	66	85	52		1	0	730	4.1%
Environmental science	273	147	90	38	58	11	7	0	624	3.5%
Chemistry	188	120	58	41	96	17	2	0	522	2.9%
Science on materials	130	174	40	31	75	54	8	0	512	2.9%
Chemical engineering	231	77	62	27	71	20	2	0	490	2.8%
Energy	194	96	84	10	79		5	0	468	2.6%
Art and humanities	170	50	62	81	12	22	10	0	407	2.3%
Business, management and accounting	173	57	25	25	23	9	9	0	321	1.8%
Pharmacology, toxicology and pharmaceutics	145	70	12	17	11	1	0	0	256	1.4%
Science on Earth and planets	83	62	55	22	19	3	1	0	245	1.4%
Health studies	88	25	42	41	43	2	3	0	244	1.4%
Decision making (interdisciplinary field)	106	35	11	4	30	8	9	0	203	1.1%
Economy, econometrics and finances	111	35	17	12	18		5	0	198	1.1%
Physiology	79	39	30	22	7	2	0	0	179	1.0%
Veterinary science	105	25	4	16	5	1	1	0	157	0.9%
Immunology and Microbiology	79	12	11	18	7	0	0	0	127	0.7%
Neuroscience	52	13	18	5	3	0	0	0	91	0.5%

Nursing science	50	8	15	6	4	3	1	0	87	0.5%
Dentistry	43	11		9	20	1	0	0	84	0.5%
Multidisciplinary fields	36	15	6	4	7	0	2	0	70	0.4%
	8840	3257	2082	1384	1520	461	272	0	**17810**	
% PER UNIVERSITY	49.6%	18.3%	11.7%	7.8%	8.5 %	2.6%	1.5%			

Thanks

Authors wish to thank dipl. comp. and dipl. bibl. Saša Madacki for the great help in obtaining and synthesis of data related to the number of higher education institutions in Bosnia and Herzegovina and the structure of scientific-research papers in the SCOPUS database.

Literature

Agency for Development of Higher Education and Quality Assurance of Bosnia and Herzegovina. List of accredited higher education institutions in B&H. Taken from http://hea.gov.ba/akreditacija_vsu/Default.aspx, 10 May 2021.

Agency for Statistics of Bosnia and Herzegovina. Demography and social statistics. Education statistics – Higher Education in 2019/2020 Academic Year, Report (Year XV, No. 2), Sarajevo, 30 October 2020.

Agency for Statistics of Bosnia and Herzegovina. Science, Technology and Digital Society, Statistics Research and Development 2019, Report, Year IX (No. 1), Sarajevo, 12 February 2021.

Babić, M. (2021). Od Srbije čekamo da nam izbroji vakcinisane. Oslobođenje [Digital Edition]. 25 May 2021. Taken from https://www.oslobodjenje.ba/vijesti/B&H/od-srbije-cekamo-da-nam-izbroji-vakcinisane-658782, 25 May 2021.

Bosnia and Herzegovina. Centre for Information and Recognition of Qualifications in Higher Education (2021). *List of Higher Education Institutions*. Taken from http://www.cip.gov.ba/images/pdf/ListaVSU/Lista_VSU.bos.pdf, 10 May 2021.

Bosnia and Herzegovina. Framework Law on Basics of Scientific-Research Activity and Coordination of Internal and International Scientific-Research Cooperation of Bosnia and Herzegovina. *Official Gazette of Bosnia and Herzegovina No*. 43/09.

Bosnia and Herzegovina. Framework Law on Higher Education in Bosnia and Herzegovina. *Official Gazette of Bosnia and Herzegovina No*. 59/07.

Bosnia and Herzegovina. Constitution of Bosnia and Herzegovina. [Annex IV of the General Framework Agreement for Peace in Bosnia and Herzegovina].

Bosnia and Herzegovina. Council of Ministers of Bosnia and Herzegovina (2016). Strategija razvoja znanosti u Bosni i Hercegovini 2017-2022: revidirani okvirni dokument. Taken from http://www.vijeceministara.gov.ba/akti/prijedlozi_zakona/?id=29796, 20 June 2016.

Bosnia and Herzegovina. Council of Ministers of Bosnia and Herzegovina (2020). Srednjoročni program rada Vijeća ministara B&H 2021-2023. Council of Ministers of

Bosnia and Herzegovina. Sarajevo. Taken from https://www.ekonsultacije.gov.ba/legislationactivities/downloaddocument?documentId=1013796, 11 June 2021.

Bosnia and Herzegovina. Council of Ministers of Bosnia and Herzegovina (2014). Odluka Vijeća ministara B&H o postupku srednjoročnog planiranja, praćenja i izvještavanja u institucijama Bosne i Hercegovine. *Official Gazette of Bosnia and Herzegovina No*. 62/14.

Bosnia and Herzegovina. Council of Ministers of Bosnia and Herzegovina. Directorate for Economic Planning (2015a). Strateški okvir za B&H. Directorate for Economic Planning Sarajevo. Taken from http://www.dep.gov.ba/naslovna/DEP%20Strateski%20okvir%20za%20B&H.pdf, 02 April 2021.

Bosnia and Herzegovina. Council of Ministers of Bosnia and Herzegovina. Directorate for Economic Planning (2015b). Strategy of Development of Bosnia and Herzegovina. Directorate for Economic Planning. Sarajevo. Taken from http://www.dep.gov.ba/razvojni_dokumenti/razvojna_strategija/Archive.aspx?langTag=bs-BA&template_id=140&pageIndex=1, 11 June 2021.

Bosnia and Herzegovina. Council of Ministers of Bosnia and Herzegovina (2010). Strategy of Development of Bosnia and Herzegovina, Working Document. Taken from http://dep.gov.ba, 11 June 2021.

