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The Impact of Infrastructure Development on the Economic Growth of the Countries in the Western Balkans and their EU Future

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Abstract

The infrastructure investment could strongly influence the economic growth in the Western Balkans countries and contribute to improved regional cooperation and reconciliation and to faster integration into the EU. However, it is essential that public investments in infrastructure are properly financed and managed. To measure the impact of infrastructure indicators on economic growth, panel regression analysis was used for the period 2000–2021, in six Western Balkan countries. The paper addresses the important question of how to intensify investments in infrastructure to achieve sustainable growth in the Western Balkans. The obtained results confirm the earlier findings about the significant impact of energy, ITC, and road infrastructure on economic growth in the Western Balkans.

Keywords: infrastructure investments, economic growth, Western Balkans, resilient economies

JEL Code: F15, F21, F23, F35, F36

1. Introduction

The question of economic growth and the factors influencing it has consistently occupied the attention of researchers and policymakers across countries for decades. The importance of public investments has become relevant as a powerful tool designed to mitigate various crisis

effects nowadays. The role of public investment has become popular in the context of post-COVID recovery efforts. The significant role that infrastructure could play in facilitating economic growth has been widely recognized, and most countries have designed strategies for such a recovery, placing public investment projects as an important tool to support short-term employment and economic activity.

At the same time, economic aid programs designed to mitigate the effects of the Coronavirus epidemic, together with a drop in government revenues, led to a larger budget deficit in 2020 and to an increase in public debt in most of the countries. With the War in Ukraine, the picture has changed totally, and the implications of geoeconomics and geopolitics have affected the importance of public infrastructure, significantly. Nevertheless, the effects of COVID-19 and war in Ukraine should be taken in consideration seriously in current development strategies in the medium and long term for the Western Balkans.

The best-known early works argue in favor of a strong and positive relationship between public investment and productivity growth in the most developed countries – the G7 (Aschauer, 1989; Abiad et al., 2014, Canning & Pedroni, 2008; Tatom, 1991; Fosu, 2019). In the case of the EU countries, public infrastructure development has had a significant impact on the development of the less developed members, such as the Mediterranean and Central and Eastern European countries (CEEC), where the positive impact of investments in transport infrastructure on economic growth has been confirmed in numerous works (Miljković, 2020; Zaninović, 2022).

Abiad and a group of researchers provide new evidence of the positive macroeconomic effects (Abiad et al., 2014) for other less developed countries, while others find that increased public investments (physical) are not statistically significant in increasing the productivity of the overall economy (Canning & Pedroni, 2008; Tatom, 1991). These effects are especially significant in the case of the least developed countries, according to Fosu (2019).

The most recent work confirms that roads with high accessibility are of greater importance for economic performance, especially in countries with lower levels of urbanization and exports, where improvements to road infrastructure are crucial (Zheng, et al., 2024). On the other hand, some authors have pointed out that certain types of infrastructure, such as investments in telecommunications and the energy sector, have a greater positive impact on economic growth, compared to investments in roads and railways (Egert et al., 2009).

The research is focused on the linkage between infrastructure and economic growth in the Western Balkans (WB), which has been demonstrated in the works of Murgasova et al., Holzner and Schwarzhappel, and Holzner and Grieveson, who identify the infrastructure gap

in the region (Murgasova et al., 2015; Holzner & Grieveson, 2018; Holzner & Schwarzhappel, 2018). Other authors argue that the infrastructure gap in the Western Balkans is significant and is widely considered as a major constraint for the countries of the region in their efforts to substantially catch up in economic terms (Atoyan et al., 2017, EBRD, 2017). Berthomieu and his research group indicate that physical capital per capita in this region is estimated to be below 30% of the European Union average (Berthomieu et al., 2016).

However, for the majority of the region's countries, closing the infrastructure deficit will be quite difficult due to their constrained budgets. Budgetary revenue and debt financing are the two main sources of fiscal resources needed to close significant infrastructure deficits. To increase infrastructure spending, domestic funding sources are probably insufficient. On the other hand, debt financing has its limitations, as most of Western Balkan countries are in the public debt "risky zone" (Atoyan et al., 2024). The effects of Covid-19 increased public debt in 2020 by over 10% of GDP across the region, where Montenegro and Albania, remained the countries with the highest debt ratios, at 69.5% and 64.6% of GDP, respectively, by the end of 2022 (European Commission, 2023). In addition, the Western Balkans' economic recovery has slowed down due to the consequences of Russia's aggressive war against Ukraine.

That is why this paper aims to contribute to the growing infrastructure literature in the Western Balkan, particularly in the current context shaped by the impacts of COVID-19 and ongoing geopolitical shifts. By examining infrastructure investment through a novel combination of indicators – including internet access, government burden, electric power transmission and distribution losses - and employing distinct methodological approaches not previously used in similar studies, this research provides fresh insights that are highly relevant to the region's contemporary challenges.

The aim of the study is to empirically confirm a potentially new perspective of investing in infrastructure (physical, energy and digital) considering the changed geopolitical environment and financial constraints, as an essential prerequisite for accelerating economic development in the Western Balkans.

Thus, the paper raises several important questions. First, what are the priority sectors for investments in infrastructure that have the greatest potential for sustainable and resilient growth, in contemporary times? Second, how to balance EU standards on infrastructure development and the current strong need for capital? Third, how to intensify (finance) investments in infrastructure in order to achieve sustainable growth in the Western Balkans and faster integration into the EU?

