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Za Izdavača
Dekan, Milena Jakšić

Glavni i odgovorni urednik
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Kontakt
Ekonomski fakultet Univerziteta u Kragujevcu,
Liceja Kneževine Srbije 3, 34 000 Kragujevac; Tel. 034 303 507
www.horizonti.ekfak.kg.ac.rs horizonti@kg.ac.rs

ČASOPIS IZLAZI TRI PUTA GODIŠNJE - u aprilu, avgustu i decembru

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UVODNIK

Sveska 3 Volumen 27 Godište 2025 naučnog časopisa *Ekonomski horizonti,* nakon sprovedenog dvostruko anonimnog recenzentskog postupka, sadrži tri izvorna naučna članka, tri pregledna članka i Pregled autora i naslova svih priloga publikovanih u Časopisu u 2025. godini.

Koautori *Andrija Popović, Andreja Todorović* i *Vladan Vučić* analiziraju odnos privrednog rasta, konkurentnosti i inovacija u cirkularnoj ekonomiji u 27 zemalja Evropske unije tokom perioda 2011-2020. godine. Primenom deskriptivne statistike, analize glavnih komponenti (PCA), regresije panel podataka i klaster analize, u radu se ispituje kako ključni ekonomski indikatori, kao što su bruto domaći proizvod (BDP), BDP po glavi stanovnika i bruto formacija stalnog kapitala, utiču na performanse cirkularne ekonomije. Rezultati ukazuju na pozitivnu korelaciju ukupnog privrednog rasta i cirkularne konkurentnosti. Analizom se naglašava potreba za prilagođenim, specifičnim nacionalnim politikama radi promovisanja održive prakse cirkularne ekonomije, posebno u manje razvijenim privredama. Istraživanje generiše empirijski relevantne uvide kreatorima politika koji nastoje da uravnoteže privredni rast sa održivošću.

Polazeći od stava da je u teorijsko-metodološkim istraživanjima potvrđena teza da akumulacija fizičkog kapitala samo delimično objašnjava dinamiku stopa ekonomskog rasta zemalja, kao i da je fokus istraživača i kreatora ekonomskih politika sve više na ljudskom kapitalu, koautori *Đorđe Kotarac* i *Zoran Popović* istražuju uticaj ovog kapitala na stopu rasta *per capita* dohotka. Rezultati istraživanja primenom panel regresionog modela ukazuju na statistički značajan uticaj unapređenja ljudskog kapitala na povećanje dohotka *per capita* na uzorku 10 zemalja Centralne i Istočne Evrope (CEE-10). Rad time dopunjuje naučnu literaturu posvećenu ispitivanju veze ljudskog kapitala i rasta dohotka u ovim privredama. U radu se ističe i značaj investiranja u ljudski kapital kao efikasan instrument za unapređenje privrednog razvoja zemalja.

Ističući da se ekonomska literatura u velikom broju radova bavi efektima priliva stranih direktnih investicija (SDI) i uticajem kvaliteta institucija na ekonomsku aktivnost, a da postoji relativno mali broj studija koje proučavaju uticaj institucionalnog kvaliteta na privlačenje stranih direktnih investicija (SDI) i/ili zajednički uticaj ova dva faktora na ekonomski rast, koautori *Iva Glišić* i *Slavica Manić* istražuju upravo ovu povezanost. U radu analiziraju panel podatke za pet zemalja Zapadnog Balkana u periodu 2007-2022. Rezultati istraživanja ukazuju na neočekivan pozitivan efekat manje kvalitetnog institucionalnog okruženja na ekonomsku aktivnost kroz kanal SDI. Potencijalno objašnjenje ovakvog rezultata jeste teza da manje razvijeno zakonodavstvo (posebno ekološko) u zemljama Zapadnog Balkana privlači upravo one SDI koje uz ekonomski rast produkuju i negativne eksterne efekte. Dodatno, ovakav nalaz ukazuje na potrebu razmatranja dugoročnih rizika po ekonomski rast koji se pretežno oslanja na ovu vrstu SDI.

Koautori *Paskal Zhelev* i *Olga Malashenkova* u radu razmatraju Evroazijsku ekonomsku uniju (EAEU) kao regionalni ekonomski integracioni blok, istovremeno analizirajući njenu evoluciju, trgovinsku integraciju i okvir industrijske politike usred promena globalne dinamike. Brojni pritisci i izazovi sa kojima se EAEU suočava od osnivanja, doveli su do prekida u trgovinskim tokovima, proširili ekonomske disparitete među državama članicama Unije i testirali

* *Korespondencija*: M. Jakšić, Ekonomski fakultet Univerziteta u Kragujevcu, Liceja Kneževine Srbije 3, 34000 Kragujevac, Republika Srbija; e-mail: milenaj@kg.ac.rs

koheziju tog bloka. U radu se naglašava činjenica da je sve jača konkurentnost od kritičnog značaja za otpornost EAEU, pri čemu industrijska politika služi kao ključni element tog napora. Primenom trgovinskih indikatora, kao što su međuregionalni udeli u trgovini i indeks otvorene komparativne prednosti, u radu se ističu nejednaka integracija i zavisnost od izvoza zasnovanog na resursima. Nalazi do kojih se u ovoj studiji došlo ukazuju na to da bi podsticanje modernizacije industrije i ostvarivanje bolje sinergije između domaćih politika i regionalnih ambicija mogli da pospeše otpornost tog bloka i njegovu globalnu konkurentnost.

Shodno stavu da je ekonomsko rivalstvo zemalja BRIKS-a i zemalja članica Grupe 7 (G7) već decenijama središnja tema globalnog razvoja, koautori *Farial Faizi, Mariam Sawas, Dina Abohassan, Ilija Stojanović* i *Marko Selaković* upoređuju dinamiku rasta BDP-a ovih grupacija zemalja. Koautori istovremeno ispituju diferencijalni uticaj ključnih makroekonomskih pokazatelja na pravce njihovog ekonomskog razvoja. U tu svrhu, u radu se primenjuje statistička metodologija, koja uključuje i testove međusubjektnih efekata radi procene varijacije u efektima koeficijenata regresije za makroekonomske faktore koji utiču na rast BDP-a. Istraživanje polazi od pretpostavke da distinktivne ekonomske strukture zemalja BRIKS-a i zemalja članica G7 vode ka promenljivim makroekonomskim uslovima, koji oblikuju obrasce rasta tih zemalja na različite načine. Rezulati studije nude uvide u najjače i najslabije odrednice rasta BDP-a unutar tih ekonomskih blokova, koji mogu imati i svoju praktičnu primenu i doprineti širem istraživačkom okviru u domenu globalne ekonomske konkurencije.

Koautori *Ventsislav Vasilev* i *Radka Vasileva* razmatraju odabrane metode za procenu rizika i utvrđivanje optimalnih nivoa zadržavanja rizika u kasko osiguranju, posebno se usredsređujući na upoređivanje triju statističkih tehnika: Čebiševljeve nejednakosti, Monte Karlo simulacije i normalne raspodele. Na temelju istorijskih podataka o odštetnim zahtevima na bugarskom tržištu osiguranja koje objavljuje Komisija za finansijski nadzor Bugarske, u ovoj studiji se istražuje verovatnoća da odštetni zahtev premaši pragove zadržavanja rizika i istovremeno upoređuje tačnost i preciznost svakog od navedenih metoda. Dok Čebiševljeva nejednakost pruža konzervativnu procenu, Monte Karlo simulacija nudi probabilistički pristup koji modelira različite ishode, a normalna distribucija pretpostavlja obrazac simetričnog gubitka. Rezultati istraživanja pokazuju da Monte Karlo simulacija nudi visok nivo tačnosti i pouzdanosti procene kad su u pitanju odluke o zadržavanju rizika u domenu kasko osiguranja zahvaljujući svojoj fleksibilnosti u modelovanju različitih scenarija gubitka.

U ime Uredništva Časopisa i u svoje ime zahvaljujem autorima priloga koji su objavljeni u Svesci 3 Časopisa. Istovremeno, posebnu zahvalnost dugujemo recenzentima koji su, svojim konstruktivnim i kritičkim komentarima i sugestijama autorima podnetih priloga, doprineli podizanju nivoa kvaliteta publikovanih članaka.

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Glavni i odgovorni urednik
Milena Jakšić

Milena Jakšić je redovni profesor na Ekonomskom fakultetu Univerziteta u Kragujevcu. Doktorirala je na Ekonomskom fakultetu Univerziteta u Kragujevcu, iz uže naučne oblasti Opšta ekonomija i privredni razvoj. Ključne oblasti njenog naučnoistraživačkog interesovanja su finansijski sistem, finansijska tržišta, finansijski instrumenti i finansijske institucije.

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PROCENA UTICAJA PRIVREDNOG RASTA NA KONKURENTNOST I INOVACIJE U OKVIRU CIRKULARNE EKONOMIJE

Andrija Popović[1]*, Andreja Todorović[1] i Vladan Vučić[2]

[1] *Univerzitet u Nišu, Inovacioni centar, Niš, Republika Srbija*
[2] *University „UNION - Nikola Tesla", Fakultet za pravo, bezbednost i menadžment, Niš, Republika Srbija*

U ovom radu se analizira odnos privrednog rasta, konkurentnosti i inovacija u cirkularnoj ekonomiji u 27 zemalja EU u periodu od 2011. do 2020. godine. U radu se kroz deskriptivnu statistiku, analizu glavnih komponenti (PCA), regresiju panel podataka i klaster analizu ispituje kako ključni ekonomski indikatori, kao što su BDP, BDP po glavi stanovnika i bruto formacija stalnog kapitala, utiču na performanse cirkularne ekonomije. Rezultati ukazuju na pozitivnu korelaciju između ukupnog privrednog rasta i cirkularne konkurentnosti, iako bogatije zemlje nisu uvek lideri u cirkularnoj tranziciji. Analizom se naglašava potreba za prilagođenim, specifičnim nacionalnim politikama kako bi se promovisale održive prakse cirkularne ekonomije, posebno u manje razvijenim privredama. Istraživanje pruža vredne uvide tvorcima politika koji nastoje da uravnoteže privredni rast sa održivošću.

Ključne reči: cirkularna ekonomija, privredni rast, inovacije, održivost, EU, konkurentnost

JEL Classification: Q56, O44, O33

UVOD

U savremenoj globalnoj ekonomiji, konkurentnost i inovacije nametnule su se kao glavni pokretači rasta, održivosti i prosperiteta. Potencijal zemlje u smislu produktivnosti i rasta, oblikovan je konkurentnošću, koja utiče na raspodelu resursa, povoljnost proizvodnje i celokupan ekonomski učinak (Vuță, Vuță, Enciu & Cioacă, 2018). Inovacije, naročito u kontekstu cirkularne ekonomije (CE), donose nove tehnologije i prakse koje unapređuju konkurentnost optimizacijom korišćenja resursa i minimizacijom otpada (Mitrović & Veselinov, 2018; Silvério, Ferreira, Fernandes & Dabić, 2023). Evropska unija (EU) je dala prioritet ovom razvoju kroz inicijative kao što su Evropski zeleni dogovor i Akcioni plan za cirkularnu ekonomiju (CEAP), s ciljem promovisanja održivih rešenja (OECD, 2019; European Commission, 2020).

* *Korespodencija:* A. Popović, Univerzitet u Nišu, Inovacioni Centar, Vardarska 10/6/11, 18000 Niš, Republika Srbija; e-mail: andrija.m.popovic@gmail.com

Ipak, nedavna revizija Evropskog revizorskog suda (European Court of Auditors, 2023) ukazuje na „ograničene dokaze" da su dosadašnje CEAP mere ubrzale cirkularni dizajn u ranim fazama, čime je istaknut jaz između političkih ambicija i opipljivog napretka.

Međutim, uprkos ostvarenim pomacima, i dalje postoje praznine u razumevanju odnosa ekonomskog rasta i cirkularne konkurentnosti u različitim zemljama. Dok je znatna pažnja posvećena uticaju cirkularnih praksi na privredni rast, manje je poznato kako privredni rast utiče na sposobnost jedne zemlje da inovira i takmiči se u CE (Karman & Pawlowski, 2022). Ovo je posebno važno za zemlje EU, gde se održivi rast smatra ključnim za buduću konkurentnost (Popović & Milijić, 2022). Nedavne panel-analize na uzorku više zemalja pokazuju pozitivnu vezu bruto domaćeg proizvoda (GDP) i cirkularnosti (Hondroyiannis, Papapetrou & Tzeremes, 2024), dok je veza sa bruto domaćim proizvodom po glavi stanovnika (GDPpc) znatno dvosmislenija, u nekim kontekstima pozitivna, u drugim neutralna ili čak negativna, u zavisnosti od otiska potrošnje i kvaliteta politika (European Court of Auditors, 2023; Lacko, Hajduova & Dula, 2024). Ovi rezultati odražavaju ranije dokaze da visoke stope privrednog rasta same po sebi ne garantuju značajne performanse u CE bez istovremenih tehnoloških inovacija i napredaka u efikasnom korišćenju resursa (Ying & Wen-Ping, 2015; Jakopin, 2020).

Globalizacija je pojačala zabrinutost da zemlje koje ne usvoje cirkularne inovacije mogu izgubiti konkurentnost. One koje daju prioritet efikasnom korišćenju resursa imaju bolju šansu da privuku strane investicije i ostanu konkurentne na globalnom tržištu (Ferrante & Germani, 2020; Silvério *et al*, 2023). Stoga je presudno ispitati da li je privredni rast usklađen sa naporima EU da unapredi cirkularnu konkurentnost i inovacije. Velike razlike među zemljama, posebno postojanje trajne podele Sever-Jug i Zapad-Istok u efikasnosti cirkularnih procesa (Hondroyiannis *et al*, 2024; Lacko *et al*, 2024), ukazuju na to da strukturni, institucionalni i investicioni faktori posreduju u ovoj usklađenosti.

Pored toga, i dalje postoje istraživački jazovi u pogledu kreiranja standardizovanih alata za merenje performansi CE u različitim zemljama (Vuță *et al*, 2018; Busu & Trica, 2019). Iako je EU 2023. godine ažurirala svoj okvir za praćenje CE, istraživači i dalje ističu nedostatke u podacima, posebno u podacima o dizajnu proizvoda i društvenim ishodima, te apeluju na kreiranje sveobuhvatnijeg skupa indikatora i usklađene metodologije (Ghormare, Patil & Petrescu, 2024). Prethodna istraživanja uglavnom su se bavila razvijenim ekonomijama, ostavljajući otvoreno pitanje kako zemlje sa sporijim rastom prolaze u pogledu cirkularne konkurentnosti (Popović, Ivanović Đukić & Milijić, 2022). Ovaj rad nastoji da popuni te praznine ispitivanjem u kojoj meri privrede sa sporijim rastom mogu da drže korak sa naprednijim zemljama u tranziciji ka CE.

Ovim istraživanjem analizira se kako privredni rast utiče na konkurentnost i inovacije u CE u 27 zemalja EU između 2011. i 2020. godine, pritom se fokusirajući na ključne indikatore kao što su GDP, GDPpc i bruto formiranje osnovnog kapitala (GFCF). Performanse CE procenjuju se kroz stopu cirkularne upotrebe materijala (CMUr), cirkularne patente i zaposlenost u cirkularnim sektorima. Cilj rada je da utvrdi da li privredni rast podstiče konkurentnost i inovacije u CE.

Istraživanje je zasnovano na tri glavne hipoteze:

H1: Viši nivo GDP, GDPpc i njihove stope rasta pozitivno su povezani sa višim nivoom konkurentnosti i inovacija u CE.

H2: Zemlje sa višom produktivnošću resursa (ResP, ResPppp) pokazuju bolje performanse u CE.

H3: Zemlje sa višim investicijama (GFCF, InvAbs) teže ostvaruju značajnije inovacije i viši nivo konkurentnosti, merene Indeksom cirkularne konkurentnosti i inovacija - CCII (patentima, GVA) u CE.

Pored testiranja ovih hipoteza, rad daje doprinos teoriji kontekstualizacijom paradoksa GDP-cirkularnost kroz prizmu otiska potrošnje i usmeravanja investicija, kao i praksi kroz identifikaciju poluga

politika, podsticaja za dizajn, finansiranja usmerenog na inovacije i digitalnog praćenja koji mogu ubrzati zaostalu tranziciju EU. Ostatak rada je strukturiran da obuhvati pregled literature, objašnjenje podataka, varijabli i metoda, prikaz empirijskih rezultata, diskusiju implikacija i preporuke za politike, a na kraju i zaključak celokupnog istraživanja.

PREGLED LITERATURE

Veza privrednog rasta i konkurentnosti u cirkularnoj ekonomiji (CE) sve više privlači pažnju, ali u literaturi i dalje postoje neslaganja oko njenih mehanizama i ishoda. CE nastoji da odgovori na izazove održivosti, iako ostaje sporno u kojoj meri rast podstiče cirkularne prakse. U ovom kontekstu, J. Korhonen, A. Honkasalo i J. Seppälä (2018) ukazuju na paradoks između potrošnje vođene rastom i načela CE modela o efikasnosti resursa i smanjenju otpada.

Rast GDP-a je istovremeno i pokretač i prepreka prelasku na CE. W. R. Stahel (2016) tvrdi da su privrede sa visokim rastom bolje pozicionirane za širenje CE praksi zahvaljujući ulaganjima u istraživanje, razvoj i infrastrukturu, ali i upozorava da nekontrolisani rast može dovesti do neodržive potrošnje. A. Popović *et al* (2022) sličnog su mišljenja, naglašavajući da, iako viši GDP može podstaći cirkularne inovacije, on takođe može učvrstiti linearne ekonomske aktivnosti ukoliko nema adekvatnog vođenja. Đ. Mitrović i M. Veselinov (2018) dodaju da bogatije zemlje, iako imaju veće kapacitete za sprovođenje CE praksi, nisu imune na izazove, posebno ako su politički podsticaji slabi. Serija novijih panel-studija potvrđuje postojanje pozitivne dugoročne korelacije ukupnog GDP-a i nacionalnih stopa cirkularnosti (Hondroyiannis *et al*, 2024), ali ukazuje i na nejasnu, ponekad negativnu povezanost sa GDPpc, nakon što se u obzir uzmu rastuće potrošačke tendencije (Lacko *et al*, 2024; Marjanović, Stanković, Östh, Marković & Stanojević, 2025). Nalazi F. Ying i Z. Wen-Ping (2015) i E. Jakopin (2020) dodatno ukazuju da brza ekspanzija privrede, bez pratećeg tehnološkog unapređenja može usporiti napredak CE.

ResP, kao ključni pokazatelj CE, meri koliko efikasno privrede koriste prirodne resurse za kreiranje vrednosti. M. Busu (2019) je utvrdio da zemlje sa višom ResP obično imaju veću konkurentnost u cirkularnim sektorima, dok X. Zhou, M. Song i L. Cui (2020) tvrde da se unapređenje ResP često povezuje sa ulaganjima u cirkularne tehnologije, potvrđujući vezu privrednog rasta i CE konkurentnosti. Slično tome, E. Hysa, A. Kruja, N. U. Rehman i R. Laurenti (2020) navode da su inovacije ključne za prelazak na cirkularnu ekonomiju, pri čemu se viši nivo inovacija najčešće povezuje sa većom cirkularnom konkurentnošću. Detaljnije analize pokazuju da uticaj ResP zavisi od konteksta: investicije omogućavaju usvajanje cirkularnih tehnologija (Karman & Pawłowski, 2022), inovacioni kapaciteti dobijaju na značaju kako sistemi sazrevaju (Hysa *et al*, 2020; Herrero-Luna, Ferrer-Serrano & Latorre-Martinez, 2022), a u EU je dokumentovana izražena disperzija efikasnosti pomoću DEA kompozitnog indikatora (Marjanović *et al*, 2025).

Investicije, naročito u fizičku imovinu, od suštinskog su značaja za podsticanje inovacija u CE. A. Karman i M. Pawlowski (2021) naglašavaju da veći obim GFCF pruža podršku usvajanju cirkularnih tehnologija, posebno u oblasti obnovljivih izvora energije i održive proizvodnje. Ipak, S. Herrero-Luna *et al* (2022) ističu da, iako investicije donose kratkoročne dobitke u konkurentnosti, dugoročni efekti cirkularnih ulaganja, poput uticaja na zaposlenost i raspodelu dohotka, ostaju nedovoljno istraženi. European Court of Auditors (2023) ukazuje na to da se sredstva EU i dalje nesrazmerno usmeravaju na „*end-of-pipe*" upravljanje otpadom, umesto na dizajn u ranoj fazi, što ublažava efekte kapitalnih tokova. Komplementarni dokazi na nivou preduzeća, poput istraživanja D. Jovanović i V. Janjić (2018) o uvođenju ISO 14001 i A. P. Egbunike i E. G. Okoro (2018) o izdacima za zeleno računovodstvo, potvrđuju da ciljano finansiranje zaštite životne sredine može poboljšati efikasnost i profitabilnost.

Tabela 1 daje sintetički prikaz postojećih empirijskih studija, najrelevantnijih za naše tri hipoteze, grupisanih prema osnovnoj ekonomskoj poluzi koja se ispituje (rast, produktivnost resursa ili investicije/inovacije).

Literatura ukazuje na to da postoje i mogućnosti i izazovi u usklađivanju privrednog rasta sa cirkularnom konkurentnošću. Iako veći rast može podržati tranziciju ka CE, njime se rizikuje narušavanje održivosti ukoliko nije praćen adekvatnom regulativom. Međutim, jaz i dalje postoji u razumevanju dugoročnog uticaja privrednog rasta na CE konkurentnost, naročito u manje razvijenim zemljama. Buduća istraživanja treba da koriste longitudinalne pristupe kako bi se ispitalo kako se ovaj odnos menja vremenom. Pored toga, istraživači ističu nerešena metodološka pitanja (Busu & Trica, 2019; Ghormare *et al*, 2024) i trajne regionalne razlike u Evropi (European Court of Auditors, 2023), što ukazuje na potrebu za usklađenim indikatorima i kontekstualizovanim političkim intervencijama.

METODOLOGIJA ISTRAŽIVANJA I PODACI

Ovo istraživanje primenjuje sveobuhvatnu kvantitativnu metodologiju kako bi se ispitala međusobna veza privrednog rasta, konkurentnosti i

Tabela 1 Sinteza empirijskih studija

Grupa/ Hipoteza	Autori	Uzorak i period	Ključne ekonomske varijable	CE pokazatelji	Metod	Glavni nalaz
H1: Rast	W. R. Stahel (2016)	Konceptualno	GDP growth (rast BDP-a)	Skalabilnost CE	Teorija	Rast podstiče, ali može i da oslabi CE.
	F. Ying i Z. Wen-Ping (2015)	Shaanxi, 2000-12	GDP, GDPpc	Faza CE putem IPAT	IPAT/OLS	Visok GDP uz slabu tehnologiju zadržava CE na „srednjem" nivou.
	G. Hondroyiannis *et al* (2024)	EU-28, 1995-2022	Real GDP	Stepen cirkularnosti	FMOLS	Dugoročni GDP dovodi do višeg nivoa cirkularnosti.
	R. Lacko *et al* (2024)	EU-11 posle 2004.	GDPpc	Efikasnost CE	DEA	Efekat GDPpc je za neke zemlje pozitivan, a za druge negativan.
H2: Produktivnost resursa	M. Busu (2019)	EU-27, 2008-17	ResP	Indeks CE	Panel FE	Viši ResP povećava konkurentnost u CE.
	X. Zhou *et al* (2020)	Kina, 2000-16	ResP, tech change	GDP growth (rast BDP-a)	Spatial panel	Napredak ResP podstiče eko-rast.
	I. Marjanović *et al* (2025)	EU-27 (2019)	Ulazi/izlazi iz Eurostat CE indikatora	DEA efikasnost	DEA (CCR; superefikasnost)	Izražena međudržavna heterogenost; više članica je efikasno što umereno korelira sa razvojem
H3: Investicije i inovacije	A. Karman i M. Pawlowski (2021)	EU-27, 2010-19	GFCF	Indeks konkurentnosti CE	Catastrophe prog./PCA	GFCF je snažno povezan sa vođstvom u CE.
	S. Herrero-Luna *et al* (2022)	38 studija	Investment	Mešoviti ishodi u CE	Systematic review	Dugoročni socio-ekonomski efekti ulaganja u cirkularne prakse ostaju nejasni.
	D. Jovanović i V. Janjić (2018)	Srbija, anketa	EMS investment	Efikasnost, profit	Deskriptivno/ logit	ISO 14001 poboljšava efikasnost i profit.
	A. P. Egbunike i E. G. Okoro (2018)	Nigerija, 2012-16	Green CAPEX	ROE, Tobin's Q	Canonical corr.	Zeleni izdaci su neutralni u odnosu na zaradu - potrebna je politička podrška.

Izvor: Autori

inovacija u CE u 27 zemalja članica EU tokom perioda od 2011. do 2020. godine. Struktura istraživanja direktno se bavi definisanim ciljevima i omogućava testiranje hipoteza, uz istovremeno obezbeđivanje metodološke sveobuhvatnosti i pouzdanosti.

Odabir promenljivih zasnovan je na detaljnom pregledu prethodne literature i dostupnosti pouzdanih izvora podataka, slično pristupima koje su koristili M. Vuță *et al* (2018) i Đ. Mitrović i M. Veselinov (2018). Podaci su prikupljeni iz dva glavna izvora:

- World Bank: Za makroekonomske indikatore kao što su GDP, GDPpc i GFCF (World Bank, 2024).
- Eurostat: Za indikatore specifične za CE, poput ResP, CMUr i patenata povezanih sa cirkularnim inovacijama (Eurostat, 2024).

Skup podataka obuhvata nezavisne promenljive (pokazatelje ekonomskog rasta) i zavisne promenljive (pokazatelje performansi CE). U inicijalni skup nezavisnih promenljivih uvršteni su GDP, stopa rasta GDP-a (GDPgr), GDPpc, stopa rasta GDPpc (GDPpcg), GFCF, stopa rasta GFCF-a (GFCFgr), ResP i produktivnost resursa u paritetu kupovnih snaga (ResPppp). Zavisne promenljive obuhvatile su CMUr, patente povezane sa tehnologijama ublažavanja klimatskih promena, zaposlenost u cirkularnim sektorima i investicije u cirkularne sektore. Važno je napomenuti da u skupu podataka nije bilo nedostajućih vrednosti, što je obezbedilo potpunost analize.

Pre sprovođenja analize, autori su pažljivo ispitali distribuciju vrednosti promenljivih kako bi utvrdili eventualne ekstremne vrednosti ili nepravilnosti. U skladu sa savremenim raspravama o kompleksnostima u merenju (Ghormare *et al*, 2024), posebna pažnja posvećena je obezbeđivanju konzistentnosti vrednosti podataka za sve zemlje i godine. Radi uporedivosti rezultata, korišćene su sledeće tehnike normalizacije: Logaritamska transformacija, Z-score normalizacija, Min-Max normalizacija.

Ove tehnike normalizacije u skladu su sa onima koje su korišćene u sličnim studijama (Hysa *et al*, 2020; Karman & Pawlowski, 2021) i prate pristup F. Ying i Z. Wen-Ping (2015), koji naglašavaju značaj prilagođavanja asimetričnih ekonomskih pokazatelja prilikom ispitivanja faza cirkularnih performansi.

Autori su primenili Analizu glavnih komponenti (PCA) radi smanjenja dimenzionalnosti skupa podataka i formiranja dva složena indeksa, prateći pristup A. Andronicеanu, J. Kinnunen i I. Georgescu (2021):

- Indeks cirkularne konkurentnosti i inovacija (CCII): Agregira indikatore u vezi sa performansama u CE.
- Indeks privrednog rasta (EG): Obuhvata tradicionalne indikatore ekonomskog rasta.

Oba indeksa su standardizovana i skalirana u opsegu od 0 do 100 radi lakše interpretacije i poređenja između zemalja i vremenskih perioda.

PCA za CCII izvršena je na devet promenljivih: CMUr, Patents, PatentsPM, PersEmp, PersEmpPerc, InvAbs, InvPerc, GVA i GVAperc. Za EG indeks, PCA je sprovedena na užem skupu od pet promenljivih: GDP, GDPpc, GFCF, ResP i ResPppp.

Autori su na početku sproveli regresionu analizu panel-podataka korišćenjem modela sa fiksnim i slučajnim efektima, radi ispitivanja odnosa indikatora ekonomskog rasta i ishoda CE. Hausman test je primenjen kako bi se utvrdila najprimerenija specifikacija modela, prateći pristup M. Busu (2019). Nakon početne regresione analize, autori su sproveli nekoliko dijagnostičkih testova radi provere validnosti i pouzdanosti rezultata: Breusch-Pagan test, Wooldridge test i analizu faktora inflacije varijanse (VIF).

Na osnovu rezultata ovih testova, autori su precizirali model prilagođavanjem skupa nezavisnih promenljivih. Konačni skup nezavisnih promenljivih je uključivao GDP, GDPpc, GFCF, ResP i ResPppp, adresirajući probleme multikolinearnosti i poboljšavajući prilagođavanje modela. Ovakav pristup usklađen je sa nedavnim nalazima (Jakopin, 2020; Lacko *et al*, 2024) koji ističu da istovremeno kontrolisanje nivoa rasta i efikasnog korišćenja resursa može bolje obuhvatiti pokretače cirkularne konkurentnosti.

Koristeći prilagođeni skup promenljivih, autori su sproveli revidiranu regresionu analizu panel-podataka. Radi dalje jasnoće, opšti osnovni model može se izraziti na sledeći način:

$$CCII_{it} = \alpha + \beta_1 GDP_{it} + \beta_2 GDPpc_{it} + \beta_3 GFCF_{it} + \beta_4 RESP_{it} + \beta_5 RESPppp_{it} + \epsilon_{it} \quad (1)$$

Gde:

$CCII_{it}$ - CCII za zemlju *i* u periodu *t*,

GDP_{it} - GDP za zemlju *i* u periodu *t*,

$GDPpc_{it}$ - GDPpc za zemlju *i* u periodu *t*,

$GFCF_{it}$ - GFCF za zemlju *i* u periodu *t*,

$RESP_{it}$ - ResP za zemlju *i* u periodu *t*,

$ResPppp_{it}$ - ResPppp za zemlju *i* u periodu *t*,

ϵ_{it} - slučajna greška,

α - Konstanta,

$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$ - Koeficijenti koji se procenjuju.

što omogućava zajedničko testiranje tri postavljene hipoteze.

Kako bi se utvrdili obrasci i grupisanja zemalja na osnovu performansi u CE i ekonomskom rastu, autori su sproveli K-means klaster analizu koristeći standardizovane indekse CCII i EG. Na ovaj način, zemlje su svrstane u različite grupe u zavisnosti od nivoa cirkularne konkurentnosti i ekonomskog rasta, slično pristupu R. Bucea-Manea-Tonis, A. Ševic, M. P. Ilić, R. Bucea-Manea-Tonis, N. Popovic Ševic i L. Mihoreanu (2021). Ovde su rezultati klasterovanja tumačeni u kontekstu potencijalnih podela Sever-Jug i Zapad-Istok u EU (Hondroyiannis *et al*, 2024).

Radi obezbeđivanja pouzdanosti nalaza, autori su sproveli nekoliko provera robusnosti: *Cronbach's Alpha*, analiza osetljivosti, alternativne specifikacije modela.

Neophodno je istaknuti nekoliko ograničenja primenjene metodologije:

- Potencijalna endogenost u odnosu ekonomskog rasta i performansi CE.
- Izazov potpunog obuhvatanja svih aspekata konkurentnosti i inovacija u CE putem kvantitativnih indikatora.

Uprkos ovim ograničenjima, primenjena metodologija nudi sveobuhvatan i pouzdan pristup ispitivanju odnosa ekonomskog rasta i konkurentnosti i inovacija u CE u 27 zemalja članica EU. Kombinacija regresione analize panel-podataka, formiranja kompozitnih indeksa i klaster analize pruža višedimenzionalnu perspektivu ovog odnosa. Dodatno, pozivanje na dopunske uvide na nivou preduzeća (Jovanović & Janjić, 2018; Egbunike & Okoro, 2018) naglašava značaj ciljnih ulaganja u zaštitu životne sredine za podršku makroekonomskim nalazima.

REZULTATI ISTRAŽIVANJA

Ovaj deo prikazuje detaljne nalaze studije. Dobijeni rezultati pružaju ključne uvide u različite ekonomske putanje i njihove implikacije za razvoj CE u EU.

Deskriptivna statistika

Radi boljeg razumevanja veze privrednog rasta i CE, autori započinju deskriptivnom analizom odabranih promenljivih u 27 zemalja EU.

Tabela 2 prikazuje pregled deskriptivne statistike za odabrane promenljive, uključujući kako ekonomske indikatore tako i pokazatelje CE za zemlje EU27 u periodu 2011-2020.

Deskriptivna analiza ukazuje na značajne razlike u ekonomskim i cirkularnim performansama u EU27, naglašavajući potrebu za prilagođenim pristupima koji bi podstakli cirkularnu konkurentnost. Ove razlike otvaraju prostor za kompleksniju analizu primenom PCA i regresije panel-podataka.

Podaci o GDP-u pokazuju visoku varijabilnost među zemljama EU, uz SD ($882,92 milijarde) koja znatno premašuje srednju vrednost ($557,85 milijardi), ukazujući na izražene ekonomske razlike. Visok koeficijent varijacije (158,27%) i asimetrija (2,36) ukazuju na postojanje zemalja sa izrazito visokim performansama (outliers), što doprinosi ekonomskim disparitetima koji oblikuju ishode cirkularne konkurentnosti, a koji će biti analizirani u nastavku.

Tabela 2 Deskriptivna statistika ključnih promenljivih za EU27 (2011-2020)

Zemlja	Promenljiva	Broj	Ar. sredina	St. devijacija	Medijana	Trimovana vrednost	Mad	Min	Max	Range	Asimetri-čnost	Spljošte-nost	SE	verovatnoća
EU27	CMUr	270	8,61	6,22	6,95	7,79	5,63	1,3	29,1	27,7	1,12	0,78	0,38	5.35E-13
EU27	Patents	270	11,94	19,33	4,13	7,44	6,12	0	110,25	110,25	2,71	8,04	1,18	1,79E-23
EU27	PatentsPM	270	0,84	1,31	0,48	0,58	0,71	0	11,9	11,9	4,4	27,11	0,08	5,34E-25
EU27	PersEmp	270	136250,60	189837,14	51803,00	94489,90	51436,58	1700,00	764770,00	763070,00	1,77	1,74	11553,12	5,60E-23
EU27	PersEmpPerc	270	1,79	0,5	1,75	1,79	0,67	0,4	3,5	3,1	0,04	-11,47	0,04	2,05E-03
EU27	InvAbs	270	3240,46	5650,32	741	1806,15	917,73	33	34489,00	34456,00	2,87	9	343,87	9,01E-25
EU27	InvPerc	270	0,67	0,34	0,6	0,63	0,3	0,1	1,7	1,6	0,87	0,55	0,02	1,42E-09
EU27	GVA	270	8453,77	14424,51	2587,00	4651,55	3249,86	144	79177,00	79033,00	2,66	7,12	877,85	9.62E-25
EU27	GVAperc	270	1,74	0,73	1,6	1,66	0,44	0,5	6,2	5,7	3,16	15,33	0,04	6,41E-21
EU27	GDP (USD bn)	270	557,85	882,92	227,73	329,96	269	9,46	3974,44	3964,98	2,36	4,88	53,73	5,03E-24
EU27	GDPgr	270	1,63	3,61	1,95	1,81	2,13	-11,17	24,48	35,64	0,16	6,8	0,22	1,27E-12
EU27	GDPpc	270	33664,95	22852,78	25689,15	30372,64	17580,27	7078,86	123678,70	116599,84	1,7	3,57	1390,78	1,56E-16
EU27	GDPpeg	270	1,4	3,59	1,54	1,61	2,45	-11,6	23,3	34,9	0,02	5,83	0,22	2,71E-11
EU27	GFCF	270	20,95	4,37	20,49	20,81	3,22	10,69	54,27	43,59	2	1,.8	0,27	5,48E-15
EU27	GFCFgr	270	3,09	11,5	2,34	2,04	6,09	-25,37	100,69	126,06	3,48	22,93	0,7	1,29E-20
EU27	RESP	270	1,74	1,05	1,39	1,63	0,99	0,.3	4,47	4,17	0,76	-0,29	0,06	1,59E-10
EU27	RESPppp	270	1,83	0,8	1,62	1,77	0,66	0,62	4,09	3,48	0,65	-0,28	0,05	6,02E-09

Izvor: Autori na osnovu podataka Svetske banke (2024) i Eurostata (2024)

CMUr takođe pokazuje izrazitu raspršenost (srednja vrednost 8,61%, SD 6,22%, CV 72,24%), što odražava neujednačeno usvajanje principa cirkularne ekonomije (Busu, 2019). Raspon tipičnih CMUr vrednosti (od 4,33% do 18,75%) ukazuje na značajne razlike u stepenu implementacije cirkularnih praksi u EU (Popović *et al*, 2022).

Patenti pokazuju visoku spljoštenost (8,04), ukazujući na raspodelu sa izrazito „teškim krajevima" (Herrero-Luna *et al*, 2022). Ovo sugeriše da nekoliko zemalja generiše nesrazmerno veliki broj patenata povezanih sa CE, dok većina zaostaje (Zhou *et al*, 2020).

Ovi uvidi čine osnovu za naprednije tehnike modelovanja koje će obuhvatiti složene odnose privrednog rasta i performansi CE (Andronicean *et al*, 2021).

Nemačka, najveća privreda u EU, ima prosečan GDP od $3716,90 milijardi i prosečan GDPpc od $4.427,04. CMUr iznosi 11,67% (nešto iznad proseka EU), a ResP 2,44 EUR/kg, što ilustruje da ekonomska snaga sama po sebi ne garantuje lidersku poziciju u CE (Stahel, 2016).

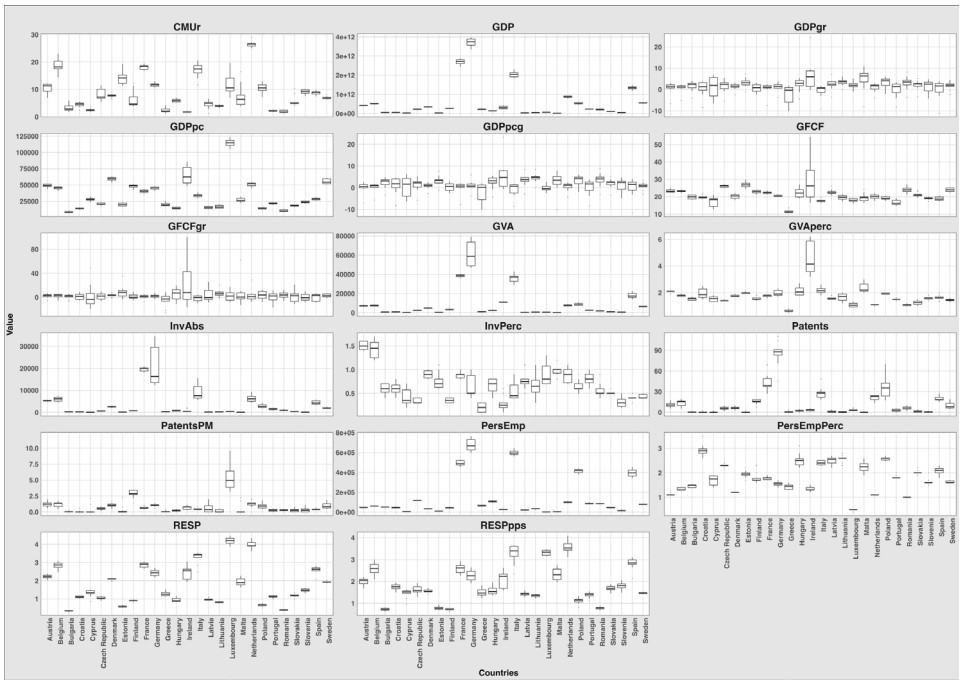
Francuska ima prosečan GDP od $2689,12 milijardi i prosečan GDPpc od 40411,76 USD. CMUr iznosi 18,15%, nadmašujući prosečni nivo EU, dok je GFCF 22,42% BDP-a. Vidljiva je pozitivna korelacija između ekonomskog razvoja i usvajanja CE (Hysa *et al*, 2020).