Bosnia and Herzegovina. Council of Ministers of Bosnia and Herzegovina (2016). Odluka Vijeća ministara o sistemu koordinacije procesa europskih integracija u Bosni i Hercegovini *Official Gazette of Bosnia and Herzegovina No*. 72/16 Taken from http://vijeceministara.gov.ba/home_right_docs/default.aspx?id=23422&langTag=hr-HR, 11 June 2021.

Bosnia and Herzegovina. Council of Ministers of Bosnia and Herzegovina (2015). Strateški okvir za Bosnu i Hercegovinu. Taken from http://dep.gov.ba/naslovna/DEP%2'strateski%20okvir%20za%20B&H.pdf, 11 June 2021.

Božac, M.G. (2008). SWOT analiza i TOWS matrica – sličnosti i razlike. *Ekonomska istraživanja*. Vol. 21 (No. 1), pp. 20 – 23.

Consejo Superior de Investigaciones Científicas (2021). *Ranking Web of Universities - Bosnia and Herzegovina*. Taken from https://webometrics.info/en/Europe/Bosnia%20and%20Herzegovina%20, 11 June 2021.

Cvitković, I. [ed.] (2017). *Demografske i etničke promjene u B&H*, Academy of Sciences and Arts of Bosnia and Herzegovina, Sarajevo.

Čičić, M. [ed.] (2020). *Studija o emigracijama Bosne i Hercegovine*. Academy of Sciences and Arts of Bosnia and Herzegovina, Sarajevo.

Emirhafizović, M. & Zolić, H. (2017). Dobna struktura i reprodukcija stanovništva Bosne i Hercegovine. [ed.] Cvitković, I. *Demografske i etničke promjene u B&H*, (pp. 11-54). Academy of Sciences and Arts of Bosnia and Herzegovina, Sarajevo.

European Commission (2019). The European Charter for Researchers: The Code of Conduct for the Recruitment. Office for Official Publications of the European Communities. Luxembourg. Taken from https://www.unsa.ba/sites/default/files/inline-iles/EU%20Povelja%20i%20Kodeks%20za%20istrazivace_BOS.pdf, 11 June 2021.

European Commission (2021). EURAXESS - Researchers in Motion. Taken from https://euraxess.ec.europa.eu/, 11 June 2021.

Federation of Bosnia and Herzegovina. Bosnian Podrinje Canton Goražde (2015) Strategija razvoja Bosansko-podrinjskog kantona Goražde za period 2016.-2020. Godine, Taken from Http:// www. zzpr.gov.ba/bs/docs/25/4/kantonalni zzh.ba/images/PDF/Strategije/Strategija%20razvoja%20Zupanije%20Zapadnohercegovacke%202021-2027-RADNA%20VERZIJA.pdf -strateski-dokumenti, 11 June 2021.

Federation of Bosnia and Herzegovina. Federal Institute for Development Programming. *Uredbe*. Taken from https://www.fzzpr.gov.ba/bs/docs/35/8/uredbe

Federation of Bosnia and Herzegovina. Federal Institute for Development Programming. *Kantonalni strateški dokumenti*. Taken from https://fzzpr.gov.ba/public/bh/strateski-dokumenti/kantonalni-strateski-dokumenti, 11 June 2021.

Federation of Bosnia and Herzegovina. FB&H Ministry of Education and Science (2010). Strategija razvoja nauke u Federaciji Bosne i Hercegovine za period 2011 – 2021. FB&H Ministry of Education and Science. Mostar.

Federation of Bosnia and Herzegovina. Herzegovina-Neretva Canton (2020). Strategija razvitka Hercegovačko-neretvanske županije za period 2021. – 2027. – Nacrt strateške platforme. Taken from https://www.vlada-hnz-k.ba/sites/default/files/17.11.strateska_platfroma_hnk_2021_2027_nacrt_mm_1.pdf, 11 June 2021.

Federation of Bosnia and Herzegovina. Canton 10 (2015). Strategija razvoja kantona 10 za period 2016 – 2020: Nacrt. Taken from https://www.fzzpr.gov.ba/bs/docs/25/4/kantonalni-strateski-dokumenti, 11 June 2021.

Federation of Bosnia and Herzegovina. Sarajevo Canton (2020). Strategija razvoja Kantona Sarajevo, Nacrt – proširena verzija. Taken from https://zpr.ks.gov.ba/strategija-razvoja-kantona-sarajevo-2021-2027strateska-platforma-nacrt-prosirena-verzija, 11 June 2021.

Federation of Bosnia and Herzegovina. Central Bosnia Canton (2016). Taken from https://sbk-ksb.gov.ba/images/Strategija_razvoja_SBK_2016-2020.pdf, 11 June 2021.

Federation of Bosnia and Herzegovina. Tuzla Canton (2015). Nacrt strateške platforme razvoja Tuzlanskog kantona. Taken from http://www.vladatk.kim.ba/Vlada/Novosti_2014/Nacrt_Strateske_platforme_razvoja_Tuzlanskog_kantona.pdf, 11 June 2021.

Federation of Bosnia and Herzegovina. Una-Sana Canton (2014). Integrirana strategija razvoja Unsko-Sanskog kantona, Taken from https://www.fzzpr.gov.ba/bs/docs/25/4/kantonalni-strateski-dokumenti, 11 June 2021.

Federation of Bosnia and Herzegovina. Uredba o izradi strateških dokumenata u Federaciji Bosne i Hercegovine. *Official Gazette of the Federation of Bosnia and Herzegovina* No. 74/19

Federation of Bosnia and Herzegovina. Government of the Federation of Bosnia and Herzegovina (2020). Strategija razvoja Federacije Bosne i Hercegovine. Taken from http://fzzpr.dgov.ba/bs/pages/48/16/strategija-razvoja-federacije-B&H-2021-2027, 11 June 2021.

Federation of Bosnia and Herzegovina. Government of the Federation of Bosnia and Herzegovina (2021). *Strategija razvoja Federacije Bosne i Hercegovine 2021-2027*. Government of the Federation of Bosnia and Herzegovina. Sarajevo. Taken from http://www.sogfB&H.ba/sites/default/files/javni_dokument/2021-05/Strategija%20razvoja%20FB&H%202021.%20-%202027..pdf, 11 June 2021.