The methodology used in the paper is panel regression analysis, covering the period 2000-2021, based on data from the World Bank, the Organization for Economic Cooperation and Development (OECD), the U.S. Energy Information Administration (EIA), World Economic Forum (WEF) and other relevant internet sources.

The paper is structured as follows. First, a historical overview of the literature is provided, related to the infrastructural impact on economic growth, with a special focus on the Western Balkans region. Second, the WB's need for infrastructure is addressed. Third, data and the results from the model are discussed. Fourth, EU demands regarding infrastructure projects are considered, as well as the presence of other geopolitical actors. And finally, we conclude by examining whether a mutuallybeneficial situation is possible, and by trying to set policy recommendations for the Western Balkan region.

2. Literature Review

Numerous authors have studied the relationship between economic growth and infrastructural development for decades. According to Rostow (1990), road and infrastructure upkeep is highlighted as one of the fundamental requirements for economic progress, while Palei (2015) identifies the key elements that influence economic growth and national competitiveness, such as the state of infrastructure, which is mostly governed by the conditions of the roads, railways, air transportation, and electrical supply. The research by Badalyan et al. underscores the pivotal role of efficient and affordable infrastructure in fostering economic growth, as transportation infrastructure is crucial for regional prosperity in less developed countries like Armenia, Turkey, and Georgia (Badalyan et al., 2014).

Similar studies have been conducted for Central and Eastern European countries. Namely, Komornicki and Goliszek emphasized transport connections between major cities as catalysts for growth and highlighted the early impact of transport infrastructure development on economic growth in these regions (Komornicki & Goliszek, 2023). Similarly, Lenz et al. and Egert et al. assessed the macroeconomic impact of transport infrastructure on economic growth and revealed positive effects of population growth, capital formation, trade openness, and road infrastructure on economic growth. Surprisingly, however, railway infrastructure showed a significant but negative impact on GDP growth, pointing to the urgent need to replace outdated and inefficient systems (Lenz et al., 2018, Egert et al., 2009). Other authors also focused on other aspects of infrastructure, such as telecommunications networks (Rutherford, 2005), as well as water supply and power (Iimi, 2011).

On the other hand, the energy sector is fundamental to modern life but poses serious environmental challenges, notably greenhouse gas (GHG) emissions and also climate change. This paradigm shift in energy production policy has been caused by current geostrategic concerns, as the sector of renewable energy production must dramatically expand over the next few decades to meet European demand (Lauf & Zimmermann, 2023). Integrating green breakthroughs and digital technology into a broader energy strategy should be a top priority for policymakers. This can include making significant investments in digital infrastructure to support the adoption of Internet of Things (IoT) devices, smart grids, and sophisticated data analytics for energy management (Alofaysan et al., 2024).

Some more recent works have proven the importance of digital infrastructure to economic growth. For instance, Gruber (2001) examined mobile telecommunications diffusion, stating that faster diffusion is experienced by late adopters, indicating convergence, and also that diffusion is accelerated by several newly set up enterprises, making simultaneous entry more successful. In addition, Toader with a group of colleagues conducted an 18-year study in EU nations to assess how ICT infrastructure impacts economic growth, measured by GDP per capita (Toader et al., 2018). The results show a consistenly positive relationship between ICT infrastructure and economic development. However, the strength of the relationship varies depending on the particular technology examined, which was found by Leibrecht and Liebensteiner (2012).

For the Western Balkan region, long-term economic expansion is a prerequisite for infrastructure development. (Badalyan et al., 2014; Gruber, 2001). In line with this, Popovic and Eric argue that infrastructure serves as the foundation for growth in these economies that are trying to catch up. Improved infrastructure lowers production costs, increases investment profitability, and accelerates economic growth rates. These factors create a wider market, which is essential for drawing in foreign capital (Popović & Erić, 2018).

Specific research of infrastructure in the WB focuses on the empirical analyses found in the works of Holzner with a group of authors (Holzner & Schwarzhappel, 2018; Holzner et al., 2015; Holzner & Grieveson, 2018) who state that the WB needs a significant increase in infrastructure investment to achieve higher long-term productivity growth (Berthomieu et al., 2016). Although the transport infrastructure of the WB has improved, poor rail and road densities remain low and energy infrastructure is still lacking, as noted by Holzner (2015), He concludes that the region has enormous potential for economic catch-up. The results of the work undertaken by Lenz et al. show that in the Western Balkans, infrastructure is a "long-term vital factor" of economic growth and development (Lenz et al., 2018). A group of authors reached similar conclusions that infrastructure investments are crucial for catching up, given the region's

prospects for growth and trade integration, the need to optimize energy resources, improve infrastructure, and increase innovation (Sanfey et al., 2017).

Complementary to the development of physical infrastructure, WBs energy sector holds enormous growth potential and could significantly contribute to the region's future economic development. Due to its geographic location, energy potentials and the recent rise in geopolitical concerns, the Western Balkans region could be a potential energy hub for the European Union. Encouraging infrastructure projects that use abundant renewable energy sources could be essential for the region's development (Turčalo, 2020). These advantages might elevate the WB countries to the status of potential "winners" in the new energy competition (Šekarić Stojanović, 2022, Đurašković et al., 2021).