Holandija beleži prosečan GDP od $863,11 milijardi, najviši CMUr (26,55%) i 1,35 patenata na milion stanovnika. Ovo pokazuje kako manje razvijene privrede mogu postići izvanredne rezultate u cirkularnim praksama kroz ciljane politike (Busu, 2019; European Commission, 2020).

Poljska ima prosečan GDP od $533,05 milijardi, a njen GDPpc iznosi $14030,31. CMUr je 10,55%, blizu proseka EU. Ovo ukazuje na posvećenost CE uprkos ekonomskim ograničenjima (Popović *et al*, 2022).

Rumunija beleži nizak GDPpc ($10562,86), CMUr od 1,94% i 0,30 patenata na milion stanovnika. Ovo naglašava izazove sa kojima se suočavaju istočnoevropske zemlje u cirkularnim tranzicijama (Zhou *et al*, 2020).

Luksemburg ima najviši GDPpc (114426,14 USD), CMUr od 11,97% i 5,84 patenata na milion. Ovo potvrđuje da visoki GDPpc ne obezbeđuje automatski uspeh u CE (Mitrović & Veselinov, 2018).



Slika 1 Boks-dijagrami deskriptivne statistike promenljivih u pojedinačnim zemljama

Izvor: Autori na osnovu World Bank (2024) i Eurostat (2024)

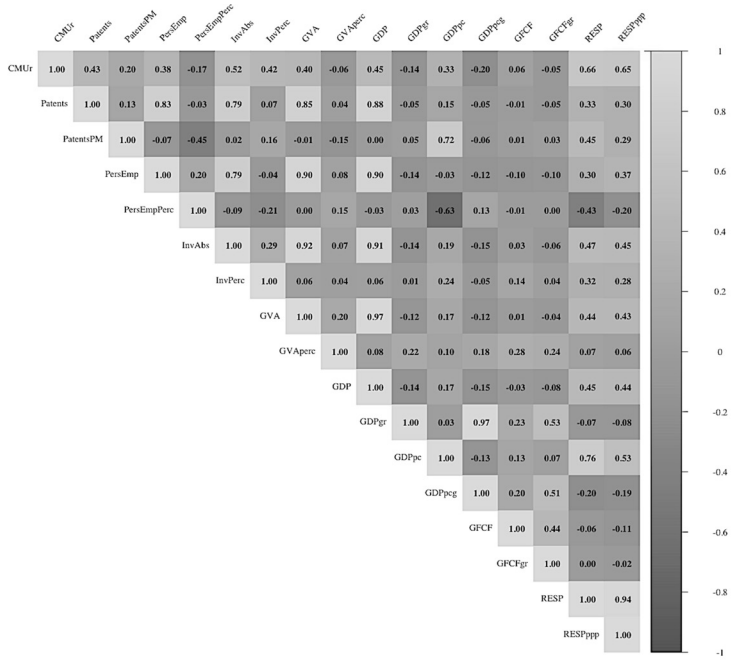
Analiza pokazuje da, iako razvijene privrede generalno ostvaruju bolje rezultate u CE, izuzeci ukazuju na složenu dinamiku. Ovi nalazi podržavaju tvrdnje A. Androniceanu *et al* (2021) da je potrebno kreirati prilagođene strategije unutar EU. Razlike u ResP i CMUr pružaju mogućnosti za razmenu znanja (Ferrante & Germani, 2020). Ekonomska snaga obezbeđuje osnovu za razvoj CE, ali nije jedini presudni faktor.

Ove uvide dalje produbljuju PCA i regresione analize panel-podataka, kako bi se rasvetlile ključne dinamike u razvoju cirkularne konkurentnosti i inovacija u okviru EU.

Korelaciona matrica ističe ključne odnose u razvoju CE:

- CMUr pozitivno korelira sa ResP (r = 0,66) i Patentima (r = 0,43), potvrđujući prethodne nalaze o značaju efikasnosti resursa i inovacija u cirkularnim privredama.
- Patenti snažno koreliraju sa Investicijama (r = 0,79) i GVA (r = 0,85), što potvrđuje argument A. Karman i M. Pawlowski (2022) o ulozi ulaganja u cirkularnim inovacijama.
- GDPpc snažno korelira sa ResP (r = 0,76), ali slabo sa CMUr (r = 0,33), što ukazuje na to da bogatstvo ne vodi nužno ka višim CMUr.
- GFCF pokazuje slabe ili negativne korelacije sa indikatorima CE, dovodeći u pitanje uobičajene pretpostavke o ulozi formiranja kapitala.
- RESP i RESPppp snažno koreliraju (r = 0,94), ukazujući na konzistentnost bez obzira na razlike u kupovnoj moći.
- PersEmp ima jaku korelaciju sa GVA (r = 0,90) i apsolutnim investicijama (InvAbs) (r = 0,79), što je usklađeno sa naglaskom European Commission (2020) na potencijal stvaranja radnih mesta.

Ovi odnosi ukazuju na složenu prirodu razvoja CE, sugerišući da, iako ekonomski prosperitet generalno olakšava usvajanje cirkularnih praksi, putevi razvoja variraju u zavisnosti od posmatranih indikatora.



Slika 2 Korelaciona matrica ključnih promenljivih

Izvor: Autori na osnovu World Bank (2024) i Eurostat (2024)

Analiza naglašava potrebu za sofisticiranim modelovanjem i prilagođenim politikama.

Analiza glavnih komponenata (PCA) i kreiranje indeksa

Nakon deskriptivne analize, sprovedena je PCA radi dubljeg sagledavanja ključnih pokretača cirkularne konkurentnosti i privrednog rasta. PCA sažima podatke u glavne komponente, otkrivajući centralne promenljive koje utiču na pomenute ishode. Ovaj korak omogućava konstrukciju dva indeksa - CCII i EG - kojima se meri performansa u EU27 za period 2011-2020.

PCA za CCII pokazala je da prve četiri komponente objašnjavaju 87,30% ukupne varijanse indikatora CE, što ukazuje na visok stepen zadržavanja informacija. Tabela 3 prikazuje opterećenja komponenti:

Tabela 3 Opterećenja komponenti za CCII

Varijable	PC1	PC2	PC3	PC4
CMUr	0,421	-0,183	0,265	0,102
Patents	0,475	0,112	-0,138	-0,092
PatentsPM	0,453	0,165	-0,201	-0,073
PersEmp	0,418	-0,246	0,185	0,124
PersEmpPerc	-0,089	0,587	0,321	0,418
InvAbs	0,399	-0,278	0,194	0,153
InvPerc	-0,065	0,595	0,302	0,385
GVA	0,412	-0,258	0,189	0,138
GVAperc	-0,078	0,592	0,315	0,401

Izvor: Autori

Prva glavna komponenta (PC1) pokazuje snažna pozitivna opterećenja za Patentima, CMUr i PersEmp, što sugeriše da ona obuhvata sveukupne performanse CE. Ovo se poklapa sa nalazima E. Hysa *et al* (2020) o značaju ovih faktora u tranziciji ka CE. Čini se da PC2 naglašava relativni značaj cirkularnih sektora

u privredi, uz visoka opterećenja za promenljive izražene u procentima, odražavajući strukturalne aspekte integracije CE o kojima diskutuje M. Busu (2019).

Za EG, prve tri komponente objašnjavaju 91,21% ukupne varijanse, što ukazuje na visok nivo sažimanja podataka. Tabela 4 predstavlja opterećenja komponenti.

PC1 beleži snažna pozitivna opterećenja za GDP, GDPpc, RESP i RESPppp, predstavljajući sveukupne ekonomske performanse. Ovo podržava naglasak Đ. Mitrović i M. Veselinov (2018) na ove indikatore pri oceni privrednog rasta. PC2 i PC3 obuhvataju dodatne aspekte privrednog rasta, pri čemu PC2 naglašava investicije (GFCF), dok PC3 pokazuje kontrast između investicija i produktivnosti resursa, odražavajući složenu vezu između formiranja kapitala i efikasnosti resursa koju navode A. Karman i M. Pawlowski (2021).

Na osnovu ovih rezultata PCA, autori su konstruisali desetogodišnje indekse CCII i EG za svaku zemlju i godinu u posmatranom skupu podataka. Indeksi su standardizovani i skalirani u rasponu 0-100 radi lakše interpretacije i poređenja među zemljama i

Tabela 4 Opterećenje komponenti za EG

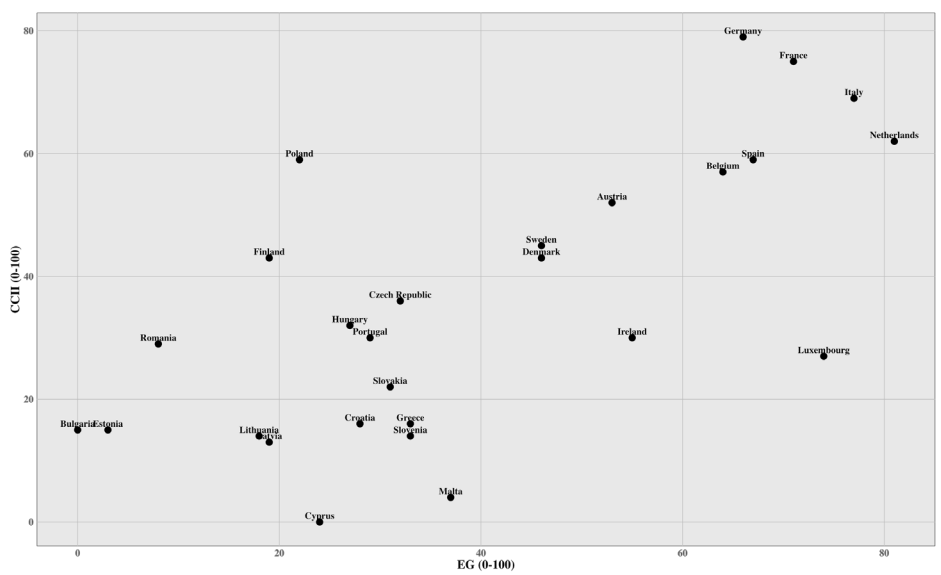
Varijable	PC1	PC2	PC3
GDP	0,512	-0,245	0,168
GDPpc	0,498	0,312	-0,215
GFCF	0,089	0,687	0,718
RESP	0,487	0,325	-0,398
RESPppp	0,495	0,307	-0,242

Izvor: Autori

vremenskim periodima. Slika 3 prikazuje dijagram rasipanja prosečnih CCII i EG vrednosti za svaku od 27 zemalja EU u periodu 2011-2020.

Dijagram rasipanja otkriva ključne obrasce u performansama CE u EU:

- Pozitivna korelacija: CCII i EG skorovi generalno pokazuju pozitivan međusobni odnos, podržavajući W. R. Stahel-ov (2016) argument da ekonomska snaga olakšava cirkularnu tranziciju.
- Klaster lidera: Nemačka, Francuska, Italija i Holandija ističu se i u privrednom rastu i u cirkularnim praksama.



Slika 3 Dijagram rasipanja prosečnih vrednosti CCII naspram EG za EU27 (2011-2020)

Izvor: Autori na osnovu World Bank (2024) i Eurostat (2024)

- Različite performanse: Luksemburg i Irska imaju visoke EG skorove, ali umerene CCII skorove, dok Poljska ima viši CCII u odnosu na EG, što podržava zapažanje Đ. Mitrović i M. Veselinov (2018) da GDPpc nije garant liderstva u CE.
- Potencijal za sustizanje: Zemlje Istočne Evrope grupisane su u donjem levom kvadrantu, što je u skladu sa nalazima A. Popović *et al* (2022) o izazovima tranzicije.
- Srednji rang: Austrija, Švedska, Danska i Finska pokazuju umerene do dobre performanse na oba indeksa.
- Autlajeri: Kipar ima primetno nizak CCII u odnosu na svoj EG skor.

Ova analiza pruža sveobuhvatan pregled pejzaža CE u EU, ističući dostignuća i oblasti za unapređenje. Ona čini osnovu za naredne analize panel-podataka i klaster analizu, omogućavajući nijansirano razumevanje odnosa privrednog rasta i konkurentnosti CE u EU.

Analiza panel podataka

Nakon identifikovanja ključnih pokretača cirkularne konkurentnosti putem PCA, autori su nastavili sa regresionom analizom panel-podataka. Početni model se suočio sa izazovima poput heteroskedastičnosti, multikolinearnosti i autokorelacije, koji su rešeni preciziranjem modela.

Autori su sproveli regresione analize panel-podataka koristeći i modele sa fiksnim efektima i modele sa slučajnim efektima, primenjujući prečišćeni skup nezavisnih promenljivih (GDP, GDPpc, GFCF,

Tabela 5 Rezultati regresione analize panel-podataka za CCII

Zemlja	Tip Modela	Nezavisna promenljiva	Zavisna promenljiva	Ocenjeni koeficijent.	St. greška.	t-vrednost	p-vrednost
EU27	Fiksni efekti	GDP	CCII	1,8609	1,0148	1,8338	0,0679
		GDPpc		-2,2070	2,3615	-0,9346	0,3509
		GFCF		1,6993	0,6652	2,5545	0,0113
		RESP		-1,9733	0,9421	-2,0946	0,0373
		RESPppp		1,5892	0,5328	2,9828	0,0032
		(Konstanta)		0,4063	0,3362	1,2084	0,2269
	Slučajni efekti	GDP		3,3335	0,2450	13,6055	0,0000
		GDPpc		-2,8025	1,1574	-2,4215	0,0155
		GFCF		1,4024	0,6302	2,2252	0,0261
		RESP		0,4017	0,4984	0,8059	0,4203
		ResPppp		0,2879	0,3260	0,8830	0,3772
	Hausman Test					8,493	0,1332
	Fiksni efekti	GDP	CCII standardized	0,4713	0,2570	1,8338	0,0679
		GDPpc		-0,5589	0,5981	-0,9346	0,3509
		GFCF		0,4304	0,1685	2,5545	0,0113
		RESP		-0,4998	0,2386	-2,0946	0,0373
		RESPppp		0,4025	0,1349	2,9828	0,0032
		(Konstanta)		0,0676	0,0852	0,7939	0,4273
	Slučajni efekti	GDP		0,8442	0,0621	13,6055	0,0000
		GDPpc		-0,7098	0,2931	-2,4215	0,0155
		GFCF		0,3552	0,1596	2,2252	0,0261
		RESP		0,1017	0,1262	0,8059	0,4203
		ResPppp		0,0729	0,0826	0,8830	0,3772
	Hausman Test					8,4493	0,1332
	Fiksni efekti	GDP	CCII (0-100)	9,8311	5,4296	1,8106	0,0715
		GDPpc		-12,1820	12,6354	-0,9641	0,3360
		GFCF		8,7066	3,5593	2,4461	0,0152
		RESP		-10,6121	5,0407	-2,1053	0,0363
		RESPppp		8,5221	2,8508	2,9893	0,0031
		(Konstanta)		41,1882	1,7983	22,9034	0,0000
	Slučajni efekti	GDP		17,8408	1,3099	13,6198	0,0000
		GDPpc		-15,4568	6,1943	-2,4953	0,0126
		GFCF		7,1202	3,3750	2,1097	0,0349
		RESP		2,3215	2,6675	0,8703	0,3841
		ResPppp		1,4344	1,7450	0,8220	0,4111
	Hausman Test					9,4332	0,0930

Izvor: Autori

ResP i ResPppp) i CCII kao zavisnu promenljivu. Hausmanov test je primenjen da bi se odredila najprikladnija specifikacija modela. Rezultati su prikazani u Tabeli 5.

Rezultat Hausmanovog testa ukazuju da je model sa slučajnim efektima prikladniji za našu analizu. Ovo je u skladu sa nalazima A. Karman i M. Pawlowski (2021), koji su primetili da modeli sa slučajnim efektima često efikasnije obuhvataju varijacije i unutar zemalja i između njih u studijama o CE.

Na nivou EU27, model sa slučajnim efektima otkriva nekoliko značajnih odnosa. GDP pokazuje snažnu pozitivnu vezu sa CCII, ali interesantno, GDPpc pokazuje negativnu vezu sa CCII. GFCF pokazuje pozitivnu vezu sa CCII. Rezultati RESP i RESPppp nisu statistički značajni u modelu sa slučajnim efektima.

Analiza panel-podataka otkriva različite obrasce na nivou zemalja u vezi privrednog rasta i cirkularne konkurentnosti. Ovi obrasci mogu se grupisati na sledeći način:

- Prva grupa obuhvata zemlje sa značajnom pozitivnom vezom GDP i CCII. Tu spadaju Belgija, Malta i Holandija. Ove zemlje pokazuju snažnu pozitivnu vezu između ukupnog privrednog rasta i performansi CE, sugerišući da je ukupni privredni rast usko povezan sa performansama CE u ovim državama.
- Druga grupa zemalja pokazuje značajnu negativnu vezu GDPpc i CCII. Belgija i Holandija pokazuju negativnu vezu, ukazujući da veće individualno bogatstvo ne mora nužno da se pretoči u bolje performanse CE.
- Treća grupa zemalja pokazuje značajnu pozitivnu vezu GFCF i CCII. Irska i Portugal demonstriraju snažnu pozitivnu vezu između GFCF i cirkularne konkurentnosti, sugerišući da investicije u osnovna sredstva igraju ključnu ulogu u njihovom razvoju CE.
- Četvrtu grupu čine zemlje sa značajnom pozitivnom vezom RESP i CCII. Belgija, Danska, Mađarska, Irska i Malta pokazuju pozitivnu vezu između produktivnosti resursa i cirkularne konkurentnosti, ukazujući da je efikasna upotreba resursa ključni faktor u njihovim performansama CE.
- Peta grupa obuhvata zemlje sa značajnom negativnom vezom RESP i CCII. Bugarska se ističe negativnom vezom, sugerišući jedinstvenu dinamiku u njenom razvoju CE.
- Sledeća grupa su zemlje sa značajnom negativnom vezom RESPppp i CCII. Danska, Mađarska i Irska pokazuju negativnu vezu između produktivnosti resursa prilagođene standardima kupovne moći i cirkularne konkurentnosti, ukazujući na složenu interakciju između efikasnosti resursa i ekonomskih faktora.
- Poslednja i najveća grupa zemalja nema statistički značajne veze. Austrija, Hrvatska, Kipar, Češka Republika, Estonija, Finska, Francuska, Nemačka, Grčka, Italija, Letonija, Litvanija, Luksemburg, Poljska, Rumunija, Slovačka, Slovenija, Španija i Švedska nisu pokazale statistički značajne veze između posmatranih promenljivih i CCII. Ova velika grupa zemalja demonstrira složenost razvoja CE širom EU.

Ovi nalazi naglašavaju heterogenost razvoja CE širom EU i potrebu za prilagođenim pristupima, specifičnim za svaku zemlju, u promovisanju cirkularne konkurentnosti. Oni su takođe u skladu sa zapažanjima A. P. Egbunike i E. G. Okoro (2018) da kapitalni i zeleni izdaci ne daju uvek uniformne rezultate u različitim kontekstima.

Analize osetljivosti i alternativne specifikacije modela potvrdile su robusnost nalaza:

- Zemlje EU15 pokazale su sličnu GDP-CCII vezu ($\beta = 3{,}5621$, $p < 0{,}001$) kao EU27 ($\beta = 3{,}3335$, $p < 0{,}001$).
- GDPpc-CCII veza je varirala: negativna u EU27 ($\beta = -2{,}8025$, $p < 0{,}05$), statistički neznačajna u EU15 ($\beta = -1{,}9876$, $p = 0{,}1234$).
- GDP-CCII veza je jačala tokom vremena (2011-2015: $\beta = 2{,}9876$, $p < 0{,}01$; 2016-2020: $\beta = 3{,}7654$, $p < 0{,}001$).

Alternativne specifikacije su otkrile:

- Zaostajuće promenljive poboljšale su prilagođenost modela, podržavajući nalaze X. Zhou *et al* (2020) o odloženim efektima.
- Interakcija GDP-RESP bila je značajna ($\beta = 0{,}4567$, $p < 0{,}05$), ukazujući na jači uticaj GDP-a na CCII u zemljama sa višom produktivnošću resursa.
- Kvadratni član GDP-a ($\beta = -0{,}0234$, $p < 0{,}05$) sugerisao je opadajuće prinose na visokim nivoima ekonomskog outputa.

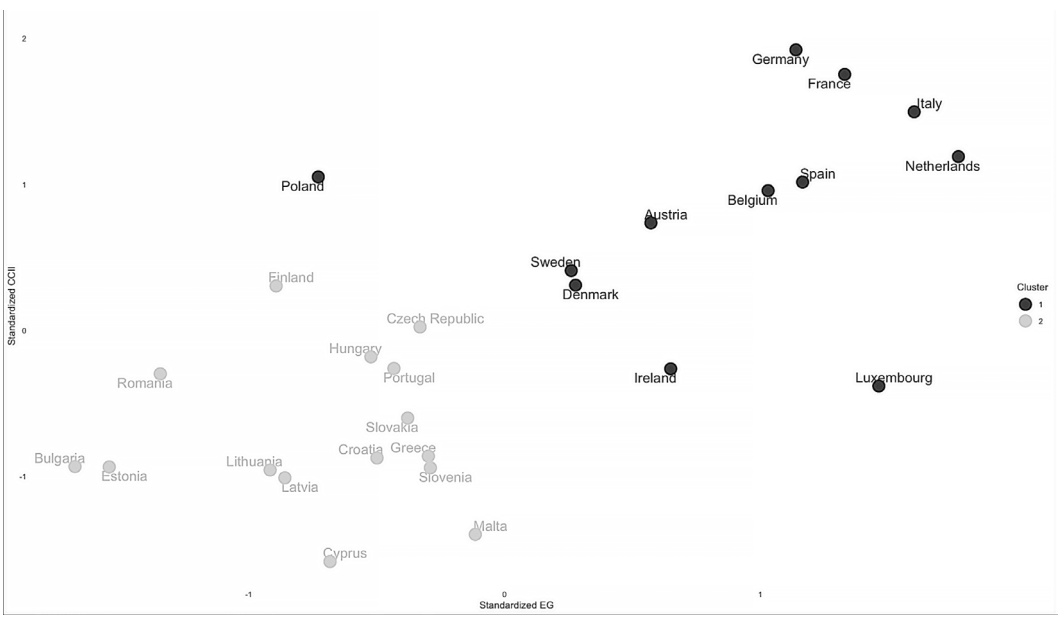
Ove analize naglašavaju složenu, nelinearnu i vremenski zavisnu prirodu faktora koji utiču na cirkularnu konkurentnost, ističući potrebu za dinamičkim pristupima koji uzimaju u obzir i neposredne i dugoročne efekte ekonomskih politika.

Klaster analiza

Da bi se dalje istražili obrasci identifikovani putem panel regresije, autori su izvršili K-means klaster analizu, grupišući zemlje EU na osnovu njihove CCII i EG. Ovo klasterovanje pruža dodatne uvide u to kako se različite ekonomije usklađuju ili razilaze u svojim putanjama CE. Na osnovu metoda „lakta", „siluete" i „statističkog jaza" za K-means klasterovanje, kao i prosečne širine siluete za hijerarhijsko klasterovanje, utvrđeno je da je optimalan broj klastera dva. Analiza je otkrila jasne klastere, kao što je ilustrovano na Slici 4.

Klaster analiza je otkrila dve jasne grupe:

- Napredne cirkularne ekonomije (Klaster 1): Ovaj klaster uključuje zemlje sa generalno višim skorovima i u CCII i u EG, kao što su Nemačka, Francuska, Italija, Holandija, Španija, Belgija, Austrija, Švedska, Danska, Finska, Luksemburg i Irska. Ove zemlje pokazuju različite stepene uspeha u kombinovanju privrednog rasta sa praksama CE. Unutar ovog klastera, identifikovano je više podgrupa:
  - Vodeće ekonomije: Nemačka, Francuska i Holandija pokazuju najviše kombinovane skorove, ukazujući na snažnu usklađenost između ekonomskih performansi i praksi CE.



Slika 4 Klaster dijagram standardizovanih CCII naspram EG skorova za zemlje EU27

Izvor: Autori

  - Snažne ekonomije: Italija, Španija i Belgija demonstriraju visoke skorove, mada nešto niže od vodećih.
  - Nordijske zemlje: Švedska, Danska i Finska čine posebnu podgrupu sa natprosečnim performansama na oba indeksa.
  - Ekonomske sile sa umerenom cirkularnošću: Luksemburg i Irska pokazuju visoke EG skorove, ali relativno niže CCII skorove, što je u skladu sa zapažanjem Đ. Mitrović i M. Veselinov (2018) da visok GDPpc ne vodi automatski ka liderstvu u CE.

- Cirkularne ekonomije u razvoju (Klaster 2): Ovaj klaster prvenstveno obuhvata zemlje Istočne i Južne Evrope, uključujući Poljsku, Češku Republiku, Portugal, Mađarsku, Rumuniju, Bugarsku, Hrvatsku, Slovačku, Sloveniju, Grčku, Litvaniju, Letoniju, Estoniju, Kipar i Maltu. Ove zemlje generalno pokazuju niže skorove i u EG i u CCII, ali sa značajnim varijacijama:
  - Lideri u nastajanju: Poljska se ističe unutar ovog klastera, pokazujući viši CCII skor u odnosu na svoj EG skor, sugerišući uspešnu implementaciju praksi CE uprkos nižem ukupnom ekonomskom outputu.
  - Tranzicione ekonomije: Zemlje poput Češke Republike, Portugala i Mađarske pokazuju umerene skorove, ukazujući na napredak i u privrednom rastu i u usvajanju CE.
  - Ekonomije u razvoju: Zemlje kao što su Rumunija, Bugarska i Baltičke države pokazuju niže skorove na oba indeksa, odražavajući izazove sa kojima se suočavaju manje ekonomski razvijene članice EU u tranziciji ka modelima CE, kako primećuju L. Ferrante i A. R. Germani (2020).

Zaključno, rezultati iz deskriptivne statistike, PCA, panel regresije i klaster analize otkrivaju složen odnos između privrednog rasta i cirkularne konkurentnosti u EU. Iako ekonomska snaga generalno podržava cirkularne inovacije, varijabilnost među zemljama naglašava potrebu za prilagođenim politikama, specifičnim za svaku zemlju. Ovo ističe da se jedinstvene ekonomske i strukturne karakteristike svake zemlje moraju se uzeti u obzir za efikasnu cirkularnu tranziciju. Štaviše, ovi nalazi rezoniraju sa zapažanjem European Court of Auditors (2023) da političke ambicije moraju biti praćene diferenciranijim strategijama, posebno u regionima sa slabijim performansama.

DISKUSIJA

Ova studija ispitala je kako privredni rast utiče na konkurentnost i inovacije u CE u 27 zemalja EU u periodu od 2011. do 2020. godine. Dobijeni nalazi ukazuju na složene interakcije između ekonomskih pokazatelja i cirkularnih performansi, ističući da, iako rast može podržati cirkularne tranzicije, dinamika tog procesa nije ujednačena među zemljama.

Odnos između privrednog rasta i konkurentnosti i inovacija u cirkularnoj ekonomiji

Hipoteza 1 (H1) pretpostavljala je da će viši GDP, GDPpc i njihove stope rasta biti pozitivno povezani sa višim nivoom konkurentnosti i inovacija u CE. Nalazi delimično podržavaju ovu hipotezu, ukazujući na nijansiran odnos privrednog rasta i cirkularnih performansi. Dok je GDP snažno povezan sa uspehom u CE, što potvrđuje pozitivna veza sa CCII, negativni koeficijent za GDPpc naglašava da ekonomska snaga sama po sebi ne garantuje naprednu implementaciju CE. Ovo je u skladu sa složenostima koje su identifikovali F. Ying i Z. Wen-Ping (2015) u kontekstu visokog rasta ali niže tehnološke razvijenosti. Nalaz sugeriše da se bogatije nacije mogu suočavati sa dodatnim izazovima u postizanju cirkularne konkurentnosti, potencijalno zbog ukorenjenih linearnih privrednih praksi ili slabih podsticajnih politika za održivost, što je u skladu sa argumentom W. R. Stahel (2016) da ekonomska snaga obezbeđuje neophodne resurse za cirkularne tranzicije.

Međutim, veza između GDPpc i CCII pokazala se negativnom, što je u suprotnosti sa delom prve

hipoteze. Ovaj neočekivani rezultat odražava zapažanja Đ. Mitrović i M. Veselinov (2018), ukazujući da viši nivo individualnog bogatstva ne mora nužno voditi ka boljim performansama CE. Takođe odražava kontrastne ishode primećene u nekim naprednim ekonomijama sa umerenim cirkularnim pokazateljima (European Court of Auditors, 2023). Ovaj nalaz dovodi u pitanje pretpostavku da su bogatije zemlje automatski veštije u primeni praksi CE. On sugeriše da drugi faktori, kao što su okviri politika, industrijske strategije i društveni stavovi prema održivosti, mogu biti presudniji pokretači cirkularne konkurentnosti nego sam dohodak po stanovniku.

Klaster analiza dodatno osvetljava ovu složenu vezu. Iako zemlje u Klasteru 1 generalno pokazuju visoke skorove i u EG i u CCII, postoje značajni izuzeci. Luksemburg i Irska demonstriraju visoke EG skorove, ali relativno niže CCII skorove, pojačavajući ideju da visok GDPpc ne vodi automatski ka liderstvu u CE. Suprotno tome, Poljska u Klasteru 2 pokazuje viši CCII skor u odnosu na svoj EG skor, sugerišući da efikasne politike i ciljani napori mogu pokrenuti performanse CE čak i u zemljama sa nižim ukupnim ekonomskim učinkom. Ovo je u skladu sa naglaskom A. P. Egbunike i E. G. Okoro (2018) na ciljane investicije u životnu sredinu i instrumente politike, koji mogu prevazići niže osnovne nivoe dohotka.

Uloga investicija u razvoju cirkularne ekonomije

Naša treća hipoteza (H3) pretpostavila je da zemlje sa višim investicijama (GFCF, InvAbs) teže da imaju značajnije inovacije i viši nivo konkurentnosti u CE. Rezultati podržavaju ovu hipotezu, naglašavajući važnost formiranja kapitala u pokretanju cirkularnih tranzicija.

Model sa slučajnim efektima pokazao je pozitivnu vezu GFCF i CCII. Ovaj nalaz je u skladu sa tvrdnjom S. Herrero-Luna *et al* (2022) da su investicije u materijalnu imovinu ključne za cirkularne tranzicije. To sugeriše da zemlje koje alociraju više resursa u osnovna sredstva, potencijalno uključujući infrastrukturu i tehnologije koje podržavaju prakse CE, teže da ostvare bolje rezultate u pogledu cirkularne konkurentnosti.

Na nivou pojedinačnih zemalja, ova veza je bila posebno izražena u Irskoj (β = 2,0618, $p < 0,05$) i Portugalu (β = 23,3467, $p < 0,05$). Ovi rezultati ukazuju da ciljane investicije mogu značajno podstaći performanse CE, čak i u zemljama sa različitim ukupnim ekonomskim položajem. Takvi ciljani pristupi dalje rezoniraju sa nalazima Jakopin (2020) u vezi sa strukturnim reformama i alokacijom kapitala, ukazujući da usklađivanje investicija sa ciljevima CE može prevazići ograničenja rasta.

Značaj investicija dodatno je potvrđen alternativnim specifikacijama modela, koje su pokazale da uključivanje zaostajućih GFCF promenljivih poboljšava prilagođenost modela i smanjuje autokorelaciju. Ovo podržava nalaze X. Zhou *et al* (2020) o odloženim efektima ekonomskih faktora na ishode CE, sugerišući da koristi od investicija u inicijative CE možda nisu odmah vidljive, ali mogu imati značajne dugoročne uticaje.

Produktivnost resursa i performanse cirkularne ekonomije

Druga hipoteza (H2) sugerisala je da zemlje sa višim ResP i ResPppp ispoljavaju bolje performanse CE. Rezultati pružaju ograničenu i mešovitu podršku ovoj hipotezi, otkrivajući složen odnos između efikasnosti resursa i cirkularne konkurentnosti.

U modelu sa slučajnim efektima za EU27, rezultati za RESP i RESPppp nisu bili statistički značajni. Ova dvosmislenost odražava zapažanja M. Busu (2019) o složenoj vezi između produktivnosti resursa i performansi CE. To sugeriše da, iako je efikasnost resursa teorijski ključna za prakse CE, njen uticaj može biti posredovan drugim faktorima kao što su usvajanje tehnologije, regulatorni okviri i industrijska struktura.

Na nivou pojedinačnih zemalja, primećeni su mešoviti rezultati. Neke zemlje, poput Belgije (RESP: β = 33,1388, $p < 0,1$) i Danske (RESP: β = 22,3519, $p < 0,05$), pokazale

su pozitivne veze između produktivnosti resursa i CCII. Međutim, druge, poput Bugarske (RESP: $\beta = -40{,}2117$, $p < 0{,}1$), demonstrirale su negativne veze. Ova varijabilnost sugeriše da je uticaj produktivnosti resursa na performanse CE zavisan od konteksta i da može interagovati sa drugim faktorima specifičnim za zemlju.

Interakcioni član između GDP i RESP u našim alternativnim specifikacijama modela ($\beta = 0{,}4567$, $p < 0{,}05$) pruža dodatni uvid. On sugeriše da je pozitivan uticaj GDP-a na CCII jači u zemljama sa višom produktivnošću resursa. Ovaj nalaz je u skladu sa I. Marjanović *et al* (2025), koji ističu kako efikasnost resursa može intenzivirati koristi ekonomskog širenja za konkurentnost CE. Sveukupno, efikasnost resursa može delovati kao moderator, pojačavajući efektivnost privrednog rasta u pokretanju cirkularne konkurentnosti.

Implikacije za politiku i praksu

Nalazi imaju nekoliko važnih implikacija za kreatore politika i praktičare:

- Iako GDP podržava cirkularni razvoj, negativna korelacija sa GDPpc ukazuje da su bogatijim nacijama potrebne ciljane politike kako bi ekonomski prosperitet pretočile u cirkularnu konkurentnost.
- Prioritizacija investicija u infrastrukturu, tehnologije i sisteme koji podržavaju cirkularne prakse biće od suštinskog značaja za održivu konkurentnost.
- Efikasnost resursa različito utiče na performanse CE u različitim zemljama. Kreatori politika treba da razviju strategije specifične za kontekst koje integrišu produktivnost resursa u šire ciljeve CE.
- Klaster analiza pokazuje potrebu za prilagođenim politikama CE, u zavisnosti od faze razvoja zemlje i njenih ekonomskih karakteristika.
- Vremenski odloženi efekti investicija i produktivnosti resursa zahtevaju održivo, dugoročno planiranje kako bi se postigli smisleni ishodi CE.

Ograničenja i budući pravci istraživanja

Iako ovo istraživanje pruža vredne uvide, ono ima nekoliko ograničenja koja ukazuju na pravce za buduća istraživanja:

- Kompozitni indeksi (CCII i EG) mogu prikriti veze specifičnih promenljivih. Buduća istraživanja treba da istraže detaljnije interakcije između pojedinačnih ekonomskih i cirkularnih indikatora.
- Analiza je ograničena na podatke od 2011. do 2020. Uključivanje novijih podataka pružilo bi uvide u evoluirajuću prirodu praksi CE.
- Fokusiranje na zemlje EU ograničava mogućnost generalizacije nalaza. Uporedne studije koje uključuju zemlje van EU mogle bi proširiti obim istraživanja CE.
- Buduća istraživanja mogla bi ispitati dodatne faktore koji utiču na cirkularnu konkurentnost, kao što su intervencije politika i inicijative specifične za sektor. Takođe bi moglo biti korisno ispitati heterogenost na nivou preduzeća, u skladu sa D. Jovanović i V. Janjić (2018) i A. P. Egbunike i E. G. Okoro (2018), kako bi se istražilo kako korporativni izdaci za mere zaštite životne sredine interaguju sa makro-nivo indikatorima.

Konačno, istraživanje otkriva složen odnos između privrednog rasta i konkurentnosti i inovacija u CE u EU. Iako ekonomska snaga generalno olakšava razvoj CE, put ka uspehu u CE nije jednostavan i zavisi od niza faktora izvan pukog ekonomskog outputa. Ovi nalazi naglašavaju potrebu za nijansiranim, kontekstualno osetljivim pristupima promovisanju praksi CE širom raznolikog pejzaža Evropske unije. Podizanje efikasnosti resursa, efektivno usmeravanje kapitala i rešavanje strukturnih disparitета ključni su za osiguravanje da se ekonomski dobici pretoče u opipljive cirkularne ishode (European Court of Auditors, 2023).

ZAKLJUČAK

Ovo istraživanje ukazuje na složen odnos između privrednog rasta i konkurentnosti u CE u zemljama EU u periodu 2011-2020. godine. Iako privredni rast, meren GDP-om, uglavnom podržava performanse CE, primećene su razlike među zemljama, što naglašava potrebu za prilagođenim politikama, specifičnim za nacionalne okolnosti. Značajno je istaći negativnu vezu između GDPpc i cirkularnih ishoda, ranije uočenu i u kontekstu privreda sa visokim rastom (Ying & Wen-Ping, 2015; European Court of Auditors, 2023). Ovo pokazuje da samo bogatstvo nije dovoljan preduslov za lidersku poziciju u CE, već da veći značaj mogu imati faktori poput okvira politika, industrijskih strategija i društvenih stavova.

Ulaganje u osnovna sredstva izdvojilo se kao ključni pokretač cirkularnih tranzicija, potvrđujući važnost infrastrukture i tehnologije za unapređenje cirkularnih praksi. Ovakva ciljana alokacija kapitala usklađena je sa nalazima da politike usmerene na „zelene" izdatke mogu podstaći efikasnost i konkurentnost (Egbunike & Okoro, 2018). Veza između produktivnosti resursa i cirkularnih performansi pokazala se složenijom, uz varijacije među zemljama koje ukazuju da privredne strukture i način korišćenja resursa različito utiču na cirkularne ishode.

Klaster analiza otkrila je dve prepoznatljive grupe zemalja: jednu s naprednim i drugu s razvijajućim se cirkularnim privredama. Neke zemlje sa nižim ekonomskim učinkom, poput Poljske, pokazuju snažne cirkularne performanse, ukazujući da efikasne politike mogu dovesti do uspeha i u manje imućnim državama. Ovo istraživanje takođe naglašava odložene efekte ulaganja, što zahteva dugoročno planiranje i istrajnost kako bi rezultati bili trajni. Pored toga, usklađivanje makroekonomskih strategija rasta sa strukturnim reformama (Jakopin, 2020) može doprineti tome da ulaganja u CE donesu dugoročnu korist.