Federation of Bosnia and Herzegovina. Zakon o razvojnom planiranju i upravljanju razvojem u Federaciji Bosne i Hercegovine. *Official Gazette of the Federation of Bosnia and Herzegovina* No. 32/17.

Federation of Bosnia and Herzegovina. Zenica-Doboj Canton (2020). Strategija razvoja Zeničko-dobojskog kantona za period 2021 – 2027: Nacrt. Taken from https://www.zdk.ba/component/k2/item/download/5098_caae7a6c7e858099211e354ca553e6ec, 11 June 2021.

Federation of Bosnia and Herzegovina. Posavina Canton (2021). Strategija razvija Županije Posavske 2021-2027. Posavina Canton. Taken from http://www.zupanijaposavska.

ba/wp-content/uploads/2020/11/FINALNI-NACRT-V2-Strategija-razvoja-Zupanije-Posavske-10-11-2020-2_compressed.pdf, 11 June 2021.

Federation of Bosnia and Herzegovina. West Herzegovina Canton (2021). Strategija razvoja Županije Zapadnohercegovačke 2021 – 2027. Taken from http://www.eui-zzh.ba/images/PDF/Strategije/Strategija_razvoja_ZZH_za_razdoblje_2021_-_2027_godine.pdf , 11 June 2021.

Institute for Statistics of FB&H (2020). *Projekcije stanovništva Federacije Bosne i Hercegovine 2020 – 2070*. Institute for Statistics of FB&H, Sarajevo. Taken from https://fzs.ba/wp-content/uploads/2020/12/PROJEKCIJE-STANOVNI%C5%A0TVA-FB&H-2020_2070_bos.pdf, 11 June 2021.

Institute for Statistics of FB&H (2020). Statistički bilten Visoko obrazovanje 2019/2020, issue 306, Sarajevo.

Institute for Statistics of FB&H. Visoko obrazovanje u Federaciji Bosne i Hercegovine u 2020./2021. Report (Year XIII, No. 12.3), Sarajevo, 03 March 2020.

Fleisher, C. & Bensoussan, B. (2007). *Business and Competitive Analysis: Effective Application of New and Classic Methods*. Pearson Education. Upper Saddle River, New Jersey. Taken from https://www.weforum.org/reports/the-global-competitiveness-report-2017-2018, 24 March 2021.

Sarajevo Canton. Government of Sarajevo Canton. Ministry of Education, Science and Youth of Sarajevo Canton (2017). Strategija razvoja obrazovanja i nauke Kantona Sarajevo za period 2018 – 2022. godine - (Nacrt). Ministry of Education, Science and Youth of Sarajevo Canton. Sarajevo. Taken from https://skupstina.ks.gov.ba/sites/skupstina.ks.gov.ba/files/nacrt_strategije_obrazovanje.pdf, 11 June 2021.

Sarajevo Canton. Government of Sarajevo Canton. Ministry of Education, Science and Youth of Sarajevo Canton. Standardi i normativi za obavljanje djelatnosti visokog obrazovanja na području Kantona Sarajevo. *Official Gazette of Sarajevo Canton* No. 33/17

Kremić, E. & Trifković, M. [ed.] (2020). Harmonizacija sistema nauke u Bosni i Hercegovini: projekt = Harmonization of the science system in Bosnia and Herzegovina: project. Federalni zavod za statistiku = Institute for Statistics of the Federation of Bosnia and Herzegovina: Akademija nauka i umjetnosti Bosne i Hercegovine = Academy of Sciences and Arts of Bosnia and Herzegovina. Sarajevo.

Nikolić, R. (s.a.). SWOT analiza: šta je to i kako se primenjuje. [Digital Edition]. Taken from www.issu.com/bisera.kardula/docs/1913_m_chapter_3_swor_manual_r-niko, 27 March 2021.

Pašalić–Kreso, A. (2017). Obrazovanost stanovništva u Bosni i Hercegovini – Bosna i Hercegovina između najviše stope nepismenosti i najnižeg nivoa obrazovanosti“ [ed.] Cvitković, I. *Demografske i etničke promjene u B&H*, (pp. 93-124). Academy of Sciences and Arts of Bosnia and Herzegovina, Sarajevo.

Radošević, S. (2011). Science-industry links in Central and Eastern Europe and the Commonwealth of Independent States: conventional policy wisdom facing reality. *Science and Public Policy*. Vol 38 (No. 5), pp. 365-378.

Radošević, S. & Lepori, B. (2009). Public Research Funding Systems in Central and Eastern Europe: Between Excellence and Relevance: Introduction to Special Section. *Science and Public Policy*, Vol. 36 (No. 9), pp. 659-666.

Republika Srpska. National Assembly of Republika Srpska. Materials for the 16th Regular Session. Taken from: http://www.narodnaskupstinars.net/sites/default/files/upload/dokumenti/materijali_za_sjednice/lat/Materijali%20za%2016.%20redovnu%20sjednicu.zip, 26 April 2021.

Institute for Statistics of Republika Srpska (2020). Statistički bilten 2019/2020, Banja Luka,

Republika Srpska. Ministry of Scientific and Technological Development, Higher Education and Information Society. *Strategije*. Taken from https://www.vladars.net/sr-SP-Cyrl/Vlada/Ministarstva/mnk/PAO/Strategije/Pages/default.aspx, 11 June 2021.

Republika Srpska. Government of Republika Srpska (2017). Strategija naučnog i tehnološkog razvoja Republike Srpske 2017 – 2021. godine – Znanje za razvoj. Government of Republika Srpska. Banja Luka. Taken from https://www.vladars.net/sr-SP-Cyrl/Vlada/Ministarstva/mnk/Documents/PRIJEDLOG%20-%20%20strategije%20naucnog%20i%20tehnoloskog%20razvoja%20RS%202017-2021%20%286%29.pdf, 11 June 2021.