With the development of digital skills and the deployment of digital infrastructure, the Western Balkans fall behind the EU (Bartlett et al., 2022), where the digital sector could play an important pillar of the future development of the region, with constantly increasing importance. Although digital connectivity is becoming more and more crucial for businesses to succeed and for nations to be economically competitive, there are significant gaps in service in rural areas throughout this region, even if major urban centers often have adequate coverage, based on (Sanfey et al., 2017, Lenz et al., 2018, Broz et al., 2020). Similarly to the transport infrastructure and the energy sector, the region lags behind the EU in the use of digital technologies, despite a growing trend in international trade (Dedaj et al., 2022)

Most of the authors agree that physical infrastructure is essential for the economic development of the Western Balkans countries in classical (normal) times. However, the impact of two recent crises could change the approach and importance of different types of infrastructure. The ambition of this paper is to measure the effects of both crises on the relationship between infrastructure and economic development in the Western Balkan region.

3. The State of Infrastructure in the Western Balkans

The Western Balkan is located in a geographically and strategically important region of Europe where trade routes link the West and the East, as well as the South and the North, and represents an important area to invest in infrastructure. But the region hasn't achieved its full investment potential, and an infrastructure gap exists, and it is significant.

The transportation infrastructure in the Western Balkans is still generally considered undeveloped in comparison to its European counterparts, even with the recent improvements carried out in the region. Road networks are not as widely distributed and have lacked proper

maintenance for a long period. The roots of this problem can be found in the history of the region. From the Ottoman Empire until the late Industrial Revolution, the WB experienced degradation and stagnation. The region suffered the greatest losses in terms of both human lives and material goods in Europe during World War II and after the Soviet Union took control. However, despite all the efforts made during Tito's industrialization era, it was still not enough to fill the gap in infrastructure development, especially when one takes into account the crises that accompanied the dissolution of Yugoslavia, conflicts and sanctions, are the appropriate maintenance and extension of both road and rail infrastructure, which had been absent for decades. A significant effort to expand the road network in WB has been made during the past ten years, and the most impressive investments were in Albania and Kosovo. However, the average road density in the Western Balkans remains more than three times lower than that of the EU-15. But an interesting fact is, that the road network is considerably lower than the average for countries in South Asia and Sub-Saharan Africa countries (Andrés et al., 2014; Ianchovichina et al., 2012). However, the gap in road infrastructure is still significant, so much more work needs to be done.

The railway infrastructure is comparable to the road infrastructure, in terms of the overall network density. Compared to the EU average, it is less than half. The train network suffered greatly from a lack of maintenance throughout the transitional phase. A significant portion of the routes had very low average speeds, the infrastructure had been destroyed, and the tracks were in terrible condition as a result of years of poor maintenance.

Energy has very high potential for development and could have a significant impact on the development of the region. The Western Balkan energy sector is characterized by a high share of coal energy (48%), then hydropower (46%), gas (4%), and fuel oil (2%) (Lachert & Kamiński, 2019). In Bosnia and Herzegovina, Kosovo, North Macedonia, and Serbia, coal-produced power accounts for the majority of total electricity production, Montenegro combines coal and hydroelectric production, and Albania produces nearly all of its electricity by hydropower. On the other hand, the region has a comparatively high share of renewable energy in its primary production, due to its relatively high share of hydropower and solid biomass-based production. However, hydropower could jeopardize ecosystems; it cannot be considered completely environmentally neutral even though it is renewable, in particular medium and small-sized hydropower plants. To minimize any potential harm from hydropower production, careful planning together with environmental goals and opportunities — like wildlife and fishing tourism, for instance — would be helpful. The potential for the development of hydropower is great in the Western Balkans. The hydropower potential is the highest in Bosnia and Herzegovina, where the majority of the potential remains unexploited, but in per capita terms, it is in Montenegro where opportunity awaits.

The Western Balkan countries import energy at a significantly lower level than the EU average, but they still are unable to meet their demand in peak months. Energy consumption is half of that in the EU, but with more energy-intensive sectors developing in the future, energy consumption will rise. For this reason, improved regional cooperation in the energy sector is vital for the countries' ability to secure their energy supply and become potential electricity exporters to the EU market.

Internet infrastructure's effects of investing in sustainable development in the region have not been investigated so far, although it could have the strongest growth potential in the region.

Trade connects the small and open countries of the Western Balkans and promotes the need for coordinated policy action. At the same time, a significant investment stimulus, aimed at meeting growth and development objectives and modernizing public infrastructure could benefit from the same sort of coordination. But, in the region, the EU is competing with other geopolitical players with their active investment policies that could be contradictory to EU policies.

Several institutional, political, legal, and regulatory restrictions will affect future development. The biggest obstacle is deciding on the right course for development and striking a balance with infrastructure spending, particularly when considering regional issues.

4. Data and Methodology

The paper uses unbalanced panel data for six Western Balkan countries (Albania, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia, and Serbia) from 2000 to 2021. The presentation of the variables used in the research is given in Table 1, where it can be seen that most of the data is from the World Bank, while other available sources were also used. The dependent variable is the gross domestic product per capita expressed in constant US$ from 2017 by purchasing power parity, while the explanatory variables are: Total energy consumption per capita (gigajoules), Internet access (% of the population using internet), Investment in roads (EUR), and Trade openness (% of GDP). Additionally, the research uses instrumental variables: School enrolment, tertiary (% gross), Electric power transmission and distribution losses (% of output), Government burden, and government final consumption expenditure (% of GDP). The choice of variables used in the research, both in terms of temporal and spatial coverage, is partly determined by data availability.