Generalno gledano, studija pokazuje da, iako ekonomska snaga olakšava razvoj CE, uspeh zavisi od različitih faktora, a ne samo od veličine ekonomskog outputa. Prilagođeni pristupi, specifični za svaku zemlju, biće od presudnog značaja kako bi EU napredovala ka održivijoj, CE. Budući napori u kreiranju politika trebalo bi da integrišu razmatranja o efikasnosti resursa u šire ekonomske agende, u skladu sa preporukama I. Marjanović *et al* (2025), osiguravajući da rast sistematski vodi ka unapređenoj cirkularnoj konkurentnosti.

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Andrija Popović je istraživač saradnik u Inovacionom centru Univerziteta u Nišu. Usko se specijalizuje za makroekonomiju, privredni razvoj, održivost, cirkularnu ekonomiju i Industriju 4.0. Autor je nekoliko naučnih radova i poglavlja u knjigama iz oblasti privrednog razvoja i cirkularne ekonomije.

Andreja Todorović je istraživač saradnik u Inovacionom centru Univerziteta u Nišu. Specijalizuje se za istraživanje u oblasti finansija i bankarstva, a posebno neto kamatnih marži banaka. Objavio je radove iz oblasti finansija i bankarstva, i prezentovao ih je na nacionalnim i međunarodnim konferencijama.

Vladan Vučić je vanredni profesor na Fakultetu za pravo, bezbednost i menadžment "Konstantin Veliki" Univerziteta "Union - Nikola Tesla" u Beogradu. Usko se specijalizuje za zaštitu konkurencije, analizu tržišta, javne finansije, makroekonomiju i privredni razvoj. Autor je nekoliko udžbenika, monografija i naučnih radova.

ASSESSING THE INFLUENCE OF ECONOMIC GROWTH ON COMPETITIVENESS AND INNOVATION WITHIN THE CIRCULAR ECONOMY

Andrija Popović[1], Andreja Todorović [1] and Vladan Vučić[2]

[1] *University of Niš, Innovation Center, Niš, Republic of Serbia*
[2] *University „UNION - Nikola Tesla", Faculty of Law, Security and Management, Niš, Republic of Serbia*

This research explores the relationship between economic growth and circular economy competitiveness and innovation across 27 EU countries from 2011 to 2020. Using descriptive statistics, Principal Component Analysis (PCA), panel data regression, and cluster analysis, the research investigates how key economic indicators, such as GDP, GDP *per capita,* and gross fixed capital formation, affect circular economy performance. Results indicate a positive correlation between overall economic growth and circular competitiveness, though wealthier nations do not consistently lead in circular transitions. The analysis underscores the need for tailored, country-specific policies to promote sustainable circular economy practices, especially in less developed economies. These findings provide valuable insights for policymakers aiming to balance economic growth with sustainability.

Keywords: circular economy, economic growth, innovation, sustainability, EU, competitiveness

JEL Classification: Q56, O44, O33

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UTICAJ UNAPREĐENJA LJUDSKOG KAPITALA NA DINAMIKU *PER CAPITA* DOHOTKA U ZEMLJAMA CENTRALNE I ISTOČNE EVROPE

Đorđe Kotarac[1*] i Zoran Popović[2]

[1]*Univerzitet u Beogradu, Poljoprivredni fakultet, Beograd, Republika Srbija*
[2]*Univerzitet u Beogradu, Ekonomski fakultet, Beograd, Republika Srbija*

U nizu teorijsko-metodoloških istraživanja potvrđena je teza da akumulacija fizičkog kapitala samo delimično objašnjava kretanje stopa ekonomskog rasta zemalja. Fokus istraživača i kreatora ekonomskih politika se pomera sa fizičkog (PC) na ljudski kapital (HC) kao determinantu privrednog razvoja. Predmet ovog rada je analiza uticaja HC na postizanje viših stopa rasta dohotka *per capita*. Prema "Lisabonskoj strategiji" i strategiji "Evropa 2020", HC se postavlja na pijedestal po važnosti, a sve u cilju dovođenja EU-27 na mesto najkonkurentnijeg tržišta sveta. Empirijski deo rada podrazumeva panel regresioni model. Rezultati istraživanja ukazuju na signifikantan uticaj HC na povećanje dohotka *per capita* na uzorku 10 zemalja Centralne i Istočne Evrope. Doprinos ovog rada se odnosi na popunjavanje praznine u naučnoj literaturi u ispitivanju uticaja HC na rast dohotka *per capita* zemalja Evrope. Zaključne smernice rada podrazumevaju isticanje značaja investiranja u HC kao efikasnog instrumenta za postizanje većeg privrednog razvoja zemalja.

Ključne reči: ljudski kapital, ekonomski rast, GDP *per capita*, zemlje CIE-10, panel model.

JEL Classification: E24, C33, O15, O47

UVOD

Ljudski kapital postaje prepoznat kao jedan od vodećih faktora ekonomskog rasta i privrednog razvoja zemalja u okviru naučnih istraživanja sprovedenih u drugoj polovini XX veka (Mincer, 1958; Schultz, 1961). Razmatranje uloge ljudskog kapitala, kao efikasnog instrumenta za postizanje viših stopa privrednog razvoja, započinje pojavom prvih teorija rasta tokom 1960-tih godina od strane R. M. Solow (1956) (Nguyen, 2023; Aslam, Mudassir, Ghouse & Farooq, 2024). Stoga, definisanje ljudskog kapitala sprovodimo u užem i širem smislu. Prema užem pristupu, ljudski kapital se odnosi na stepen obrazovanja pojedinca ili društva u celini, kao i kvaliteta obuke za izvršenje radnih operacija (Petrović, 2010). Prema širem konceptu, pojam ljudski kapital podrazumeva izdvajanje budžetskih sredstava u obrazovni sektor, subvencionisanje patenata i *start-up*

* *Korespodencija:* Đ. Kotarac, Univerzitet u Beogradu, Poljoprivredni fakultet, Nemanjina 6, 11000 Beograd, Republika Srbija; e-mail: djordje.kotarac@agrif.bg.ac.rs

proizvoda, unapređenje poslovnih veština radnika, poboljšanje mera zaštite na radu, državno ulaganje za socijalnu i zdravstvenu negu radnika, intenzivnije učešće ljudskog kapitala u izvoznim proizvodima i uslugama, kao i ostale faktore za potrebe uvećanja radne produktivnosti (Balogh, 2013).

Na osnovu niza pretpostavki neoklasičnog modela privrednog rasta, povećanje kvaliteta ljudskog kapitala je kratkoročnog karaktera, a njegov razvoj prestaje u trenutku postizanja više dugoročne ravnoteže (Solow, 1999). Naime, neoklasični model rasta podrazumeva egzogenost varijabli ukupne radne snage i fizičkog kapitala, koje ostvaruju uticaj na promenu produktivnosti rada (Pelinescu, 2015). Kao jedna od kritika neoklasičnog modela rasta, navodi se izostavljanje unapređenja nivoa obrazovanosti pojedinaca i subvencionisanja patenata rezidentata i nerezidenata, kao i nedovoljno izdvajanja budzetskih sredstava ka obrazovnom sektoru. Isključivo investiranje u R&D delatnosti i ljudski kapital obezbeđuje primenu novih tehnologija za postizanje veće radne produktivnosti (TFP), što dalje uzrokuje rast dohotka *per capita* (Borović, Tomaš & Trivić, 2023). Prema tradicionalnim modelima rasta, za povećanje radne produktivnosti zaslužna je akumulacija fizičkog kapitala, unapređenje stepena tehničko-tehnološke razvijenosti, uz rast obima ljudskog kapitala (Solow, 1999). Kritika neoklasičnog pristupa podrazumeva zanemarivanje edukacije radnika i inovacija proizvodnih procesa, uz isticanje obima radne snage, a na uštrb efikasnosti u obavljanju poslovnih operacija (Hanushek & Woessmann, 2012). Ipak, istraživanja potvrđuju da uvećanje kvaliteta ljudskog kapitala uzrokuje rast radne produktivnosti i profitabilnosti kompanija (Yahaya, Salman, Abdulsalam & Adegbayibi, 2022).

Razvojem endogenog modela rasta, tokom 1980-tih godina, menja se pogled na ulogu ljudskog kapitala, u pravcu postizanja većih stopa privrednog rasta zemalja (Barro, 2015). Takođe, proširen je skup elemenata koje obuhvata pojam "ljudski kapital". Zagovornici endogene teorije rasta smatraju da izdvajanje sredstava za unapređenje obrazovnog sistema, subvencionisanje razvoja patenata i tehnoloških inovacija, uz rast poslovnih veština radnika, čini neizostavni deo strukture ljudskog kapitala (Aghion & Howitt, 1998). Stoga, postizanje viših stopa privrednog rasta zahteva unapređenje kvaliteta ljudskog kapitala podsticanjem preduzetničkih aktivnosti i uvećanje obrazovne strukture radno sposobnog stanovništva (Molnar, Josipović & Baškot, 2024). Prema modifikovanom modelu rasta, ljudski kapital postiže dugoročni efekat na dohodak *per capita* i rast privreda (Ogbeifun & Shobande, 2022). Taj efekat se ogleda u unapređenju obrazovanog sektora, putem rasta fonda ljudskog kapitala, što vodi ka većem privrednom razvoju (Benos & Zotou, 2014).

U cilju donošenja ispravnih mera ekonomske politike, naglašava se uloga ljudskog kapitala, kao značajne determinante za povećanje radne produktivnosti, što se dalje izražava kroz povećanje dohotka po stanovniku tj. dohotka *per capita* zemalja (Lucas, 2015). U tom pogledu, zemlje koje u većem udelu plasiraju budžetska sredstva u razvoj obrazovnog sistema kao podsticajnu meru tehnološkog progresa, postižu više stope konvergencije tj. "efekat sustizanja" u nivou dohotka po stanovniku prema razvijenijim privredama sveta (Wolff, 2013). Vođena tom tezom, Evropska unija usvaja niz strategija zasnovnih na znanju i ulaganju u istraživačko-razvojnu delatnost, kako bi u doglednom vremenskom periodu zauzela mesto najkonkuretnijeg i najdinamičnijeg svetskog tržišta (Lucian, 2015). U toku 2000. godine, organizovan je Lisabonski samit, na kom su čelnici vlada zemalja članica Evropske unije usvojili strategiju zasnovanu na znanju, inovacijama i optimizaciji ljudskog kapitala, a sve u pravcu postizanja veće radne produktivnosti, viših stopa privrednog rasta, kao i socijalne kohezije. U toku 2005. godine, doneta je revidirana verzija Lisabonske strategije koja je imala za cilj postavljanje ljudskog kapitala na pijedestal po važnosti, kako bi se znanje i inovacije stavile u funkciju privrednog rasta (Mićić, 2009).

Prepoznavanje značaja ljudskog kapitala, kao instrumenta za postizanje većeg privrednog rasta zemalja, sprovedeno je u okviru nove razvojne strategije Evropske unije, čiji nacrt objavljuje Evropska Komisija 2009. godine, a konačnu verziju publikuje, tokom 2010. godine (Silander, 2019). Prioriteti navedene

strategije podrazumevaju postizanje inteligentnog rasta odnosno ekonomije zasnovane na znanju i inovacijama. U nizu donetih inicijativa strategije nazvane "Evropa 2020", koje su direktno korelisane sa kvalitetom ljudskog kapitala zemalja, izdvajamo sledeće inicijative: Unija inovacije, Mladost u pokretu, Digitalna agenda Evrope, Nove kvalifikacije i mogućnosti zapošljavanja. Cilj strategije je postizanje pametnog tj. održivog rasta, putem investiranja u razvoj inovacija i tehnoloških dostignuća, kao i procentualno uvećanje učešća stanovništva sa sekundarnim i tercijarnim nivoom obrazovanja u ukupnoj populaciji (European Commission, 2010). Istraživanja su potvrdila da je uticaj ljudskog kapitala na privredni rast zemalja veći od efekta fizičkog kapitala, usled pojave sve većeg prirasta u posmatranom vremenskom periodu. Osim obrazovne strukture stanovnišva, ljudski kapital čini plasman sredstava u istraživanje i razvoj patenata i tehnoloških inovacija (Habibi & Zabardast, 2020). Dodatno, zemlja izvozi proizvode sa intenzivnom upotrebom ljudskog kapitala. Stoga, u ovom istraživanju uzimamo u obzir spoljnotrgovinsku otvorenost zemalja, pri analizi odnosa ljudskog kapitala i njihovog privrednog razvoja (Petrović, 2010).

U skladu sa predmetom i ciljem istraživanja predstavljamo i ispitujemo sledeću hipotezu:

H1: Unapređenje ljudskog kapitala pozitivno utiče na uvećanje dohotka po stanovniku tj. dohotka *per capita*, na primeru deset zemalja Centralne i Istočne Evrope.

Od empirijskih alata u ovom istraživanju korišćene su sledeće tehnike: metod deskripcije, kao i metode analize i sinteze. Metodološki deo istraživanja biće sproveden, kroz upotrebu ekonometrijskih testova, koji se odnose na primenu balansiranog panel regresionog modela. U uvodnom delu rada, biće navedene teorijske implikacije i izvršeno obrazloženje cilja i predmeta istraživanja. U drugom delu, pružiće se osvrt na niz empirijskih naučnih radova, koji su potvrdili efekat razvoja ljudskog kapitala na postizanje većeg dohotka po stanovniku. U trećem delu rada, obezbediće se uvid u upotrebljene izvore podataka, a na osnovu kojih je formiran uzorački okvir istraživanja. Dodatno, u okviru ovog dela izvršiće se objašnjenje metodološkog dela istraživanja, koji se odnosi na upotrebu balansiranog panel regresionog modela. Na kraju, biće sprovedena interpretacija dobijenih rezultata, a na osnovu njihove vrednosti izneti zaključci do kojih se došlo.

PREGLED LITERATURE

Posmatrajući period osamdesetih godina XX veka, paralelno sa procesom modifikacije tradicionalnih modela rasta, dolazi do povećanog broja naučnih studija koje ispituju uticaj ljudskog kapitala na promenu dohotka po stanovniku. Ipak, potrebno je praviti razliku između uticaja kvaliteta obrazovnog sektora na zaradu po stanovniku, u odnosu na istraživanja koja ispituju efekat ljudskog kapitala na promenu dohotka *per capita*, što obuhvata znatno širi opseg objašnjavajućih promenjivih.

Prema M. R. Guisan i I. Neira (2006), potvrđen je uticaj ljudskog kapitala na ekonomski razvoj zemalja, sa područja Severne Amerike, Evrope, Azije i Afrike, u periodu od 1960. do 2004. godine. Pomoću panel regresione analize, autori su dokazali statistički signifikantnu vezu prosečnog broja godina školovanja, ulaganja države za obrazovni sektor i istraživanje i razvoj, uz uvećanje populacije i spoljnotrgovinske otvorenosti na rast dohotka *per capita*. Rezultati ovog istraživanja su u skladu sa prethodno dobijenim rezultatima niza studija. Prema istraživanju R. J. Barro (1991), potvrđen je direktan efekat obuhvata stanovništva sa primarnim i sekundarnim obrazovanjem na privredni rast, na uzorku od 98 zemalja, u periodu 1960-1985. U svom radu, K. Lee i B. Y. Kim (2009), dokazuju statistički značajan uticaj rasta stanovništva sa sekundarnim i tercijarnim obrazovanjem na dohodak *per capita*, na uzorku od 63 zemlje, u periodu 1965-2002. Dodatno, autori T. Suri, M. A. Boozer, G. Ranis i F. Stewart (2011), potvrđuju statistički značajan efekat sekundarnog obrazovanja na promenu dohotka *per capita*, na primeru 79 zemalja.

U radu F. Habibi i M. A. Zabardast (2020), ističe se efekat investiranja budžetskih sredstava u

obrazovanje i tehnološki progres zemalja Bliskog Istoka i OECD zemalja. Rezultati rada sprovedenog od strane Q. Kong, D. Peng, Y. Ni, X. Jiang i Z. Wang (2021), verifikuju uticaj spoljnotrgovinske otvorenosti na postizanje većih stopa privrednog rasta i dohotka stanovništva, u kratkom i dugom roku. Razlog je ugradnja ljudskog kapitala pri proizvodnji izvoznih dobara ili usluga. Isti rezultat dobijaju autori D. Dekkiche i O. B. Leila (2024), putem ARDL panel metoda, gde potvrđuju statistički značajnu vezu spoljotrgovinske otvorenosti i privrednog razvoja zemalja BRIKSA-a. Prema nalazima I. Hasan i C. L. Tucci (2010), zemlje sa kvalitetnim patentima postižu više stope privrednog razvoja, što je dokazano na uzorku od 58 zemalja, u periodu od 1980. do 2003. godine. Identičan zaključak izvode A. M. Pece, O. Simona i F. Salisteanu (2015), koji glasi da ulaganje u tehnološke inovacije i oblast istraživanja i razvoja doprinosi privrednom rastu i dohotku *per capita*, kod zemalja CEE. Prema navodima C. P. Nguyen i N. Doytch (2022), potvrđuje se uticaj registrovanih patenata na dohodak po stanovniku i privredni razvoj ukupno 43 zemlje, u periodu od 1998. do 2016. godine. Motivisani navedenim referencama, ispitaćemo uticaj ljudskog kapitala na promenu dohotka *per capita* CIE-10 zemalja.

METODOLOGIJA I PODACI

Metodološki deo ovog rada započinjemo kroz formiranje uzorka istraživanja, koji sačinjavaju zemlje Evropske unije, a koje su svoje formalno članstvo ostvarile tokom i nakon 2004. godine. Za potrebe formiranja uzoračkog okvira ovog istraživanja, korišćeni su podaci za grupu od deset zemalja Centralne i Istočne Evrope. U analizu su uključene članice Evropske unije: Bugarska, Mađarska, Češka, Letonija, Litvanija, Estonija, Poljska, Rumunija, Slovačka i Slovenija. Iz uzorka smo isključili pet članica Evropske unije koje geografski pripadaju regionu Centralne i Istočne Evrope. Analizom nisu obuhvaćene sledeće zemlje: Malta, Hrvatska, Luksemburg, Irska i Kipar. Razlog isključivanja navedenih pet zemalja iz uzorka je ekonomske prirode. Navedene zemlje koje su članice Evropske unije (27), značajno su manje privrede, uz postizanje značajno niže godišnje stope rasta dohotka *per capita*, u odnosu na ostalih deset zemalja Centralne i Istočne Evrope. Dodatni razlog, usled koga smo izostavili pet zemalja Evropske unije iz uzorka istraživanja, odnosi se na delimičnu nedostupnost podataka o nivou kretanja dohotka po stanovniku tj. dohotka *per capita*, u pojedinim godinama. Analogno tome, uočeni su nepotpuni podaci za vremenske serije koje se odnose na promenjive, za koje smatramo da sačinjavaju ljudski kapital. Stoga, za uzorački okvir ovog istraživanja biće korišćene vremenske serije deset zemalja Centralne i Istočne Evrope, za koje ćemo pri interpretaciji dobijenih rezultata upotrebljavati skraćenicu CIE-10, što je u skladu sa troznačnim skraćenicama prema upustvu međunarodne organizacije za standardizaciju (ISO standard).

Period istraživanja podrazumeva interval, počev od prvog kvartala 2012. godine, do poslednjeg kvartala 2023. godine. Istraživanje je sprovedeno u periodu nakon pojave i trajanja negativnog efekta Svetske finansijske krize (2008), čime se izostavlja negativni uticaj strukturnih lomova na kretanje vremenskih serija dohotka po stanovniku tj. dohotka *per capita* CIE-10 zemalja. Podaci su obuhvaćeni zaključno sa 2023. godinom, kao poslednjom godinom sa javno raspoloživim podacima u momentu realizacije istraživanja. U svrhu prikupljanja podataka, upotrebljena je javno dostupna baza podataka Svetske Banke (World Bank), kao i javno raspoloživa baza podataka Eurostata.

Za potrebe realizacije metodološkog dela rada i dobijanja relevantnih rezultata istraživanja, korišćen je metod panel podataka. Usled analize više različitih jedinica posmatranja (i), pri čemu je i=1, 2, 3, …, 9, 10, u posmatranom vremenskom periodu (t), što je u našem modelu t=1, 2, 3, …, 11, 12, obezbeđuje se dovoljan broj opservacija za potrebe panel testiranja. Panel metod poseduje balansirane podatke, što se odnosi na jednak broj opservacija prema svakoj jedinici posmatranja (i). Panel model u ovom istraživanju karakteriše relacija $N < T$ tj. broj jedinica posmatranja je manji od posmatranog vremenskog perioda, a kao bitna karakteristika, navodi se primena mikro panel podatka, koji spadaju u grupu linearnih modela.

Prednost upotrebe panel podataka kao metodološkog alata odnosi se na kontrolu individualne heterogenosti, zatim odsustvo kolinearnosti između uključenih varijabli, kao i omogućavanju varijabilnosti i dobijanju kvalitetnijih i preciznijih rezultata istraživanja (Hsiao, 2022). Ukoliko posmatramo uticaj više jedinica posmatranja u jednom vremenskom periodu, tada koristimo metod uporednih podataka. Međutim, kada merimo efekat jedne jedinice posmatranja kroz različite vremenske periode, tada koristimo metode za analizu vremenskih serija (Baltagi *et al*, 2008).

Pri merenju istovremenog efekta većeg broja jedinica posmatranja kroz različite vremenske intervale, tada upotrebljavamo metod panel podataka (Baltagi *et al*, 2008). S obzirom da naše istraživanje obuhvata deset različitih jedinica posmatranja, u više vremenskih perioda, korišćenje uporednih podataka ili metoda za analizu vremenskih serija dovelo bi do pristrasnih ocena, nepouzdanih rezultata i pogrešnih zaključaka (Wooldridge, 2010). U tom smislu, uticaj ljudskog kapitala na promenu stopa rasta dohotka po stanovniku tj. BDP *per capita*, biće testiran kroz primenu panel metoda. Analizu započinjemo postavkom panel modela združenih efekata (Pooled OLS model). U cilju ocenjivanja navedenog modela, postavljamo regresionu jednačinu, koja poseduje sledeći oblik:

$$Y_{it} = \alpha + \beta_1 X_{1,it} + \beta_k X_{k,it} + V_t + \varepsilon_i + u_{it},$$

$$i = 1,\ldots,N,\ t = 1,\ldots,T,\ k = 2, 3, 4,\ldots,n \qquad (1)$$

pri čemu je:

N - broj jedinica posmatranja, T - broj vremenskih perioda;

α - slobodni član za *i*-tu jedinicu posmatranja, u vremenskom trenutku *t*;

Y_{it} - vrednost stope rasta dohotka po stanovniku (BDP *per capita*), za *i*-tu jedinicu posmatranja, u vremenskom trenutku *t*;

β_k - nepoznati regresioni parametar *k*-te nezavisne varijable, za *i*-tu jedinicu posmatranja, u vremenskom trenutku *t*;

$X_{k,it}$ - vrednost nezavisne promenjive X_k, za jedinicu posmatranja *i*, u datom vremenskom trenutku *t*;

V_t - vremenski efekti;

ε_i - individualni efekti;

u_{it} - vrednost slučajne greške sa nultom srednjom vrednošću i konstantnom varijansom.

Model zdruzenih efekata (pooled OLS model) odbacujemo, usled činjenice da model zanemaruje pretpostavku heterogenosti različitih jedinica posmatranja, što vodi ka zaključku da sve uključene zemlje u okviru panel modela reaguju na identičan način (Hsiao, 2022). Kako bi se prevazišlo potencijalno odsustvo heterogenosti različitih jedinica posmatranja, biće korišćeni panel modeli fiksnih efekata ili panel modeli stohastičkih efekata. U prvom koraku, sprovešće se analiza panel modela fiksnih efekata (Fixed Effects model), a nakon toga analiza podataka putem modela slučajnih efekata (Random Effects model). U modelu fiksnih efekata, individualni efekti direktno su uključeni u model kao fiksni parametri, putem slobodnih članova. Za dobijanje rezultata i ocenu jednačine putem modela fiksnih efekata, postavljamo sledeću jednačinu:

$$Y_{it} = \alpha + \alpha_i + \beta_1 X_{1,it} + \ldots + \beta_k X_{k,it} + \varepsilon_{it},$$

$$i = 1,\ldots,N,\ t = 1,\ldots,T,\ k = 2,3,4,\ldots,n \qquad (2)$$

Panel model fiksnih efekata podrazumeva nekorelisanost slučajnih grešaka i objašnjavajućih promenjivih u modelu. Međutim, panel model fiksnih efekata omogućava korelisanost individualnih efekata i nezavisnih varijabli (Baltagi *et al*, 2008). U pravcu prevazilaženja problema korelisanosti individualnih efekata i slučajnih grešaka, a i za potrebe testiranja koji model je reprezentativniji tj. koji model pruža naučno robustnije rezultate, biće primenjen model slučajnih efekata (Random Effects model). U tom pogledu, postavljamo i ocenjujemo regresionu jednačinu, koja poseduje sledeći oblik:

$$Y_{it} = \alpha + \beta_1 X_{1,it} + \ldots + \beta_k X_{k,it} + V_{it},$$

$$V_{it} = \alpha_i + \varepsilon_{it},\ i = 1,\ldots,N,\ t = 1,\ldots,T \qquad (3)$$

U funkciji objašnjavajućih promenjivih ovog istraživanja, a čiji uticaj na zavisnu promenjivu merimo putem metoda panel podataka, nalaze se sledeće varijable:

$X_{1,it}$ - objašnjavajuća varijabla koja se odnosi na stepen obrazovanja ukupne populacije, kroz merenje broja stanovnika sa diplomom srednje škole i diplomom fakulteta. Varijabla izražava udeo populacije sa sekundarnim i tercijarnim obrazovanjem u ukupnoj populaciji;

$X_{2,it}$ - objašnjavajuća varijabla koja prati ukupan broj godišnje registrovanih patenata, što spada u domen intelektualne svojine. Varijabla se odnosi na broj registrovanih patenata od strane rezidenata i nerezidenata u jedinici posmatranja *i*, za vremenski trenutak *t*;

$X_{3,it}$ - objašnjavajuća promenjiva koja se odnosi na ukupno investiranje države tj. ulaganje u razvoj obrazovnog sektora. Merena je kroz procentualno izdvajanje u odnosu na ukupna budžetska sredstva određene jedinice posmatranja *i*, u datom trenutku vremena *t*;

$X_{4,it}$ - objašnjavajuća promenjiva koja se odnosi na ukupnu količinu proizvoda i usluga koji su izvezeni iz jedne zemlje u određenom vremenskom periodu (jedna godina). Izvoz proizvoda i usluga predstavlja meru trgovinske otvorenosti date jedinice posmatranja *i*, u trenutku vremena *t*;

$X_{5,it}$ - objašnjavajuća varijabla koja označava indikator zdravlja određene populacije, a meri se putem predviđanja prosečnog trajanja života novorođenčadi, pod uslovom da nivo smrtnosti određenih uzrasta ostane konstantan po jedinici posmatranja *i*, u periodu vremena *t*;

$X_{6,it}$ - objašnjavajuća varijabla koja meri promenu cena proizvoda i usluga koja domaćinstva kupuju u svrhu zadovoljenja sopstvenih potreba, po svakoj jedinici posmatranja *i*, u vremenskom periodu *t*;

$X_{7,it}$ - objašnjavajuća varijabla koja meri procentualni udeo urbanog stanovništva u ukupnoj populaciji, što podrazumeva udeo stanovništva koje živi u najvećim gradovima jedinice posmatranja *i*, za vremenski trenutak *t*.

Na mestu zavisne promenjive ovog istraživanja, nalazi se varijabla, putem koje se meri ukupni godišnji dohodak po stanovniku zemalja CIE-10 tj. BDP *per capita* datih zemalja. Oznaka zavisne promenjive u modelu je Y_{it}. Prema E. N. Wolff (2013), dohodak po stanovniku odnosno BDP *per capita*, izjednačava se sa produktivnošću rada, što je alternativna mera stope ekonomskog rasta zemalja. Naime, kretanje BDP po stanovniku prati BDP po zaposlenom, što podrazumeva definiciju produktivnosti rada. Uslov da prethodno navedeno važi, podrazumeva stabilnost nivoa nezaposlenosti tj. odsustvo naglih promena u kretanju stopa nezaposlenosti. Prema tome, u okviru istraživanja se alternativno upotrebljava varijabla dohodak *per capita*, kao mera ekonomskog rasta zemalja (Wolff, 2013).

Za analizu uticaja objašnjavajućih promenjivih na zavisnu varijablu, prvobitno će biti upotrebljen model fiksnih efekata, a zatim će se koristiti model stohastičkih tj. slučajnih efekata. Za odabir reprezentativnijeg panel modela, koristiće se Hausmanov test. U cilju provere validnosti dobijenih rezultata istraživanja, kroz ocenu postavljene regresione jednačine putem panel modela, sprovešće se testiranje multikolinearnosti, autokorelacije promenjivih i heteroskedastičnosti slučajne greške. Za ispitivanje prisustva autokorelacije između varijabli u izabranom panel modelu, biće korišćen test pod nazivom Wooldridge test. Ukoliko se ispostavi da rezultati primene Hausman-ovog testa upute na upotrebu modela sa fiksnim efektima, za testiranje heteroskedastičnosti slučajne greške, biće korišćen test pod nazivom Wald test.

Za ispitivanje heteroskedastičnosti slučajne greške, biće upotrebljen Breusch Pagan Langrange multiplier test, koji je karakterističan za model sa slučajnim efektima (RE model). Kao uslov za dobijanje relevantnih rezultata istraživanja, neophodna je ispunjenost svih pretpostavki slučajne greške u odabranom panel regresionom modelu.

U okviru Tabele 1, navedeni su izvori podataka, uz predstavljanje promenjivih istraživanja. U nastavku rada, izvršiće se interpretacija rezultata panel testiranja efekta objašnjavajućih na zavisnu varijablu. Za dobijanje relevantnih rezultata ovog istraživanja, biće postavljena i ocenjena regresiona jednačina, uz primenu različitih dijagnostičkih testova.

Na osnovu Tabele 2, prikazana je deskriptivna statistika uključenih varijabli u datom panel regresionom modelu. Zavisna promenjiva koja podrazumeva godišnju vrednost dohotka *per capita* postiže prosečnu vrednost od 31502,48 dolara. Prva objašnjavajuća promenjiva je fundamentalno merilo kvaliteta ljudskog kapitala, pri čemu je prosečan nivo populacije sa sekundarnim i tercijarnim nivoom obrazovanja iznosio 86,41%, od ukupne populacije zemalja CIE-10. Prosečna ulaganja u obrazovanje iznosila su 4,87% BDP-a zemalja CIE-10.

Utvrđeno je da prosečan broj registrovanih patenata od strane rezidenata i nerezidenata zemalja CIE-10 je iznosio 17,77. Prosečna trgovinska otvorenost zemalja CIE-10 iznosila je 84,5 milijardi dolara. Očekivani prosečni životni vek novorođenčadi iznosio je 76,44 godine. Prosečan udeo urbanog stanovništva u ukupnoj populaciji koja živi u najvećim gradovima iznosio je 28,29%. Za opravdanost izbora varijabli panel modela, sprovodi se testiranje kauzalnosti varijabli, putem primene E. I. Dimitrescu i C. Hurlin (2012) Granger-ovog testa.

Na bazi testova kauzalnosti, potvrđena je kauzalnost više objašnjavajućih na zavisnu varijablu, poput: nivoa obrazovanosti, očekivanog životnog veka, udela urbanog stanovništva u populaciji, kao i broja registrovanih patenata.

Tabela 1 Definisanje zavisne i objašnjavajućih varijabli, izvori podataka

Naziv varijable	Oznaka varijable	Opis varijabli	Izvori podataka
Dohodak po stanovniku (BDP *per capita*)	Y_{it}	Ukupna vrednost ostvarenog dohotka u jednoj zemlji, u određenom vremenskom periodu, posmatrana po stanovniku. Navedena varijabla je obračunata kao odnos vrednosti godišnjeg bruto domaćeg proizvoda i ukupnog broja stanovnika zemlje. Dohodak *per capita* je meren u stalnim cenama, izraženim u američkim dolarima.	The World Bank data (2023)
Stepen obrazovanja stanovništva	$X_{1,it}$	Stepen obrazovanja stanovništva se odnosi na ukupan broj stanovnika sa diplomom srednje škole, diplomom više škole i diplomom fakulteta, koji su u intervalu od 18 godina do 64 godine starosti. Varijabla je procentualni udeo stanovništva, koje poseduje sekundarno i tercijarno obrazovanje.	Eurostat database -European Commission
Broj registrovanih patenata	$X_{2,it}$	Merena putem godišnjeg broja registrovanih patenata od strane rezidenata i nerezidenata određene zemlje. Izražena u prirodnim brojevima, za određenu jedinicu posmatranja, posmatrano na godišnjem nivou.	The World Bank data (2023)
Ulganje države u obrazovanje (% od BDP-a)	$X_{3,it}$	Pokazuje udeo budžetskih izdavajanja države za razvoj obrazovnog sektora zemlje, kao i stvaranje visoko obrazovnog kadra na tržištu rada. Prikazana kao procentualni udeo BDP-a, koji je investiran za potrebe unapređenja sektora obrazovanja.	Eurostat database - European Commission
Trgovinska otvorenost (% od BDP-a)	$X_{4,it}$	Merena putem procentualnog udela izvoza proizvoda i usluga u izgradnji ukupne vrednosti bruto domaćeg proizvoda zemalja, na godišnjem nivou. Varijabla podrazumeva obim spoljnotrgovinske razmene sa inostranim partnerima.	The World Bank data (2023)
Ukupan očekivani životni vek novorođenčadi	$X_{5,it}$	Varijabla meri očekivano trajanje života novorođenčadi, pod uslovom da nivo smrtnosti, koji je specifičan za određenu kohortu populacije ostane konstantan. Varijabla je indikator zdravstvenog stanja populacije.	The World Bank data (2023)
Indeks potrošačkih cena (CPI)	$X_{6,it}$	Varijabla meri prosečnu ponderisanu cenu tržišne korpe dobara i usluga koje potrošači kupuju. CPI indikator oslikava promenu troškova života stanovništva tokom vremena.	The World Bank data (2023)
Populacija u najvećim gradovima (% od urbane populacije)	$X_{7,it}$	Varijabla podrazumeva procentualni udeo urbanog stanovništva u ukupnoj populaciji zemalja, koji se odnosi na onaj deo stanovništva koji živi u najvećim gradovima tj. metropolama datih zemalja.	The World Bank data (2023)

Izvor: Autori

Tabela 2 Deskriptivna statistika uključenih varijabli u panel modelu

Varijable	Prosek	Standardna devijacija	Minimum	Maksimum
id	5,5	2,884324	1	10
Y_{it}	31502,48	8292,13	15747,39	51695,17
$X_{1,it}$	86,41417	4,798534	73,6	93,6
$X_{2,it}$	17,77317	17,79044	0,99	78,48
$X_{3,it}$	4,8725	0,9662335	2,8	6,9
$X_{4,it}$	8,45e+10	7,61e+10	1,36e+10	3,59e+11
$X_{5,it}$	76,44309	2,146859	71,46341	81,52927
$X_{6,it}$	114,7837	10,92856	101,8029	151,9433
$X_{7,it}$	28,29007	15,30413	7,419745	55,751

Izvor: Autori

Tabela 3 Rezultati testiranja kauzalnosti varijabli (Dimitrecsu & Hurlin-Granger test)

Smer Kauzalnosti	Zbar-Stat.	Prob.	Smer kauzalnosti	Zbar-Stat.	Prob.
Y_{it} ima kauzalni efekat na $X_{1,it}$	3,6126	0,000	$X_{1,it}$ ima kauzalni efekat na Y_{it}	3,6488	0,003
Y_{it} ima kauzalni efekat $X_{2,it}$	7,3710	0,000	$X_{2,it}$ ima kauzalni efekat na Y_{it}	2,0158	0,043
Y_{it} ima kauzalni efekat na $X_{3,it}$	3,8869	0,001	$X_{3,it}$ nema kauzalni efekat na Y_{it}	-1,1338	0,256
Y_{it} nema kauzalni efekat na $X_{4,it}$	0,9272	0,353	$X_{4,it}$ nema kauzalni efekat na Y_{it}	-0,7324	0,463
Y_{it} ima kauzalni efekat $X_{5,it}$	7,9841	0,000	$X_{5,it}$ ima kauzalni efekat na Y_{it}	5,6542	0,000
Y_{it} nema kauzalni efekat na $X_{6,it}$	-0,968	0,333	$X_{6,it}$ nema kauzalni efekat na Y_{it}	0,9522	0,341
Y_{it} ima kauzalni efekat na $X_{7,it}$	8,9933	0,000	$X_{7,it}$ ima kauzalni efekat na Y_{it}	4,3292	0,000

Napomena: Ako je verovatnoća (Prob.) vrednosno manja od nivoa značajnosti (α=0,05), tada se odbacuje nulta hipoteza i donosi odluka o postojanju kauzalnosti varijabli modela.

Izvor: Autori

Suprotno, potvrđen je kauzalni uticaj zavisne na objašnjavajuće varijable: nivo obrazovanosti, ukupan broj registrovanih patenata, javna ulaganja, očekivani životni vek i udeo urbanog stanovništva u ukupnoj populaciji.

REZULTATI I DISKUSIJA

Rezultate testiranja stacionarnosti vremenskih serija, koje su uključene u postavljeni panel model, obezbeđujemo kroz primenu testova jediničnog korena, koji su karakteristični za panel podatke. Testovi jediničnog korena u panel podacima poseduju više zajedničkih karakteristika, sa testovima za proveru jediničnog korena vremenskih serija. U našem istraživanju su primenjeni testovi jediničnog korena prve i druge generacije. Prema testovima prve generacije, događaji i promena uslova u jednoj zemlji neće ostvariti uticaj na promenu uslova u zemljama u okruženju, što ih čini testovima nezavisnih panela. Suprotno tome, testovi druge generacije uzimaju u obzir tezu da promena privrednih uslova u jednoj zemlji izaziva promenu uslova u drugim zemljama, što ih čini testovima zavisnih panela. U nizu naučnih istraživanja, primetna je veća zastupljenost testova prve generacije u komparaciji sa primenom testova druge generacije (Pesaran, 2012). Međutim, u okviru našeg istraživanja, primenili smo podjednako testove prve i druge generacije, kako bi ispitali stacionarnost serija u postavljenom panel modelu. U cilju dobijanja robusnih rezultata istraživanja, primenjuju se testovi za proveru stacionarnosti panela, kroz upotrebu

sledećih testova: Levin-Lin-Chu test (2002), Harris-Tzvalis test (1999), Im-Pesaran-Shin test (2003), Fisherov test (2001), Breitung test (2000), itd. Svi navedeni testovi jediničnog korena, polaze od nulte hipoteze, koja podrazumeva posedovanje jediničnog korena, dok se alternativnom hipotezom potvrđuje odsustvo jediničnog korena. Putem odbacivanja nulte hipoteze, uz nivo značajnosti (α = 0,05), potvrđuje se stacionarnosti postavljenog panel modela.