Republika Srpska. Zakon o naučnoistraživačkoj djelatnosti i tehnološkom razvoju. *Official Gazette of Republika Srpska* No. 6/12, 33/14 66/18 and 84/19. Taken from http://spu.ba/wp-content/uploads/2018/02/zakon_o_naucnoistrazivackoj_djelatnosti_i_tehnoloskom_razvoju.pdf, 11 June 2021.

Republika Srpska. Zakon o visokom obrazovanju. *Official Gazette of Republika Srpska* No. 67/202

Schwab, K. (2017). *The Global Competitiveness Report 2017-2018*. [Digital Edition]. World Economic Forum. Cologny/Geneva. Taken from

Schwab, K. (2019). *The Global Competitiveness Report 2019*. [Digital Edition]. World Economic Forum. Cologny/Geneva. Taken from http://www3.weforum.org/docs/WEF_TheGlobalCompetitivenessReport2019.pdf, 24 March 2021.

Statista (2021). *Number of novel coronavirus (COVID-19) deaths worldwide as of May 24, 2021, by country*. Taken from https://www.statista.com/statistics/1093256/novel-coronavirus-2019ncov-deaths-worldwide-by-country/, 24 May 2021.

Steiner, C. [et. al.] (2010). Constitution of Bosnia and Herzegovina: Commentary. Konrad Adenauer Foundation e.V.. Sarajevo.

Trifković, M. (2020a). Uticaj Dejtonskog mirovnog sporazuma na inovacioni sistem u Bosni i Hercegovini. *Dijalog*, 2020 (no. 3-4), pp. 40-59. ISSN 0350-6177.

Trifković, M. (2020b). *Harmonizacija sistema nauke u Bosni i Hercegovini*. Academy of Sciences and Arts of Bosnia and Herzegovina. Sarajevo.

Trifković, M. [ed.] (2020c). Zadržavanje mladih u Kantonu Sarajevo: analiza determinanti i prijedlog strateških mjera. Academy of Sciences and Arts of Bosnia and Herzegovina, Sarajevo.

Wikipedia (2021). *List of countries by GDP (PPP) per capita*. Taken from https://en.wikipedia.org/wiki/List_of_countries_by_GDP_(PPP)_per_capita, 24 March 2021.

World Bank (2021). *World bank Data: Science and Technology*. Taken from https://data.worldbank.org/topic/14, 26 March 2021.

World Intellectual Property Organization (2020). *Global Innovation Index. Bosnia and Herzegovina*. Taken from https://www.wipo.int/edocs/pubdocs/en/wipo_pub_gii_2020/ba.pdf, 24 March 2021.

Biographies

Mile Babić was born in 1947 in Družnovići near Prozor, Bosnia and Herzegovina. In 1965 he entered the novitiate at the Franciscan Province of the Holy Cross in Kraljeva Sutjeska and studied philosophy and theology at the Franciscan Theology Faculty in Sarajevo. Mr. Babić continued his studies in Innsbruck, Austria, and graduated from the Catholic Theological Faculty in Zagreb in 1974, defending the thesis *Freedom in Hegel's "Phenomenology of Spirit"*. He was ordained a priest in 1973 in Wattens near Innsbruck. In 1977 he obtained a Master's degree and in 1987 he defended his doctoral dissertation entitled *Himan Fil 2,6-12 in Christology by Theodoret of Cyrus*, both at Catholic Theological Faculty in Zagreb. In 1988, he received his Master's degree in philosophy from the Faculty of Philosophy in Sarajevo with the thesis *Freedom and Unity in Hegel's "Philosophy of Law"*. In 2009 the same institution awarded him second PhD, after defending the dissertation titled *The Metaphysical Foundation of Politics in Hegel's "Philosophy of Law"*. In addition to philosophy and theology, he studied Croatian-Serbian language and the history of Yugoslav literature at the Faculty of Philosophy in Sarajevo from 1974 to 1978, and he successfully completed this study with the work *Poetry by Dobriša Cesarić*.

Since 1977, he has been a professor of philosophy and theology at the Franciscan Theology Faculty in Sarajevo. At the same time he has lectured at the Centre for Interdisciplinary Postgraduate Studies at the University of Sarajevo, Department of Religious Studies, 2007-2012, and at the Faculty of Humanities, Džemal Bijedić University in Mostar from 2007 to 2014. In addition to a sizeable number of scientific and professional papers published in domestic and foreign periodicals, he participated in domestic and foreign symposia and colloquia on philosophical and theological issues, in Austria, Croatia, Germany, Italy, Hungary, United States, Canada, France, Brazil, Philippines, Serbia, Montenegro, Slovenia, Switzerland. Throughout his career Prof. Mile Babić has been active in philosophical and scientific activities in different social and political associations as well as in humanitarian, media and cultural institutions.

He has received the following citations and awards for his scientific, cultural and social work: his book *Eranistes* was declared a national project in Croatia in 2005;

the FBiH Publishing Foundation Award 2005 for his translation of the book *On Peace Among Religions* by Nicholas of Cusa; Isa Bey Ishakovic Award, Science category, 2010; the award of the Association of Publishers and Bookstores of BiH for the best scientific and professional work in 2010 for the work *Hegel's Philosophy of Law* (this book is used as a textbook by the Faculty of Law, University of Sarajevo); *Freedom Award* for outstanding contribution to humanism, struggle for human rights and freedom in Bosnia and Herzegovina, Europe and the World, 2005 (International Centre for Peace, Sarajevo); recognition for a lecture held at the *Concilium* international conference in Manila (Philippines) in 2017, awarded by Adamson University and St. Vincent School of Theology; Charter "Golden Ahdnama" awarded by the Bosnian-Turkish friendship association "Bosphorus", 2017.