Table 1. Variables Used in the Research

Code	Explaination	Source
GDPpc	GDP per capita, PPP (constant 2017 US$)	World Bank
Enpc	Total energy consumption per capita (gigajoules)	U.S. Energy Information Administration - EIA
IN	Internet access (% of population using internet)	World Bank
IR	Investment in roads (EUR)	OECD
TO	Trade openness (% of GDP)	World Bank
Instrumental variables		
SC	School enrollment, tertiary (% gross)	World Bank
ELL	Electric power transmission and distribution losses (% of output)	World Bank
GB	Government burden, government final consumption expenditure (% of GDP)	World Bank

Notes: This table provides an overview of the key variables used through analysis and its source

To provide a comprehensive visual understanding of the data, we present the following graphical representations of the main variables used in our analysis. Each variable is depicted both in its original levels and in logarithmic form. Due to space constraints, detailed multiple graphs are provided in the Appendix (Figure A1 and A2).

Table 2 presents the descriptive statistics for all variables, both in original (first row) and logarithmic values (second row). The average value of gross domestic product according to purchasing power parity in the analyzed countries is 12,703.08 (constant 2017 US$), while the total energy consumption per capita is 64.646 gigajoules on an annual basis. On average, 46.57% of the population had access to the Internet, while the average annual investment in roads amounted to 1,999e+08 EUR. The average share of trade in the GDP of the analyzed countries is 89.2%.

Table 2. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
GDPpc	124	12,703.08	3556.59	5,892.58	21,553.96
lgdp	124	9.409	0.292	8.681	5.247
ENpc	112	64.646	23.154	21.127	189.94
lenpc	112	4.113	0.333	3.050	5.247
IN	104	46.568	25.103	0.114	89.443
lin	104	3.447	1.296	-2.171	4.494
IR	61	1.999e+08	1.42e+08	274,052	5.84e+08
lir	61	18.798	1.060	12.522	20.19
TO	124	89.181	18.974	22.492	148
lto	124	4.467	0.229	3.113	4.997
Instrumental variables					
ELL	85	20.182	8.619	8.181	72.902
lell	85	2.939	0.349	2.102	4.289
SC	95	48	27.568	1	95
lsc	95	3.587	0.926	0	4.554
GB	124	17.594	4.634	9.692	29.941
lgb	124	2.830	0.279	2.271	3.399

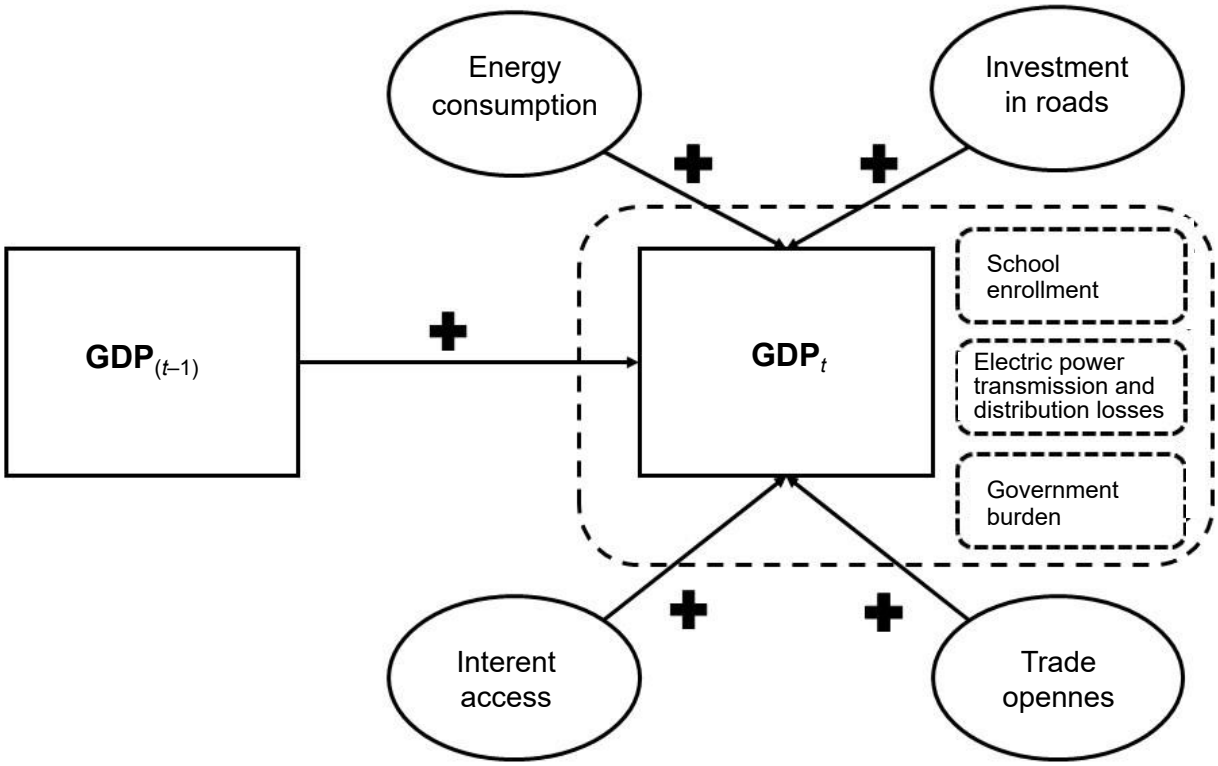
Notes: This table provides summary statistics for the key variables.

Source: Authors' calculations are performed using STATA.

To identify and analyze outliers in our dataset, we have employed Box plot graphical presentations for the key variables. The Box plots, provided in the Appendix (Figure A3), visually depict any extreme values that significantly deviate from the rest of the data. These Box plots reveal the presence of some extreme values in certain variables. We acknowledge these outliers and recognize that particularly in the context of limited panel data, such outliers may reflect significant economic events or structural changes.