Prema rezultatima testova u okviru Tabele 4, donosimo zaključak o ukupnoj stacionarnosti panel modela. Uz korišćenje logartimovanih podataka, pomoću prve diference, postignuta je stacionarnost svih serija, koje su uključene u panel model. Obračunata verovatnoća testova jediničnog korena je manja od *Prob.*=0,05, što potvrđuje stacionarnost uključenih vremenskih serija. Za ispitivanje prirode veze i kolinearnosti objašnjavajućih varijabli modela, upotrebljen je Pirsonov koeficijent korelacije. U nastavku rada, prikazujemo rezultate provere linearne korelacione veze, kako zavisne varijable, tako i skupa objašnjavajućih promenjivih.

Na osnovu Tabele 5, donosimo zaključak da je između uključenih promenjivih u panelu prisutna slaba korelaciona veza. Najviša korelaciona veza je uočena između promenjivih ulaganje u obrazovanje i broja registrovanih patenata, u iznosu od 0,5771. Dok je najniža korelaciona veza detektovana između varijable koja se odnosi na trgovinsku otvorenost zemalja i varijable BDP *per capita* zemalja, na nivou od 0,0187. S obzirom na to, da korelaciona veza između bilo koje od promenjivih u modelu nije iznad vrednosti od 0,58, donosimo zaključak da ne postoji multikolinearnost između uključenih promenljivih u postavljenom panel modelu.

U cilju donošenja odluke za odabir metoda za ocenu panel podataka, na uzorku od deset zemalja Centralne i Istočne Evrope, a u vremenskom intervalu od 2012. do 2023. godine, koristimo vrednosti Hausman-ovog testa. Prema dobijenoj statistici Hausman-ovog testa, koja je viša od x^2 (broj stepeni slobode), uz određen nivo značajnosti vršimo odbacivanje nulte hipoteze i prihvatanje alternativne hipoteze datog testa. Alternativna hipoteza sugeriše da je model slučajnih efekata (Random Effects model) relevantniji u odnosu

Tabela 4 Provera stacionarnosti uključenih serija u panel modelu

Varijable	Y_{it}	$X_{1,it}$	$X_{2,it}$	$X_{3,it}$	$X_{4,it}$	$X_{5,it}$	$X_{6,it}$	$X_{7,it}$
Levin-Lin-Chu test	-6,0618 (0,0000)	-6,7577 (0,0000)	-6,9503 (0,0000)	-5,3366 (0,0000)	-2,8981 (0,0019)	-4,0417 (0,0000)	-4,8864 (0,0000)	-1,4922 (0,0678)
LLC trend test	-4,3686 (00000)	-10,9779 (0,0000)	-8,2728 (0,0000)	-7,3692 (0,0000)	-2,7105 (0,0034)	-5,4342 (0,0000)	-3,3946 (0,0003)	-1,4922 (0,0678)
Harris-Tzvalis test	0,0165 (0,0000)	-0,0787 (0,0000)	-0,2343 (0,0000)	-0,0603 (0,0000)	-0,1734 (0,0000)	-0,4484 (0,0000)	0,5274 (0,0000)	-0,8734 (0,0000)
HT trend test	0,0995 (0,0011)	0,0889 (0,0008)	-0,1930 (0,0000)	-0,0412 (0,0000)	-0,1140 (0,0000)	-0,4270 (0,0000)	0,0392 (0,0015)	-0,7668 (0,0000)
Breitung test	-3,7943 (0,0001)	-3,2997 (0,0005)	-4,3196 (0,0000)	-3,8587 (0,0001)	-5,0245 (0,0000)	-6,9674 (0,0000)	-3,6131 (0,0002)	-2,4694 (0,0068)
BT trend test	-2,9848 (0,0014)	-1,7860 (0,0370)	-4,2417 (0,0000)	-2,3293 (0,0099)	-3,6599 (0,0001)	-1,5905 (0,0597)	-1,3885 (0,0825)	-2,0780 (0,0189)
Im-Pesaran-Shin test	-2,9219 (0,0017)	-3,6562 (0,0001)	-4,9999 (0,0000)	-3,0436 (0,0012)	-4,2613 (0,0000)	-4,0766 (0,0000)	-2,2107 (0,0135)	--6,2933 (0,0000)
IPS trend test	-4,2730 (0,0000)	-3,7333 (0,0001)	-4,9800 (0,0000)	-3,8170 (0,0001)	-4,4512 (0,0000)	-3,8551 (0,0001)	-2,2243 (0,0131)	-1,7654 (0,0388)
Fisher dfuller test	7,4440 (0,0000)	9,3479 (0,0000)	29,9766 (0,0000)	6,6583 (0,0000)	10,8235 (0,0000)	9,6253 (0,0000)	29,9766 (0,0000)	6,8505 (0,0000)

Izvor: Autori

na metod fiksnih efekata (Fixed Effects model). Naime, u cilju ocene regresione jednačine i donošenja validnih zaključaka, primenili smo metod slučajnih efekata, pri čemu je $x^2(6) = 1{,}95$, dok je *prob.* > $x^2(5) = 0{,}9245$. Za ocenu statističke signifikantnosti uticaja varijabli koje predstavljaju kvalitet ljudskog kapitala, na uvećanje stope rasta, kao i privrednog razvoja zemalja Centralne i Istočne Evrope, biće postavljena i ocenjena regresiona jednačina sledećeg oblika:

$$YCEI(10)_{it} = \alpha + \beta_1 X_{1,it} + \beta_2 X_{2,it} + \beta_3 X_{3,it} + \beta_4 X_{4,it} + V_{it} \quad (4)$$

Neposredno pred ocenjivanje regresione jednačine putem modela slučajnih efekata (Random Effects model), sprovodimo analizu rezultata dijagnostičkih testova. Za testiranje heteroskedastičnosti, kod metoda slučajnih efekata, primenjujemo originalni Breusch and Pagan LM test. Pretpostavke modela slučajnih efekata podrazumevaju: E(α)=0 i $Var(a_i) = \sigma_\alpha^2 > 0$. Vrednost statistike Breusch and Pagan LM testa iznosi $x^2(45) = 91{,}64$, dok je vrednost obračunate verovatnoće testa *prob.* = 0,0000. Na osnovu obračunate vrednosti Breusch and Pagan LM testa iz Tabele 6, odbacujemo nultu i prihvatamo alternativnu hipotezu datog testa, uz nivo značajnosti od 0,05. Stoga, zaključujemo da je rezidualna heteroskedastičnost prisutna odnosno varijansa rezidualnih odstupanja nije konstantna. Za potrebe ispitivanja postojanja autokorelacije u modelu slučajnih efekata, upotrebljen je Wooldridge test. Vrednost statistike Wooldridge testa je $x^2(7) = 589{,}61$, dok je obračunata verovatnoća *prob.* = 0,0000. Na osnovu obračunate verovatnoće testa, uz nivo značajnosti od α = 0,05, sprovodimo odbacivanje nulte hipoteze testa, koja se odnosi na odsustvo autokorelacije odnosno postojanja međusobno korelacione veze između slučajnih grešaka u panel modelu slučajnih efekata.

Prema navodima D. Hoechle (2007), za prevazilaženje problema heteroskedastičnosti i problema autokorelacije u modelu slučajnih efekata (Random

Tabela 5 Provera multikolinearnosti u panel modelu

	Y_{it}	$X_{1,it}$	$X_{2,it}$	$X_{3,it}$	$X_{4,it}$	$X_{5,it}$	$X_{6,it}$	$X_{7,it}$
Y_{it}	1,0000							
$X_{1,it}$	0,1755	1,0000						
$X_{2,it}$	0,1063	-0,0882	1,0000					
$X_{3,it}$	0,1523	0,0587	-0,2713	1,0000				
$X_{4,it}$	0,5771	0,0187	0,1465	-0,1649	1,0000			
$X_{5,it}$	0,2477	-0,0260	0,1115	-0,1932	0,1855	1,0000		
$X_{6,it}$	0,5326	0,0503	0,0987	0,0395	0,3563	0,4627	1,0000	
$X_{7,it}$	0,0892	-0,0618	0,0523	-0,0938	-0,0472	0,0826	0,1272	1,0000

Izvor: Autori

Tabela 6 Dijagnostički testovi panel modela

Zemlje Centralne i Istočne Evrope (10)	Hausman test	Wooldridge test (Random Effects model)	Breusch and Pagan Langrangian multiplier test (Random Effects model)
Vrednost statistike testa	$x^2(6) = 1{,}95$	$x^2(7) = 589{,}61$	$x^2(45) = 91{,}646$
Verovatnoća testa (Prob.)	0,9245	Prob.statist.= 0,0000	Prob. statist.= 0,0000

Izvor: Autori

Effects model), potrebno je uključiti robusne standardne greške *vce(robust)*. Prema navodima B. H. Baltagi (2008), ocenjivanje modela slučajnih efekata (Random Effects model), sprovodi se uz upotrebu robusnih slučajnih grešaka, što vodi ka prevazilaženju problema nekozistentnosti slučajnih grešaka. Metod za ocenu modela putem kovarijacione matrice predstavljaju naučnici poput: H. White (1980) i G. Frahm (2009). Putem primene prethodno opisane korekcije, obezbeđuje se konzistentnost slučajnih grešaka, bez obzira na potvrdu heteroskedastičnosti reziduala. Nakon prevazilaženja problema heteroskedastičnosti i autokorelacije u modelu slučajnih efekata, sprovodimo ocenu panel regresije, a na osnovu nje dobijamo robusne rezultate i validne zaključke ovog istraživanja.

Uticaj nivoa razvijenosti ljudskog kapitala na promenu godišnjeg dohotka po stanovniku tj. BDP *per capita* stanovništva, zemalja Centralne i Istočne Evrope, ispitujemo putem regresione jednačine, a rezultate istraživanja prikazujemo u okviru Tabele 7. Postizanje većeg dohotka *per capita* predstavlja alternativnu meru ekonomskog rasta i privrednog razvoja zemalja (Wolf, 2013). U pravcu analize pojedinačnih elementa koji učestvuju u izgradnji ljudskog kapitala, regresionom jednačinom biće ocenjeni koeficijenti svake varijable pojedinačno, kao i izmeren njihov uticaj na zavisnu promenjivu.

U nastavku ovog rada, sprovodi se interpretacija dobijenih rezultata istraživanja. Validnost postavljenog modela obezbeđujemo putem vrednosti ukupne statistike modela od 589,61, uz nivo značajnosti od 0,01. Prema vrednosti koeficijenta determinacije, koja se nalazi na nivou od 0,7350, dokazujemo da je približno 74% varijabiliteta dohotka po stanovniku tj. BDP *per capita*, objašnjeno putem

Tabela 7 Ocenjivanje panel regresione jednačine

Varijable modela	Panel model (Random-effects GLS regression)	
Dohodak po stanovniku (BDP *per capita*)	Ocenjeni regresioni koeficijenti	Vrednost standardnih grešaka
Stepen obrazovanja stanovništva	0,8843876** (0,028)	0,4033031
Broj registrovanih patenata	0,0097988** (0,021)	0,0422565
Ulaganje države u obrazovanje	0,14818*** (0,002)	0,0477228
Trgovinska otvorenost	0,3847617*** (0,000)	0,0431631
Promena cene proizvoda i usluga (CPI)	0,2829279*** (0,003)	0,096777
Ukupan očekivani životni vek stanovništva	0,1356885 (0,488)	0,1958549
Populacija u najvećim gradovima (% of Urban Population)	0,4570091 (0,107)	0,2839146
Konstanta	0,0273071*** (0,000)	0,0038577
Broj opservacija	120	N = 1,2,3, … ,8,9, 10 T= 1,2,3, … , 10, 11, 12
Koeficijent determinacije (R^2)	0,7350	
Verovatnoća testa	Prob. > (x^2) = 0,0000	

Napomena: Oznake ***, **, * podrazumevaju nivo značajnosti sa kojima donosimo odluku od 0,01, 0,05, 0,10, respektivno.

Izvor: Autori

nezavisnih promenjivih modela. Na osnovu 120 opservacija, ocenjeni su regresioni koeficijenti, koji stoje uz objašnjavajuće promenjive modela, dajući uvid u statističku signifikantnost uticaja nezavisnih na zavisnu varijablu istraživanja.

Na osnovu obračunate vrednosti koeficijenta, koji opisuje efekat nivoa obrazovanosti stanovništva na izmereni nivo dohotka po stanovniku, donosimo zaključak o statističkoj siginifikantnosti uticaja stepena obrazovanja na nivoe zarade stanovništva zemalja CIE-10. Prema rezultatima predstavljenih u okviru Tabele 7, stepen obrazovanja stanovništva ostvaruje statistički značajan i pozitivan uticaj na promenu vrednosti dohotka po stanovniku posmatranih zemalja. Usled povećanja stepena obrazovanja za 1%, dolazi do rasta dohotka po stanovniku odnosno BDP *per capita* za 0,8843%. Naime, deo stanovništva sa većim nivoom obrazovanja, u proseku postiže veći dohodak u odnosu na manje obrazovan sloj društva. Na osnovu toga, donosimo zaključak da nivo obrazovanja pojedinca predstavlja signal njegove sposobnosti i radne efikasnosti, što uzrokuje postizanje viših nivoa dohotka. U okviru Evrozone su stanovnici sa primarnim nivoom obrazovanja ostvarivali prosečnu godišnju zaradu od 17590 evra, stanovnici sa sekundarnim nivoom obrazovanja 23006 evra, dok su stanovnici sa višim i visokim nivoom obrazovanja zarađivali 30081 evra, što je mereno na kraju 2023. godine (Eurostat, 2024).

Prema dobijenim rezultatima, promenljiva koja se odnosi na ukupan broj registrovanih patenata od strane rezidentana i nerezidenata zemalja, ostvaruje pozitivan i statistički značajan efekat na dohodak *per capita* datih zemalja, u posmatranom vremenskom periodu. Varijabla koja meri broj registrovanih patenata zemalja CIE-10 za 1%, utiče na povećanja dohotka *per capita* za 0,009%. Takođe, povećanje proseka ponderisane vrednosti tržišne korpe dobara i usluga (CPI) za 1% utiče na povećanje dohotka *per capita* za 0,2829%. Dodatno, rezultati panel regresionog modela ukazuju na pozitivan i statistički signifikantan uticaj trgovinske otvorenosti zemalja na promenu dohotka po stanovniku, posmatrano na uzorku zemalja CIE-10. Spoljnotrgovinska otvorenost zemalja je merena ukupnom količinom proizvoda i usluga, koja je proizvedena i plasirana iz zemalja CIE-10, prema raznim tržištima spoljnotrgovinskih partnera. Povećan nivo produktivnosti rada, koja nastaje usled razvoja poslovnih veština i tehnološkog progresa, kao i uvećanje učešća ljudskog kapitala u proizvodnji izvoznih outputa, u konačnici se prenosi na povećanje zarada *per capita*. Pri rastu izvoza proizvoda i usluga za 1% zemalja CIE-10, dolazi do rasta dohotka po stanovniku od 0,3847%.

Ulaganje u obrazovni sektor podrazumeva važnu meru u okviru uspostavljene strategije razvoja obrazovanja tj. pismenosti stanovništva zemalja CIE-10. Iznadprosečno investiranje u obrazovanje, kroz unapređenje insfrastrukture u obrazovnom sistemu i sprovođenje reformi obrazovnog sistema, dovele bi do povećanja kvaliteta ljudskog kapitala, kao i postizanja većeg privrednog rasta zemalja CIE-10. Prema dobijenim rezultatima, dokazuje se pozitivna i statistički značajna relacija investiranja u obrazovanje i ostvarivanja većeg dohotka po stanovniku. Usled rasta udela budžetskih sredstava u obrazovni sektor za 1%, dolazi do povećanja dohotka po stanovniku tj. dohotka *per capita* za 0,1481%. Stoga, zaključujemo da će povećanje izdvajanja od strane države u razvoj obrazovanog kadra na tržištu rada doprineti povećanju zarada *per capita*, mereno na godišnjem nivou. Prema dobijenim rezultatima, potvrđuje se pozitivna i statistički signifikantna veza između elemenata, koji čine meru kvaliteta ljudskog kapitala na rast dohotka po stanovniku, zemalja CIE-10.

ZAKLJUČAK

Ljudski kapital, ili prethodno korišćen termin "vrednost čoveka", odnosi se na merilo obrazovanja, posedovanje radnih veština, efikasnosti u obavljanju poslovnih zadataka, sklonosti ka pokretanju patenata i razvoju inovacija, od strane stanovništva određene zemlje. Sa jedne strane, ljudski kapital predstavlja pokretač razvoja najsavremenijih tehnoloških inovacija, dok sa druge strane, dodatna funkcija ljudskog kapitala se odnosi na nivo kapaciteta koji je potreban pri kreiranju infrastrukture za prihvatanje novih tehnologija, kao i njihove dalje implementacije.

Rezultati ovog istraživanja su dokazali pozitivan i statistički značajan uticaj ljudskog kapitala na promenu dohotka po stanovniku, na uzorku od deset zemalja Centralne i Istočne Evrope (CIE-10). Naime, povećano učešće stanovništva sa sekundarnim i tercijarnim nivoom obrazovanja u ukupnoj populaciji, zatim povećanje broja registrovanih patenata rezidenata i nerezidenta, veće izdvajanje budžetskih sredstava prema istraživačko-razvojnim delatnostima i podsticanju *start-up* ideja, uz povećanje količine izvoznih proizvoda i usluga, u čiju strukturu je ugrađen ljudski kapital, statistički značajno utiču na postizanje većeg nivoa dohotka po stanovniku tj. BDP *per capita*, na primeru zemalja CIE-10. Na osnovu dobijenih rezultata istraživanja, potvrđena je početno postavljena hipoteza ovog rada. Kao primarno ograničenje istraživanja navodi se kritika teorije ljudskog kapitala. Naime, činjenica je da povećan nivo obrazovanja stanovništva ne vodi, nužno, ka uvećanju radne produktivnosti pojedinaca, već ono predstavlja pokazatelj kognitivnih sposobnosti, talenata i veština pojedinaca, što će potencijalno uticati na postizanje većeg nivoa radne produktivnosti. Preporuka za buduća istraživanja se zasniva na proširenju postavljene regresione jednačine, kroz uključivanje kontrolnih varijabli, koje mere prosečne godine školovanja stanovništva, uz analizu njenog uticaja na kretanje dohotka po stanovniku. Pored toga, preporuka za sprovođenje budućih istraživanja se odnosi na prethodno proširenje uzoračkog okvira, kroz obuhvat drugih regiona Evropske unije (27), kao i izvršenje komparativne analize drugih grupa zemalja sa rezultatima za zemlje CIE-10.

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Đorđe Kotarac je doktorand Ekonomskog fakulteta Univerziteta u Beogradu, gde se usavršava u naučnoj oblasti opšte ekonomske teorije i razvojne ekonomije. Obavlja funkciju asistenta na odseku za ekonomiju, Poljoprivrednog fakulteta Univerziteta u Beogradu. Ključne sfere njegovog istraživanja su ekonomija rasta i razvoja, teorije konvergencije, digitalna ekonomija, ekonomija znanja.

Zoran Popović je vanredni profesor na Ekonomskom fakultetu Univerziteta u Beogradu. Doktorirao je na Ekonomskom fakultetu Univerziteta u Beogradu, na temu analize dinamičkih modela opšte ekonomske ravnoteže. Ključne oblasti njegovog naučnog istraživanja su opšta ekonomska ravnoteža, teorija igara, matematičko programiranje.

THE IMPACT OF HUMAN CAPITAL IMPROVEMENT ON *PER CAPITA* INCOME DYNAMICS IN THE CENTRAL AND EASTERN EUROPEAN COUNTRIES

Đorđe Kotarac[1] and Zoran Popović[2]

[1]*University of Belgrade, Faculty of Agriculture, Belgrade, Republic of Serbia*
[2]*University of Belgrade, Faculty of Economics and Business, Belgrade, Republic of Serbia*

Theoretical and empirical findings confirm the thesis that the accumulation of physical capital partly explains the movement of countries' economic growth rates. Researchers in the field of development economics, as well as creators of economic policies, are shifting their focus from physical (PC) to human capital (HC) as a determinant of countries' economic development. The subject matter of this paper is the analysis of the impact of HC on achieving higher *per capita* income growth rates. According to the "Lisbon Strategy" and the "Europe 2020 Strategy", HC is placed on a pedestal of importance, all with the aim of making the EU-27 the most competitive market in the world. The empirical part was conducted using a panel regression model. The research results indicate a significant impact of HC on the *per capita* income of the CEE-10 countries. This research study contributes by reducing a gap in the scientific literature by examining the impact of HC on the *per capita* income of the European countries. The concluding implications point to the importance of HC development as an effective instrument for ensuring countries' greater economic growth.

Keywords: human capital, GDP *per capita*, economic growth, CEE-10, panel data.

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STRANE DIREKTNE INVESTICIJE I/ILI INSTITUCIJE U FUNKCIJI RASTA ZAPADNOG BALKANA: OČEKUJ (NE) OČEKIVANO

Iva Glišić i Slavica Manić*

Ekonomski fakultet Univerziteta u Beogradu, Republika Srbija

Ekonomska literatura obiluje radovima koji analiziraju efekte priliva stranih direktnih investicija (SDI) ili uticaj kvaliteta institucija na ekonomsku aktivnost. Navedeno se ne može tvrditi za studije koje proučavaju uticaj institucionalnog kvaliteta na privlačenje SDI i/ili zajednički uticaj ova dva faktora na ekonomski rast, posebno ako je reč o Zapadnom Balkanu. Naša analiza pokriva pet zemalja ovog regiona, u periodu 2007-2022. i ima za cilj da doprinese relevantnoj literaturi upravo u tom pogledu. Podaci panela modelirani su korišćenjem metode uopštenih najmanjih kvadrata. Rezultat finalnog (od tri ocenjena) modela implicira neočekivan pozitivan efekat manje kvalitetnog institucionalnog okruženja na ekonomsku aktivnost kroz kanal SDI. Potencijalno objašnjenje ovakvog rezultata jeste teza da „slabije" zakonodavstvo (posebno ekološko) u zemljama Zapadnog Balkana privlači upravo one SDI koje uz ekonomski rast produkuju i negativne eksterne efekte. Dodatno, ovakav nalaz ukazuje na potrebu razmatranja dugoročnih rizika po ekonomski rast koji se pretežno oslanja na ovu vrstu SDI.

Ključne reči: strane direktne investicije, institucije, privredni rast, Zapadni Balkan

JEL Classification: E02, F21, O43, C33

UVOD

Integracija zemalja Zapadnog Balkana u svetske tokove kapitala i evolucija tržišnih uslova u Albaniji, Bosni i Hercegovini, Severnoj Makedoniji, Srbiji i Crnoj Gori dovela je do povećanog priliva stranih direktnih investicija (SDI) u ovaj region. U teoriji, interesovanje investitora bazirano je na visokim stopama povrata na investiciju, a poverenje u sigurnost investiranja izgrađuje se kroz neprekidno poboljšanje poslovne klime i ekonomski napredak privreda u koje se ulaže (Hanson, 2001). Takođe, ekonomska teorija identifikuje i brojne, raznolike benefite za zemlje domaćine SDI (Blomström & Kokko, 1998; Forte & Moura, 2013). Smerovi empirijskih istraživanja, kada su pitanju teme ekonomskog rasta, institucija i SDI, uglavnom se oslanjaju na analizu u parovima, uz retki osvrt na interakciju ovih varijabli. Pored toga, najveći broj analiza sproveden je na primeru zemalja EU, dok su istraživanja fokusirana na zemlje Zapadnog Balkana

* *Korespodencija:* S. Manić, Univerzitet u Beogradu, Ekonomski fakultet, Kamenička 6, 11000 Beograd, Republika Srbija; e-mail: slavica.manic@ekof.bg.ac.rs

raritetna (uglavnom zbog problema sa dostupnošću i kvalitetom podataka). Motivacija za ovaj rad proistekla je upravo iz težnje da se, kroz identifikaciju mehanizama koji su na snazi kada su u pitanju interakcija SDI, institucija i ekonomske aktivnosti za zemlje Zapadnog Balkana, pruži doprinos i popuni gore navedena praznina u relevantnoj literaturi. Naša je namera da, ekonomskom interpretacijom rezultata dobijenih kvantitativnim metodama (koje se mogu primeniti na baze podataka sa brojnim ograničenjima kakva su prisutna kada je u pitanju statistika regiona), omogućimo sticanje uvida u slaganje ili odstupanje realnosti od ekonomske teorije o benefitima priliva SDI i kvaliteta institucija za zemlje Zapadnog Balkana.

Izbor metodologije primerene istraživanju opredeljen je, između ostalog, i osobenostima samog regiona. Generalno posmatrano, Zapadni Balkan beleži značajne i rastuće prilive SDI tokom perioda 2007-2022 (World Bank, 2024a). Po ukupnom prilivu SDI (naročito u poslednjih deset godina), Srbija dominira (sa udelom od oko 60%), dok se prosečni udeli u navedenom periodu kreću u rasponu od 3,2% BDP-a, koliko iznosi učešće SDI u Bosni i Hercegovini, do 14,9% BDP-a, koliko pomenuto učešće iznosi u Crnoj Gori. I struktura SDI, po industriji u koju se investira i zemlji porekla, varira od zemlje do zemlje. Značajan udeo prerađivačke industrije u poslednjih pet godina beleži se u Bosni i Hercegovini, Severnoj Makedoniji i Srbiji (Eurostat, 2024). Pojedinačno najveći investitori u skorijem periodu (2021-2023) za Albaniju, Bosnu i Hercegovinu, Severnu Makedoniju i Srbiju su, respektivno, Holandija, Ujedinjeno Kraljevstvo, Turska i Kina, a Evropska unija kao entitet ostaje najznačajniji investitor za region u celosti (Eurostat, 2024). Kvalitet institucija takođe ispoljava varijacije. Njegovo kretanje, mereno kroz indikatore Svetske banke (World Bank, 2024c), poprilično je volatilno, uz periode poboljšanja i periode pogoršanja koji se smenjuju. S druge strane, ekonomski rast, meren realnim rastom BDP-a u istom periodu, znatno je manje raspršen i kreće se u rasponu od 2,4% do 3,3% (World Bank, 2024b). Na osnovu navedenih podataka, jasno je da je reč o regionu koji pokazuje izvesni stepen heterogenosti, ali uz prisutan značajan broj zajedničkih faktora (istorijskih, geografskih i ekonomskih, koje su i dalje predmet interesovanja - npr. Jano, 2022), te je kao takav pogodan za neki oblik analize podataka panela. Panelskom strukturom donekle se umanjuju nedostaci pojedinačnih baza podataka za svaku od zemalja (o kojima će više reči biti u nastavku), ali i otvara prostor za kompleksnije analize zahvaljujući većem broju opservacija.

U radu će biti testirane sledeće hipoteze:

H1: Priliv SDI je statistički značajna varijabla u objašnjenju rasta BDP-a zemalja Zapadnog Balkana.

H2: Kvalitet institucija pojačava efekat priliva SDI na rast BDP-a.

H3: Varijabla interakcije priliva SDI i kvaliteta institucija pozitivno utiče na stopu rasta BDP-a zemalja Zapadnog Balkana.

Navedene hipoteze će biti testirane korišćenjem metode uopštenih najmanjih kvadrata na panelskim podacima u programu STATA.

Strukturu rada, pored uvodnih napomena, sačinjavaju osvrt na relevantnu literaturu, pregled korišćenih indikatora i dostupnih podataka, ocena modela panela u tri iteracije (bez efekta kvaliteta institucija, sa indikatorom institucionalnog kvaliteta, sa varijablom interakcije SDI i kvaliteta institucija), i zaključna razmatranja.

PREGLED LITERATURE

Niz radova poslednjih godina bavi se efektima SDI na ekonomsku aktivnost, od kojih se neki bave ispitivanjem validnosti rasta vođenog SDI (Kisswani, Kein & Shetty, 2015; Lee & Dolfriandra, 2020), odnosno oslanjanja na ovakav vid investiranja, koji je veoma zastupljen i u zemljama Zapadnog Balkana, kao i efektima na domaće investicije (Sucubasi, Trenovski, Imeri & Merdzan, 2021). S druge strane, iako broj radova koji se bavi efektom koji institucije imaju na tokove SDI na primeru regiona Zapadnog Balkana nije veliki, zapažanja i uvidi istih predstavljaju nesumnjiv doprinos relevantnoj literaturi i važnu polaznu osnovu za naše istraživanje. Tako na primer, T. Stevanović, I. Marković i V. Lepojević (2022) koriste

pristup modela panela kako bi utvrdili važnost institucija za privlačenje stranog kapitala u zemljama Zapadnog Balkana. Glavni zaključak do kog dolaze je da su za posmatrane zemlje Zapadnog Balkana ekonomske koristi od SDI realne, ali ne i automatski ostvarive, već da zavise od kvaliteta poslovnog okruženja.

Jedan od radova koji posredno koristi indikator institucija odnosi se na proučavanje uticaja kompozitnog indeksa inovacija na konkurentnost privreda Zapadnog Balkana. I. Stojanović, A. Puška i M. Selaković (2022) analizirali su efekat inovacija u zemljama zapadnog Balkana koristeći GII (*Global Innovation Index*) u periodu 2019-2021. GII kvantifikuje sveobuhvatan inovacijski efekat zemalja i sastoji se od indikatora institucija, ljudskog kapitala, infrastrukture, sofisticiranosti tržišta i poslovanja. Autori su rangirali zemlje Zapadnog Balkana prema vrednosti pomenutog indeksa, pri čemu je najbolji rezultat zabeležila Crna Gora, koja i prema bazi Svetske Banke za indikatore upravljanja (*World Governance Indicators*) ima najbolju sveobuhvatnu prosečnu vrednost indikatora institucija u periodu 2007-2022.

R. Desbordes i V. Vicard (2009) takođe postavljaju pitanje kauzalnosti kvaliteta institucija i priliva SDI, i jedan od zaključaka do kojeg dolaze je da profit od SDI značajno zavisi od kvaliteta političkih odnosa zemlje porekla i zemlje u koju se investira. Slično, A. Dorakh (2022) postavlja tezu o značaju povezanosti zemalja EU i zemalja kandidata za članstvo kada su u pitanju tokovi SDI, zaključivši da su stare zemlje članice EU generalno neto investitori, dok su nove zemlje članice EU, zemlje kandidati i novi kandidati za EU (gde spadaju i zemlje Zapadnog Balkana) generalno neto primaoci intraevropskih SDI. Baveći se procesom pristupanja EU i efektom na SDI, L. Benfratello, A. D'Ambrosio, A. Sangrigoli i G. Scabbia (2022) u svojoj analizi pokušavaju da izdvoje efekte koje različite faze procesa pristupanja EU (predpregovaračka faza, pregovaračka faza, odobrenje i efektivno članstvo), mogu imati na verovatnoću da neka zemlja u balkanskom regionu privuče SDI. Autori su pokazali da su sve faze povezane sa pozitivnim prirastom SDI i identifikovali "efekat očekivanja" koji se javlja u fazi odobrenja i utiče i na evropske i na vanevropske investicije. Ovaj rezultat naglašava važnost kako stvarnog, tako i potencijalnog članstva u EU pri odlučivanju o investiranju u zemlje Balkana. Jedini izuzetak je negativan uticaj članstva u EU na lokaciju SDI u prerađivačkoj industriji.

A. Hayat (2019) se bavi pitanjem uloge koju kvalitet institucija ima kada je u pitanju ekonomski rast zemlje. Dodatno, on postavlja pitanje koliko se uticaj institucija prenosi na ekonomski rast kroz kanal stranih direktnih investicija. Baza podataka korišćena u ovom radu broji 104 zemlje, te je kao takva pogodna za korišćenje uopštenog metoda momenata za dinamičko modeliranje podataka panela. Na osnovu podatka korišćenih u GMM modelu zaključuje se da SDI imaju pozitivan uticaj na ekonomsku aktivnost u državama sa niskim i srednjim nivoom dohotka, dok kod zemalja sa visokim dohotkom SDI beleže negativan doprinos. Kvalitet institucija pozitivno utiče na ekonomsku aktivnost bez obzira na nivo dohotka, ali je efekat poboljšanja kvaliteta institucija značajniji u zemljama sa niskim i visokim dohotkom u poređenju sa zemljama sa srednjim nivoom dohotka. Konačno, veći kvalitet institucija dodatno pojačava pozitivan efekat priliva SDI na ekonomsku aktivnost u zemljama niskog i srednjeg dohotka. Slično, S. Arsov i A. Naumoski (2024) nalaze da institucionalno okruženje igra važnu ulogu u privlačenju stranih investitora u zemljama EU, pošto su SDI znatno veće u zemljama sa manje korupcije, efektivnijom upravom, i većim poverenjem u pravni sistem, takođe korišćenjem GMM modela.

Posebno interesantan jeste rad novijeg datuma (Smolo, 2023) koji se upravo bavi efektom SDI, institucija i njihove interakcije na ekonomsku aktivnost u Zapadnom Balkanu. Analiza autora pokazuje da strane investicije i institucije negativno utiču na ekonomski rast regiona. Dodatno, kada se strane investicije kombinuju sa indikatorom razvoja institucija, oba faktora, uključujući njihovu interakciju, pokazuju negativan (iako statistički nesignifikantan) uticaj na ekonomski rast.

Ovaj rezultat je usko povezan sa temom institucionalne arbitraže, koja, prema M. Perkmann, N. Phillips i R.

Greenwood (2022), označava „kako akteri ostvaruju korist spajanjem nekompatibilnih institucionalnih logika". Iako pojam potiče iz finansija, može se šire primeniti, tj. na bilo koji pokušaj iskorišćavanja postojećih razlika. Kao takav, primenljiv je na situaciju prikazanu u prethodno pomenutom radu, s obzirom na to da zemlje Zapadnog Balkana imaju koristi od toga što nisu unapredile svoje institucionalne okvire, bilo namerno ili ne (što je jedno od pitanja).

Korišćeni modeli u relevantnoj literaturi uglavnom se baziraju na nekoj primeni metoda panela, bilo dinamičkoj ili ne, dok je sam izbor konkretnog modela za naš rad u velikoj meri ograničen karakteristikama baze podataka, što će biti pokazano u nastavku.

PODACI, VARIJABLE I OCENA MODELA

Modeliranje efekta SDI i institucija na realni rast BDP-a, kroz pojedinačni i zajednički efekat, sprovodi se na osnovu panelske baze podataka koja sadrži pet zemalja, vremenske dimenzije koja obuhvata period od 16 godina i sa šest potencijalnih pojedinačnih objašnjavajućih varijabli (isključujući zajednički efekat). Početni okvir potencijalnih objašnjavajućih varijabli sadrži kontrolne varijable za koje očekujemo da u nekoj meri imaju objašnjavajuću moć kada je u pitanju modeliranje rasta ekonomske aktivnosti kroz indikator rasta realnog BDP-a, a isti je odabran na bazi modela ocenjenih u relevantnim radovima poput T. Stevanović *et al* (2022) i A. Hayat (2019). U ovom slučaju dodatno ograničenje nametnuto je relativno malom bazom podataka, imajući u vidu da je glavni cilj rada da ustanovimo efekte i dejstva i sadejstva indikatora SDI i institucija kada su u pitanju zemlje Zapadnog Balkana. Iz navedenih razloga skup potencijalnih regresora čine indikatori fiksnih investicija, državne potrošnje i obima spoljne trgovine kroz logaritmovane vrednosti učešća u BDP-u kao kontrolne varijable, a zatim i varijable od interesa za ovaj rad - učešće SDI u BDP-u i kompozitna mera institucionalnog kvaliteta (prosek ocena koju zemlje dobijaju u okviru WGI (*World Governance Indicators*), kao i varijabla njihove interakcije (za detaljan opis videti Tabelu 1). Grupu zemalja obuhvaćenih analizom sačinjavaju Albanija, Bosna i Hercegovina, Severna Makedonija, Crna Gora i Srbija.

U procesu pripreme baze podataka za ocenjivanje, varijable su testirane za prisustvo jediničnog korena koristeći Im-Pesaran-Šinov test jediničnog korena (Tabela 2), koji je pokazao da su logaritmovane vrednosti kontrolnih varijabli i netransformisane vrednosti varijabli SDI i institucija stacionarne.

Provera postojanja multikolinearnosti ukazuje na postojanje potencijalno statistički značajne korelacije fiksnih investicija i državne potrošnje, što je donekle očekivano imajući u vidu i dalje značajni doprinos državnih investicija ekonomskom rastu u zemljama Zapadnog Balkana. Potencijalno značajna korelacija postoji i između indikatora obima spoljne trgovine i ostalih kontrolnih varijabli. Kako bi se ispitao ukupan značaj ovih korelacija kada je u pitanju efekat na model koristimo analizu faktora inflacije varijanse (*VIF, variance inflation factors* - Tabela 3) koja se bazira na odnosu varijansi u modelu koji sadrži više regresora naspram modela sa samo jednim regresorom. Kao i kod izračunavanja stepena korelacije, i kod ove analize ne postoji konsenzus kada je u pitanju prag tolerancije. Imajući u vidu da individualne vrednosti ovog testa kao i njegova ukupna vrednost nalaze između 1 i 5, čak i kad se držimo konzervativnijih smernica, može se zaključiti da problem multikolinearnosti nije presudan kada je u pitanju modeliranje ovih varijabli. Sve kontrolne varijable imaju značajan stepen korelacije sa zavisnom. S druge strane, varijable SDI i institucija pokazuju značajniji stepen međusobne korelacije, ali ne i korelacije sa zavisnom varijablom. Recipročna korelacija između varijabli FDI i institucija može predstavljati problem endogenosti koji se najbolje može rešiti pomoću GMM modela. Nažalost, dostupni skup podataka nije pogodan za takvu analizu jer je broj raspoloživih opservacija relativno mali (80 u T i N dimenzijama) i reč je o „dugačkom panelu" u kojem T dimenzija dominira nad N dimenzijom. S druge strane, koeficijent korelacije manji od 0,5 ne mora nužno predstavljati problem, naročito u kombinaciji sa prilično niskom VIF vrednošću (manjom od 1,5). U tom kontekstu, koristi od primene odgovarajućeg kvantitativnog okvira na tako ograničene podatke

Tabela 1 Pregled varijabli

Varijabla	Opis	Izvor
BDP	Stopa rasta bruto domaćeg proizvoda.	Eurostat
SDI/BDP	Učešće priliva stranih direktnih investicija u BDP-u.	Eurostat
Fiksne investicije/BDP	Učešće fiksnih investicija (investicija u građevine, mašineriju, opremu, softvere, književne i umetničke originale, i slično) u BDP-u.	Eurostat
Državna potrošnja/BDP	Ukupna državna potrošnja na dobra i usluge izražena kao učešće u BDP-u.	World Bank (2024b)
Obim spoljne trgovine/BDP	Ukupna vrednost izvoza i uvoza dobara i usluga izražena kao procenat BDP-a.	World Bank (2024b)
Institucije	Kompozitni indikator sačinjen od narednih šest indikatora:	
Vladavina zakona	Mera poverenja u poštovanje pravila, posebno onih koja tangiraju sprovođenje ugovornih obaveza, poštovanje imovinskih prava, poverenje u policiju i sudove, kao i verovatnoću kriminala i nasilja.	World Bank (2024c)
Kontrola korupcije	Indikator meri obim u kome se javna vlast koristi za privatnu dobit, uključujući krupnije i sitnije oblike korupcije, kao i „zarobljavanje" države od strane elita i privatnih interesa. Takođe meri snagu i efikasnost politike i institucionalnog okvira zemlje za sprečavanje i borbu protiv korupcije.	World Bank (2024c)
Regulatorni kvalitet	Percepcija sposobnosti vlade da formuliše i primeni zdrave politike i propise koji dozvoljavaju i promovišu razvoj privatnog sektora.	World Bank (2024c)
Efektivnost Vlade	Percepcije o kvalitetu javnih usluga, kvalitetu državne službe i stepenu njene nezavisnosti od političkih pritisaka, kvalitetu formulisanja i sprovođenja politike, kao i kredibilitet vladine posvećenosti takvim politikama.	World Bank (2024c)
Politička stabilnost i odsustvo nasilja	Percepcija verovatnoće političke nestabilnosti i/ili politički motivisanog nasilja, uključujući terorizam.	World Bank (2024c)
Pravo glasa i odgovornost	Percepcija u kojoj meri građani zemlje mogu da učestvuju u izboru svojih predstavnika, da li su mediji slobodni, te da li su prisutne slobode izražavanja i udruživanja.	World Bank (2024c)

Izvor: Eurostat, World Bank

donekle prevazilaze rizike pristrasnosti uzrokovane endogenošću, barem dok ne bude dostupno više podataka za prevazilaženje takvih izazova.