He was elected a corresponding member of the Academy of Sciences and Arts of Bosnia and Herzegovina (Department of Humanities) in 2018. Mile Babić is head of the Centre for Philosophical Research of ANUBiH.

Fikret Čaušević is a professor of economics and finance at the School of Economics and Business, University of Sarajevo. He has taught the following courses: Principles of Economics, Financial System of the EU, International Finance, and History of Economic Thought (PhD program). Since the fall of 2016, Čaušević has taught three courses at the Szechenyi Istvan University Doctoral Program in Management and Transdisciplinarity, Budapest/Gyor: Economic Aspects of Globalization, Finance, and Disequilibrium Dynamics. From 2002 to 2010, he was the South-East Europe Faculty Development Visiting Fellow at the London School of Economics and Political Science. In the 2011/2012 academic year he was the Alpha Bank Visiting Fellow at St Antony's College, University of Oxford. Since 2018 Čaušević has been a corresponding member of the Academy of Sciences and Arts of Bosnia and Herzegovina. Over the last seven years he has published four research monographs: *The Global Crisis of 2008 and Keynes's General Theory* (Springer, 2014); *Globalization, Southeastern Europe, and the World Economy* (Routledge, 2015), *A Study into Financial Globalization, Economic Growth, and (In)Equality* (Palgrave Macmillan, 2017), and *Financial Globalization, Economic Power, and (In)Efficiency* (Springer International Publishing: Palgrave Macmillan, 2020).

Benjamin Fetić was born on January 1st 1984 in Doboj, Bosnia and Herzegovina. He completed primary and secondary education in the city of Tešanj. For his academic achievements, he was elected valedictorian of the class 2002/2003 in Gymnasium “Musa Ćazim Ćatić”. He continued his education at the Department of Physics at Faculty of Science in Sarajevo where he completed his Bachelor, Master and PhD theses with the theory group of academician Dejan B. Milošević.

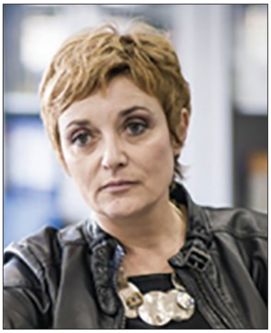
After receiving a Bachelor degree in physics in 2008, he began working as a high school physics teacher at the First Gymnasium in Sarajevo. In 2011 he was appointed teaching assistant at the Faculty of Science, Department of Physics where he still works and holds the position of an Assistant Professor.

The focus of his research is improving the existing and developing new numerical methods for solving time-dependent Schrödinger equation for studying interaction of atomic and molecular targets with strong laser fields, with the emphasis on processes such as high-order harmonic generation and above-threshold ionization. For his scientific achievements he has been recognized by the Ministry of Education, Science and Youth of Canton Sarajevo and by the Rectorate of the University of Sarajevo.

For the past ten years Benjamin Fetić has also been active in promoting physics among elementary and high school students by participating in organization of the national physics competitions and numerous physics summer and winter camps. He was a leader of the national team at the International Physics Olympiad in 2015, 2018 and 2021.

In 2017 he was elected the president of the Physics Society of the Federation of Bosnia and Herzegovina, a non-governmental organization established in 2001 for promoting physics, physics education and related subjects among students.

He is happily married and father to a beautiful boy.



Dženana Husremović is a doctor of psychological sciences. She is an associate professor at the Department of Psychology, University of Sarajevo. Currently, she is the vice-rector for teaching and student affairs, while in the previous rector's term she was the vice-rector for science and research. She believes that the knowledge is the main pillar of any society, and education is the process in which every person should be able to develop his/her capacities and be respected for his/her uniqueness. Scientific approach to social processes like education and employment is the key for effective strategies and policies aiming to strengthen human and social capital, as well as economic stability. We all have a personal responsibility for social welfare and justice.

She graduated and obtained her Master's and doctoral degrees at the University of Sarajevo. She won the JFDP scholarship from US State Department in 2013, and a fellowship from the UK Foreign Office for education in public policy, reform of the public sector and effective state management. For the last fifteen years, Dženana Husremović has been an active researcher in education and labor policies. Her experience in international research cooperation involves different education projects coordinated by university and civil society organizations. Currently, she is a coordinator of ERASMUS + project aimed at developing short-term and part time studies, and member of the university team for developing dual studies at universities in Bosnia and Hercegovina.

Dženana Husremović is the local coordinator of the International STICS (Social Trauma in Changing Society) network run by a group of seven universities from Bosnia, Serbia, Bulgaria and Germany. She is also one of the academic members and teachers in continuous education of university teachers. She is the author or co-author of two books, six manuals, three book chapters and a number of articles in education policy, work and organizational psychology, psychometrics and career counseling. She provided expertise for a number of strategic documents produced by the ministries of education in BiH and the State Agency for Preschool, Primary and High School.

Štěpán Jurajda has been the Mellon Endowment Professor with Tenure (under US permanent charter) at CERGE-EI and a member of the Executive and Supervisory Committee of CERGE-EI since 2004. Between January 2009 and December 2013, he served as the Director of CERGE, Charles University, and the Economics Institute of the Czech Academy of Sciences (EI), where he is a Full Professor and a Senior Researcher, respectively. He graduated from the Prague School of Economics in Econometrics and Operations Research and received his M.A. and Ph.D. degrees in Labor Economics from the University of Pittsburgh. He was an Assistant Professor of Economics at CERGE-EI, where he served as Deputy Director for Research from 2000 to 2001 and from 2005 to 2007. He defended his professorship at Charles University, where he also received the Gold Commemorative medal. He defended his habilitation in economics at the Faculty of Social Sciences of Charles University, and received the Otto Wichterle Prize for young scientists awarded by the Czech Academy of Sciences. He is also affiliated with CEPR, London, and IZA, Bonn. Štěpán was also a Visiting Research Fellow at Princeton University, Department of Economics. He was a member of the Executive Committee of the European Association of Labour Economists, and chair of the Economics Panel and the Social Sciences and Humanities Committee at the Czech Science Foundation. He received the Fernand Braudel Senior Fellowship at the European University Institute and became a member of the Research, Development and Innovation Council of the Government of the Czech Republic. He has been a member of the National Economic Council of the Government of the Czech Republic.