The theoretical foundation of our study is based on the premise that infrastructure development, alongside other key economic variables, plays a critical role in driving economic growth. The graphical presentation (Figure 1) illustrates the relationships between GDP and various determinants, as considered in our analysis.

Figure 1. Conceptual Model of Infrastructure and Economic Growth Dynamics



Source: Authors' own elaboration

At the core of our framework is the concept that current GDP is influenced not only by its previous value but also by several critical factors, including infrastructure-related variables and other economic indicators. Energy consumption is a vital component of infrastructure, representing industrial and commercial activity that directly supports economic output. Higher energy consumption is expected to correlate positively with GDP, as indicated by the "+" sign. In the modern economy, internet access is a crucial infrastructure element that facilitates communication, commerce, and access to information. Increased internet penetration is hypothesized to have a positive impact on GDP growth. Investment in road infrastructure is directly linked to economic growth through improved transportation efficiency, which lowers costs and

facilitates trade and mobility. This variable is expected to have a positive effect on GDP. Trade openness is included to capture the extent to which an economy is integrated into the global market. Greater openness typically enhances economic growth through increased market access and competition. The framework also considers several instrumental variables, such as school enrollment, electric power transmission and distribution losses, and government burden. These factors, represented within the dashed box, account for broader socio-economic influences that may also affect GDP.

Based on the previous theoretical analysis, the following model was specified:

$GDPpc = f(ENpc, IN, IR, T0)$

To analyze the relationship between gross domestic product per capita and explanatory variables, several regression techniques were used, and all variables were used, in the form of logarithmic data. Namely, using panel analysis, the following model was estimated:

$$\lg dp_{i,t} = \alpha_0 + \alpha_1 lenpc_{i,t} + \alpha_2 lin_{i,t} + \alpha_3 lir_{i,t} + \alpha_4 lto_{i,t} + \varepsilon_{i,t}$$

where *lgdp* represents the logarithm of gross domestic product per capita, *lenpc* the logarithm of energy consumption per capita, *lin* the logarithm of the percentage of the population that uses the Internet, *lir* the logarithm of investment in roads and *lto* is the logarithm of trade openness. Based on a comprehensive theoretical analysis, the potential significance of the lagged dependent variable on the current value of gross domestic product is observed, so the model is expanded by introducing a dynamic component.

$$\lg dp_{i,t} = \alpha_0 + \alpha_1 lenpc_{i,t} + \alpha_2 lin_{i,t} + \alpha_3 lir_{i,t} + \alpha_4 lto_{i,t} + \alpha_5 \lg dp_{i,t-1} + \varepsilon_{i,t}$$

Applying the GMM system based on Arellano and Bover (1995) can control individual and time-specific effects and overcome the endogeneity bias that occurs by expanding the model with a lagged dependent variable. In addition, this method allows the explanatory variables to be treated as potentially endogenous or exogenous and eliminates any bias that may arise from ignoring the dynamic component. System GMM also provides theoretically based and powerful instruments that account for simultaneity while eliminating any unobservable heterogeneity as well as better performance compared to the Difference-GMM estimator in terms of finite sample bias and root mean square error (Alege & Ogundipe, 2013). In accordance with the mentioned advantages, the System GMM model is considered superior for the subject analysis compared to other estimators (fixed and random effects models), which will be used for robustness testing and additional verification of the results.

5. Empirical Results

In order to analyze the impact of explanatory variables on gross domestic product, several models were estimated and developed using different methods. The model estimation approach was used through ordinary least squares methods, then panel models with fixed and random effects, as well as the system GMM model. Additionally, a distinction can be made between those models where the lagged value of the dependent variable is used as an explanatory variable and the other static models.

Table 3 shows six estimated panel models as follows: Model 1 – pooled regression, Model 2 – pooled regression with lagged dependent variable, Model 3 – fixed effect panel, Model 4 – fixed effect panel with lagged dependent variable, Model 5 – random effect panel, Model 6 – random effect panel with lagged dependent variable, Model 7 – GMM dynamic panel. The instrumental variables used in the estimation system of the GMM model are: logarithm of school enrollment, logarithm of electric power transmission and distribution losses and logarithm of government burden.

The first step in the analysis was an estimation of the pooled OLS model (Model 1), where income is represented as a function of four explanatory variables. It was observed that there is significance of the model and a high coefficient of determination, while three of the four explanatory variables show a statistically significant influence with a significance level of 1%. For the purpose of a more detailed analysis, and in order to take into account the specificities that exist in the analyzed countries, models with fixed and random effects were estimated (Models 3 and 5). The results of the estimated models confirm the previous results of the pooled OLS model that three of the four explanatory variables do indeed show a significant impact on the level of income in the countries of the Western Balkans, and that the models are statistically significant and have high coefficients of determination. The estimated panel models, based on all 3 approaches, show that there is a significant positive impact of energy consumption per capita, as a measure of energy infrastructure development, and Internet access, as a measure of IT infrastructure development, on income per capita, while a positive impact of trade openness was also determined, as a control variable.