Testiranje na prisustvo autokorelacije u panelu Wooldrige-ovim testom ukazuje na statistički značajnu autokorelaciju u bazi podataka koja mora biti uzeta u obzir prilikom modeliranja (vrednost test statistike 6,238, i prateća p-vrednost 0,066). Imajući u vidu dugu strukturu panela (T > N), nameće se upotreba metode uopštenih najmanjih kvadrata (UNK) u modeliranju panelskih podataka, koja je, shodno D. Hoechle (2007), posebno korisna u slučaju prisutne autokorelacije. Slično, neophodno je proveriti da li je u podacima prisutna heteroskedastičnost. Budući da korišćenje uopštenih najmanjih kvadrata, kao metode za ocenjivanje parametara modela

Tabela 2 Rezultati testova stacionarnosti varijabli

IPS test stacionarnosti	
Objašnjavajuća varijabla	Vrednost Statistike
Fiksne investicije/BDP	-3,901 (0,000)
Državna potrošnja/BDP	-3,924 (0,000)
SDI/BDP	-3,406 (0,000)
Obim spoljne trgovine/BDP	-4,762 (0,000)
Institucije	-2,01 (0,018)

Napomene: U zagradama su date p-vrednosti. Ho: Paneli sadrže jedinične korene.

Izvor: Autori

Tabela 3 Pregled koeficijenata korelacije i mere VIF

Koeficijenti korelacije	BDP	Fiksne investicije/ BDP	Državna potrošnja/ BDP	SDI/BDP	Obim spoljne trgovine/ BDP	Institucije	VIF
BDP	1						
Fiksne investicije/BDP	0,254	1					1,32
Državna potrošnja/BDP	-0,518	0,224	1				1,45
SDI/BDP	0,039	-0,050	0,062	1			1,32
Obim spoljne trgovine/BDP	0,644	0,301	-0,421	-0,157	1		1,55
Institucije	-0,060	-0,041	-0,020	0,470	-0,033	1	1,29
							Mean VIF: 1,38

Izvor: Autori

panela, svakako daje ocene po metodi maksimalne verodostojnosti, lako je primeniti LR test, koji ukazuje na prisustvo heteroskedastičnosti (vrednost test statistike 13,81, i prateća p-vrednost 0,008). Dakle, radi se o bazi podataka u kojoj su prisutne i autokorelacija i heteroskedastičnost. Konačno, potrebno je sprovesti i test zavisnosti uporednih podataka. Prema R. E. De Hoyos i V. Sarafidis (2006), struktura „dugog" panela (u kom je broj jedinica posmatranja manji od broja perioda) upućuje na korišćenje Pesaranovog CD testa na prisustvo zavisnosti uporednih podataka, čiji su rezultati predočeni u Tabeli 4.

Očigledno je da se u modeliranju podataka panela moraju uzeti u obzir autokorelacija, heteroskedastičnost i postojanje međuzavisnosti između panelskih jedinica, kao i činjenica da je u pitanju panel sa strukturom T > N. Sva navedena ograničenja moguće je uzeti u obzir korišćenjem *xtgls* komande u STATA programu, čijom upotrebom se dobijaju robusne (ali optimistične) standardne greške (Hoechle, 2007). Dodatno, ocenjuju se sledeća tri modela:

$$Y_{it} = const + \beta X_{it} + \gamma SDI_{it} + \varepsilon \quad (1)$$

$$Y_{it} = const + \beta X_{it} + \gamma_1 SDI_{it} + \gamma_2 Inst_{it} + \varepsilon \quad (2)$$

$$Y_{it} = const + \beta X_{it} + \gamma_1 SDI_{it} + \gamma_2 Inst_{it} + \gamma_3 (SDI_{it} \times Inst_{it}) + \varepsilon \quad (3)$$

U sve tri jednačine X_{it} označava matricu kontrolnih varijabli. U modelu (1), pored matrice kontrolnih varijabli uključena je i varijabla SDI kao objašnjavajuća varijabla, zatim u iteraciji (2) i varijabla institucija, i konačno u iteraciji (3) varijabla njihove interakcije.

Tabela 4 Rezultati testa zavisnosti uporednih podataka

CD test zavisnosti uporednih podataka panela	
Objašnjavajuća varijabla	Vrednost statistike
Fiksne investicije/BDP	3,537 (0,000)
Državna potrošnja/BDP	6,027 (0,000)
SDI/BDP	1,982 (0,048)
Obim spoljne trgovine/BDP	9,637 (0,000)
Institucije	4,449 (0,000)

Napomene: U zagradama su date p-vrednosti. Ho: Uporedni podaci panela su nezavisni.

Izvor: Autori

REZULTATI I DISKUSIJA

Rezultati ocene navedenih modela dati su u Tabeli 5. Inicijalni model (1) sadrži samo kontrolne varijable, i na osnovu njega se može zaključiti da su svi indikatori, izuzev učešća fiksnih investicija u BDP-u, statistički značajni kada je u pitanju modeliranje realnog rasta BDP-a. Što se tiče predznaka koeficijenata, indikatori SDI i obima spoljne trgovine imaju očekivani pozitivni predznak, imajući u vidu da bi trebalo da pozitivno utiču na ekonomski rast. S druge strane, indikator državne potrošnje beleži negativni koeficijent. Literatura o očekivanom efektu državne potrošnje na ekonomsku aktivnost nije homogena. S jedne strane, očekuje se da će veća državna potrošnja stimulisati privredu, i kao takva trebalo bi da beleži pozitivni doprinos, makar kroz neke njene segmente poput ulaganja u obrazovanje (Hansson & Henrekson, 1994). S druge strane, preveliki državni sektor može negativno uticati na privrednu aktivnost, uz brojne razloge poput neefikasnih investicija i preobimnih socijalnih davanja (Kutasi & Marton, 2020). Dodatno, mora se uzeti u obzir činjenica da vremenski raspon obuhvaćen bazom podataka (2007-2022) sadrži nekoliko izazovnih perioda za zemlje Zapadnog Balkana koje su uključene u analizu. U datom periodu beleže se efekti finansijske krize, nekoliko vremenskih nepogoda, pandemija i pojačane geopolitičke tenzije, tokom kojih je očekivana veća državna potrošnja kako bi se pomenuti negativni efekti donekle neutralisali. Kako državna potrošnja nije potpuno (a nekad ni većinski) efikasna u ovom poduhvatu, u nizu perioda beležiće se slab rast ekonomske aktivnosti u paru sa velikim udelom državne potrošnje. Nominalno bi duža vremenska serija neutralisala efekat ovih lomova, ali zbog njihovog obima, rasprostranjenosti i intenziteta, kao i ograničene dostupnosti podataka, baza podataka će neminovno biti opterećena ovim problemom.

U drugoj iteraciji modela uključuje se efekat institucija na ekonomsku aktivnost, i uočava se njegov statistički značajan doprinos. Negativan predznak koeficijenta uz investicije zahteva dodatno pojašnjenje. Naime, kod svih zemalja izuzev Crne Gore prisutna je negativna srednja vrednost varijable institucija u rasponu od

Tabela 5 Rezultati ocenjenih modela

	Metoda UNK sa panelski-specifičnom autokorelacijom tipa AR(1) i korekcijom za heteroskedastičnost i zavisnost uporednih jedinica			
Objašnjavajuća varijabla	(1)	(2)	(3)	(4)
Fiksne investicije/BDP	3,499 (2,237)	3,387 (2,193)	2,078 (2,363)	
Državna potrošnja/BDP	-20,556*** (3,730)	-20,021*** (3,769)	-21,341*** (3,856)	-21,208*** (3,790)
SDI/BDP	0,063* (0,038)	0,127 *** (0,049)	0,159*** (0,049)	0,138*** (0,043)
Obim spoljne trgovine/BDP	14,342*** (2,493)	15,421*** (2,523)	14,537*** (2,603)	14,872*** (2,403)
Konstanta	1,656*** (0,559)	0,775 (0,669)	0,739 (0,648)	1,076** (0,552)
Institucije		-2,552** (1,223)	-0,469 (1,547)	
Interakcija institucija i SDI			-0,595** (0,261)	-0,569*** (0,184)

Napomene: Broj opservacija za sve iteracije modela je 80. Zavisna varijabla u modelu je realni rast BDP-a. Wald-ov test sa nultom hipotezom o izostanku statističke značajnosti uključenih parametara odbacuje se za sve iteracije modela. *** Statistička značajnost koeficijenta na nivou od 1%. ** Statistička značajnost koeficijenta na nivou od 5%. * Statistička značajnost koeficijenta na nivou od 10%. Vrednost standardne greške data je u zagradi

Izvor: Autori

-0,08 do -0,36. Crna Gora beleži blago pozitivnu aritmetičku sredinu od 0,08. Od 80 opservacija, u svega 22 ustanovljene su nenegativne vrednosti indikatora institucija, od kojih je čak 15 zabeleženo u Crnoj Gori. Ovakav rezultat implicira veći pozitivan efekat institucija na ekonomsku aktivnost kada su institucije lošije ocenjene, te se postavlja pitanje na koji način se može interpretirati dobijeni nalaz. Jedan od razloga takvog rezultata može biti izostanak varijable koja uzima u obzir efekat konvergencije ka razvijenijim ekonomijama (tzv. *catch-up* efekat), kada zemlje sa nižim standardom, dohotkom, ili nižom zabeleženom stopom rasta beleže intenzivniji rast kada dođe do implementacije povoljnih politika. Institucije bi u tom slučaju bile proksi za početnu poziciju i njenu evoluciju, i samim tim pokazuju združeni efekat više izostavljenih indikatora. Za buduće analize korisno bi bilo ispitati sličnu formu predloženog modela uzimajući u obzir ne samo nivo institucionalnog kvaliteta, već njegovu promenu kroz vreme, čime bi se na bolji način mogao izolovati efekat poboljšanja institucionalnog okruženja. Za potrebe naše analize, ovakav rezultat pokušali smo da interpretiramo iz ugla SDI, daljim unapređivanjem modela.

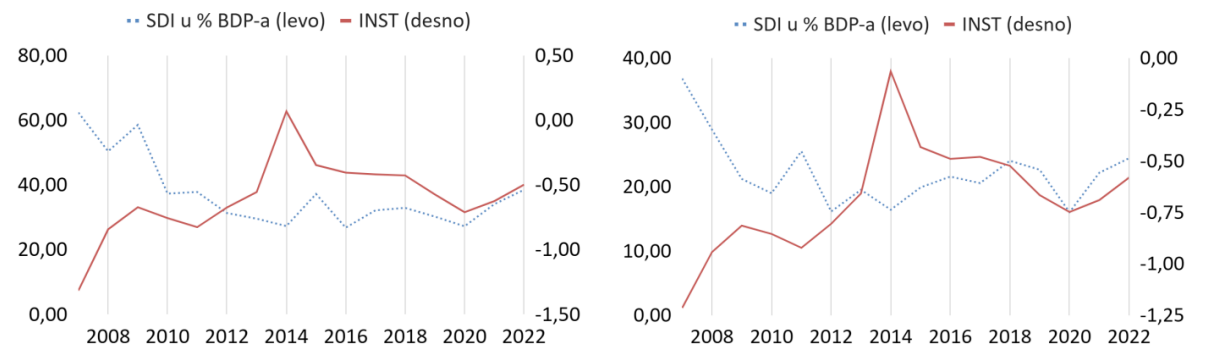
Stoga se, u trećoj iteraciji, uključuje i efekat interakcije SDI i varijable institucija. Varijabla interakcije nam omogućava da procenimo deo uticaja kvaliteta institucija na efekte SDI priliva kada je u pitanju ekonomska aktivnost. U takvoj specifikaciji modela, koeficijent uz priliv SDI pokazuje efekat na ekonomsku aktivnost ako se zanemari kvalitet institucija, i on iznosi 0,138. Ukupan efekat priliva SDI na ekonomsku aktivnost se dalje može razložiti na ovaj, direktni efekat, i efekat proizašao iz interakcije sa kvalitetom institucija. Kako bismo dobili ukupan efekat za pojedinačnu zemlju, neophodno je izračunati prosečnu vrednost kompozitnog pokazatelja kvaliteta institucija. Na primeru Srbije, možemo videti da je prosečna vrednost indikatora institucija -0,12. Efekat SDI se dakle može razložiti na direktni efekat koji je definisan koeficijentom uz varijablu SDI, i indirektni efekat koji je proizvod koeficijenta interakcije i prosečne vrednosti indikatora institucija, odnosno 0,068. Iz toga sledi da ukupan efekat SDI na stopu rasta BDP-a nije 0,138, već 0,206. Interesantno, identifikacijom posrednog efekta institucija kroz kanal SDI, institucije prestaju da imaju statistički značajan direktan efekat na rast BDP-a. Sličan rezultat prikazan je u A. Hayat (2019), s tim što se statistička značajnost ne gubi, već samo opada vrednost koeficijenta uz indikator investicija što je i očekivano izolovanjem efekta koji se manifestuje kroz kanal SDI.

Ovakav rezultat u trećoj i finalnoj iteraciji modela nam donekle može pomoći da identifikujemo potencijalne razloge za negativan predznak koeficijenta institucija, budući da se efekat „povoljnijih loših institucija'' sada manifestuje kroz kanal SDI, dok direktan efekat na ekonomsku aktivnost statistički nije značajan. Slično kao za direktni efekat, objašnjenje može biti u povoljnijoj klimi za strane investitore kada su u pitanju zemlje u razvoju i zemlje u usponu. Kao što je pokazano u A. Dorakh (2022), zemlje nove članice i zemlje u procesu pristupanja EU su generalno neto primaoci SDI, ne samo zbog potencijalnog većeg povrata na investiciju, manje konkurencije i manjih troškova, već i zbog izgrađenih odnosa između dve zemlje, investitora i domaćina.

Postoji još jedan ugao gledanja na ovakav rezultat, koji dovodi u pitanje navedene motivacije investitora, i implicira značajno drugačiju interpretaciju rezultata. Naime, u analizi koju su sproveli A. Pavlović M. Njegovan, A. Ivanišević, M. Radišić, A. Takači, A. Losonc i S. Kot (2021), balkanske zemlje su okarakterisane kao svojevrsna utočišta za strane zagađivače, uz zaključak da njihovo „slabije" ekološko zakonodavstvo, između ostalog, privlači SDI koje uz ekonomski rast donose zagađenje životne sredine. Interesantno, Crna Gora se izdvaja iz ove grupe zemalja koju čine i Slovenija, Grčka, Bugarska, Hrvatska i Rumunija, pored zemalja Zapadnog Balkana, kao zemlja koja ima odlično ekološko zakonodavstvo koje je doprinelo da bude označena kao nosilac „ekološkog oreola", što je u skladu sa rezultatima ovog modela i manjeg doprinosa SDI ekonomskoj aktivnosti kada je u pitanju crnogorska privreda ukoliko se uključi indirektan efekat institucija. Posmatrajući iz ovog ugla, manjak regulative i efikasnosti u sprovođenju zakona, veća sklonost ka korupciji, i odsustvo odgovornosti upravo bi bili razlozi za investiranje u zemlje Zapadnog Balkana, čime bi (kratkoročno) došlo do pozitivnog efekta na ekonomsku aktivnost.

Ovaj rezultat donekle je sličan rezultatu u E. Smolo (2023), pri čemu autor kao adekvatnu meru predlaže unapređenje infrastrukture i sprovođenje neophodnih ekonomskih prilagođavanja kako bi privukli više stranih investicija, što bi zauzvrat podržalo razvoj institucija i infrastrukture. Naša preporuka za prevazilaženje navedenih izazova oslanja se na privlačenje kvalitetnijih SDI, pre nego na njihovu brojnost. Sličan rezultat o uticaju institucija na ekonomsku aktivnost može se pronaći u N. Alimi i L. B. Dhiab (2023), u kom rezultati panelske analize ukazuju na negativnu vezu ekonomskog rasta i kvaliteta institucija. Međutim, oni takođe podvlače da ovakav rezultat ne sme osporiti značaj kvalitetnih institucija za dugoročni ekonomski napredak, već ukazuju na značaj izgradnje adekvatnog okruženja u kom će poboljšanje institucija biti moguće i neće ići na uštrb ekonomskog rasta. Takođe, ako se osvrnemo na rad L. Benfratello *et al* (2022) u kome je proces pristupanja EU povezan sa rastom priliva SDI, jedini izuzetak predstavlja prerađivačka industrija. Ukoliko proces pristupanja EU poistovetimo sa unapređenjem institucionalnog okruženja, implicirano je da je takav proces nepoželjan za investitore u prerađivačku industriju, čiji je udeo u zemljama Zapadnog Balkana najveći, a koja ima najveći potencijal za zagađivanje. Dodatno, analiza u S. Estrin i M. Uvalić (2016) ukazuje na nedostatak efekta prelivanja kada su u pitanju strane direktne investicije u prerađivačku industriju u zemljama Zapadnog Balkana, odnosno da nema statistički značajnog rasta dodate vrednosti, zaposlenosti ili izvoza u prerađivačkom sektoru, a kao potencijalni uzrok navode između ostalog i institucionalno okruženje navedenih zemalja. Da bi se testiralo da li rezultati predstavljeni u ovom radu važe za sve industrije, bilo bi korisno koristiti razložene kategorije SDI kao varijable, umesto ukupnih SDI. To bi predstavljalo validno unapređenje modela. Kvalitativno gledano, korisno je napomenuti da su prerađivačka industrija, građevinarstvo i rudarstvo činili preko 60% ukupnog priliva SDI u Srbiju tokom perioda 2021-2023 (Narodna banka Srbije, 2024), nešto više od 30% u Severnu Makedoniju (Narodna banka Republike Severne Makedonije, 2024) i nešto više od 40% u Bosnu i Hercegovinu (Centralna banka Bosne i Hercegovine, 2024). Podaci su dostupni samo za ove zemlje. Prerađivačka industrija dominira u sve tri, ali se struktura značajno razlikuje, što čini kvantitativno testiranje naophodnim za dobijanje smislenih rezultata. Nažalost, kako su podaci još više ograničeni kada se razlažu po granama, takvo testiranje bi bilo veoma izazovno za sprovođenje.

Na osnovu grafikona se može primetiti da kontraintuitivan odnos stranih direktnih investicija i kvaliteta institucija potencijalno slabi u skorijim



Grafik 1. SDI u % BDP-a i Kvalitet institucija, zemlje Zapadnog Balkana isključujući Crnu Goru (levo), i uključujući Crnu Goru (desno)

Izvor: Obračun autora na osnovu World Bank (2024a) i World Bank (2024c)

godinama. Ipak, ovu opservaciju treba tumačiti s oprezom, jer je posmatrani period u velikoj meri pod uticajem posledica pandemije COVID-19. Uprkos tome, moguće je da se u zemljama Zapadnog Balkana nazire pomak - onaj koji podržava i veći priliv SDI i institucionalni napredak.

Nalazi ovog rada ukazuju na potrebu za određenim prilagođavanjem na putu ka održivijoj budućnosti, uz regulatorni okvir koji bi zemlje Zapadnog Balkana više pozicionirao u skladu sa interesima „zelenijih" investitora. Koraci ka takvom rešenju možda su već preduzeti: prema J. Jung (2020), svaka promena politike u jednoj zemlji može imati značajne posledice za održivost u njenom neposrednom okruženju. Kako se Crna Gora ističe kao primer zemlje koja se dosledno pozicionira kao održivi lider u regionu, možemo se nadati efektima prelivanja i na ostatak Zapadnog Balkana. Imajući u vidu da su sve pomenute zemlje na putu ka članstvu u Evropskoj uniji, može se razumno očekivati da će usklađivanje regulativa sa EU standardima ubrzati neophodna prilagođavanja i u pogledu SDI. Još jedan potencijalni pravac za kreatore politika mogao bi se preuzeti iz rada X. Wang i Y. Luo (2020): vlade bi trebalo da intenziviraju napore u podizanju svesti o ciljevima zaštite životne sredine, naglase značaj ekološkog nadzora i strogo kontrolišu zagađenje koje potiče od privrednih subjekata, koristeći kombinaciju ekonomskih, administrativnih i pravnih mera. Svaka preporuka politike mora uključivati unapređenje regulatornog okvira u oblasti zaštite životne sredine, kao i poboljšanje ekološke procene stranih investicija kroz efikasne i adaptivne mehanizme praćenja.

ZAKLJUČAK

Ekonomska teorija sugeriše da priliv SDI i kvalitet institucija, svaka ponaosob, imaju pozitivan uticaj na ekonomski rast zemlje. Dalje zaključivanje dovelo bi nas do tvrdnje da onda svakako i njihova interakcija mora imati pozitivan uticaj na ekonomsku aktivnost. Ipak, budući da debata o ulozi priliva SDI na realni i dugoročni rast i razvoj zemalja još uvek nije završena, u ovom radu smo istraživali i dalje diskutabilno pitanje odnosa SDI i ekonomskog rasta kroz uticaj različitog kvaliteta institucija na taj odnos. Ocenjeni modeli imaju za cilj bolje razumevanje efekata navedenih varijabli u zemljama Zapadnog Balkana kao regiona koji je izazovan za modeliranje zbog svojih ograničenja i kompleksnosti. Za ocenjivanje modela panela korišćena je metoda uopštenih najmanjih kvadrata u programu STATA, uz korekciju za autokorelaciju, heteroskedastičnost i zavisnost uporednih podataka. Sve iteracije modela (bez efekta kvaliteta institucija, sa indikatorom institucionalnog kvaliteta, sa varijablom interakcije SDI i kvaliteta institucija) statistički su značajne. Na osnovu dobijenih rezultata panelskog modela potvrđuje se statistička značajnost i pozitivan efekat priliva SDI na stopu rasta BDP-a zemalja Zapadnog Balkana, pri čemu dolazi do pojačavanja ovog pozitivnog efekta kada se uzme u obzir i institucionalno okruženje, čime se potvrđuju sve tri hipoteze postavljene u uvodu ovog rada. S druge strane, smer uticaja varijable interakcije nije u skladu sa inicijalnim očekivanjima, budući da se tumačenjem finalnog modela dolazi do rezultata koji implicira pozitivan efekat manje kvalitetnog institucionalnog okruženja na ekonomsku aktivnost kroz kanal SDI. Jedno od objašnjenja ovakvog rezultata jeste teza da „slabije" zakonodavstvo (posebno ekološko) u zemljama Zapadnog Balkana privlači SDI koje uz ekonomski rast donose negativne eksterne efekte (zagađenje životne sredine), te zemlje regiona postaju svojevrsna skloništa za strane zagađivače. Činjenica je da je rast baziran na ovakvim osnovama kratkoročan, i da su neophodne dalje analize koje će potvrditi i produbiti, ili pak opovrgnuti navedene teze. Potencijalni načini za unapređenje analize iznete u ovom radu su brojni, a baziraju se, pre svega, na uključivanju dinamičkih kategorija kroz varijable promene indikatora, zatim na identifikaciji uticaja pojedinačnih indikatora institucija (a ne samo agregatnog pokazatelja), kao i na utvrđivanju varijabli koje mogu efikasno izolovati ekološki efekat dosadašnjeg priliva SDI u region Zapadnog Balkana. Izazovi u sprovođenju nekih od njih su detaljnije analizirani u samom radu (kao što je GMM modeliranje i razlaganje SDI po granama). Svakako, kompleksnije analize zahtevaju i obimnije baze podataka, te će tema obrađena u ovom radu biti

još jedna u nizu koja će u budućnosti imati koristi od dužih, konzistentnih i usklađenih vremenskih serija makroekonomskih, ali i alternativnih indikatora ekonomske aktivnosti i njenih pokretača. Kao što su brojne studije navodile, koristi od solidnih institucija su značajne, dok kratkoročni dobici koji proizilaze iz slabih institucionalnih okvira retko nadmašuju dugoročne prednosti. Potencijalna promena koju sugerišu skoriji trendovi je obećavajuća, ali se još uvek nije u potpunosti materijalizovala - i malo je verovatno da će se to dogoditi bez kontinuirane posvećenosti institucionalnom poboljšanju, posebno na duži rok.

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Iva Glišić je doktorand Ekonomskog fakulteta Univerziteta u Beogradu, gde je diplomirala (2020) kao student generacije na modulu Ekonomska analiza i politika i stekla zvanje master ekonomista (2023) na modulu Ekonometrija. Ključne oblasti njenog naučno-istraživačkog interesovanja su: primenjena makroekonomija, institucionalna ekonomija, ekonomski razvoj.

Slavica Manić je redovni profesor Ekonomskog fakulteta Univerziteta u Beogradu, gde je diplomirala, magistrirala i doktorirala. Izvodi nastavu na sledećim predmetima: Metode ekonomske analize, Uvod u institucionalnu ekonomiju, Ekonomika tranzicije (osnovne studije), Metodologija naučnog istraživanja, Politika konkurentnosti (master), Metode ekonomske analize, Strategija konkurentnosti (doktorske studije). Glavne oblasti njenog naučno-istraživačkog interesovanja su ekonomska metodologija, institucionalna ekonomija, ekonomski razvoj.

FOREIGN DIRECT INVESTMENT AND/OR INSTITUTIONS IN THE GROWTH FUNCTION OF THE WESTERN BALKANS: EXPECT THE (UN)EXPECTED

Iva Glišić and Slavica Manić

University of Belgrade, Faculty of Economics and Business, the Republic of Serbia

The economic literature is rich in papers analyzing the effects of FDI inflows or the impact of institutional quality on economic activity. The same is not true for analyzing the impact of institutional quality on FDI attraction and/or the joint impact of these two factors on economic growth, especially concerning the Western Balkans region. Our analysis covers five countries in this region over the period from 2007 to 2022 and aims to contribute to the relevant literature in that segment. The panel data were modelled using the GLS method. The result of the final model (out of the three evaluated) indicates an (un)expected positive effect of a lower institutional quality on economic activity through the FDI channel. One possible explanation for this finding is the hypothesis that "weaker" legislation (especially in the environmental field) in the Western Balkan countries attracts precisely the FDI that generates negative externalities in addition to economic growth. Nevertheless, it also suggests the necessity for considering the long-term risks associated with economic growth, relying predominantly on this type of FDI.

Keywords: foreign direct investment, institutions, economic growth, the Western Balkans

JEL Classification: E02, F21, O43, C33

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THE EURASIAN ECONOMIC UNION AT CROSSROADS: NAVIGATING TRADE INTEGRATION AND COMPETITIVENESS

Paskal Zhelev[1]* and Olga Malashenkova[2]

[1]*University of National and World Economy, Department of International Economic Relations and Business, Sofia, Bulgaria*
[2]*Minsk Branch of Plekhanov University of Economics, Minsk, Belarus*

This study investigates the Eurasian Economic Union (EAEU) as a regional economic integration bloc, analyzing its evolution, trade integration, and industrial policy framework amid shifting global dynamics. Established in 2015, the EAEU has encountered structural challenges, geopolitical upheavals, and intensifying sanctions, especially following the war in Ukraine. These pressures have disrupted trade flows, widened economic disparities among member states, and tested the bloc's cohesion. The paper emphasizes the fact that enhancing competitiveness is critical for the resilience of the EAEU, with the industrial policy serving as the cornerstone of this effort. Employing trade indicators, such as intra-regional trade shares and the Revealed Comparative Advantage (RCA) index, the study highlights uneven integration and dependence on resource-based exports. It evaluates the institutional framework of the EAEU's industrial policy, focusing on subsidy harmonization, value-added industry development, and coordination between national and regional priorities. Despite persistent institutional weaknesses and external pressures, the findings suggest that fostering industrial modernization and achieving better synergy between domestic policies and regional ambitions could strengthen the bloc's resilience and global competitiveness.

Keywords: Eurasian Economic Union, industrial policy, international competitiveness, regional economic integration, sanctions

JEL Classification: F15, L52, O24

INTRODUCTION

Amid complex global challenges, economic alliances have become vital strategies for fostering resilience and mutual benefit. Established in 2015 and comprising Armenia, Belarus, Kazakhstan, Kyrgyzstan, and Russia, the Eurasian Economic Union (EAEU) exemplifies this trend. By consolidating economic policies and reducing trade barriers, the EAEU seeks to build an integrated market that leverages collective strengths to drive growth and enhance competitiveness. The Union's tenth anniversary

* *Correspondence to:* P. Zhelev, University of National and World Economy, Department of International Economic Relations and Business, Sofia, Bulgaria
e-mail: pzhelev@unwe.bg

in 2025 provides a timely opportunity to assess integration outcomes and remaining challenges.

The EAEU offers a compelling case study due to its unique context - once part of the Soviet Union, its member states share deep historical, economic, and political ties; however, they are now faced with the complex challenge of balancing national sovereignty with regional integration. Russia's dominant role within the bloc creates a significant asymmetry, influencing the EAEU's internal cohesion and global economic positioning. Moreover, the EAEU aspires to establish itself as a competitive economic power bloc amid shifting global dynamics, making it a valuable lens through which to examine how emerging regional unions address challenges to competitiveness. This is particularly critical for the EAEU, as its long-term viability depends on its ability to deliver tangible economic benefits to its member states, ensuring their continued commitment to the integration project.

Recent global events, including the COVID-19 pandemic and Russia's war in Ukraine, have tested the bloc's resilience. These crises disrupted supply chains, strained economies, and exacerbated geopolitical tensions. Sanctions on Russia and shifts in global alliances further destabilized the EAEU, exposing disparities in its member states' positions and questioning the bloc's capacity to remain cohesive. Additionally, competition for foreign investments and trade opportunities undermines regional collaboration, hindering deeper integration (Krapohl, 2019).

Studying the EAEU is particularly important as countries such as Georgia and Moldova continue to weigh strategic dilemmas akin to the one Ukraine confronted, deciding between deeper ties with the EAEU or alignment with the European Union (EU). This issue is also relevant for Serbia, whose prospective EU accession would require the termination of its free trade agreement with the EAEU. These scenarios underscore the intricate geopolitical and economic trade-offs countries face when balancing competing integration blocs - the choices that profoundly shape their strategic alignments and future development trajectories.

The paper examines the EAEU's trade integration and external competitiveness in the first decade of its operation. The goal is to assess the extent and evolution of intra-regional exchange and the Union's position in world markets under heightened geopolitical and economic stress. Specifically, the study poses the following research questions: (RQ1) Has intra-EAEU trade deepened since the Union's formation in 2015, and how uneven is this integration across the member states? (RQ2) Has the EAEU's global competitiveness improved, as indicated by world-export shares, external-market concentration, and the trade balance? (RQ3) Is structural upgrading underway - namely a shift in comparative advantages from resource-dependent sectors towards more diversified, higher-value-added, and more technology-intensive exports, as proxied by changes in sectoral specialization? (RQ4) What observable advances and persistent gaps characterize the EAEU's industrial-policy coordination to date? To address these questions, the paper adopts a mixed-method design combining quantitative trade indicators - specifically intra-regional export shares, the Union's and member states' shares in world exports, export/import (X/M) ratios, and the revealed comparative advantage (RCA) index - with a qualitative appraisal of industrial-policy coordination across the EAEU member states, guided by an institutional and political-economy perspective on regional integration and competitiveness. The findings aim to deepen the understanding of regional integration under asymmetric power conditions and to inform policy efforts to strengthen competitiveness within the EAEU.

The remainder of the paper comprises a review of the evolution and institutional architecture of the EAEU, an outline of the data and the indicators, a presentation of the results on intra-EAEU trade integration in a comparative perspective, market shares, trade balances, and sectoral specialization, a review of industrial-policy coordination, and the conclusion, including implications and limitations.

THE HISTORY AND EVOLUTION OF THE EURASIAN ECONOMIC UNION

The Eurasian Economic Union (EAEU) traces its origins to the dissolution of the Soviet Union in 1991, which left newly independent states grappling with economic instability and transitioning to market economies. The establishment of the Commonwealth of Independent States (CIS) in 1991 marked an early attempt at regional economic cooperation. However, the CIS struggled due to political conflicts, ideological divides, and economic devastation, leading to its limited success as an integration mechanism (Verdiyeva, 2018; Zhelev & Garashchuk, 2019).

A pivotal moment in post-Soviet regionalism came in 1994, when Kazakhstan's President, Nursultan Nazarbayev, proposed the creation of the Eurasian Union so as to strengthen economic ties. Progress was slow, with the initiatives like the Free Trade Area hindered by a lack of consensus, particularly from Russia. However, renewed efforts led to the establishment of the Eurasian Economic Community (EurAsEC) in 2000, comprising Belarus, Kazakhstan, Kyrgyzstan, Russia, and Tajikistan. EurAsEC aimed to create the Customs Union and Single Economic Space, advancing economic cohesion through qualified majority voting, rather than by consensus (Vinokurov, 2018).

The ambition for a stronger union took a significant step forward in 2006, with Russia, Kazakhstan, and Belarus proposing a new customs union (CU), which laid the groundwork for a unified legal framework to replace individual national laws, marking a crucial progression towards an integrated region. The launch of the Common Customs Tariff among the three principal promoters of integration commenced in 2010, marking the beginning of the CU. Therefore, it can be viewed that the CU served as an important antecedent to pave way for the establishment of the EAEU.

The efforts to integrate more deeply culminated in the formation of the EAEU in January 2015, following the signing of an agreement in January 2012 intended to establish the Single Economic Space (SES), harmonizing the economic and trade policies of the member states. Before the Treaty on the Union, signed in Astana in May 2014, took effect, Armenia and Kyrgyzstan submitted applications for admission. They were subsequently accepted as members in January 2015 and August 2015, respectively.

Article 1 of the Founding Treaty states that, within the EAEU, "the free movement of goods, services, capital, and labor is guaranteed, along with the implementation of coordinated, harmonized, or unified policies in certain economic sectors," outlining the establishment of an international organization for regional economic integration that constitutes an economic union.

The institutional framework of the EAEU facilitates supranational governance through several key bodies. The Supreme Eurasian Economic Council (SEEC), comprising the heads of state, sets strategic directions and rotates meetings annually to share leadership. The Eurasian Intergovernmental Council (EIC), made up of the heads of government, oversees the implementation of the EAEU Treaty, meeting at least twice a year. The Eurasian Economic Commission (EEC), based in Moscow, acts as the regulatory body, handling integration proposals, compliance, and areas like customs and competition policy. It includes the Council (deputy prime ministers) and the Board (ministers from each state), with authority to issue binding decisions. The Court of the EAEU, located in Minsk, ensures legal consistency by interpreting the Treaty and resolving disputes. The Financial Regulatory Authority is planned for Kazakhstan to oversee financial markets but remains unestablished. The geographical distribution of these bodies, alongside the rotational meetings of the SEEC and EIC, reflects the Union's commitment to equitable partnership, balancing the influence among the member states, reducing potential sovereignty conflicts, and enhancing the integration infrastructure.

The EAEU Treaty defines three policy types: unified, coordinated, and harmonized. Unified policies apply uniformly across all the member states, coordinated policies align national strategies without full

unification, and harmonized policies standardize regulations while allowing for national adaptations. Although this flexible approach accommodates differing levels of integration, critics argue it can create legal ambiguities, hinder deeper integration and reduce overall effectiveness.

However, at present, the EAEU cannot even be characterized as a common market due to the existing barriers to the free intra-regional exchange of products and production factors, as well as varying national standards concerning products and resources from third countries. Although the Union's Founding Treaty proclaims the goal of creating a common market, which ultimately should include services and production factors, it lacks provisions for specific measures covering areas beyond goods trade. The expansion of economic integration into realms beyond the trade of goods is seen as a task for "secondary legislation" stemming from the decisions of the EAEU's bodies, which have been scarce or ineffectively implemented so far (Mukhametdinov 2020).

In the area of the free movement of goods, integration within the EAEU is at its most advanced stage, yet progress has not been achieved easily. For example, the EAEU Customs Code (CC) was supposed to come into effect at the beginning of 2016, but its adoption was delayed, forcing economic agents to adhere to various national rules and international agreements, thus presenting a significant administrative barrier to mutual trade. The original Customs Code that had been in place before the creation of the EAEU was plagued by administrative barriers and inconsistencies in regulations. Following the resolution of discussion points at an intergovernmental council attended by the prime ministers of the five member states, a treaty for the EAEU CC was signed on 11th April 2017, which codified all the previously concluded international treaties governing customs relations and all the current customs procedures and technologies. A new EAEU CC was adopted, entering into force on 1st January 2018. The primary goal of this new code was to simplify the customs processes and speed up the customs clearance while removing administrative obstacles among the member nations. The Code introduced several key innovations aimed at optimizing external trade regulations and maintaining a balance of interests between the state authorities and the business community, namely electronic customs declarations, automated operations, shorter timeframes for the release of goods, authorized economic operators, and a "single window" system for services (EDB Centre for Integration Studies, 2019). However, the empirical evidence suggests that, despite such trade-facilitating measures, the EAEU's impact has mainly been confined to boosting mutual trade flows so far, without significant effects on the GDP growth, consumption, or capital formation, and with an even negative influence on employment (Pomerlyan & Belitski, 2024).

Within the EAEU's internal markets, the member states encounter various obstacles that hinder the free movement of goods, services, capital, and labor (see Table 1). These obstacles are classified into three categories (Eurasian Economic Commission, 2023):

Table 1 Obstacles in the EAEU internal market (2015-2024)

	2015	2016	2017	2018	2019	2020	2021	2024
Obstacles	259	60	62	65	71	66	59	50
Barriers	19	9	8	11	16	15	11	1
Restrictions	45	34	37	37	38	37	35	35
Exceptions	195	17	17	17	17	14	13	14

Source: Eurasian Economic Union (2024)

- barriers - obstacles to the free movement of goods, services, capital, and the labor force, arising due to the inconsistencies in the existing or adopted legislative norms not yet entered into force,
- restrictions - obstacles to the free movement of goods, services, capital, and labor, resulting from the absence of legal regulation, and
- exemptions - derogations provided for by the Union law in terms of the non-application by a Member State of the Union of the general rules of the functioning of the internal market.

To effectively address and eliminate these obstacles, the EAEU has established a comprehensive online resource, accessible at *https://barriers.eaeunion.org*. This platform enables businesses, individuals, and other stakeholders to submit appeals and report the identified barriers, restrictions, or exemptions that negatively impact trade or economic activities within the EAEU. The resource provides detailed information on the existing obstacles, procedures for their elimination, and updates on the status of submitted appeals. The platform facilitates communication between stakeholders and the EAEU regulatory bodies, promoting transparency and collaborative problem-solving.