Suad Kunosić is an associate professor at the Department of Physics, Faculty of Natural Sciences and Mathematics, University of Tuzla, Bosnia and Herzegovina. He graduated and obtained his PhD degree at the Faculty of Natural Sciences and Mathematics, University of Tuzla, where he also served as Dean from 2014 to 2016. His area of research includes biophysics, radiology, medical physics, scientometrics and scientific ranking. In 2018, together with his colleague professor Zerem, he presented computer software that simply computes the Z-score (new science metrics system) as well as its components. He has published more than 30 scientific papers in refereed journals (most of them in WoS (CC/SCI)) and co-authored several books in physics. He is the editor of the international book "Scientometrics Recent Advances", which is indexed in several databases. This book provides the reader with a detailed insight into relevant scientometric methods and criteria, their individual strengths and weaknesses in the process of ranking scientists, scientific centers and institutions, as well as their application to the process of planning scientific projects and isolated medical specialties. Since April 2021, he has been a member of the Steering Board of the Agency for the Development of Higher Education and Quality Assurance of Bosnia and Herzegovina.

Dejan Milošević is born on July 5th, 1959, in Sarajevo, Bosnia and Herzegovina, where he finished primary school and gymnasium. He graduated with a gold medal in 1981 from the Faculty of Science, University of Sarajevo, Department of Physics. He finished postgraduate study of theoretical physics at the Faculty of Physics, Faculty of Science and Mathematics, University of Belgrade and defended his M.Sc. thesis in 1986, and his Ph.D. thesis with the title "Atomic processes in a strong laser field" in 1990.

His first position was research assistant (1982-84) at the Institute of Physics, Faculty of Science, University of Sarajevo. In 1984 he become a researcher at the Research & Development Centre of Zrak Co. in Sarajevo. In 1991 he was elected assistant professor at the Faculty of Mechanical Engineering, University of Sarajevo. In 1998 he became associate professor and in 2004 full professor of theoretical physics at the Department of Physics, Faculty of Science, University of Sarajevo. Since 2001, he has been head of the Department of Atomic, Molecular and Optical physics. He held various positions at this institution, including vice-dean for international collaboration and quality assurance (2011-16), member of ethics committee of the University of Sarajevo (2012-16), head of the doctoral study at the Department of Physics (2013-19), chairman of the Council for Science and Arts of the University of Sarajevo, member of the Steering committee of the University of Sarajevo (since 2017).

His scientific research visits include: Laboratoire de Physique Atomique et Moléculaire Université Catholique de Louvain, Belgium (1995-97), Institute for Theoretical Physics, University of Innsbruck, Austria (1997-98), Department of Physics and Astronomy, The University of Nebraska, Lincoln, USA (1998-99), Max-Born-Institut, Berlin, Germany (Alexander von Humboldt fellowship 1999-2000), Institute of Applied Physics and Computational Mathematics, Beijing, China (2017).

In 2008 he was elected corresponding member and in 2012 full member (academician) of the Academy of Sciences and Arts of Bosnia and Herzegovina. In 2009 he was awarded Best Professor in 2008/09 by the University of Sarajevo. In 2011 he was awarded the individual Sixth of April Award of the City of Sarajevo. Since

2014 he has been a member of the European Academy of Sciences and Arts. In 2016 he got a plaque for outstanding achievements in scientific research, Faculty of Science, University of Sarajevo, while in 2018 he got the Sarajevo Canton Plaque. Since 2018 he is a Member of the Advisory Board of the Institute of Physics, Zagreb. In 2018 he won the State Award in the field of science for international success in 2017. The highest award he achieved is the Georg Forster Research Award by the Alexander von Humboldt Foundation in 2018. Finally, in 2019 he got The University of Sarajevo Medal.

Dejan Milošević is a Life member of the American Physical Society, Member of the Optical Society of America, and Member of the Physical Society in Bosnia and Herzegovina. He is a referee for 36 international journals and for international scientific agencies such as U.S. Department of Energy, German Research Foundation (DFG), Special Research Program (SFB) Austria, Aarhus Institute for Advances Study (AIAS), Israel Science Foundation etc. According to the database Web of Science Core Collection (09.09.2021), Milosevic DB has published 200 papers cited 8472 times (h-index 49).

Dražen Prelec is the Digital Equipment Corp. Leaders for Global Operations Professor of Management and a Professor of Management Science and Economics at the MIT Sloan School of Management.

Prelec holds appointments in the Department of Economics and in the Department of Brain and Cognitive Sciences. His research deals with the psychology and neuroscience of decision-making, including behavioral economics and neuroeconomics, risky choice, time discounting, self-control, and consumer behavior. He works on both the development of normative decision theory and the exploration of the empirical failures of that theory, using behavioral and fMRI methods. A current project on "self-signaling" tries to understand the strange power of non-causal motivation—when individuals favor actions that are diagnostic of good outcomes, even though these actions have little or no causal force. Diagnostic motivation is real, and is probably essential for human self-control. Its cognitive and neural mechanisms are not well understood, however. A second "Bayesian truth serum" project deals with scoring systems for evaluating individual and collective judgment in knowledge domains where no external truth criterion is available. Examples would be long-range forecasts, political or historical inferences, and artistic or legal interpretations. Prelec is developing scoring systems that reward honest judgments and that can identify truth even when majority opinion is wrong.

He was a Junior Fellow in the Harvard Society of Fellows, and has received a number of distinguished research awards, including the John Simon Guggenheim Fellowship. Prelec holds an AB in applied mathematics from Harvard College and a PhD in experimental psychology from Harvard University.

Slavo Radosević
Professor of Industry and Innovation Studies at the University College London.