Table 3. Regression results

	Model (1)	Model (2)	Model (3)	Model (4)	Model (5)	Model (6)	Model (7)#
	Lg*dp*	**lg*dp***	**lg*dp***	**Lg*dp***	**Lg*dp***	**Lg*dp***	**lg*dp***
lenpc	0.295*** (0.028)	0.048*** (0.014)	0.319** (0.132)	0.122*** (0.038)	0.295*** (0.028)	0.048*** (0.014)	0.096*** (0.018)
lin	0.091*** (0.007)	0.013*** (0.005)	0.090*** (0.010)	0.009 (0.005)	0.091*** (0.007)	0.013*** (0.005)	0.017*** (0.006)
lir	0.011 (0.014)	0.013*** (0.004)	0.015 (0.024)	0.013* (0.007)	0.011 (0.014)	0.013*** (0.004)	0.017*** (0.001)
lto	0.358*** (0.049)	0.097*** (0.018)	0.351*** (0.067)	0.110*** (0.022)	0.358*** (0.049)	0.097*** (0.253)	0.156*** (0.010)
l.*lg*dp		0.783*** (0.036)		0.793*** (0.035)		0.783*** (0.036)	0.680*** (0.050)
Cons.	6.107*** (0.331)	1.143*** (0.253)	5.961* (0.777)	0.702** (0.336)	6.107*** (0.331)	1.143*** (0.253)	1.565*** (0.357)
Observat.	54	52	52	52	54	52	37
F test	272.53	2228.51	127.73	1224.17			
***p*-value**	0.000	0.000	0.000	0.000			
Adj R-squared	0.953	0.995	0.991	0.991	0.957	0.996	
F (all ui=0)			0.03	3.30			
Wald chi2					1090.13***	11142.54***	1848.54***
AR (1)							–1.64 0.100
AR(2)							–0.14 0.890
Sargan test							36.55
***p*-value**							0.227
Hansen test							0.00
***p*-value**							1.00

Note: All variables in models are logarithmic. *Significance at 10% **Significance at 5% ***Significance at 1%; #Instrument variables: lsc, lell, lgb

Source: Author' calculations are performed in STATA

On the basis of a detailed theoretical analysis, and in accordance with the papers (Alotaibi et al., 2022; Baiashvili & Gattini, 2020; Boopen, 2006), it was assumed that the value of income in the previous year has a significant impact on the movement of gross domestic product in the current year, so the models were expanded by including a dynamic component. By expanding the number of regressors and by adding income from the previous period, the pooled OLS model and models with fixed and random effects (Models 2, 4 and 6) were estimated. It was observed that, in all specifications, the lagged value of gross domestic product has a significant and positive impact on the current level of income, and that all four remaining explanatory variables also have a significant and positive impact. The estimated models are characterized by a high value of the coefficient of determination and the statistical significance of the regression. The inclusion of the lagged variable, in accordance with the theoretical analysis, proved to be justified and significant from the aspect of an analysis of the determinants of gross domestic product, however, methodologically, the problem of endogeneity arises.

To ensure the robustness of our model selection, we performed the Hausman test to compare the Fixed Effects (FE) and Random Effects (RE) models. The Hausman test helps determine whether the unique errors (ui) are correlated with the regressors, which influences whether an FE or RE model is more appropriate. Therefore, we conducted two separate Hausman tests. For the model without lagged dependent variables, the p-value of the Hausman test was 0.9714 (chi-square = 0.06). This high p-value indicates that we failed to reject the null hypothesis, suggesting that the RE model is appropriate in this case because the unique errors are not correlated with the regressors.

For the model including the lagged dependent variable, the p-value of the Hausman test was 0.0496 (chi-square = 6.01). This lower p-value indicates that we reject the null hypothesis at the 5% significance level, suggesting that the FE model is more appropriate in this case, because there is evidence that the unique errors are correlated with the regressors. The difference in Hausman test results underscores the complexity of our data and the presence of potential endogeneity, particularly in the dynamic model with a lagged dependent variable. This makes a strong case for employing the System GMM methodology for the following reasons: 1) The inclusion of a lagged dependent variable indicates the presence of dynamic relationships in our data, which are best captured by a dynamic model such as System GMM; 2) The rejection of the null hypothesis in the Hausman test for the model with a lagged dependent variable suggests the presence of endogeneity, which System GMM is designed to address by using internal instruments; 3) System GMM provides more efficient and consistent estimates in the presence of endogeneity and dynamic relationships by combining equations in levels and differences, thus improving the robustness of our findings. Due to the fact that endogeneity can

affect the results of previously estimated models, the generalized method of moments will be used for the dynamic panel. The advantage of the GMM methodology is that it allows relaxing the assumption of strong exogeneity of the explanatory variables and provides a convenient framework for obtaining asymptotically efficient estimators (Arellano & Bond, 1991).

The estimated System GMM model (Model 7), with robust standard errors, is used as a benchmark for analyzing the relationship between infrastructure development and economic growth. Based on the results of Sargan's test (Chi-sq. statistic=36.55, p-value =0.227) and Hansen J statistic (Chi-sq. statistic=0.00, p-value 1.000), we accept the null hypothesis that the instruments in the system GMM model are exogenous. The Arellano–Bond test for autocorrelation shows that the corresponding p-values for the AR (1) and AR (2) processes in first differences are 0.100 and 0.890 respectively, so there is no autocorrelation problem. Namely, we conclude that the model meets the necessary criteria of exogeneity of the regressor and the absence of an autocorrelation problem, so it can be used in further analysis.

To further strengthen our analysis and address potential concerns, we included additional diagnostic tests specifically focused on the residuals of our model. Namely, we performed two-unit root tests to check for stationarity, as part of our effort to validate the robustness of our model. The results of the Im, Pesaran and Shin W-stat (Stat=0.294, p-value=0.384) and the PP - Fisher Chi-square test (Stat=10.943, p value=0.091) indicated that the residuals do not exhibit unit roots, thereby confirming the reliability of our panel data analysis.