The established procedures for considering and eliminating obstacles involve submitting detailed information about the obstacle identified through the online platform by stakeholders. Then, the EEC reviews it in order to determine its validity and assesses the obstacle as either a barrier, or a restriction, or an exemption. Consultations with the relevant member state are performed, and appropriate steps are taken so as to eliminate the obstacle. Throughout this process, the EEC monitors the implementation of the elimination measures and provides updates to the stakeholder.

Despite the availability of this online resource and the established procedures, challenges persist in effectively removing obstacles within the EAEU internal market, such as bureaucracy, differing national interests over collective EAEU goals, resulting in resistance to removing certain barriers, and variation in the legal frameworks or limited awareness of the platform and procedures.

METHODOLOGY

This study employs a mixed-method approach to evaluate the integration and competitiveness of the EAEU, combining quantitative trade indicators with a qualitative analysis of the policy frameworks and institutional developments. While econometric methods are often used in similar assessments, they are not appropriate here due to the limited available time series data since the EAEU was founded in 2015. Additionally, the structural heterogeneity among the member states, along with significant geopolitical and institutional influences, makes it difficult for standard econometric models to capture the full complexity of the integration process. Instead, the approach employed in this study integrates key trade indicators with insights from the literature review and political economy analysis, offering a more comprehensive understanding of the EAEU's dynamics.

The share of intra-regional trade in the total trade of the region is the indicator most commonly used for measuring the degree of trade integration within a regional economic union (Arupov, Abaidullaeva, Kalieva & Arupova, 2015). To this end, various modifications of the market share indicator (XS) are calculated, following the formula:

$$XS = \frac{\sum_{sd} X_{sd}}{\sum_{sw} X_{sw}} * 100 \quad (1)$$

where s represents the set of the source countries, d is the set of the destination countries, w are the countries worldwide, and X denotes the value of exports.

Thus, the numerator represents the exports from the countries within the studied region (the source countries) to the destination countries (in this case, the partner countries from the same region), while the denominator represents the region's total exports to the world. XS ranges between 0 and 100 percent, with higher values indicating a greater significance of

a given regional trade bloc. An increase in HS over time can be interpreted as indicating the fact that the economies in question are becoming more integrated (Mikic & Gilbert, 2007). For a more comprehensive analysis of the degree of trade integration, a comparative approach will be employed, calculating the market share indicator for intra-regional trade not only within the EAEU but also in other regional economic unions from various parts of the world.

To investigate the international competitiveness of the EAEU and its dynamics, the market share indicator will be used again, this time for the member states on the world market. High and increasing values of this indicator signify improved competitive positions in the global economy. This approach allows for gauging the effectiveness of the EAEU in realizing its integrative objectives and makes it possible to understand the extent to which it has been able to leverage its collective resources in order to enhance the economic standing of its member states on the world stage.

The analysis of the Export/Import ratio data for the EAEU and its member states from 2015 to 2024 provides valuable insights into the trade balance dynamics and economic resilience of the Union and the individual countries within it. This ratio is a crucial indicator, with the values above 1.0 signifying that a country exports more than it imports, indicating a positive trade balance, whereas the values below 1.0 suggest a trade deficit.

Finally, to evaluate the international competitiveness of the EAEU, the RCA index, which measures the relative export performance of a country or regional bloc in a specific product or sector, will be applied. An RCA value greater than one indicates a comparative advantage, suggesting that the country is competitive in that sector on the global market. The analysis of the RCA data for the EAEU member states enables the identification of the areas of strength and specialization, providing insights into how effectively the Union leverages its collective resources to enhance its global trade position.

The RCA index is calculated using the following formula:

$$\mathrm{RCA} = \frac{\left(\frac{X_{ij}}{X_{it}}\right)}{\left(\frac{X_{wj}}{X_{wt}}\right)} \quad (2)$$

where Xij represents the export value of the product j from the country i, Xit is the total export value of the country i, Xwj is the world export value of the product j, and Xwt is the total world export value. An RCA index greater than 1 indicates that the bloc has a comparative advantage in the given product or sector, suggesting the specialisation that could be leveraged in the context of the EAEU's integration objectives.

RESULTS AND DISCUSSION

The trade integration of the EAEU in a comparative perspective

Table 2 demonstrates a significant variation in the intra-regional export shares across the major economic blocs, reflecting differences in their integration levels, economic structures, and geopolitical contexts. The European Union (EU-27) leads with an average intra-regional export share of 58.6% over 2015-2024, peaking at 60.8% in 2022, and remaining close to that level thereafter (60.2% in 2023; 59.7% in 2024). This exceptional performance highlights the EU's advanced integration, supported by the robust legal and institutional frameworks that facilitate the free movement of goods, services, capital, and labor. As the model of regional economic cohesion, the EU often serves as an inspiration for the EAEU's integration ambitions (Klofat, 2017).

In comparison, the EAEU's intra-regional export share averages just 10.4%, aligning more closely with developing regional blocs, such as MERCOSUR (11.7%), COMESA (9.1%), and the GCC (10.0%). This modest figure underscores the bloc's limited economic interdependence and progress in creating a unified internal market.

MERCOSUR and ASEAN illustrate varied integration outcomes among developing regions. MERCOSUR's

Table 2 The intra-regional export shares within the EAEU and the selected integration blocs (2015-2024, %)

	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2015-24
Gulf Cooperation Council	8.8	8.6	10.1	10.6	11.0	11.9	10.7	9.6	10.6	7.9	10.0
EU-27	56.6	57.4	57.6	58.2	57.7	58.3	59.7	60.8	60.2	59.7	58.6
MERCOSUR	13.6	13.1	12.7	12.0	10.5	11.0	10.8	10.7	11.6	10.9	11.7
ASEAN	24.3	23.8	23.8	24.2	23.3	21.4	21.6	22.9	22.1	21.2	22.9
NAFTA	50.4	50.3	50.1	49.4	49.6	49.2	49.8	49.8	50.7	50.6	50.0
COMESA	9.8	10.5	8.6	8.2	8.5	9.8	9.5	9.1	9.8	7.2	9.1
EAEU	10.9	11.9	12.1	10.7	11.6	12.9	11.7	5.5	7.5	9.2	10.4
Armenia	16.0	21.7	25.8	27.9	28.4	27.4	28.2	46.4	42.7	25.3	29.0
Belarus	40.9	48.2	46.4	41.0	43.9	47.5	37.3	9.4	11.8	13.3	34.0
Kazakhstan	11.1	10.7	10.6	9.7	10.9	11.8	13.0	12.7	14.0	13.4	11.8
Kyrgyzstan	31.0	27.0	31.7	32.2	31.6	27.8	48.4	66.8	38.5	36.9	37.2
Russia	8.3	8.9	9.3	8.4	8.9	9.8	9.3	3.9	5.3	7.5	8.0

Source: Authors based on the ITC data

share trends downward relative to the mid-2010s (from 13.6% in 2015 to 10.9% in 2024, with a trough of 10.5% in 2019), while ASEAN's fluctuating average (22.9%) represents moderate success in fostering economic cooperation despite some easing in the early 2020s. Meanwhile, NAFTA (now the USMCA) maintains stability, with a decade-long average of 50.0%, showcasing strong and durable interdependence among its member states.

The EAEU's modest internal trade intensity reflects pronounced structural asymmetries. Smaller economies - Armenia (29.0%) and Kyrgyzstan (37.2%) - are markedly more reliant on intra-bloc markets, whereas Russia (8.0%) and Kazakhstan (11.8%) remain outward-oriented. Belarus is an outlier: despite a high decade average (34.0%), its shares a plunge to 9.4% (2022), 11.8% (2023) and 13.3% (2024). The timing and magnitude suggest statistical breaks (confidentiality, flow reclassification, mirror-flow lags) layered onto sanctions-related reorientation; these observations should be treated with caution.

War-era shocks accentuated these differences. Russia's intra-EAEU share fell to 3.9% in 2022 and recovered only to 7.5% by 2024 as exports pivoted towards extra-regional partners. Kazakhstan edged up (14.0% in 2023; 13.4% in 2024) but remains with limited regional value-chain links. Armenia and Kyrgyzstan acted as intermediary hubs: Armenia surged to 46.4% in 2022 (42.7% in 2023) before normalizing to 25.3% in 2024; Kyrgyzstan spiked to 66.8% in 2022 and eased to 38.5% and 36.9% in 2023-2024 - still above the mid-2010s levels. Overall, the 2015-2024 evidence points to the internal market that is thin and shock-sensitive: wartime re-exports and intermediation produced only a partial rebound and did not restore pre-war intensity, while revealing divergent member responses to shared shocks.

The geopolitical shifts following the war in Ukraine have forced the EAEU to re-orient its trade focus toward Asia. Figure 1 shows China as the largest destination in 2024 (29.0% of the total exports), followed by India (12.9%) and Türkiye (9.5%). This pivot partly offsets losses in Western markets due to sanctions but increases partner concentration: the top three now absorb just over one-half of the total exports. With negligible sales to the Americas and the limited reach beyond Asia, the export base remains narrow, leaving the bloc exposed to partner- and corridor-specific shocks.

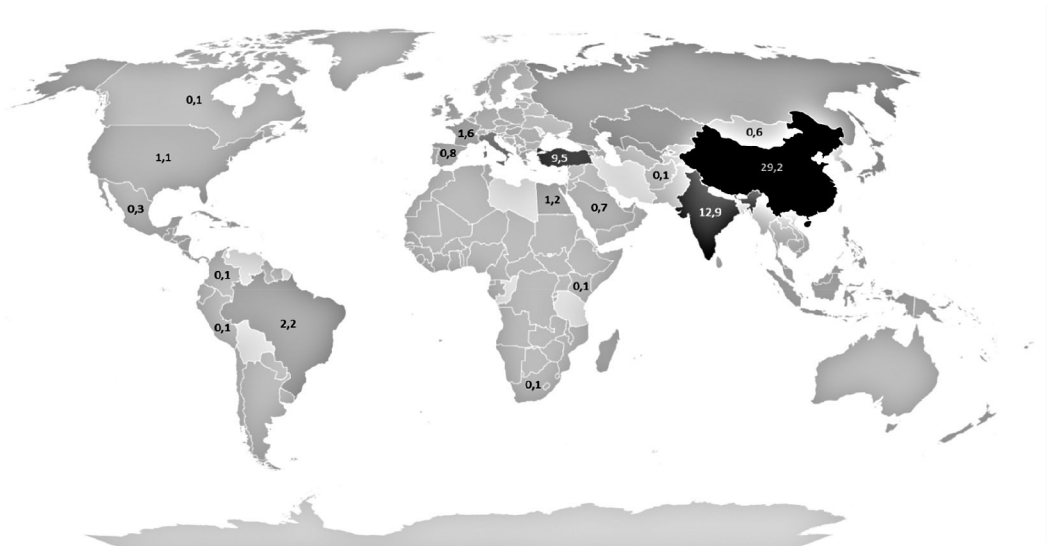

Figure 1 The top export markets of the EAEU in 2024 (in %)

Source: Authors based on the ITC data

The international competitiveness of the EAEU

Regional integration blocs offer countries opportunities to enhance their productivity and international competitiveness through increased market access, economies of scale, foreign investment attraction, technological transfer, and production specialization. Established with these goals in mind, the EAEU seeks to foster stable economic development, improve living standards, and enhance the competitiveness of its member states. Article 4 of the Founding Treaty articulates these objectives, including the creation of a single market for goods, services, capital, and labor, and a comprehensive modernization of national economies for global competitiveness.

Table 3 illustrates the EAEU's fluctuating share in global exports from 2015 to 2024. After the 2016 trough, the share rose to local highs in 2018-2019 (~2.8%), dipped with the 2020 pandemic shock, briefly rebounded in 2021-2022, and then fell to a decade low in 2024 (2.11%). The profile - episodic gains interrupted by sanctions and other external shocks, compounded by internal structural constraints - underscores the bloc's difficulty in achieving sustained improvements in global competitiveness.

Russia, the bloc's dominant economy, largely shapes the aggregate trajectory: after local highs in 2018 (2.32%) and 2022 (2.35%), its share fell to 1.79% in 2023 and 1.67% in 2024. Belarus also contracted sharply - from ~0.17-0.18% pre-2021 to 0.03% in 2023-2024 - but, as indicated earlier, this may reflect a statistical break in the series. By contrast, Kazakhstan edged up from 0.28% (2015) to 0.34% (2024), suggesting relative resilience in commodity exports. The smallest economies, Armenia and Kyrgyzstan, remain marginal in global terms but registered war-era upticks (Armenia from 0.01% to 0.05% by 2024; Kyrgyzstan from 0.01% to 0.02%), consistent with increased re-exports and intermediation.Top of Form

The Export/Import (X/M) ratio, shown in Table 4, reveals the trade-balance dynamics of the EAEU and its member states. While the Union as a whole maintained a positive trade balance, peaking at 2.58 in 2022, the decline to 1.62 in 2023 - and the persistence of 1.62 in 2024 - indicates that the 2022 spike was temporary, driven by the extraordinary price and volume effects that subsequently unwound.

Table 3 The market share of the EAEU and its member states in world exports (2015-2024, in %)

Years	EAEU	Armenia	Belarus	Kazakhstan	Kyrgyzstan	Russia
2015	2.49	0.01	0.16	0.28	0.01	2.03
2016	2.19	0.01	0.15	0.23	0.01	1.79
2017	2.50	0.01	0.17	0.28	0.01	2.03
2018	2.84	0.01	0.17	0.32	0.01	2.32
2019	2.76	0.01	0.18	0.31	0.01	2.25
2020	2.39	0.01	0.17	0.27	0.01	1.93
2021	2.70	0.01	0.18	0.27	0.01	2.22
2022	2.73	0.02	0.05	0.31	0.01	2.35
2023	2.21	0.04	0.03	0.33	0.01	1.79
2024	2.11	0.05	0.03	0.34	0.02	1.67

Source: Authors based on the ITC data

Table 4 The Export/Import ratio of the EAEU and its member states (2015-2024)

Years	EAEU	Armenia	Belarus	Kazakhstan	Kyrgyzstan	Russia
2015	1.67	0.46	0.88	1.50	0.42	1.88
2016	1.44	0.56	0.85	1.46	0.39	1.57
2017	1.47	0.55	0.85	1.65	0.40	1.57
2018	1.72	0.50	0.88	1.87	0.36	1.89
2019	1.56	0.52	0.83	1.50	0.40	1.73
2020	1.34	0.55	0.89	1.23	0.53	1.46
2021	1.54	0.56	0.95	1.46	0.30	1.68
2022	2.58	0.61	0.89	2.46	0.23	2.91
2023	1.62	0.70	0.44	1.29	0.27	1.93
2024	1.62	0.78	0.40	1.37	0.31	1.93

Source: Authors based on the ITC data

Russia, which largely determines the aggregate, sustained a positive X/M throughout, having surged to 2.91 in 2022 before normalizing to 1.93 in 2023-2024. Kazakhstan also remained in surplus, with the wartime peak of 2.46 in 2022, followed by a retreat to 1.29 in 2023 and 1.37 in 2024, consistent with commodity-cycle swings. Belarus continued to register a deficit, deteriorating from near-balance in the late 2010s to 0.44 in 2023 and 0.40 in 2024. Armenia and Kyrgyzstan likewise posted deficits, though their trajectories diverged: Armenia improved steadily from 0.46 (2015) to 0.78 (2024), whereas Kyrgyzstan fell to 0.23 (2022), with only a partial recovery to 0.31 (2024).

Taken together, these patterns underscore the Union's heterogeneity. Russia and Kazakhstan underpin the EAEU's overall surplus position. At the same time, Belarus, Armenia, and Kyrgyzstan continue to face persistent external imbalances, highlighting ongoing challenges in achieving sustained improvements in trade performance across the Union.

In Figure 2, the RCA index provides an analytical view of the EAEU's export specialization across the three post-treaty intervals: 2015-2017, 2018-2020, and 2022-2024. The data confirm a persistent and pronounced comparative advantage in Mineral Products (HS 25-27) and Chemicals (HS 28-38). Mineral Products

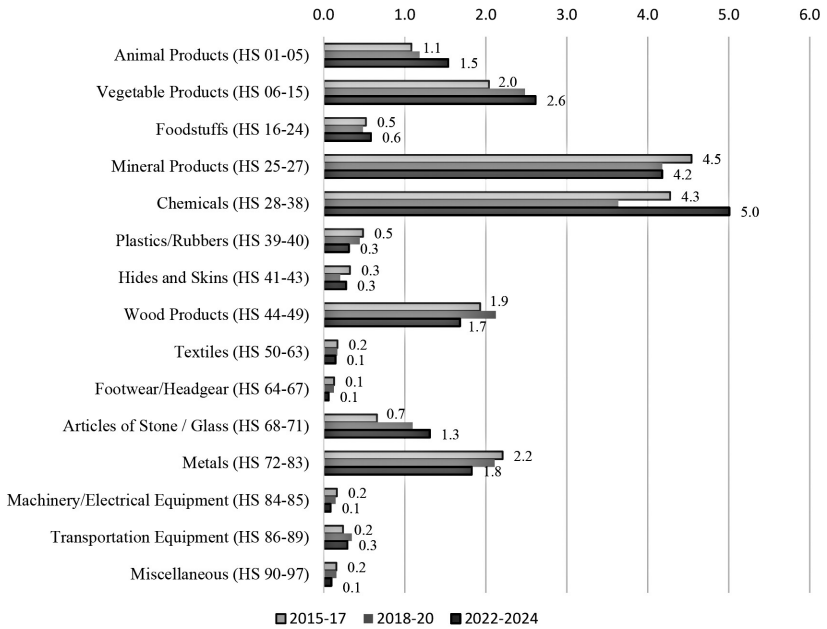

Figure 2 The RCA index (weighted average) of the EAEU in world trade for the period from 2015 to 2017, 2018 to 2020, and 2022 to 2024.

Source: Authors based on the ITC data

remain high and broadly stable (RCA 4.5 in 2015-2017; 4.2 in 2018-2020 and 2022-2024). Chemicals declined during the pandemic (from 4.3 to 3.6) and then rose to 5.0 in 2022-2024, chiefly reflecting the performance of fertilizers. Agriculture strengthens in that RCAs for Animal Products increase from 1.1 to 1.5 and for Vegetable Products from 2.0 to 2.6, while Foodstuffs edge up but remain below unity (0.6 in 2022-2024). This pattern is consistent with the EAEU's emphasis on import substitution and the expansion of domestic agricultural production under sanctions and is primarily driven by developments in Russia.

By contrast, intermediate and higher-technology manufactures weaken: Metals fall from 2.2 to 1.8; Plastics/Rubbers from 0.5 to 0.3; and Machinery/Electrical Equipment remains persistently low at about 0.1. Transportation Equipment improves slightly from 0.2 to 0.3 but remains far below unity. A notable exception is Articles of Stone/Glass, which move above unity (from 0.7 to 1.3), while Wood Products soften (from 2.1 to 1.7).

Overall, the data point to the critical constraints: resilience in the resource-based sectors and gains in agriculture coexist with continued reliance on commodities and weak performance in technology-intensive industries - a configuration also observed in Serbia's post-transition industrial trajectory, where the limited upgrading of the technological base curtailed competitiveness and export diversification (Mićić, 2015). Against this backdrop, it is essential the EAEU's industrial-policy framework, and the mechanisms of intra-regional coordination should be examined more closely, which is the focus of the next section.

The industrial policy of the EAEU - achievements and challenges

The industrial policy of the EAEU is a central pillar of its integration strategy, designed to enhance its economic competitiveness and foster structural transformation across the member states. Rooted in the Treaty on the EAEU, signed in May 2014, the policy

framework emphasizes a balanced development while safeguarding national sovereignty. Article 92 of the Treaty outlines the guiding principles, such as equal rights, respect for national interests, and the protection of economic independence (Eurasian Economic Commission, 2014). Despite these aspirations, the practical implementation of the industrial policy reveals a stark contrast between the stated objectives and the realities on the ground, often hindered by divergent national priorities.

The institutional framework of the EAEU's industrial policy is based on a collaborative model involving both the EEC and national authorities. The EEC is responsible for coordinating policy measures, harmonizing regulations, and overseeing the implementation of industrial initiatives. However, the existing approach has been criticized as disjointed and more theoretical than practical due to the ineffective coordination mechanisms (Gusakov, Andronova, Ganeeva & Dyuzheva, 2019). In practice, the EEC often lacks the necessary authority and resources to enforce its recommendations, especially in politically sensitive areas like subsidies and industrial partnerships. National governments frequently prioritise domestic interests, leading to delays in joint projects such as the development of industrial clusters and technological platforms. This fragmented approach, coupled with conflicting strategies among the member states, undermines collective action and hinders deeper integration (Alzhanova, Dnishev & Alzhanova, 2023).

The "Main Directions of Industrial Cooperation until 2025", a key policy document approved by the Intergovernmental Council in 2015, outlines strategic priorities for industrial development. This plan emphasizes innovation and technological advancement through initiatives such as the creation of technological platforms in sectors like space, medicine, and information technologies (Eurasian Economic Commission, 2015). Additionally, guidelines for financing interstate projects aim to enhance industrial collaboration among the member states. However, progress has been uneven, often hindered by bureaucratic inefficiencies and varying levels of political commitment.

These challenges are compounded by the lack of coordination between national industrial policies, including import substitution programs, which undermines the overall effectiveness of the EAEU's industrial policy. The absence of a structured framework for selecting priority industries and forming integrated value chains further restricts the bloc's ability to achieve cohesive industrial development (Kusainov & Zhumabekova, 2022). Strengthening coordination and aligning national strategies with the Union's goals remain critical for realizing the objectives outlined in the EAEU's industrial agenda.

A persistent challenge in the EAEU's industrial policy lies in the regulation of state subsidies. Article 93 and Annex 28 of the EAEU Treaty classify subsidies into permissible, specific, and prohibited categories to maintain fair competition. However, discrepancies in how subsidies are allocated across the member states create significant barriers to effective policy harmonization. For example, Kazakhstan's broad, untargeted subsidies dilute the impact of industrial support, whereas the low levels of export-credit subsidies hinder competitiveness in key markets (Kamalyan, Tsybulnik & Pak, 2022). The lack of a unified approach to subsidies exacerbates tensions among the member states, complicating the efforts to develop a cohesive industrial strategy and fostering the perceptions of favoritism.

These tensions are evident in the Kazakh dairy sector, where extensive state support to Russian and Belarusian producers, combined with the post-sanctions redirection of their supplies to EAEU markets, has generated an influx of the low-priced imports that Kazakh farms struggle to match. Despite sustained public investment in farm modernization, local producers face weak demand from processing plants and continued persistent price undercutting, broadly perceived as *de facto* dumping, producing acute financial stress (Yesbolova, Abdikerimova, Kuashbay, Sadykbekova & Bigeldieva, 2025). In response, the government has considered additional support to domestic farms; however, absent tighter Union-wide discipline on subsidies and enforceable anti-dumping remedies, unilateral measures risk a subsidy race and deeper intra-Union frictions.

In spite of these challenges, the EAEU has made progress in certain aspects of the industrial policy. The creation of the EAEU Industrial Policy Council and the Agro-Industrial Policy Council has facilitated dialogue among the member states, leading to initiatives such as the integration of the space and geo-information systems and the development of industrialization maps. Consisting of 158 major investment projects worth over $239 billion across 34 industries, the Industrialization Map focuses on promoting import substitution and enhancing cross-border cooperation, particularly in machinery, forestry, and construction materials. Furthermore, the annual review of over 800 subsidy-related legal acts has contributed to improved regulatory coherence, reducing disparities in industrial support measures across the Union (EEC, 2023).

Structural challenges remain a significant barrier to the EAEU's industrial development. Most member states remain focused on traditional, capital-intensive industries, limiting diversification and the development of new growth sectors. The economies of Russia and Kazakhstan are heavily reliant on the export of raw materials, making them vulnerable to fluctuations in global commodity prices. This dependence limits the Union's ability to diversify its industrial base and reduces its resilience against external economic shocks. Moreover, economic disparities among the member states pose a challenge to integration; while Russia and Belarus have established industrial bases, Armenia and Kyrgyzstan lag in terms of industrial development and infrastructure, constrained by structural economic limitations, logistical bottlenecks, and small-scale agricultural production systems (Bekbolotova, Djanibekov & Herzfeld, 2025). The imposition of international sanctions on Russia and Belarus has further complicated the situation, disrupting supply chains and slowing down the efforts to modernize industries across the region (Kamalyan *et al*, 2022).

A significant weakness in the EAEU's industrial policy lies in the insufficient technological integration among the member states, exacerbated by the weak legal frameworks and the inadequate infrastructure for technology transfer, which hinder the development of a cohesive and innovative industrial base (Alzhanova *et al*, 2023). The bloc's heavy reliance on external markets for intermediate goods, alongside limited intra-EAEU trade, reveals critical vulnerabilities in establishing resilient and integrated value chains. Studies indicate that reliance on foreign markets for industrial supplies exceeds intra-EAEU trade volumes by more than five times, highlighting the urgent need for enhanced internal cooperation and robust supply chain development (Krivoguz & Fesenko, 2022).

Looking ahead, the EAEU aims to extend its industrial cooperation strategy to 2030, focusing on smart technologies, expanding cooperation in nonfinancial industrial support mechanisms, and enhancing export promotion to third-country markets such as China, Türkiye, and African nations. These priorities reflect emerging opportunities and strategic directions for the Union's industrial development (Borisenko, 2022).

The financial support mechanism for industrial cooperation in the EAEU, signed in May 2023 and ratified in June 2024, aims to foster technological development, create value chains, and boost mutual investments among the member states. The mechanism provides financial subsidies, primarily through reduced interest rates on loans, to the cooperative projects that involve participants from at least three member countries. While the mechanism seeks to strengthen industrial ties and create sustainable value chains, it faces challenges, including the complexity of coordination between multiple stakeholders and potential disparities in financial and industrial capacities across the member states. The effectiveness of the mechanism will largely depend on its ability to ensure equal participation and benefits for all the member states, as well as its responsiveness to evolving economic conditions.

CONCLUSION

Drawing the evidence together, the EAEU's thin integration and narrow, resource-based specialization are explained through asymmetric endowments and limited supranational authority,

and a transparent indicator framework linking intra-union trade intensity, the world-market share, export concentration, and revealed comparative advantage is proposed.

In direct response to the research questions, only the modest and uneven deepening of intra-EAEU trade across the member states is found (RQ1); there is no sustained improvement in global competitiveness, as indicated by the Union's share of world exports and the diversification of external markets (RQ2); no durable structural upgrading away from resource dependence, with persistent disadvantages in higher-technology, and value-added manufactures is found (RQ3); finally, there is an industrial-policy trajectory marked by demonstrable advances alongside persistent gaps in implementation and enforcement (RQ4).

The EAEU's industrial policy holds a significant potential to enhance global competitiveness but demonstrates a dual reality - notable achievements alongside persistent challenges. Progress has been made in harmonizing regulations, aligning subsidy frameworks, and initiating collaborative projects. Initiatives such as the Industrialization Map and the promotion of green technologies reflect the Union's ambition to foster innovation and reduce import dependency in the key sectors. However, these efforts are often undermined by the inconsistencies between national and regional priorities, uneven industrial development, and a lack of a coordinated implementation. The member states frequently prioritize domestic interests over collective goals, while less industrialized economies struggle to compete with more advanced ones.

To address these challenges, the EAEU must adopt a cohesive and strategic approach to the industrial policy. Strengthening the Eurasian Economic Commission's supranational authority is critical for improving coordination and resolving conflicts between national and regional objectives. Prioritizing technological modernization, with investment in high-tech industries and value-added production, is essential to reducing dependence on raw materials. The comparative evidence from Serbia shows that such shifts require not only investment but also coherent reform strategies and sustained policy consistency to enable transition from low- to high-value-added industries (Mićić, 2015; Jakopin, 2020). Through integrated value chains and reduced trade barriers, enhanced intra-regional trade will also bolster economic resilience. Additionally, diversifying export markets by forging stronger ties with emerging economies will mitigate the risks of over-reliance on limited external markets.

A coordinated, forward-looking strategy that aligns national and regional priorities is vital for the EAEU to overcome internal disparities, advance technological innovation, and foster intra-regional trade. By addressing these challenges, the Union can strengthen its global competitiveness and achieve sustainable economic growth for its member states.

These conclusions should be read with due regard to several limitations: the study is observational and relies on the aggregate goods-trade indicators over a relatively short post-formation horizon punctuated by large exogenous shocks, services and firm-level dynamics are not fully captured, and re-exports and parallel-trade channels may bias intra-union diagnostics. Future research should examine the causal effects of subsidy harmonization and the cooperation-finance mechanism on intermediate-goods trade and upgrading, undertake firm- and product-level studies of technology adoption and export sophistication, improve the accounting of re-exports, extend coverage to services and digital trade, and conduct project-level evaluations of the Industrialization Map and related initiatives, including counterfactual benchmarking against peer regional blocs.

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Paskal Zhelev is an Associate Professor at the University of National and World Economy, Sofia, Bulgaria, and a Researcher (R3) at the Bratislava University of Economics and Business, Slovakia. His research focuses on economic integration, industrial policy, international trade, and foreign direct investment. He was a Fulbright Visiting Scholar at the University of Illinois at Urbana-Champaign (2015) and a Visiting Scholar at Shanghai Jiao Tong University (2019).

Olga Malashenkova is an Associate Professor at the Minsk Branch of Plekhanov Russian University of Economics, Minsk, Belarus, and a Consultant to the United Nations. Her research focuses on economic integration, sanctions and human rights, digital transformation in education, and academic entrepreneurship. She was a Fulbright Fellow and Lecturer at the University of North Carolina at Chapel Hill (2021-2022).

EVROAZIJSKA EKONOMSKA UNIJA NA RASKRŠĆU - UPRAVLJANJE TRGOVINSKOM INTEGRACIJOM I KONKURENTNOŠĆU

Paskal Zhelev[1] and Olga Malashenkova[2]

[1]*University of National and World Economy, Department of International Economic Relations and Business, Sofia, Bulgaria*

[2]*Minsk Branch of Plekhanov University of Economics, Minsk, Belarus*

Ova studija istražuje Evroazijsku ekonomsku uniju (EAEU) kao regionalni ekonomski integracioni blok, istovremeno analizirajući njenu evoluciju, trgovinsku integraciju i okvir industrijske politike usred promena globalne dinamike. Osnovana 2015. godine, EAEU se suočavala sa strukturnim izazovima, geopolitičkim prevratima i sve intenzivnijim sankcijama, posebno od izbijanja rata u Ukrajini. Ti pritisci su doveli do prekida u trgovinskim tokovima, proširili su ekonomske disparitete među državama članicama Unije i testirali koheziju tog bloka. U ovom radu se naglašava činjenica da je sve jača konkurentnost od kritičnog značaja za otpornost EAEU, pri čemu industrijska politika služi kao kamen temeljac tog napora. Primenom trgovinskih indikatora kao što su međuregionalni udeli u trgovini i indeks otvorene komparativne prednosti, u ovoj studiji se ističu nejednaka integracija i zavisnost od izvoza zasnovanog na resursima. U njoj se procenjuje institucionalni okvir industrijske politike EAEU, usredsređujući se istovremeno na usklađivanje subvencija, razvoj industrije dodate vrednosti i koordinisanje nacionalnih i regionalnih prioriteta. Uprkos upornim institucionalnim slabostima i spoljašnjim pritiscima, nalazi do kojih se u ovoj studiji došlo ukazuju na to da bi podsticanje modernizacije industrije i ostvarivanje bolje sinergije domaćih politika i regionalnih ambicija mogli da pospeše otpornost tog bloka i njegovu globalnu konkurentnost.

Ključne reči: Evroazijska ekonomska unija, industrijska politika, međunarodna konkurentnost, regionalna ekonomska integracija, sankcije

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ANALYZING THE IMPACT OF MACROECONOMIC CONDITIONS ON GDP GROWTH: BRICS VS. G7 COUNTRIES

Farial Faizi[1], Mariam Sawas[1], Dina Abohassan[1], Ilija Stojanović[1] and Marko Selaković[2*]

[1]*American University in the Emirates, Dubai International Academic City, Dubai, UAE*
[2] *S P Jain School of Global Management, Dubai International Academic City, Dubai, UAE*

The economic rivalry between the BRICS countries and the G7 nations has been a central theme in global development for decades. This study seeks to compare the GDP growth dynamics between the BRICS and G7 countries, while examining the differential impact of the key macroeconomic indicators on their economic trajectories. To achieve this, statistical methodologies, including independent t-tests and ANOVA, were utilized so as to compare the group-level differences, while the tests of between-subjects effects were applied to assess the variations in the effects of the regression coefficients for the macroeconomic factors influencing GDP growth. The study posits that the distinct economic structures of the BRICS countries and the G7 nations lead to varying macroeconomic conditions which shape their growth patterns in distinct ways. The findings of this research offer actionable insights into the strongest and weakest determinants of the GDP growth within these economic blocs. It contributes to a broader discourse on global economic competition, offering evidence-based recommendations for balanced growth strategies.

Keywords: macroeconomic conditions, GDP growth, BRICS, G7

JEL Classification: E01, E60, O47, C33, F43

INTRODUCTION

The global economic landscape has significantly been shaped by the interplay between developed and emerging economies, with the G7 and the BRICS nations representing two pivotal blocs in this dynamic. Composed of advanced industrialized countries, the G7 has historically dominated global economic leadership through its technological innovations, robust institutions, and established markets. Formed in 1975, the G7 includes the world's most advanced economies, namely France, Germany, Italy, Japan, the U.S., the U.K., and Canada, which joined in 1976 (Rustamov, 2023). Conversely, BRICS - a coalition of emerging economies - has rapidly risen in prominence, challenging the traditional

* *Correspondence to:* M. Selaković, S P Jain School of Global Management, Dubai International Academic City, Dubai, UAE; e-mail: marko.selakovic@spjain.org

dominance of the G7 with its resource-rich markets, demographic advantages, and increasing integration into global trade. The BRICS nations - Brazil, Russia, India, China, and South Africa - are broadly recognized as a significant economic bloc characterized by their remarkable recent economic growth (Siljković, Dedović & Kalač, 2024). Over the past two to three decades, these nations have undergone unprecedented economic expansion, solidifying their status as pivotal players in the global economy (Budhwar, Tung, Varma & Do, 2017). The 15th BRICS Summit held at the Sandton Convention Centre in Johannesburg, South Africa, from August 22 to 24, 2023, marked a significant milestone for the BRICS Diplomatic Progress Initiative by broadening its membership diversity. Starting January 1, 2024, six new countries were invited to the five existing members, i.e. Argentina, Egypt, Ethiopia, Iran, Saudi Arabia, and the United Arab Emirates (Antony, 2023).

This study is specifically focused on several research objectives, particularly intending:

1. to analyze and compare the GDP growth rates of the BRICS and the G7 countries, identifying the key variations in their economic performances,
2. to investigate the influence of specific macroeconomic factors - such as the inflation rate, the unemployment rate, the real interest rate, the exchange rate stability, the export of goods and services, the government debt-to-GDP ratio, FDI net inflows and outflows, and agriculture, forestry, and fishing value-added - on the GDP growth within each group,
3. to evaluate and contrast the macroeconomic impacts on the GDP growth between the BRICS and the G7 countries, highlighting similarities and differences in how these factors shape economic growth in emerging versus developed economies, and
4. to assess the relative contribution of these macroeconomic factors to the overall GDP growth trends in the BRICS and the G7 countries, providing insights into their economic resilience and adaptability to global economic changes.

In order to identify the key differences in the GDP growth rates between the BRICS and the G7 countries over the past decade, the study's initial hypotheses are as follows:

$H1_0$: There is no significant difference in the average GDP growth rate between the BRICS countries and the G7 countries ($\mu_{BRICS}=\mu_{G7}$).

$H1_a$: There is a significant difference in the average GDP growth rate between the BRICS countries and the G7 countries ($\mu_{BRICS}\neq\mu_{G7}$).

This study also aims to bridge this gap by systematically examining the GDP growth trends in the BRICS and the G7 nations over the past decade and is focused on understanding the key macroeconomic factors driving the GDP growth disparities between the BRICS and the G7 countries and how these factors influence economic performance in emerging and developed economies differently. In this regard, the study's second and third hypotheses are established:

For the BRICS countries:

$H2_0$: The independent variables (Inflation Rate, Unemployment Rate, Real Interest Rate, Exchange Rate Stability, Export of Goods and Services, Government Debt-to-GDP Ratio, FDI Net Inflows, FDI Net Outflows, and Agriculture, Forestry, and Fishing Value-Added) have no significant effect on the GDP growth in the BRICS countries ($\beta1 = \beta2 = \beta3 = ... = \beta_k = 0$).

$H2_a$: At least one independent variable has a significant effect on the GDP growth in the BRICS countries ($\beta_k \neq 0$ for at least one$_k$),

where β_k represents the regression coefficients of the independent variables for the BRICS countries.

For the G7 Countries:

$H3_0$: The independent variables (Inflation Rate, Unemployment Rate, Real Interest Rate, Exchange Rate Stability, Export of Goods and Services, Government Debt-to-GDP Ratio, FDI

Net Inflows, FDI Net Outflows, and Agriculture, Forestry, and Fishing Value-Added) have no significant effect on the GDP growth in the G7 countries. ($\beta1 = \beta2 = \beta3 = ... = \beta_k = 0$).

$H3_a$: At least one independent variable has a significant effect on the GDP growth in the G7 countries ($\beta_k \neq 0$ for at least one$_k$),

where β_k represents the regression coefficients of the independent variables for the G7 countries.

As these blocs navigate their distinct economic trajectories, a comparative analysis of their GDP growth and the underlying macroeconomic factors is crucial for understanding the drivers of economic success and stability in developed versus emerging economies. Given the additional interest in uncovering the impact of FDI net inflows, FDI net outflows, and the government debt-to-GDP ratio on the economic performance in emerging (BRICS) versus developed (G7) countries, and identifying the key similarities and differences in the effect of these factors, the fourth hypothesis was developed as follows:

$H4_0$: There is no significant difference in the effects of the independent variables on the GDP growth between the BRICS and the G7 countries ($\beta_{BRICS}=\beta_{G7}$).

$H4_k$: There is a significant difference in the effects of the independent variables on the GDP growth between the BRICS and the G7 countries. In other words, the regression models differ between the two groups ($\beta_{BRICS}\neq\beta_{G7}$).

LITERATURE REVIEW

Gross Domestic Product (GDP) represents the value of the goods and services produced within a country's economy, overlooking production costs. GDP is also the total of personal consumption expenditures, gross private domestic investment, the net export of goods and services, and the government consumption expenditures and gross investment (Dynan & Sheiner, 2018). GDP is an essential measure of an economy's wellbeing and allows for direct comparisons between countries (Fraumeni, 2022). GDP is measured by assessing the total value of all goods and services produced, using the value-added method to highlight the economy's main drivers. There are two key attitudes for measuring the GDP, which theoretically produce the same outcome. Firstly, the expenditure approach computes GDP by adding personal spending, capital investment, the government expenditure, and net exports. Secondly, the income approach measures GDP by adding firm profits and household income earned from providing resources (Trinh, 2017).