Prof Radosević has been acting and deputy director of School of Slavonic and East European Studies. He worked at the University of Sussex SPRU as a researcher (1993-1999), as a researcher in Croatia, as a government economist and was federal under-secretary for development in the former Yugoslavia.

He has published extensively in international journals on innovation policy and has edited several volumes on these issues. He acts as an expert for the EC, OECD, UNESCO, UNIDO, World Bank, UNECE and Asian Development Bank and several governments in the CEE. He has been a special advisor to the EC DG Commissioner for Regional and Urban Policy (2015-2019).

Zijada Rahimić is a professor at the School of Economics and Business, University of Sarajevo (Bosnia and Herzegovina). Furthermore, she is the head of the Department of Management and Organization, as well as head of the Master's Programme on Human Resources Management and Knowledge Management at the same institution. In addition to her professional academic experience in undergraduate, postgraduate and doctoral studies, Prof. Rahimić has domestic and international consulting and lecturing experience. Her main research interests include human resources management, with a specific focus on talent and knowledge management, employee engagement, gender equality in organizations and strategic management with the focus on competitive advantages, R&D and innovation systems.

Prof. Rahimić is the author and co-author of several books, book chapters and a handbook for Master's studies. In addition, she has published over 70 scientific and 15 expert papers in the field of human resources management, strategic management and diversity management. She has also reviewed numerous papers for international scientific journals and conferences. Her international engagement is evident in joint research projects, several scholarships, and in having been a guest lecturer at universities in Austria, Canada, Croatia, Germany, Italy, Portugal, Romania and Slovenia.

Joseph Straus was born in 1938 in Trieste, Italy. He received a Law Diploma in 1962 from the University of Ljubljana, Slovenia, and a Dr. jur. 1968 from Ludwig-Maximilian-University in Munich. In 1986 followed a Habilitation and election to a Full Nominated Professor for Intellectual Property at the University of Ljubljana. In 1992 he became Lecturer for Patent Law University of Munich, in 1998 a Honorarprofessor for Patent Law at the University of Munich. From 1972 to 2001 he was Head of Department and Head of Library, Max-Planck-Institute for Foreign and International Patent, Copyright and Competition Law, Munich, whose Scientific Member and Director he was 2001-2008; since then Emeritus Scientific Member and Emeritus Director of that Institute, now Max-Planck-Institute for Innovation and Competition. Other positions: Visiting Professor of Law, Cornell Law School, Ithaca, N.Y. (1989-98); Marshall B. Coyne Visiting Professor of International and Comparative Law, George Washington University Law School, Washington D.C (2001-19); Distinguished Visiting Professor Faculty of Law, University of Toronto (Spring 2005); NIPMO-UNISA Chair for Intellectual Property, University of South Africa (UNISA), Pretoria (2011-2016); Visiting Professor Tsinghua University Law School, Beijing (2015-17); Visiting Fellow, Hoover Institution, Stanford University (2009-14); Honorary Professor at Chinese Universities: Tongji University, Shanghai, Huazhong University of Science and Technology (HUST), Wuhan, and the Xiamen University, Xiamen.

Awarded Honorary Doctorates of the University of Ljubljana (2001) and the University of Kragujevac (2003). Recipient of numerous awards, e.g. the 2000 Science Award of the Foundation for the German Science, Grosses Verdienstkreuz (Commander's Cross) des Verdienstordens der Bundesrepublik Deutschland (2005), 4th Venice Award for Intellectual Property (2007), Order of Merit of the Republic of Slovenia (2010), Ambassador of Science of the Republic of Slovenia (2011). Corresponding Member of the Slovenian Academy of Sciences and Arts (1995), Member Academia Europaea (2001, Chair of the Law Section 2009-15), Member of the European Academy of Sciences and Arts (2001, Vice President 2010-15), Foreign Member of the Accademia Nazionale dei Lincei (2017), Foreign Member Academy of Sciences and Arts of Bosnia and Herzegovina (2018).

He belongs to a number of professional associations: International Association for Teaching and Research in Intellectual Property (ATRIP, President 1993-95), International Association for the Protection of Intellectual Property (Chair of the Program Committee 1997-06, Honorary Member), Human Genome Organization (HUGO, Chair of intellectual Property Rights Committee 1995-06), German Association for the Protection of Intellectual Property (Vice- president 2001-08, Honorary Member). He has acted as consultant to OECD, WIPO, EU Commission, World Bank, UNIDO, UNCTAD, German, Slovenian, and Swiss governments, and the European Patent Office. He has more than 350 publications in all areas of intellectual property, and has mentored more than 50 Ph.D. and many more Master's students.

Miloš Trifković was born in 1939 in Sarajevo. He graduated from the Faculty of Law, University of Sarajevo in 1962, got his Master's in 1969 and Ph.D. degree in Business Law in 1971 from the Faculty of Law, University of Belgrade. In 1964 he became an assistant in business law at the Faculty of Economics, University of Sarajevo, and full professor for the same subject in 1981. He has also taught International Business Law. Prof. Trifković is Professor Emeritus of the University of Sarajevo since 2014.