In addition, the Cramer-von Mises (W2) and Watson (U2) tests were conducted to examine the distribution of residuals. These tests results (W2 stat=0.113, p-value=0.072 and U2 stat=0.086, p-value=0.141) indicated that the residuals conform to the expected theoretical distribution. The results of these diagnostic tests confirmed our initial belief that our model is well specified. These findings reinforce the reliability and robustness of our model.

To ensure the reliability and originality of our results, we conducted several robustness checks. These checks are designed to confirm that our findings are not dependent on specific model specifications or time periods. Given the fact that we estimated several alternative models, including pooled regression, Fixed Effects (FE), Random Effects (RE), and the dynamic GMM model, the results from the comparison of these models allowed us to verify the consistency and robustness of our results across different specifications. However, additional efforts have further enhanced the robustness and originality of our study. We estimated another model using a different period from 2005 to 2015, while our baseline model covers the period from 2000 to 2021. This analysis demonstrated the stability of our coefficients across different time periods, confirming that our results are not driven by any specific period. Estimation results are presented in Appendix (Figure A4).

By conducting these additional analyses, we have strengthened the credibility and originality of our study, providing further confidence in our empirical results.

Based on the results of the System GMM model, it is observed that there is a relatively greater influence of trade openness and energy infrastructure on the gross domestic product compared to road infrastructure in the case of the analyzed countries. The relative impact of investments in IT infrastructure is close to the impact of road infrastructure; however, the impact of IT infrastructure is shown to be significant when applying more estimators than for road infrastructure. Also, the dynamic impact proved to be crucial, which is in line with the initial expectations and the chosen methodology.

6. Discussion of the Results

The development of infrastructure and greater investments in the energy and IT sectors, as well as road infrastructure, could play a significant role in achieving economic development in the Western Balkans, as indicated by the results of our model. Particularly, investments in energy infrastructure, IT and road infrastructure development have a strong, significant, and positive impact on the level of gross domestic product per capita (Table 3), and undoubtedly should be taken into account when designing development strategies for the region and individual countries. However, infrastructure investments in the Western Balkans face numerous challenges that could seriously limit sustainable growth, and this will be further discussed and finalized in conclusion.

In addition, the models show that there is a positive relationship between trade openness and the dependent variable. So, we can conclude that the increasing level of trade openness among Western Balkan countries could contribute to the economic development of the region and help speed up the catch-up process. This conclusion is consistent with the latest suggestion from the European Commission, "The New Growth Plan & Reform and Growth Facility for the Western Balkans (European Commission, 2023). Free trade among WB countries and a functional common regional market would enhance economic integration with the European Union's Single Market and could double regional GDP in ten years, according to the New Growth Plan.

An increase in energy consumption per capita by 1% leads to an increase in income per capita by 0.096%, with unchanged conditions, suggesting the coefficients in the model. Similar findings have been confirmed in recent works by several authors (Egert et al., 2009; Iimi, 2011; Srinivasu & Srinivasa, 2013). The indicator level strongly suggests that the development of energy infrastructure could benefit economic development the most in the WB. These findings should be taken into serious consideration by regional governments and EU financial institutions

when making decisions about which projects should be financed. There is a lot of ground for investments; existing electrical networks require modernization in order to increase efficiency, reduce the emission of harmful gases, and development of renewable energy sources. The green transition and geo-economics go strongly hand in hand with the development of the energy sector, particularly renewable energy (Abramović et al., 2016; D'Adamo & Rosa, 2020; Đorić, 2021; Jacimovic & Korohodova O., 2023).

Internet access, as a measure of IT infrastructure development based on income per capita, leads to an increase in income per capita by 0.017%, with unchanged conditions. Although the positive effects of investing in Internet infrastructure on sustainable development in the WB have not been formally investigated so far, they have been found in recent research (Broz et al., 2020; Egert et al., 2009; Iimi, 2011; Lenz et al., 2018; Rutherford, 2005; Srinivasu & Srinivasa, 2013). The Internet is a key infrastructural component that has constantly grown in the region, although at a significantly lower level when compared to EU countries. In the overall structure of connections, the share of optics is low. The average fixed Internet speed is significantly lower than the world average, and the use of the Internet for online activities is several times lower than in more developed European countries, and any new 5G network coverage is at a low level. All these factors explain the lower level of significance of the infrastructure components, but with significant future development, we can assume that it could have an increasing and crucial impact on the further development of the region.

Additionally, a statistically significant contribution of investments in road infrastructure to growth has been found in this research. The model shows that a 1% increase in investment in road infrastructure leads to a 0.017% increase in gross domestic product per capita, which is in line with many other authors' results indicating a positive relationship among transport infrastructure in Central and Eastern Europe (Miljković, 2020; Pašakarnis & Maliene, 2010; Skorobogatova & Kuzmina-Merlino, 2017; Spiekermann & Wegener, 2006; Zaninović, 2022). However, it would not be surprising to find different results due to the quite different economic and political environments of the timelines, for similar research undertaken in these two regions. Although some progress has been made in the transport sector in terms of new construction in the WB (Albania) recently, other efforts to modernize the road and railway networks have faced very limited capacity, poor maintenance and an insufficient level of connectivity.