Moreover, GDP measures a country's domestic income and productivity over a definite period. It signifies the total market value of all final products and services generated within the country during that time. Additionally, GDP originates from the total real demand for national products, both local and foreign. Local demand involves spending through governments, households, and organizations, while foreign demand is driven from exports. However, imports, which satisfy part of local demand, may reduce the overall GDP (Khan & Khan, 2021).

The key macroeconomic factors affecting GDP growth

The performance of an economy depends on the stability of the main macroeconomic indicators, such as the supply of money, inflation and the exchange rate, as well as other fundamental factors (Kankpeyeng, Maham & Abubakar, 2021). Macroeconomics focuses on the performance of the overall economy, taking a comprehensive perspective on economic trends. It observes significant economic indicators and interactions among diverse segments to better understand how the entire economy functions. As one of the key macroeconomic factors, inflation considerably affects economic development. It signifies the general rise in the prices of products and services over time within an economy. Moreover, labor force participation, shaped by Foreign Direct Investment (FDI), plays a fundamental role. FDI can improve access to the funds (Selaković, 2022) and

employment opportunities in hosting nations and facilitate the relocation of advanced technological proficiencies (Shah, Asghar & Riaz, 2020). Furthermore, GDP *per capita* and the gross savings rate are positively correlated, indicating that a higher savings rate is associated with a higher GDP *per capita* (Ahsan, 2024).

The economic profiles of the BRICS and G7 countries

Over the last 20 years, economic dominance worldwide has significantly shifted. This transformation has occurred mostly due to the emergence of China (Janković, 2018), but in a broader perspective owing to the BRICS countries, consisting of Brazil, Russia, India, and China. The confidence of BRICS in accomplishing their goals can be seen through their economic efficiency. The economic growth of BRICS has been observed by many countries, except in 2021, when the global economy was impacted by COVID-19. The BRICS economies account for 25.61% of the world's GDP (Paudel, 2023).

The Group of Seven (G7), consisting of the United States, Japan, Germany, the United Kingdom, France, Italy, and Canada, is a political forum containing some of the world's leading economies. These countries are characterized by their significant levels of industrialization, economic strength, and commitment to international economic stability. Advocating for the GDP of over $29 trillion, the United States has the leading economy and is a frontrunner in technology, finance, and healthcare. The third largest economy is Japan, with the GDP of about $4.07 trillion. It is recognized for its advanced technology, export-oriented fields, and automative industries. Germany, on the other hand, with its GDP of $4.71 trillion, is the leading economy in Europe. The country specializes in engineering and the export of machinery and vehicles. With the GDP exceeding $3.59 trillion, the United Kingdom is an international financial center, with London acting as the primary base for banking and financial facilities. With the GDP of $3.17 trillion, France tracks closely because of its varied economy that contains robust sectors for luxury goods, agriculture, and aerospace. With its GDP of $2.38 trillion, Italy is known for its flourishing manufacturing segment, and is particularly strong in the fashion, automative, and design industries. Finally, Canada, with the GDP of $2.21 trillion, is heavily reliant on natural capitals, such as minerals, oil, and gas, and also has an advanced financial sector and close economic bonds with the United States (Statista, 2024).

The GDP growth rate and inflation

The GDP growth of the US has been steady and strong, whereas Japan, the UK, Italy, France, and Canada have faced some fluctuations over the recent years. Inflation is a result of money supply exceeding the production of goods and services in an economy, mainly driven by extreme aggregate demand. Temperate inflation can affect the output, while extreme inflation lessens labor demand, leading to lower production and eventually slowing down economic development (Kankpeyeng *et al*, 2021). The Keynesian School implies a positive connection between inflation and GDP growth, while the neoclassical view claims that rising inflation diminishes the output and wellbeing. Additionally, higher inflation lowers purchasing power, discouraging spending on goods and capital, eventually reducing the stable output (Tien, 2021). Inflation can significantly influence economic progress, making price constancy essential for emerging economies. Defined as the sustained rise in overall price levels over time, inflation poses a significant obstacle to economic balance. By increasing manufacturing costs for businesses, traditional economists reason that inflation obstructs economic growth (Haider, Ullah, Khan, Raza & Ali, 2024). Furthermore, inflation brings out currency devaluation. Excessive inflation lowers product demand, which consequently decreases national production. As production deteriorates, demand for labor declines, thus significantly increasing unemployment (Alam, Nur Alam & Hoque, 2020).

In the long run, GDP growth leads to inflation. If not controlled, inflation can accelerate into hyperinflation, creating a self- perpetuating cycle. In an environment

of rising inflation, people are likely to spend more, expecting that their money will lose value eventually. This increased spending for the time being boosts GDP, further escalating prices (Ali, Yusop, Kaliappan, Chin & Meo, 2022).

An alternative interpretation is that rising inflation is not the cause of gradual economic development, but rather an indication of core concerns, similar to supply disruptions or fiscal imbalances. Certain theories, like New-Keynesian models, imply that inflation may even boost GDP in the short run in specific circumstances. Nevertheless, these theories struggle to account for situations like stagflation, where a high level of inflation and slow growth take place at the same time (Agarwal & Baron, 2024).

National economic competitiveness in global trade relies on inflation, because higher inflation increases export prices while cutting import prices, resulting in trade inconsistencies and the current account gaps. Huge inflation rates trigger capital outflows across countries because investors hunt for low-inflation areas, which eventually stress foreign exchange rates and reduce foreign currency stocks. Certain economists argue that inflation needs to exist at a low rate in order to stimulate economic development through elevated spending, while improving debt viability over time. Sustaining inflation at an average level continues to function as a top policy aim, supporting the stability of the economy and development sustainability (Xavier, Fernandes & de Oliveira, 2021).

The impact of unemployment on GDP growth

Unemployment describes a condition where people who are willing and able to work cannot find appropriate paid employment. As unemployment rates increase in an economy, so do the levels of poverty and related welfare matters. Creating employment opportunities is crucial for economic development and poverty reduction. Moreover, labor plays a vital role in development. Employment concerns are deeply linked to the environment and can generate new challenges in both economic and noneconomic areas. High unemployment results in lower income, thus leading to poverty (Dahliah & Nur, 2021). Besides, excessive unemployment causes a reduced industrial output and the inefficient application of both industrial and social capital. It aggravates inefficiency by deteriorating workers' skills and weakening their motivation (Janoski, 1990). Economic growth leads to employment opportunities, which in turn reduces unemployment, which builds a nonlinear relationship between unemployment and economic growth, causing a zigzag pattern (Hashmi, Khushik, Gilal & Yongliang, 2021). Unemployment rates in France, Italy, and the United Kingdom show long-term persistence (the unit root), while those in Germany and Italy are stationary. In Canada, unemployment rates additionally have a unit root, whereas in Japan and the United States, they are stationary only in the first regime. This suggests that unemployment hysteresis affects France, Italy, the United Kingdom, and the second regime of Japan and the United States (Yilanci, Ozkan & Altinsoy, 2020).

The key differences between the BRICS and the G7 countries

In 2010, the BRICS countries (with 2.8 billion people) had a significantly larger population compared to the G7 countries (740 million). The BRICS united in trade negotiations against the G7, which had controlled global trade for decades. While the G7 lost momentum, the BRICS economies flourished. By 2019, BRICS' GDP reached $21 trillion, whereas the G7's was $39 trillion, reflecting accelerated economic growth, as well as a progressively influential role in the global economy. BRICS' GDP grew 1.8 times, whereas the G7's grew 1.2 times. In terms of science and technology, the G7 countries have a more uniformed structure dominated by biosciences. In contrast, the BRICS countries mainly focus on core sciences, excluding Brazil, where biosciences dominate. Turning to another aspect, BRICS' GDP ratio to the global GDP grew from 0.12 to 0.236 between 2009 and 2019, emphasizing its growing economic effect. In contrast to the G7, BRICS' broadening influence in financial markets has attracted attention as a potential

source of international threats. This shift could reform market integration, affecting investment, speculation, and risk variation strategies (Agyei, Owusu Junior, Bossman, Asafo-Adjei, Asiamah & Adam, 2022).

RESEARCH METHODOLOGY

In terms of the research methodology, the collected secondary data summarize the GDP growth rates through the historical figures of the two groups of countries, namely the BRICS nations (Brazil, Russia, India, China, South Africa, Egypt, Ethiopia, Iran, Saudi Arabia, and the UAE) and the G7 nations (the United States, Japan, Germany, the United Kingdom, France, Italy, and Canada). The dataset was extracted from credible sources, including the Federal Reserve Economic Data (FRED), the International Monetary Fund (IMF), and the World Bank (WB), encompassing a 12-year period from the year 2011 to 2022.

Prior to conducting the analysis, cleaning and organizing the data was performed so as to ensure accurate and reliable results. This process consisted of the elimination of the missing values and the positioning of each observation to its corresponding year in order to maintain consistency and comparability.

To test the first hypothesis, focusing on testing the difference in the average GDP growth rate between the BRICS countries and the G7 countries, an independent two-sample t-test was applied under the assumption that BRICS and the G7 are two independent groups. The data pertaining to the GDP growth rates for BRICS (Brazil, Russia, India, China, South Africa, Egypt, Iran, Ethiopia, the UAE) and the G7 (Canada, France, Germany, Italy, Japan, United Kingdom, the United States) were being collected over the period of 12 years from 2011 to 2022, sourced from the World Bank Open data website. A t-test was conducted in order to compare the means of the BRICS and the G7 groups, determining whether significant differences in the GDP growth do exist between the two groups. Additionally, how the two blocks are concise in terms of their growth was analyzed measuring the growth disparity from the mean within each bloc by evaluating the level of the standard deviation for each group.

In the second step, the research objective on how macroeconomic factors such as the inflation rate, the unemployment rate, and the real interest rate influenced the GDP growth within the BRICS and the G7 countries was distinctively addressed. To test the second and third hypotheses, a multiple regression model was developed:

GDP Growth $(\gamma)_t$: $\gamma = \beta_0 + \beta_1$(Inflation Rate) + β_2(Unemployment Rate) + β_3(Real Interest Rate) + β_4(Exchange Rate Stability) + β_5(Export of Goods and Services) + β_6(Government Debt-to-GDP Ratio) + β_7(FDI Net Inflows) + β_8(FDI Net Outflows) + β_9(Agriculture, Forestry, and Fishing Value-Added) + ε

where:

- β_0 is the intercept.
- β_1 to β_9 are the coefficients for the respective independent variables.
- ε represents the error term.

This model was applied individually for the BRICS and the G7 groups so as to identify the most impactful macroeconomic factors for the GDP growth in each group for the period t = 2011 to 2022. The initial analytical approach was through ANOVA in order to understand if the set of the independent variables in the regression model collectively explained a significant amount of variance in the GDP growth separately for the BRICS and the G7 countries. Through Multiple Linear Regression (MLR), the relationship between the dependent variable, the GDP growth, and various independent variables was analyzed so as to identify the key macroeconomic factors influencing economic performance. The variables were taken from the WorldBank Open Database. The values were not transformed but rather used in their original percentages or local currency units, as reported by the source. The variables included in the model are as follows:

- Y: GDP Growth,
- X1: Inflation Rate,

- X2: Unemployment Rate,
- X3: Real Interest Rate,
- X4: Exchange Rate Stability,
- X5: Export of Goods and Services,
- X6: Government Debt-to-GDP Ratio,
- X7: FDI Net Inflows,
- X8: FDI Net Outflows,
- X9: Export of goods and services,
- X10: Agriculture, Forestry, and Fishing Value-Added, Agriculture and Rural Development.

The regression models were developed separately for the BRICS and the G7 countries, where each group was treated as an aggregated cross-sectional dataset. The focus was mainly on group-level modelling with the primary objective to evaluate the macro-level differences between the two economic blocs, not within individual countries, over time.

Given the additional interest in uncovering the differences of the effects of the independent variables on the dependent variable in the two different regression models, namely for BRICS and the G7, the fourth hypothesis was tested. To test the aforementioned hypothesis, a Tests of Between-Subjects Effects test was used to determine whether there were significant differences between the coefficients of the two linear regression models, which results from the fact that the relationship between the dependent and the independent variables was suspected to differ across these two groups, namely the BRICS and the G7 countries.

RESEARCH FINDINGS

The group statistics in Table 1 displays the summary of the descriptive statistics comparing the GDP growth rates between the two groups:

- Group 1 (V1 = 1) represents the BRICS countries.
- Group 2 (V1 = 2) represents the G7 countries.

According to the results of the descriptive statistics for the GDP growth rate across the BRICS and the G7 countries, the average GDP growth rate is significantly higher in BRICS, with 3.7%, in comparison with that of the 1.3% rate in the G7 countries. Therefore, the BRICS economies - often categorized as evolving markets - demonstrate stronger growth than the more advanced G7 countries.

Moreover, the standard deviation outcomes underline a greater inconsistency - therefore lesser reliability - in the GDP growth among the BRICS countries (3.79), as opposed to the lower variability and comparatively higher consistency shown in the G7 countries (2.92).

Notwithstanding the results of the descriptive statistics, a t-test was conducted in order to test the H_1 hypothesis for the significance of the difference in the means. The products of Levene's Test for Equality of Variances are shown in Table 2.

The results of the Independent Samples t-test comparing the GDP growth rates (%) between the BRICS and the G7 countries indicated the F-value: 14.355 and the p-value of 0.000. Since the significance level is below 0.05, this shows that the variances are not equal. Therefore, it can be concluded that there is a difference in the variability of the GDP growth among the two groups. Hence, the values based on nonequal

Table 1 The descriptive statistics for the GDP growth

Group Statistics					
	V1	N	Mean	Std. deviation	Std. error mean
GDP Growth Rate %	1	108	3.702214280233629	3.799638393509069	.365620374885950
	2	84	1.335643623688180	2.926090481867369	.319262645796358

Source: Authors

Table 2 The independent samples t-test

		Levene's test for equality of variances		t-test for equality of means					
		F	Sig.	t	df	Sig. (2-tailed)	Mean difference	Std. error difference	95% Confidence interval of the difference
									Lower	Upper
GDP Growth Rate %	Equal variances assumed	14.355	.000	4.722	190	.000	2.366570656545449	.501230167308057	1.377880025861309	3.355261287229588
	Equal variances not assumed			4.876	189.986	.000	2.366570656545449	.485393547065299	1.409117761254293	3.324023551836605

Source: Authors

variances were applied, rather than assumed, to interpret the outcomes. The results of the independent samples t-test based on the assumption of unequal variances show a statistically significant difference in the GDP growth rates between the BRICS and the G7 countries. The t-value is 4.876 with 189.99 degrees of freedom and the p-value is 0.000, which leads to the conclusion that $H1_0$ should be rejected, meaning that there is a statistically significant difference in the average GDP growth rates among the BRICS and the G7 nations. The mean difference is 2.366%, denoting that the BRICS countries have a higher GDP growth rate on average in comparison to the G7 countries. Thus, a fact can be established that the BRICS countries exceed the G7 countries with respect to the GDP growth rate, as the mean difference shows a positive sign. Since there is a statistically significant difference in the GDP growth rates among the two groups, the null hypothesis $H1_0$ is rejected and the alternative $H1_a$ is accepted, signifying that the average GDP growth rates of the two groups are significantly different.

To evaluate the hypotheses H_2 and H_3, two separate regression analyses were carried out. The findings are showcased in the following sections.

Regression analysis assumptions

To check the model assumptions, the Shapiro-Wilk test was conducted so as to assess whether the residuals from the regression model were normally distributed. According to the findings, the W statistic = 0.968 with the p-value = 0.080. These results indicated that residuals did not significantly deviate from normality. Thus, the assumption was met. Furthermore, the linearity check showed that all the variables demonstrated either linear or approximately linear relationships with the GDP Growth Rate. Thus, the linearity assumption was reasonably met for the regression analysis. The Variance Inflation Factor (VIF) was also checked so as to detect multicollinearity in the multiple regression model. According to the findings, there was no significant multicollinearity among the predictors as all the predictor VIF values were well below 5, which means that the assumption was also met in this case. The Breusch-Pagan test revealed that the test statistic = 13.75, with the p-value = 0.056. Therefore, the assumption of the constant variance of the residuals (homoscedasticity) was reasonably met, although being borderline.

Regression analysis for the BRICS countries

Table 3 demonstrates the results of the regression analysis model for the BRICS countries. Based on R^2=0.725, it was determined that the model had displayed a relatively strong descriptive fit for explaining the variations of the GDP growth in the BRICS countries, drawing from changes in the

independent variables. Here, 72.5% of the variation in the dependent variable is explained by the model. Overall, the model is reasonably well-fitted, as is implied by the standard error of 2.056, which is low to moderate, suggesting that the predictors, which include the key economic indicators such as foreign direct investment (inflows and outflows), exports, and inflation significantly contribute to the explanation of the differences in the GDP growth between the BRICS and the G7 countries.

The ANOVA (Analysis of Variance) outcomes for the regression model forecasting the GDP growth rate for the BRICS countries are portrayed in Table 4. The Regression Sum of Squares (SST): 312.722 represents the variation in the GDP growth rates explained by the predictors (the independent variables), while the Residual Sum of Squares (SSR): 118.370 represents the unexplained ones. To summarize, the independent variables in the model significantly describe the variation in the GDP Growth Rate %. Overall, the ANOVA results signify that the regression model is statistically significant (F = 7.397, p = 0.000), suggesting that the predictors explain a substantial portion of the variation in the GDP growth rates for the BRICS countries. With the SST (312.722) being much greater than the remaining sum of squares (118.37), the model appears to show a strong explanatory power for this dataset, which is consistent with the earlier findings, accounting for the fact that the economic variables, such as foreign direct investment, exports, and inflation are the critical elements of the GDP growth for BRICS.

Table 5 identifies the key elements influencing the GDP growth in the BRICS countries:

Table 3 The regression model summary for the BRICS countries

Model summary[a]				
Model	R	R square	Adjusted R square	Std. error of the estimate
1	.852[b]	.725	.627	2.056090069103176

a. V1 = 1

b. Predictors: (Constant), Agriculture, Forestry, and Fishing, Value-Added (% of the GDP), Government Debt, total (% of the GDP), Inflation Rate %, Foreign Direct Investment, Net Inflows (% of the GDP), Export of Goods and Services (% of the GDP), Foreign Direct Investment, Net Outflows (% of the GDP), Export of Goods and Services $, Exchange Rate Stability (LCU per US$, the period average), Real Interest Rate %, Unemployment Rate %

Source: Authors

Table 4 ANOVA model for BRICS countries

ANOVA[a,b]						
Model		Sum of squares	df	Mean square	F	Sig.
1	Regression	312.722	10	31.272	7.397	.000[c]
	Residual	118.370	28	4.228		
	Total	431.092	38			

a. V1 = 1

b. Dependent Variable: GDP Growth Rate %

c. Predictors: (Constant), Agriculture, Forestry, and Fishing, Value-Added (% of the GDP), Government Debt, total (% of the GDP), Inflation Rate %, Foreign Direct Investment, Net Inflows (% of the GDP), Export of Goods and Services (% of the GDP), Foreign Direct Investment, Net Outflows (% of the GDP), Export of Goods and Services $, Exchange Rate Stability (LCU per US$, the period average), Real Interest Rate % , Unemployment Rate %.

Source: Authors

- FDI Inflows: A 1 percentage point increase boosts the GDP growth by 0.672 percentage points, keeping the other variables constant (Sig. = 0.013).
- FDI Outflows: A 1 percentage point increase raises the GDP growth by 1.38 percentage points, keeping the other variables constant (Sig. = 0.03).
- Agriculture, Forestry, and Fishing Value-Added: A 1 percentage point increase in the GDP share adds 0.58 percentage points to the GDP growth, keeping the other variables constant (Sig. = 0.004).

Apart from the significant factors, the non-significant factors for the GDP growth in the BRICS bloc include the Inflation Rate, the Unemployment Rate, the Real Interest Rate, the Exchange Rate Stability, the Export of Goods and Services ($), the Government Debt and the Export of Goods and Services (% of the GDP).

Based on the significant predictors, the null hypothesis ($H2_0$) is rejected, and the alternative hypothesis ($H2_a$) is accepted. Hence, to drive growth, BRICS must concentrate on drawing FDI, managing FDI outflows, and elevating the agricultural sector's role. The model found to be significant is as follows:

$$Y = -1.911 + 0.672(X7) + 1.380(X8) + 0.580(X10)$$

Regression analysis for the G7 countries

Table 6 outlines the regression model for the GDP growth in the G7 nations. $R^2 = 0.673$ shows that 67.3% of the variation in the GDP growth is defined by the model's predictors, which is lower compared to the model applied for the BRICS countries. Still, the model demonstrates a moderate overall connection between the variables included and the GDP growth. However, with a lower adjusted R^2, policymakers should focus on identifying and stressing the most significant predictors (e.g. FDI, exports, or agriculture) for impactful strategies.

Table 5 The regression coefficients for BRICS

Coefficients[a,b]						
Model	B	Unstandardized coefficients		Standardized coefficients	t	Sig.
		Std. error	Beta			
1	(Constant)	-1.911	4.268		-.448	.658
	Inflation Rate%	-.213	.184	-.164	-1.154	.258
	Unemployment Rate %	.130	.219	.293	.594	.557
	Real Interest Rate %	-.060	.068	-.240	-.881	.386
	Exchange Rate Stability (LCU per US$, the period average)	-.014	.042	-.108	-.320	.752
	Export of Goods and Services $	.000000000003539	.000	.167	.420	.677
	Government Debt, Total (% of the GDP)	-.019	.037	-.146	-.505	.617
	Foreign Direct Investment, Net Inflows (% of the GDP)	.672	.253	.329	2.653	.013
	Foreign Direct Investment, Net Outflows (% of the GDP)	1.380	.602	.423	2.293	.030
	Export of Goods and Services (% of the GDP)	-.088	.210	-.174	-.419	.678
	Agriculture, Forestry, and Fishing, Value-Added (% of the GDP)	.580	.185	.925	3.127	.004

a. V1 = 1

b. Dependent Variable: GDP Growth Rate %

Source: Authors

Moreover, Table 7 shows the ANOVA (Analysis of Variance) results for the regression model predicting the GDP growth rates for the G7 countries. The Regression Sum of Squares is 35.17, while the Residual Sum of Squares is 17.07, which indicates the portion of the variation in the GDP growth rates that is not explained by the model. To summarize, the independent variables are collectively significant in predicting the GDP Growth Rate. Overall, the ANOVA results indicate that the regression model is statistically significant ($F = 3.708$, $p = 0.008$), which means that the predictors account for a considerable portion of the variation in the GDP growth rates for the G7 countries. Thus, the regression model significantly explains the variation in the GDP Growth Rate.

Table 8 highlights the relationship between the GDP growth and several economic elements, offering insights related to the G7 economies. Among the predictors, there are two statistically significant variables:

- Unemployment Rate: A 1 percentage point increase in unemployment reduces the GDP growth by approximately 0.56 percentage points, keeping the other variables constant ($p = 0.02$).
- Real Interest Rate: A 1 percentage point increase in the real interest rates corresponds to a 0.63 percentage points decrease in the GDP growth, keeping the other variables constant ($p = 0.018$).

The other variables, however, show no statistically significant influence, including the Inflation Rate, the Exchange Rate Stability, the Government Debt (% of the GDP), Foreign Direct Investment - Net Inflows,

Table 6 The regression model summary for the G7 countries

Model Summary[a]				
Model	R	R square	Adjusted R square	Std. error of the estimate
1	.821[b]	.673	.492	.973845611784450

a. V1 = 2

b. Predictors: (Constant), Agriculture, Forestry, and Fishing, Value-Added (% of the GDP), Exchange Rate Stability (LCU per US$, the period average), Real Interest Rate % , Foreign Direct Investment, Net Outflows (% of the GDP), Export of Goods and Services (% of the GDP), Inflation Rate %, Unemployment Rate %, Foreign Direct Investment, Net Inflows (% of the GDP), Government Debt, Total (% of the GDP), Export of Goods and Services $

Source: Authors

Table 7 ANOVA model for the G7 countries

ANOVA[a,b]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	35.170	10	3.517	3.708	.008[c]
	Residual	17.071	18	.948		
	Total	52.240	28			

a. V1 = 2

b. Dependent Variable: GDP Growth Rate %

c. Predictors: (Constant), Agriculture, Forestry, and Fishing, Value-Added (% of the GDP), Exchange Rate Stability (LCU per US$, the period average), Real Interest Rate % , Foreign Direct Investment, Net Outflows (% of the GDP), Export of Goods and Services (% of the GDP), Inflation Rate %, Unemployment Rate %, Foreign Direct Investment, Net Inflows (% of the GDP), Government Debt, Total (% of the GDP), Export of Goods and Services $

Source: Authors

Table 8 The regression coefficients for the G7 countries

Coefficients[a,b]						
Model	B	Unstandardized coefficients		Standardized coefficients	t	Sig.
		Std. Error	Beta			
1	(Constant)	.924	8.902		.104	.918
	Inflation Rate%	.072	.284	.062	.254	.803
	Unemployment Rate %	-.558	.220	-.743	-2.541	.020
	Real Interest Rate %	-.625	.240	-.704	-2.601	.018
	Exchange Rate Stability (LCU per US$, the period average)	-.010	.027	-.318	-.363	.721
	Export of Goods and Services $	1.075E-12	.000	.637	.642	.529
	Government Debt, Total (% of the GDP)	.002	.025	.064	.068	.946
	Foreign Direct Investment, Net Inflows (% of the GDP)	.328	.335	.257	.978	.341
	Foreign Direct Investment, Net Outflows (% of the GDP)	-.208	.184	-.263	-1.131	.273
	Export of Goods and Services (% of the GDP)	.029	.147	.184	.200	.844
	Agriculture, Forestry, and Fishing, Value-Added (% of the GDP)	2.355	1.960	.688	1.202	.245

a. V1 = 2

b. Dependent Variable: GDP Growth Rate %

Source: Authors

Foreign Direct Investment - Net Outflows, the Export of Goods and Services (% of the GDP), Agriculture, Forestry, and Fishing Value-Added. Overall, the results suggest that, for the G7 economies, the unemployment and real interest rates are the most critical factors impacting the GDP growth, with significant negative effects.

Based on the significant predictors, the null hypothesis ($H3_0$) is rejected, and the alternative hypothesis ($H3_a$) is accepted. Hence, to drive growth, the G7 should focus on reducing the unemployment and real interest rates. The model found to be significant is as follows:

$$Y = 0.924 - 0.558(X2) - 0.625(X3)$$

Comparison of the two regression models

Table 9 lists the two groups with the sample sizes:

- V1 = 1 (N = 39): This group relates to the BRICS economies.
- V1 = 2 (N = 29): This group relates to the G7 economies.

Table 9 The Between-Subjects Factors test

Between-Subjects factors		
		N
V1	1	39
	2	29

Source: Authors

The results of the Tests of Between-Subjects Effects for the GDP Growth Rate (%) in Table 10 enables the comparison of the factors potentially affecting the BRICS and the G7 economies and the determination of the difference in the effects of these factors within the two models. The Real Interest Rate ($F = 5.651$, $p = 0.021$), Foreign Direct Investment (FDI) - Net Inflows (% of the GDP) ($F = 10.319$, $p = 0.002$) and

Table 10 The Tests of Between-Subjects Effects

Dependent Variable: GDP Growth Rate %					
Source	Type III sum of squares	df	Mean square	F	Sig.
Corrected Model	289.179[a]	11	26.289	7.474	.000
Intercept	.529	1	.529	.150	.700
Inflation Rate	4.039	1	4.039	1.148	.288
Unemployment Rate	8.691	1	8.691	2.471	.122
Real Interest Rate	19.876	1	19.876	5.651	.021
Exchange Rate Stability LCU per US$ period average	4.541	1	4.541	1.291	.261
Export of Goods and Services ($)	3.334	1	3.334	.948	.334
Government debt total (% of GDP)	6.349	1	6.349	1.805	.184
Foreign Direct Investment net inflows (% of GDP)	36.295	1	36.295	10.319	.002
Foreign Direct Investment net outflows (% of GDP)	5.191	1	5.191	1.476	.230
Export of goods and services (% of GDP)	.275	1	.275	.078	.781
Agriculture forestry and fishing value added (% of GDP)	140.848	1	140.848	40.045	.000
V1	6.073	1	6.073	1.727	.194
Error	196.964	56	3.517		
Total	794.212	68			
Corrected Total	486.144	67			

a. R Squared = .595 (Adjusted R Squared = .515)

Source: Authors

Agriculture, Forestry, and Fishing Value-Added (% of the GDP) ($F = 40.045$, $p < 0.001$) are the statistically significant predictors in the model, suggesting they have significantly different influences on the GDP growth in the BRICS and the G7 economies. In contrast, through the individual regression models, the Real Interest Rate has negative effects on the GDP growth in both groups, although it remains an insignificant factor for the GDP growth in the BRICS countries. For FDI Net Inflows, it has a positive impact in both groups, although it is considered to be an insignificant factor for the GDP growth in the G7 countries. Particularly, the significant effect of FDI Inflows emphasizes the significance of external capital in driving growth, especially within evolving markets such as BRICS. Agriculture, Forestry, and Fishing Value-Added has a positive effect on the GDP growth and is not considered as a significant factor for the GDP growth in the G7 countries.

In contrast, the variables such as the Inflation Rate, the Unemployment Rate, the Exchange Rate Stability LCU ($), the Export of Goods and Services $, the Foreign Direct Investment Net Outflows of the GDP, the Export of Goods and Services % of the GDP, and the Government Debt are not statistically significant, indicating similar effects across the two groups.

Since the two groups have significantly different regression models and the p-value being less than 0.05, the null hypothesis ($H4_0$) is rejected, and the alternative hypothesis ($H4_a$) is accepted.

The findings for V1 show p-value = 0.194, which indicates that there is no significant difference in the GDP growth between the BRICS and the G7 countries, which means that the null hypothesis $H4_0$ can be accepted. This means there is no statistically significant difference in the effects of the predictors on

the overall GDP growth between the BRICS and the G7 countries. If going into detail, some variables have different effects between the two models, including the Real Interest Rates ($p = 0.021$), FDI Inflows ($p = 0.002$), and Agriculture, Forestry, and Fishing ($p = 0.000$). These may be considered as the factors of the different economic patterns affecting the different rates of economic growth in these two blocs.

DISCUSSION AND CONCLUSION

The comparative analysis of the GDP growth and the macroeconomic determinants between the BRICS and the G7 nations provides a nuanced understanding of the divergent economic trajectories of these two influential blocs. The BRICS nations, characterized by their emerging market status, demographic advantages, and resource wealth, have demonstrated dynamic economic expansion in recent decades. Conversely, the G7 nations, as a coalition of advanced economies, continue to leverage their technological superiority, institutional stability, and well-established markets to maintain their global economic leadership. In Table 11, the overall conclusion on the research hypotheses is given.

The results show that the BRICS countries are growing faster compared to the G7 countries. However, at the same time, they are less coherent in their GDP growth compared to the G7. This has been proven by testing the difference and variance using t-tests. The economic rivalry between these two blocs underscores the complex interplay of the macroeconomic factors, such as inflation, unemployment, trade variables, and foreign direct investment in shaping their respective growth patterns.

Table 11 The conclusion on the hypotheses

Null hypotheses	Conclusion	Interpretation
$H1_0$: There is no significant difference in the average GDP growth rate between the BRICS countries and the G7 countries.	Rejected	There is a difference in the GDP growth between the BRICS and the G7 nations, with a higher GDP growth in the BRICS countries with a higher variance around the mean.
$H2_0$: The independent variables (Inflation Rate, Unemployment Rate, Real Interest Rate, Exchange Rate Stability, Export of Goods and Services, Government Debt-to-GDP Ratio, FDI Net Inflows, FDI Net Outflows, and Agriculture, Forestry, and Fishing Value-Added) have no significant effect on the GDP growth in the BRICS countries.	Accepted	The model is statistically significant in the prediction of the GDP growth in the BRICS countries with the FDI Inflows (positive), FDI Outflows (positive), Agriculture, Forestry, and Fishing Value-Added (positive) as the significant variables.
$H3_0$: The independent variables (Inflation Rate, Unemployment Rate, Real Interest Rate, Exchange Rate Stability, Export of Goods and Services, Government Debt-to-GDP Ratio, FDI Net Inflows, FDI Net Outflows, and Agriculture, Forestry, and Fishing Value-Added) have no significant effect on the GDP growth in the G7 countries.	Accepted	The model is statistically significant in the prediction of the GDP growth in the G7 countries with the Unemployment Rate (negative), Real Interest Rate (negative) as the significant variables.
$H4_0$: There is no significant difference in the effects of the independent variables on the GDP growth between the BRICS and the G7 countries.	Rejected (partially)	Although the overall model does not show significant differences in the effects of the predictors on the GDP growth between the BRICS and the G7 nations, several predictors still have different effects when observed individually, and they are the Real Interest Rate, FDI Net Inflows, Agriculture, Forestry, and Fishing Value-Added (% of the GDP).

Source: Authors

The findings of this research reveal that the BRICS countries' growth is heavily influenced by their ability to capitalize on demographic advantages and integrate into global trade networks. The factors such as the exchange rate stability, export performance, and the government debt management play a significant role in sustaining their economic momentum (Jakopin, 2012; Čupić & Vržina, 2024). To achieve this, the BRICS countries, especially following the conclusions of the Summit held in October 2024, intend to overcome the regulatory and systemic gaps and foster de-dollarization and cooperative initiatives (Shaarawy, 2024). Meanwhile, the G7's economic resilience is rooted in its capacity to manage inflation, maintain low unemployment rates, and foster innovation-driven growth. These macroeconomic conditions reflect the distinct economic structures and developmental stages of the two blocs, simultaneously highlighting their unique strengths and vulnerabilities. Despite progress and significant achievements in terms of innovations (Huang, 2024), the BRICS countries still partly struggle with income inequality. Coupled with an over-reliance on specific sectors and political instabilities, this poses challenges to their sustained growth path (Milanović, 2016). Confronting these issues through regulatory changes alongside directed developmental funding remains necessary for obtaining enduring development outcomes. Through improved regional partnerships, economic expansion, and the implementation of the measures oriented towards establishing their own cross-border payment system and funding, the BRICS nations intend to obtain increased resistance to market disruptions and improve their economic durability.

By analyzing a comprehensive dataset and applying statistical techniques such as regression, t-tests, and ANOVA, the research reveals significant differences in the growth patterns and the impact of the key economic variables. Characterized by higher but more variable growth rates, the BRICS nations benefit from the factors such as foreign direct investment and exports, whereas the G7 economies demonstrate slower, yet more stable growth. These findings underscore the unique challenges and opportunities each group faces in fostering economic development, offering valuable insights for policymakers and economists alike.

Particularly, some individual predictors of GDP growth demonstrate clear differences in their impact on the GDP growth between the BRICS and the G7 countries. Especially, FDI net inflows, the real interest rate, and agriculture's value-added play differential roles in driving the GDP depending on the group. These results support the notion that economic structures and growth drivers are not uniform across BRICS and the G7 and policies should be tailored accordingly.

The results demonstrate the need for the BRICS nations to expand their economic sectors beyond commodity exports while seeking alternative sources of stability that extend beyond the current period. The plans announced during the BRICS summit in October 2024 indicate a clear intention to establish the long-term stability of BRICS as a solid and well-integrated economic bloc. The propulsive development of innovation, coupled with significant investments in education, research and development, technological infrastructure investments, and the systemic policy and regulatory changes, intends to create economic resilience (Aleksić, Nestić, Huber & Ljepava, 2022; Selaković, Ljepava, Tarabasz & Stojanović, 2023) while steering the BRICS economies towards equilibrium growth paths.

Overall, policymakers' understanding of the differential impact of macroeconomic factors on GDP growth enables them to formulate the strategies that not only enhance domestic economic stability but also contribute to a more balanced and cooperative global economic order. The implementation of collaboration between blocs through exchanges of technology and green energy projects alongside financial integration practices will build stronger economic resistance and creative capacity. In the future, research needs to focus on the way regional economic agreements influence worldwide economic stability. Deeper insights regarding the future growth potential of BRICS emerge when the developing economic policies are studied in detail. The development of thorough economic approaches demands research in both social and political variables affecting economic expansion, along with the impact of digital transformation on predicted economic patterns.

While this study offers an essential analysis of the GDP growth patterns of the BRICS and the G7 countries, various limitations have been noted as well. Variations in data accessibility and reporting requirements, especially among the BRICS nations, may influence the accuracy and uniformity of macroeconomic elements. Moreover, while the study discusses the links between the economic variables and GDP growth, it does not construct direct causation, such as external forces, for instance financial crises, global conflicts, and market fluctuations which may also affect economic flows (Selaković, Ljepava, Tarabasz & Stojanović, 2020). Additionally, although helpful, the chosen decade timeline may not completely reflect the long-term economic trends or structural transformations. Regardless of these limitations, the study provides a strong foundation for future research in advancing economic competition among the BRICS and the G7 nations.

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Farial Faizi is a business management student at the College of Business Administration, American University in the Emirates. Her research interests are connected to the fields of business, management, and entrepreneurship.

Mariam Sawas is a student of hospital and healthcare management at the College of Business Administration, American University in the Emirates. She is passionate about advancing healthcare systems, developing leadership skills, and contributing to innovative solutions that improve the quality and accessibility of healthcare.

Dina Abohassan is a lab instructor at the College of Business Administration, American University in the Emirates. She supports students in developing practical skills in business and management. Her academic dedication and innovative approach highlight her potential for impactful contributions to teaching and research.

Ilija Stojanović is an associate professor at the American University in the Emirates with 5 years of international teaching experience and 12+ years in project and business management training and industry practice. Certified PMP, ECQA EU Project Manager, UNDP SDG Trainer, and Six Sigma holder, with research in operations, supply chains, project management, and quantitative methods.

Marko Selaković is deputy director and assistant professor at S P Jain School of Global Management. With more than 20 years of professional practice and 5 years in academia, he is specialized in strategic reputation management, crisis communication, and stakeholder relations. He is member of IPRA and Global Strategic Communication Consortium and occupies number of Board and decision-making positions in Dubai.

ANALIZIRANJE UTICAJA MAKROEKONOMSKIH USLOVA NA RAST BDP-A: ZEMLJE BRIKS-A NASPRAM ZEMALJA ČLANICA G7

Farial Faizi[1], Mariam Sawas[1], Dina Abohassan[1], Ilija Stojanović[1] and Marko Selaković[2]

[1]*American University in the Emirates, Dubai International Academic City, Dubai, UAE*
[2]*S P Jain School of Global Management, Dubai International Academic City, Dubai, UAE*

Ekonomsko rivalstvo zemalja BRIKS-a i zemalja članica Grupe 7 (G7) je već decenijama središnja tema globalnog razvoja. U ovoj studiji, težimo da uporedimo dinamiku rasta BDP-a zemalja BRIKS-a i zemalja članica G7, istovremeno ispitujući diferencijalni uticaj ključnih makroekonomskih pokazatelja na pravce njihovog ekonomskog razvoja. Da bi ostvarila svoj cilj, u studiji se primenjuju statističke metodologije, uključujući t-testove i ANOVA, sve u cilju poređenja razlika na nivou grupa, dok se testovima međusubjektnih efekata procenjuju varijacije u efektima koeficijenata regresije za makroekonomske faktore koji utiču na rast BDP-a. Ova studija polazi od pretpostavke da distinktivne ekonomske strukture zemalja BRIKS-a i zemalja članica G7 vode ka promenljivim makroekonomskim uslovima, koji oblikuju obrasce rasta tih zemalja na različite načine. Saznanja do kojih se u ovoj studiji došlo nude uvide u najjače i najslabije odrednice rasta BDP-a unutar tih ekonomskih blokova, koji mogu imati i svoju praktičnu primenu. Ona doprinosi širem diskursu u domenu globalne ekonomske konkurencije, nudeći preporuke za strategije uravnoteženog rasta zasnovane na dokazima.