In 1970-1971, he visited the School of Law, University of California Berkeley, USA. From 1974 to 1978, Prof. Trifković established and managed the Institute of Business Law and Sociology at the Faculty of Economics, University of Sarajevo. During 1979-1981, he was vice-dean of that institution. From 1979 to 2004 the Max - Planck - Insitut for Intellectual Property in Munich hosted him for multiple visits totalling two years. Prof. Trifković established and managed the Centre for International Business Law at the Faculty of Economics in Sarajevo from 1988 to 1991. In 1989, Prof. Trifković founded the Agency for Research and Consulting in Economy and was its director until 2006. From 1992 to 2001, he served as a legal advisor and member of the Bosnia's Commission for Succession Issues of the Former SFRY. The State government appointed Prof. Trifkovic to head the BiH Delegation at the final succession talks in Vienna in the year 2001. He served as the Advisor to the Minister of Trade of the FBiH Government in 1995 and 1996. In 1997, Oxford University offered him a one-month study visit. In 1999, Prof. Trifković created a course in European business law at the Interdisciplinary Postgraduate European Studies of the University of Sarajevo and headed it until 2005. He founded the Centre for International Cooperation at the Faculty of Economics in 1999 and managed it until 2000. The next two years Prof. Trifković was the head of the Publishing Department of the same institution. During 2002-2004, Professor Trifković was the Dean of the Faculty of Economics, University of Sarajevo. From retirement until 2006 Professor Trifković served as the Dean of the MBA program Sarajevo Graduate School of Business (SGSB), lead by of the University of Delaware. At SGSB, he also taught Business Ethics from 2005 to 2010. In 2008, Prof. Trifković was elected

Full Professor and from 2009-2012 he was the Dean of the Faculty of Law, Open University “APEIRON”, Travnik, later Faculty of Law, University “Vitez”, Vitez.

Professor Trifković has authored of six monographs, 13 textbooks, co-author of four professional books, and contributed chapters contributor to four books. He published 85 journal articles, has 40 legal entries in two encyclopedias, 65 scientific and professional research projects and over 140 major professional consultancy projects.

The Academy of Sciences and Arts of Bosnia and Herzegovina (ANUBiH) elected Prof. Trifković as a corresponding member in 2008 and a full member in 2012. He was the president of ANUBiH from 2014 to 2020. Professor Trifković is a member of two international academies - European Academy of Sciences and Arts (EASA) and World Academy of Arts and Sciences (WAAS).

Enver Zerem was born in 1953 in Glodnica, Jablanica. He is a full professor at the Faculty of Medicine in Tuzla and the University of Mostar, and at the Faculty of Health Studies at the Džemal Bijedić University in Mostar. He is the current coordinator of internal medicine disciplines at the Cantonal Hospital “Dr. Safet Mujić” in Mostar.

He is a specialist in internal medicine, especially gastroenterology. Most of his published works are the result of his many years of clinical practice and practical work in the field of interventional ultrasonography and pancreatology. Today, he is one of the most renowned experts in those fields in this part of Europe. He is the founder and long-time leader of interventional ultrasonography at the University Clinical Centre Tuzla, which by the Decision of the Federal Ministry of Health in 2011 became the Federal Reference Centre for interventional procedures in the pancreatic biliary tract under ultrasound control.

As Director for Scientific Research and Education at the University Clinical Centre in Tuzla (2007-2018), Head of the Doctoral Study Council at the Medical Faculty in Tuzla (2012-2017) and Head of the Clinical Research Course at the Postgraduate Study of the Medical Faculty in Tuzla (2010-2011), he has made a significant contribution to raising young scientific staff. He was also the President of the Steering Board of the University of Tuzla (2012-2016) and Vice-Dean for the clinical part of teaching at the Medical Faculty of the University of Tuzla (2002-2004).

He is a member of the editorial board of reputable international journals indexed in the database Current Contents/Clinical Medicine, *“World Journal of Gastroenterology”* and *“World Journal of Clinical Case Reports”*. He is also a member of the editorial board of the renowned international journals *Journal of Pancreas, Pancreatic Diseases and Therapy and Journal of Gastroenterology and Hepatology Research*, as well as domestic scientific journals *Acta Medica Academica, Scripta Medica* and *Acta Medica Saliniana*. He is a reviewer of several articles for journals represented in Current Contents, and is a regular reviewer of CC journals *European Radiology, World Journal Gastroenterology* and *Annals of Saudi Medicine*, and several journals cited in the SCI database. He was a reviewer in the evaluation process of the university undergraduate study of nursing at the University of Zadar and a guest professor at the doctoral study of the Faculty of Medicine in Osijek. He is a member of the European Association for the Application of Ultrasound in Medicine and Biology and a member of the American Association of Radiologists. He is also a member of a group to reach a new consensus to amend the Atlantic Classification on the assessment of the severity of acute pancreatitis. He won the Plaque of the Džemal Bijedić University in Mostar (2021).

He has published about 200 articles, of which 72 have been published in journals cited in the Current Contents database, 88 in journals cited in WoS and 118 articles in the PUBMED/MEDLINE database. To date (16 March 2021), his articles have been cited 2331 times in the Google Scholar database and 1270 times in the Scopus database. Published articles are mainly in the field of gastroenterology and scientometrics.

He was elected as a corresponding member of the Academy of Sciences and Arts of Bosnia and Herzegovina in 2012, and a full member in 2018.

CIP - Katalogizacija u publikaciji
Nacionalna i univerzitetska biblioteka Bosne i Hercegovine, Sarajevo

001.3(063)(082)

MEĐUNARODNA naučna konferencija Sistem nauke - faktor poticaja ili ograničavanja razvoja (2021 ; Sarajevo)
Zbornik radova / Međunarodna naučna konferencija Sistem nauke - faktor poticaja ili ograničavanja razvoja, Sarajevo, 5. novembra 2021. godine ; urednik Miloš Trifković. - Sarajevo : Akademija nauka i umjetnosti Bosne i Hercegovine = Academy of Sciences and Arts of Bosnia and Herzegovina, 2021. - 467 str. ; 24 cm. - (Posebna izdanja / Akademija nauka i umjetnosti Bosne i Hercegovine ; knj. 200. Odjeljenje društvenih nauka ; knj. 18)

Na spor. nasl. str.: International scientific conference Science system - factor of stimulation or limitation in development. - Bibliografija uz svaki rad i uz tekst.

ISBN 978-9926-410-72-8

I. International scientific conference Science system - factor of stimulation or limitation in development ; 2021 ; Sarajevo vidi Međunarodna naučna konferencija Sistem nauke - faktor poticaja ili ograničavanja razvoja ; 2021 ; Sarajevo

COBISS.BH-ID 45731334