Ključne reči: makroekonomski uslovi, rast BDP-a, BRIKS, G7

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COMPARATIVE ANALYSIS OF METHODS FOR ASSESSING RETENTION EXCEEDANCE PROBABILITY IN MOTOR CASCO INSURANCE: THE CASE OF BULGARIA

Ventsislav Vasilev* and Radka Vasileva

Tsenov Academy of Economics, Svishtov, Bulgaria

The study explores some methods used to assess risk and determine optimal retention levels in motor casco insurance, specifically focusing on comparing the three statistical techniques: Chebyshev's Inequality, the Monte Carlo Simulation, and Normal Distribution. By utilizing historical claims data from the Bulgarian insurance market published by the Financial Supervision Commission, the study investigates the probability of the claim exceeding retention thresholds and compares the accuracy and precision of each method. While Chebyshev's inequality provides a conservative estimate, the Monte Carlo simulation offers a probabilistic approach that models various outcomes, whereas normal distribution assumes a symmetrical loss pattern. The research aims to identify which method offers the most reliable estimation for setting retention levels in motor casco insurance. By evaluating the accuracy of each technique against real claims data, the study aims to inform insurers about the approach which optimizes their risk management decisions best. The research shows that the Monte Carlo simulation offers the most accurate and reliable estimates for motor casco retention decisions due to its flexibility in modelling various loss scenarios.

Keywords: motor casco insurance, direct insurer's retention, Chebyshev's Inequality, Monte Carlo Simulation, Normal Distribution method

JEL Classification: G22

INTRODUCTION

Motor casco insurance is an essential component of the insurance sector, not only for the insurers but also for society at large. It covers vehicles against damage caused by accidents, theft, or natural disasters, providing a safety net for vehicle owners. For individual policyholders, having a motor casco policy means peace of mind, knowing that they are financially protected in the event of unexpected damages. This coverage is particularly valuable in a society with a growing number of vehicles, where accidents or loss can result in high financial costs.

The insurance policy considered is a voluntary, comprehensive vehicle insurance that covers damages

* *Correspondence to:* V. Vasilev, Tsenov Academy of Economics, 2 Em. Chakarov str, Svishtov, Bulgaria; e-mail: v.vasilev@uni-svishtov.bg

to the policyholder's own vehicle, unlike third-party liability insurance, which only covers damages caused to others. It typically protects against risks such as accidental damage, theft, natural disasters (e.g. storms, floods), fire, and glass breakage. Insurers assess risk based on factors like the vehicle type and age, the driver's profile, and the location. These elements help determine premiums by estimating the likelihood and potential cost of claims. Claims frequency is generally moderate, with frequent minor claims (e.g. scratches) and less frequent but severe events (e.g. theft, total loss). Frequency is influenced by the driver's behavior and road conditions, while severity depends on the nature of the incident itself.

The importance of motor casco insurance extends beyond individual benefits. Broader social benefits include reducing the financial burden on the state and on other individuals in case of accidents or damages. It helps maintain the stability of the automotive sector and ensures that owners and operators can repair or replace vehicles quickly, thus contributing to the overall economic efficiency, which is especially important in a rapidly evolving economy such as Bulgarian, where a significant proportion of the population relies on personal vehicles for transportation.

Motor casco insurance plays a significant role on Bulgaria's non-life insurance market. As of 2023, motor casco represents 29% of the gross premium income, placing it in the second position after the obligatory motor third-party liability insurance, which accounts for 40% of the entire market. Simultaneously, the gross claims incurred related to motor casco insurance amounted to BGN 410,536,263, accounting for 26% of all non-life insurance claims. These figures demonstrate both the market share and the critical importance of motor casco insurance in the country's broader insurance landscape.

One of the key tasks for insurance companies, particularly in motor casco insurance, is determining how much risk they are willing to retain and how much should be transferred to a reinsurer. This decision is far from simple and requires a careful evaluation of various factors. For example, the specifics of motor casco insurance - which includes coverage for theft, damage from natural events, and accidents - present particular challenges. The frequency and severity of claims can vary greatly depending on the type of vehicle, geographic location, and other risk factors.

Insurance companies must also consider their risk appetite, which refers to the level of risk they are prepared to take on in pursuit of profit. This is influenced by the factors such as financial stability, historical loss experience, and claims management capabilities. Historical loss experience plays a crucial role in assessing potential future claims. If an insurer has faced frequent large claims in the past, they might opt for a lower retention threshold to limit their exposure. On the other hand, insurers with a track record of low loss frequency may feel comfortable retaining a higher share of risk.

One of the most effective ways for insurance companies to determine appropriate retention levels is by analyzing past claims data. By examining paid losses related to motor casco insurance, insurers can gain valuable insights into their historical loss experience, which may enable them to make informed decisions on future retention strategies. This data allows insurers to identify trends and patterns in claims frequency and severity, which can help predict the potential for future claims. Armed with this information, insurers can determine the level of risk they are comfortable retaining and make informed decisions on how much risk to transfer to reinsurers.

Given the complexities involved in determining the optimal retention level, insurers frequently rely on various mathematical and statistical methods to assess risk, manage exposure, and optimize retention strategies. These methods help insurers estimate the retention threshold exceedance probability and understand the likelihood of large claims that could impact their financial stability. Among the methods most commonly used for such assessments are Chebyshev's inequality, the Monte Carlo simulation, and normal distribution.

While distinct in their approaches, these methods all aim to help insurers quantify the risks they face and

establish the retention levels that balance profitability with financial stability. Given the complexities involved in setting retention levels, insurers are continually refining these models and exploring new techniques to improve their risk management strategies.

The primary objective of this research is to compare the accuracy and precision of different methods for estimating the probability of a claim exceeding the retention threshold in motor casco. Specifically, Chebyshev's inequality, the Monte Carlo simulation, and normal distribution will be applied to a common dataset so as to assess how closely each method estimates the likelihood of a loss surpassing the insurer's retention level. By evaluating the performance of these methods, the research goal is to identify which approach provides the most reliable and precise estimation for setting appropriate retention levels in the context of motor casco risks. Valuating the "accuracy and precision" of each method will be done using the historical loss data related to motor casco insurance published by the Financial Supervision Commission (https://www.fsc.bg/en/) in Bulgaria.

Based on this, the research hypothesis here is that the Monte Carlo simulation provides a more accurate and precise estimate of the retention threshold exceedance probability in motor casco insurance compared to the traditional methods such as Chebyshev's inequality and normal distribution, which is due to the ability of the Monte Carlo simulation to model numerous possible outcomes based on historical loss data, offering a more detailed and flexible approach to risk assessment. The hypothesis will be tested by comparing the results obtained from each method and analyzing their alignment with the observed claims data, thereby assessing which method most closely predicts the actual risk of exceeding retention. With the intention to support the statement that the Monte Carlo simulation will provide a more accurate and precise estimate, sensitivity analysis will be performed in order to validate the robustness of the results and assess how changes in the key assumptions, such as the mean loss, impact the retention threshold exceedance probability. The theoretical and methodological instruments applied include probability theory, risk modelling, and statistical simulation, with a sensitivity analysis performed on the official motor casco claims data.

The paper is structured into a few sections. Following Section 1, Section 2 is a review of the relevant literature on risk assessment and retention modelling. Section 3 presents the data used in the analysis and outlines the methodological framework, focusing on Chebyshev's inequality, the Monte Carlo simulation, and normal distribution. Section 4 discusses the results obtained by applying the selected methods and interprets their implications. Finally, in Section 5, conclusions are given by summarizing the key findings and suggesting directions for future research.

LITERATURE REVIEW

Research on the optimal motor casco insurance retention, reinsurance, and related distributions is limited, and few studies address this complex problem directly.

An in-depth examination of self-retention in property insurance, including motor casco, has been presented in several studies. In V. K. Kaishev's study (2004), the reinsurance contract is modelled under an excess of loss (XL) treaty (Kaishev, 2004). The goal is to maximize the joint survival probability of both the cedent (direct insurer) and the reinsurer. V. K. Kaishev (2004) calculates survival probabilities for both parties and determines the optimal retention that minimizes the difference between their survival probabilities. The study compares this approach with quota share reinsurance, suggesting that a balance between retention and reinsurance is crucial for optimal outcomes.

F. Glineur and J. Walhin (2006) apply convex optimization techniques to confirm de Finetti's results on proportional reinsurance. They extend these findings to variable quota share and surplus reinsurance, challenging the optimality of these approaches and providing deeper insights into how retention affects reinsurance decisions. A. Tsanakas

and P. Millossovich (2015) focus on the sensitivity and robustness of optimal retention calculations under various distributional assumptions, including normal and non-normal scenarios.

S. Li, Z. Zhu and J. Peng (2022) explore an optimal stop-loss reinsurance model in uncertain claim environments. The results of their study reveals how retention should be determined based on risk measures such as value-at-risk (VaR), which can guide insurers in volatile conditions. J. Cai and K. Tan (2007) develop two optimization criteria based on value-at-risk (VaR) and conditional tail expectation (CTE) so as to determine optimal retention levels in stop-loss reinsurance. They demonstrate that, when optimal solutions exist, both criteria yield the same retention value, although the CTE-based method is generally more applicable due to less restrictive conditions.

L. Noviyanti, A. Z. Soleh, A. Chadidjah and H. A. Rusyda (2018) explore different retention models in quota-share reinsurance and also examine possible retention optimization in Indonesia. Using bivariate lognormal and exponential distributions alongside risk measures like VaR, expected shortfall (ES), and the minimum variance (MV), the authors aim to minimize risks, while simultaneously ensuring financial stability and regulatory compliance. A. Z. Soleh, L. Noviyanti and I. Nurrahmawati (2015) discuss how stop-loss reinsurance can reduce risk exposure by optimizing retention in automobile insurance. Their study models risk using compound Poisson and lognormal distributions, showing that retention can be optimized so as to minimize VaR.

In scenarios with incomplete data, X. Hu, H. Yang and L. Zhang (2015) propose a distribution-free approach to optimize retention in stop-loss reinsurance contracts. This method helps insurers minimize risk, even with incomplete information.

The study by Y. Kroll and D. Nue (1991) introduces a portfolio management approach to retention. This framework analyzes alternative management goals and offers testable implications for setting optimal proportional reinsurance retention levels, helping insurers balance risk and profitability.

More recent studies have introduced advanced analytical tools and empirical investigations into the assessment of retention in motor casco insurance. L. Fu and H. Wang (2021) investigate attrition using survival analysis to distinguish mid-term cancellations from nonrenewal. By incorporating time-dependent macroeconomic variables into retention modelling, they introduce a more responsive approach for insurers to anticipate and manage risk exposure over time. The paper by R. Erusalimov and N. Iliev (2022) offers an empirical contribution by analyzing how the COVID-19 pandemic affected motor casco insurance in Bulgaria. Their study reveals how external shocks alter premium income, claims frequency, and indemnity payouts, thus influencing retention behavior and risk levels during crisis periods. Finally, M. Leiria, E. Rebelo and N. deMatos (2021) explore the role of intermediary loyalty programs and customer behavior in motor insurance cancellations. Their findings, based on logistic regression, show that intermediary involvement and payment methods significantly affect retention probability, adding a behavioral dimension to otherwise quantitatively modelled risk frameworks.

In this context, additional theoretical grounding is provided by research addressing capital allocation and collective risk modeling in non-life insurance. J. Kočović, M. Mitrašević, M. Kočović and M. Jovović (2011) examine the challenges of capital allocation in insurance companies, emphasizing the fact that the adequacy of allocation depends on acknowledging the inverse relationship between risk and capital, as well as the diversification effects that shape solvency and performance outcomes. Their findings highlight the necessity of selecting allocation and risk assessment techniques consistent with insurers' overarching objective of value maximization - the principle that also underpins the determination of optimal retention levels. Building on this theoretical perspective, Z. Djuric (2013) develops a collective risk model for non-life insurance, conceptualizing claim frequency and severity as stochastic processes. This framework provides a rigorous mathematical basis for simulating claim variability and estimating the probability of exceeding predefined retention thresholds, thereby complementing the methodological approach adopted in the present study.

Moreover, recent studies have expanded the application of the Monte Carlo simulation in the analysis of motor casco retention. L. Xiong and D. Hong (2020) demonstrate the fact that the Monte Carlo methods effectively predict solvency and model risk scenarios in captive insurance by simulating historical loss data, closely aligning with probabilistic retention evaluation. T. Heinrich, J. Sabuco and J. Farmer (2021) apply industry-wide simulation models addressing the risk correlation issues pertinent for estimating the probabilities of retention exceedance, thus contributing valuable perspectives on portfolio-level risk in motor casco insurance. B. Bulut Karageyik and Ş. Şahin (2017) propose the excess-of-loss criterion approach for the optimal retention calculation, emphasizing the varying premium and ruin considerations that offer a complementary empirical lens for motor casco retention frameworks. E. Roos, R. Brekelmans, W. van Eekelen, D. den Hertog and J. S. H. van Leeuwaarden (2022) advance theoretical underpinnings by developing tight tail probability bounds extending Chebyshev's Inequality, furnishing a more refined basis for conservative risk estimation in insurance retention modelling. M. Covrig and D. Badea (2017) employ generalized linear models for claim frequency analysis in motor insurance, thereby corroborating the use of normal distribution and other statistical techniques in retention risk assessment. B. Shahriar and S. M. M. Ahmadi (2008) introduce a novel methodology for determining optimal reinsurance retention by minimizing value-at-risk (VaR) via the Monte Carlo simulation, with a focus on capital adequacy and potential loss mitigation. Their empirical application to Mellat Insurance Company's portfolio demonstrates that the optimal retention levels are approximately 58%, BGN 35,845 million and BGN 18,937 million under quota share, excess of loss, and surplus reinsurance contracts, respectively. Using Nigerian motor insurance data, O. Chukwudum (2019) applies the Monte Carlo simulation combined with Extreme Value Theory to model large claims frequency and severity, enabling optimized reinsurance retention decisions using the improved estimation of capital requirements and excess-of-loss pricing.

Together, these recent contributions extend traditional retention theory into contemporary, data-driven practice. Simultaneously, they provide a deeper understanding of the multifactorial nature of retention probability assessment in motor casco insurance - spanning statistical modelling, empirical analysis, and regulatory framing.

DATA AND METHODOLOGY

Data

The analysis of a number of claims and insurance companies' paid losses on motor casco insurance in the Bulgarian insurance market covers the period from 2018 to 2022 and is carried out based on the official statistics published by the Financial Supervision Commission and available on its website (https://www.fsc.bg/en/). The reason for the five-year period chosen is a lack of the officially published market data for a longer period. The data are shown in Bulgaria's official currency - the Bulgarian Lev (BGN). Bulgaria has been on the currency board since 1997, and the exchange rate of the Bulgarian Lev (BGN) is fixed against the exchange rate of the Euro. BGN 1 is exchanged for EUR 0.511292.

The data used in this study are aggregated across the non-life insurance companies operating in Bulgaria that offer motor casco insurance. As of the end of the analyzed five-year period (2018-2022), 17 out of the 22 licensed non-life insurers in the country provided motor casco coverage, according to the official statistics published by the Financial Supervision Commission. The use of aggregated data ensures a comprehensive market-level view, which is appropriate for analyzing trends and assessing the retention threshold exceedance probability in a generalized context.

Methodology

This study employs three distinct methods to estimate the probability of exceeding a given retention

threshold in the context of motor casco insurance: Chebyshev's inequality, the Monte Carlo simulation, and normal distribution. These methods were selected based on their compatibility with the available official data, which consist exclusively of the aggregated and anonymized historical loss records published by the Financial Supervision Commission. While modern actuarial and data-driven techniques such as Generalized Linear Models (GLMs), Usage-Based Insurance (UBI), Dynamic Pricing, Machine Learning, Bayesian Methods, and Catastrophe Modelling are increasingly used in the insurance industry for pricing and risk assessment, their direct applicability to estimating optimal retention levels, particularly in the context of this research, is limited. Most of these methods are primarily designed to assess individual policyholder risk and set premiums, requiring detailed, real-time, or proprietary internal data such as telematics, detailed claims histories, and dynamic behavioral metrics. For instance, GLMs and machine learning models are commonly employed to predict claims frequency and severity at the individual level, while UBI and dynamic pricing rely on the continuous monitoring of driving behavior, and catastrophe models necessitate high-resolution exposure data. In contrast, the current study is exclusively based on the officially published aggregate data, which constrains the use of such advanced methodologies.

While certain elements of these approaches may indirectly inform strategic decisions around reinsurance and retention (e.g. through portfolio-level risk modelling), their effective application demands the data inputs that are not publicly available. Consequently, the research employs alternative methods - Chebyshev's inequality, the Monte Carlo simulation, and the normal distribution approach - which are robust to data limitations and more appropriate for estimating the probability of retention exceedance using the available data.

Each method applied in the study provides a unique approach, based on different assumptions about the distribution of losses. Below is an explanation of how each method is applied in order to estimate the upper bound probability of retention exceedance.

Chebyshev's Inequality is a non-parametric method that provides an upper bound on the probability of an event occurring beyond a certain threshold. This method is particularly useful in situations where the distribution of losses is unknown or not well-behaved, i.e. it may be skewed or have heavy tails. Skewness refers to the asymmetry of a distribution, where data is not evenly spread around the mean; if a distribution has a longer tail on the right, it is positively skewed, and if it has a longer tail on the left, it is negatively skewed. Heavy tails describe a distribution where extreme values (outliers) occur more frequently than they would in a normal distribution, meaning the probability of large deviations from the mean is higher, leading to a slower decay in the tail of the distribution. The method guarantees an upper bound on the probability of exceeding the threshold, regardless of the distribution itself.

$$P(|X - \mu| \geq k\sigma) \leq \frac{1}{k\hat{}2} \quad (1)$$

where:

X is the individual loss,

μ is the mean loss,

σ is the standard deviation of the losses, and

k is the number of the standard deviations from the mean.

In this research, Chebyshev's Inequality will be used to calculate the upper bound probability that the individual loss X will exceed the chosen retention threshold T. The threshold T is defined as:

$$T = \mu + k\sigma \quad (2)$$

where k is the multiple of the standard deviation. To calculate the probability of exceeding the threshold using Chebyshev's inequality:

1. Determine the number of the standard deviations *k:* Calculate how far the retention threshold T is away from the mean μ using the formula:

$$k = \frac{T-\mu}{\sigma} \tag{3}$$

2. Apply Chebyshev's inequality so as to find the upper bound probability of exceeding the threshold:

$$P(\mathrm{X} \geq \mathrm{T}) \leq \frac{1}{k\hat{}2} \tag{4}$$

This approach provides a conservative estimate of the probability that the individual loss will exceed the retention threshold.

The inequality gives the upper bound for the probability that the loss exceeds the retention level *T*. By adjusting *T* (the retention threshold), insurers can balance their risk exposure. Higher retention levels result in a smaller probability of exceeding the threshold, but they also expose the insurer to a greater risk. In reinsurance, this method allows the insurer to quantify the likelihood of extreme losses, which helps in setting an appropriate retention level that aligns with their risk tolerance.

The Monte Carlo Simulation is a numerical approach that estimates the probability of exceeding retention by simulating random losses based on the observed distribution. This method generates a lot of random samples and calculates the proportion of the simulated losses that exceed the retention threshold, which gives the estimated probability *P (X≥T)* or the probability that the insurer's loss exceeds the retention level. The process for applying the Monte Carlo simulation is as follows:

1. The data input. Use historical data for individual losses (e.g. the losses from 2018 to 2022). Future losses are assumed to follow the same distribution as the historical data.

2. Generate random samples. Create a lot of random samples from the observed historical data. Each sample represents a simulated individual loss.

3. Determine exceedances. For each simulation, check whether the simulated loss exceeds the retention threshold *T*. The threshold T is typically calculated utilizing the following formula:

$$T = \mu + k\sigma \tag{5}$$

4. Probability estimation. Estimate the probability *P (X≥T)* by calculating the ratio of the number of the simulations where *X≥T* to the total number of the simulations run. In other words, the probability that the loss exceeds the retention threshold is estimated as the ratio of the number of the samples that exceed the threshold to the total number of the simulations run:

$$P(\mathrm{X} \geq \mathrm{T}) = \frac{Number\ of\ simulations\ where\ X \geq T}{Total\ number\ of\ simulations} \tag{6}$$

By repeating this process for a lot of simulations (e.g. 10,000 or more), the Monte Carlo simulation provides a more accurate estimate of the retention threshold exceedance probability, thus reflecting the inherent uncertainty and variability in the loss data.

Normal Distribution assumes that individual losses follow normal distribution, characterized by the mean *(μ)* and the standard deviation *(σ)*. While this is a simplifying assumption, it is commonly used in insurance modelling when data are expected to follow the bell-shaped curve.

To calculate the retention threshold exceedance probability in a normal distribution, these steps are to be followed:

1. Calculate the *Z*-score. The *Z*-score measures how many standard deviations the retention threshold *T* is away from the mean μ. The Z-score is given by:

$$Z = \frac{T-\mu}{\sigma} \tag{7}$$

where:

μ is the mean individual loss,

σ is the standard deviation of the individual losses, and

T is the retention threshold.

2. Determine the probability. Once the Z-score is calculated, the standard normal distribution table (or the computational tool) can be used to find the cumulative probability *P(Z)*, which represents the probability that a loss is less than the threshold. The probability of exceeding the threshold is the complement of this cumulative probability:

$$P(X \geq T) = 1 - P(Z) \quad (8)$$

where *P(Z)* is the cumulative probability corresponding to the Z-score.

Although this method assumes that the losses are symmetrically distributed around the mean, real-world data, particularly in the case of motor casco insurance, may not perfectly follow a normal distribution. Loss distributions in insurance often exhibit skewness or heavy tails, which means that extreme losses are more frequent than predicted by a normal distribution. Despite this limitation, the normal distribution approach provides a convenient and broadly used method for estimating the probability of exceedances under the assumption of normality.

Each of the three methods offers a different way to estimate the retention threshold exceedance probability. Chebyshev's inequality provides a conservative estimate that does not rely on the assumptions about the distribution of losses, making it useful when the distribution is unknown. The Monte Carlo simulation uses historical data to simulate potential future losses, offering a flexible and data-driven approach. Finally, normal distribution assumes a bell-shaped distribution of losses, which simplifies the calculation but may not always reflect the true distribution of losses in real-world insurance data.

By applying these methods, it is possible to estimate the retention threshold exceedance probability under different assumptions, which helps insurers make more informed decisions on their risk retention levels.

RESULTS AND DISCUSSION

The data presented in Table 1 reflect the trends in the number of claims, the paid losses, and the mean losses in casco insurance over a five-year period from 2018 to 2022.

Several key trends and fluctuations can be observed over the five-year period. The number of claims has shown a gradual decrease from 407 760 in 2018 to 352 396 in 2022. This decline may reflect a decrease in the total number of insured vehicles or an improvement in risk management and underwriting.

The paid losses, however, did not follow the same downward trend. While the losses remained relatively stable between 2018 and 2021, they increased significantly in 2022, reaching BGN 380 201 243, which is substantially higher than in previous years.

The mean loss per claim steadily increased from BGN 817 in 2018 to BGN 1,079 in 2022, which indicates that, while the total number of claims decreased, the cost

Table 1 The number of claims and the paid losses in motor casco insurance (in BGN) by year

Year	Number of claims	Paid losses (BGN)	Mean loss (BGN)
2018	407 760	333 303 426	817
2019	403 189	345 203 045	856
2020	369 373	341 883 686	926
2021	351 763	339 662 479	966
2022	352 396	380 201 243	1079
Total mean			929
Standard deviation			102

Source: Authors, based on Financial Supervision Commission (https://www.fsc.bg/en/)

per claim had been rising over the years. In particular, the sharp rise in 2022 (from BGN 966 in 2021 to BGN 1,079) may suggest a change in the nature of the claims, such as higher costs associated with repairs, medical expenses, or legal settlements.

As for the fluctuations and variability, the standard deviation of BGN 102 calculated from the mean loss indicates a moderate variability in the annual loss amounts. The fluctuations in the paid losses between 2018 and 2022, especially the marked increase in 2022, demonstrate that, while there is a general trend of rising costs, the year-to-year differences can be significant. These fluctuations could be driven by various factors, such as changes in the frequency of catastrophic claims, inflation, or shifts in claim handling processes.

Overall, the data suggest that, while the number of claims has been decreasing, the cost per claim is on the rise, which could pose a greater financial burden on insurers. The significant rise in the paid losses in 2022 warrants further investigation into the underlying causes, such as more expensive claims or unforeseen events that led to higher payouts. Overall, while the number of claims shows some stability, the large variations in the loss amounts and the mean losses emphasize the unpredictable nature of the risk involved, underlining the importance of effective risk assessment and retention strategies.

Based on the given data, this study suggests that the direct insurer's retention threshold should be set at BGN 1 115 per individual claim, which is derived from the mean loss of BGN 929 plus 20% of the mean (i.e. BGN 186).

This threshold represents a strategic point where the insurer retains a significant but not excessive amount of risk, transferring the remaining risk to reinsurance. In assessing how accurate risk assessment is for determining this threshold, the following three methods can be utilized, namely Chebyshev's inequality, the Monte Carlo simulation, and the normal distribution approach.

Chebyshev's inequality is a non-parametric method that provides a bound on the probability of extreme outcomes, regardless of the distribution of the data. This method would estimate the probability that a claim will exceed the retention threshold (BGN 1 115) based on the mean and standard deviation of the data. Given the fact that Chebyshev's inequality applies to any distribution, it is more conservative and would likely provide an upper bound on the likelihood of exceeding the threshold. However, it may not offer the level of precision needed for more informed retention decisions because it tends to overestimate the probability in comparison to methods that take the actual data distribution into account.

By contrast, the Monte Carlo simulation is much more flexible and powerful. It simulates many possible future loss scenarios based on historical data and random sampling, generating a probability distribution for losses. Given the data, Monte Carlo simulations would estimate the retention threshold exceedance probability by running thousands of simulations with varying assumptions for claim severity and frequency. This method would offer a more precise estimate of risk and help the insurer better understand the likelihood of extreme events. It is particularly valuable in assessing complex, uncertain risk profiles and would provide a more tailored and accurate estimate than Chebyshev's inequality.

Assuming that a loss distribution follows a normal distribution, the insurer could calculate the retention threshold exceedance probability by considering the mean and the standard deviation. Based on the data, the normal distribution approach could estimate the percentage of the claims that would likely exceed the BGN 1 115 threshold. However, normal distribution is limited by the assumption that losses follow a bell-shaped curve. If the actual distribution of losses is skewed or has fat tails (as is often the case in motor casco insurance), this method may underestimate the probability of extreme losses. Despite its simplicity, the normal distribution approach could still provide a useful baseline estimate, particularly in the absence of more complex data modelling.

Table 2 presents the probabilities of exceeding the retention threshold of BGN 1115 calculated using the three different methods: Chebyshev's Inequality, the

Monte Carlo Simulation, and Normal Distribution. The calculations were performed using Microsoft Excel.

According to Chebyshev's Inequality: the 24.52% retention threshold exceedance probability represents a very conservative estimate. Chebyshev's inequality guarantees that no more than this percentage of claims will exceed the threshold, but because it does not make assumptions about the data distribution, it tends to overestimate the risk. While useful in the absence of detailed information about the loss distribution or when data is limited, it is likely to overstate the risk of large claims exceeding the threshold in this case.

Table 2 The retention threshold exceedance probabilities calculated using the three methods

Method	Retention threshold (BGN)	Retention exceedance probability
Chebyshev's Inequality	1 115	24.52 %
Monte Carlo Simulation	1 115	1.99 %
Normal Distribution	1 115	2.16 %

Source: Authors

The result of the 1.99% probability calculated from the Monte Carlo simulation is a more realistic estimate. By simulating 10000 random outcomes based on the observed loss data, this method captures the underlying variability of the losses. It can model the non-normal features of the loss distribution (such as skewness or heavy tails, providing a more precise risk estimate, which takes into account the full range of potential outcomes and reflects a more accurate risk assessment for the insurer).

The 2.16% probability calculated from the normal distribution approach is very close to the Monte Carlo result, which suggests that, for this particular dataset, normal distribution is a reasonable approximation of the actual loss distribution. Despite the moderate skewness perceived in the data, the normal distribution approach provides a useful and efficient tool for estimating retention thresholds when data are roughly symmetric or near normal by their nature. The close alignment between this method and the Monte Carlo simulation indicates that, in this particular case, the assumption of normality is valid enough to provide a similar estimate.

The results from the above calculations of the retention threshold exceedance probabilities allow for the following summary:

1. The conservatism of Chebyshev's Inequality. The method offers a safe, conservative approach but lacks precision, especially for extreme loss probabilities. The high retention threshold exceedance probability (24.52%) calculated utilizing Chebyshev's inequality emphasizes the method's conservative nature, not taking into consideration the actual characteristics of the loss data, thus leading to an overestimation of risk and to potentially higher reinsurance costs.

2. More accurate assessment by applying the Monte Carlo Simulation and the Normal Distribution Approach. The Monte Carlo simulation and normal distribution approaches provide very similar results, with the probabilities of 1.99% and 2.16%, respectively. These methods provide a more precise and realistic estimate of the retention threshold exceedance risk. The small difference between these two methods suggests that the assumption of normality is reasonably accurate in this case. Therefore, an insurance company can be more confident in using these methods for risk assessment.

3. The reliability of the Monte Carlo Simulation. The Monte Carlo simulation is generally considered the most flexible and accurate method for complex risk assessment. The relatively low probability it provides (1.99%) gives a more realistic view of the risk of loss and can be used for better-informed decision-making when setting retention thresholds. However, this approach is computationally intensive and requires a substantial amount of data and simulation runs.

4. Given the large discrepancy between Chebyshev's Inequality and the other two methods, the Monte Carlo simulation would be the most reliable approach for setting the retention threshold, especially when

dealing with complex, non-normal distributions. The normal distribution approach could also be used as a simpler alternative, but its assumptions about the data distribution should be carefully considered.

5. An insurance company can be confident in using the retention threshold of BGN 1115 based on the lower probabilities obtained through the Monte Carlo and normal distribution methods. This threshold effectively balances risk retention with risk transfer, based on the relatively low (around 2%) probability of exceeding it.

A sensitivity analysis was performed to validate the robustness of the results and assess how changes in key assumptions, such as the mean loss, impact the retention threshold exceedance probability. The purpose of this analysis was to understand how changes in the mean loss (μ) affect the retention threshold exceedance probability (BGN 1,115). The examination of this relationship can allow for the assessment of the impact of varying loss scenarios on the risk profile and provide a further context for the calculated probabilities. The sensitivity analysis helps illustrate the potential variations in the risk that may arise from changes in the loss levels, thereby supporting the results obtained using the Monte Carlo and normal distribution based on the assumptions about the underlying distribution of the losses.

The results presented in Figure 1 after the calculations have been made clearly demonstrate the fact that, as the mean loss increases, so does the retention threshold exceedance probability. When the mean loss is BGN 900, the threshold exceedance probability is 0.0175 (1.75%), which suggests that, with lower mean losses, there is a very small chance of exceeding the threshold, and thus the need for reinsurance remains minimal. As the mean loss reaches BGN 1,100, the probability increases to 0.4415 (44.15%), indicating a significantly higher risk of exceeding the retention threshold, which highlights the increasing likelihood that the insurer will need to transfer risk to reinsurance if the average loss per claim becomes substantial.

These findings underscore the importance of closely monitoring mean loss levels. As the mean loss approaches or exceeds the retention threshold (BGN 1,115), the likelihood of exceeding it rises sharply, suggesting the need for increased reinsurance coverage.

The Monte Carlo simulation generated a probability of 1.99% based on realistic, random variations in claim amounts and frequencies. When comparing this to the results obtained from the sensitivity analysis, the following can be perceived: at the mean loss of BGN

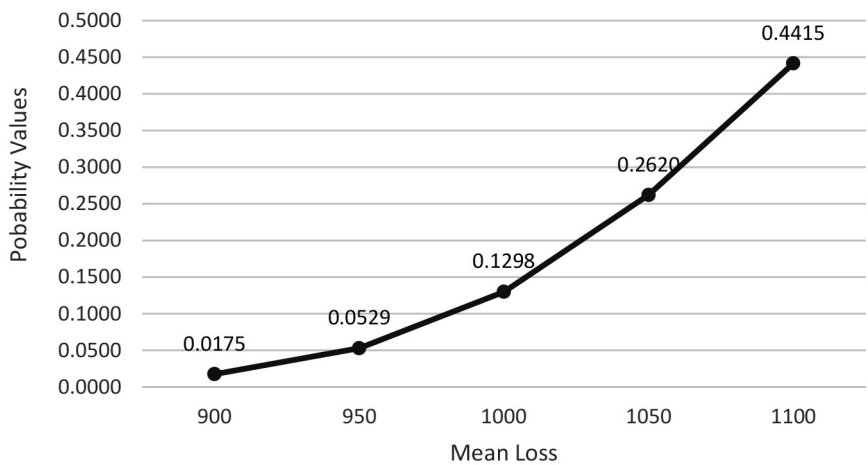

Figure 1 The changes in the retention threshold exceedance probability with the increased mean loss

Source: Authors

950, the threshold exceedance probability is 0.0529 (5.29%). For the mean loss values around BGN 1,100, the probability increases significantly, ranging from 0.2620 (26.20 %) to 0.4415 (44.15%).

Given this, the 1.99% probability derived from the Monte Carlo simulation lies in the lower end of the sensitivity analysis curve, corresponding to a mean loss between BGN 900 and 950, which suggests that the Monte Carlo result represents a scenario where the average claim loss is relatively low, and the threshold exceedance probability remains small. Thus, the Monte Carlo simulation provides a more precise estimate of risk for lower loss scenarios, and the sensitivity analysis supports this finding by showing how small variations in the mean loss directly affect the likelihood of exceeding the threshold.

CONCLUSION

The comparative analysis of the three statistical methods - Chebyshev's Inequality, the Monte Carlo Simulation, and the Normal Distribution - estimates the retention threshold exceedance probability in motor casco insurance. The analysis is exclusively based on the official, aggregated data published by the Bulgarian Financial Supervision Commission for the period from 2018 to 2022. The results indicate that the Monte Carlo simulation offers the most accurate and reliable estimates of retention-level exceedance probabilities, primarily due to its flexibility in modelling complex and non-normal loss distributions. The normal distribution method produced the results that closely align with those of the Monte Carlo Simulation, suggesting a reasonable approximation for the dataset under consideration. In contrast, Chebyshev's Inequality yielded significantly higher and more conservative estimates, reflecting its generalized, non-parametric nature.

The practical significance of these findings lies in their direct applicability to real-world insurance operations. The ability to more accurately estimate the retention threshold exceedance probability is critical for optimizing risk transfer strategies, determining reinsurance structures, and ensuring capital adequacy. Given the substantial role of motor casco insurance within the Bulgarian non-life insurance market, the implementation of more precise risk assessment methods based on available official data can contribute to more efficient financial planning and enhanced sector stability.

Despite the methodological robustness, this research is subject to several limitations. First, the study is constrained by the aggregated market-level data used, since detailed insurer-level information is not publicly available. As a result, the analysis cannot account for the heterogeneity in underwriting practices, risk profiles, or claim management strategies across individual insurers. Second, the examined timeframe is limited to a five-year period due to the absence of longer historical datasets in the public domain, which restricts the ability to assess long-term trends and may limit the generalizability of the findings. Third, all the calculations were made using Microsoft Excel, which, while suitable for the scope of this research, does not offer the computational depth of specialized statistical or actuarial pieces of software. Finally, although other advanced risk modelling techniques such as machine learning or multivariate simulation could enhance the predictive performance, their application is not feasible in this context due to the restricted availability of detailed input data.

Building on the current findings, future research could be conducted to access the insurer-level data that would allow for a better understanding of risk variability and retention behavior across companies. Furthermore, incorporating longer time series or event-based stress testing could enhance the evaluation of tail risk and extreme loss scenarios. More available data could allow for the application of advanced analytical methods, including machine learning algorithms, stochastic modelling, or copula-based approaches, and provide deeper insights into loss dependencies and risk concentration. Additionally, expanding the scope to include multi-line insurance portfolios would offer a broader view of retention optimization at the portfolio level. Finally, future studies may consider the impact of macroeconomic or regulatory changes on frequency

and severity of losses, further informing the dynamic adjustment of retention strategies.

In conclusion, this research supports the use of the Monte Carlo simulation as one of the most suitable methods among the considered ones for determining optimal retention levels in motor casco insurance based on officially available data. It offers a practical framework for insurers operating under data constraints.

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Ventsislav Vasilev is an Associate Professor in the Department of Insurance and Social Security at Tsenov Academy of Economics, Svishtov, Bulgaria. His research focuses on non-life insurance, reinsurance, and insurance company solvency. He completed his undergraduate and doctoral studies at the same institution.

Radka Vasileva earned her doctorate in the Department of Insurance and Social Security at Tsenov Academy of Economics, Svishtov. She is currently a Senior Lecturer in the Department of Foreign Language Teaching at the same institution. Her research interests include reinsurance, especially insurance company retention policy.

KOMPARATIVNA ANALIZA METODA PROCENE VEROVATNOĆE PREMAŠIVANJA ZADRŽAVANJA RIZIKA U KASKO OSIGURANJU - STUDIJA SLUČAJA NA PRIMERU BUGARSKE

Ventsislav Vasilev and Radka Vasileva

Tsenov Academy of Economics, Svishtov, Bulgaria

U ovoj studiji se istražuju neke metode koje se koriste za procenu rizika i utvrđivanje optimalnih nivoa zadržavanja rizika u kasko osiguranju, posebno se usredsređujući na upoređivanje triju statističkih tehnika, i to Čebiševljeve nejednakosti, Monte Karlo simulacije i normalne distribucije. Na temelju istorijskih podataka o odštetnim zahtevima na bugarskom tržištu osiguranja koje objavljuje Komisija za finansijski nadzor Bugarske, u ovoj studiji se istražuje verovatnoća da odštetni zahtev premaši pragove zadržavanja rizika, istovremeno upoređujući tačnost i preciznost svakog od navedenih metoda. Dok Čebiševljeva nejednakost pruža konzervativnu procenu, Monte Karlo simulacija nudi jedan probabilistički pristup koji modeluje različite ishode, a normalna distribucija pretpostavlja obrazac simetričnog gubitka. Ova studija ima za cilj da identifikuje metode koje nude najpouzdaniju procenu u svrhu postavljanja nivoa zadržavanja rizika kod kasko osiguranja. Procenom tačnosti svake od navedenih tehnika u pogledu podataka o realnim potraživanjima, ova studija ima za cilj da informiše osiguravače o tome koji od pristupa najbolje optimalizuje njihove odluke o upravljanju rizicima. Ovo istraživanje pokazuje da Monte Karlo simulacija nudi najtačnije i najpouzdanije procene kad su u pitanju odluke o zadržavanju rizika u domenu kasko osiguranja zahvaljujući svojoj fleksibilnosti u modelovanju različitih scenarija gubitka.

Ključne reči: kasko osiguranje, zadržavanje rizika direktnog osiguravača, Čebiševljeva nejednakost, Monte Karlo simulacija, metod normalne distribucije

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