The results of the model show that an increase in the ratio of the share of trade in the gross domestic product by 1% leads to an increase in income per capita by 0.156%, with conditions unchanged (Abiad et al., 2014; Ari, 2020; Lenz et al., 2018).

More importantly, based on the model, it is concluded that the current value of gross domestic product per capita is significantly and positively influenced by the previous value of gross domestic product, which means that growth creates growth in the region. The increase in the value of the gross domestic product per capita in the previous period by 1% leads to a strong increase in income per capita in the current period by 0.68%, with other conditions unchanged.

Above all, the previous discussion provides a strong argument that infrastructure investments may have strong multiplicative growth effects in the region. To maximize this potential, it is advisable to prioritize projects that demonstrate the greatest potential for sustainable development and long-term economic impact. This involves conducting thorough cost-benefit analyses to identify initiatives that offer the best value for money. Additionally, it is crucial to involve local communities in the planning process, ensuring that projects are tailored to meet their specific needs and circumstances. Emphasizing the development of green and smart infrastructure can also play a pivotal role in fostering environmentally sustainable growth. Furthermore, establishing strong public-private partnerships can attract more investment and expertise, making projects more viable and effective. Continuous monitoring and evaluation of infrastructure projects are essential to ensure they deliver the intended outcomes and adapt to changing needs over time.

7. EU Standards on Infrastructure Development in the Western Balkans

The EU enlargement of the WB requires large-scale governance reform in Western Balkan countries, where Chapters 23 and 24 of the EU's acquis communautaire are placed at the center of the process focusing on judiciary, fundamental rights, justice, freedom, and security. It means that the region has to implement and enforce EU laws, procedures, and practices, according to Miščević (2021), and to follow certain EU policies and standards regarding infrastructure investments: both political and technical.

First of all, the political aspect of the integration process strongly binds the countries of the region to the EU Common Foreign, Security and Defense Policy, where the candidates for EU membership have to progressively align with the common decisions of the EU 27. In the current geopolitical context, this condition plays the most important role in the level of cooperation between Western Balkan countries and the EU, as the region has been perceived as a playing field for the larger geopolitical actors to assert their influence. As the process of EU integration has been rather slow, increasingly open-ended and potentially never-ending,

according to Schimmelfennig (2021), what has caused WB's dissatisfaction with the EU accession process, in the last 20 years. On the other hand, some other international players, such as Russia, Turkey and China, have seen an opportunity to fill the gap and have used their soft power to increase their presence in the region. However, the sanctions imposed on Russia after its invasion of Ukraine in 2022, have dramatically affected public support for Russia in the WB, which has sharply declined, but still varies across the countries. It has led to a decrease in the Russian economic presence in the Western Balkans, but we can count on it remains highly that the „old" forces in the region, Russia and Turkey will keep using soft power. China is a „new "and increasing economic power player in the region, ready to finance, with great flexibility, a number of large infrastructure projects (Jacimovic et al., 2023). It has lately raised concerns from the EU and US. From the perspective of Chinese academics, China's strategy for the region is to promote friendly and cooperative ties, while actively fostering trade, investment, and economic development, according to Zuokui (2019).

The second group of technical aspects of the infrastructure projects in the WB come from the obligation to accept and implement the EU acquis in other relevant areas, such as: public procurement, fiscal surveillance, and environmental sustainability. The vital importance came from the implementation of EU standards on public procurement detailed in Chapter 5 of the acquis communautaire, which require transparent and equal treatment, free competition, and non-discriminatory practices among the member states, as well as any potential future member countries. The importance of these standards was reflected in their inclusion in the 'fundamentals' cluster in the revised enlargement methodology. But this has not been an easy or smooth process, and reforming public procurement procedures has become the most important issue for accession countries. However, successful implementation of the EU's public procurement procedures will contribute to the facilitation of open market practices in the region, in which transparent and open procedures will take place for all companies on the basis of non-discriminatory and equal treatment. It would be the most beneficial practice that could assist the countries in forming a regional economic market and then smooth integration into the European Single Market.

Fiscal surveillance is another very important issue under which candidate countries must comply regarding Chapter 17 of the acquis and the Stability and Growth Pact (SGP). All member states, and those that are willing to be, have to follow the rules set by the EU regarding the level of budget deficits and maximum debt levels[1]. The economically fragile and weak Western Balkan countries, in their desire to catch up economically and finance big

1 The annual budget deficits of EU member states must not exceed 3 per cent of GDP and public debt must not exceed 60 per cent of GDP.

infrastructure projects, could put themselves at risk of not being able to follow the set criteria or, in a worst-case scenario, not repaying the debts. This could export risks into the Single Market, so there are objections made by seriously concerned EU investors.

Infrastructure development in the Western Balkans has been a widely debated topic in the region and the EU among policymakers, academics, EU officials, and the general public. The biggest worries have come from the effects that these large investments might have on the sustainability of the fiscal and external sectors in these weak economies (Schwartz et al., 2020). These worries are not without solid ground. The biggest concerns like fiscal and external sector risks could be avoided if infrastructure investments are appropriately calibrated, which means the introduction of careful fiscal and external risk management. In addition to this, a safe and stable financial system is a prerequisite for sustainable economic development and investment in infrastructure.

Some of the latest modeling done by the IMF (Bizimana & Jaramillo, 2021) suggests that a combination of tax financing, concessional lending, and especially public-private partnerships are more advantageous than government borrowing through financial markets in financing large public infrastructure projects. In this way, big infrastructure investments could support growth while containing the impact on public and foreign debt at the same time. Then, an improvement of weak infrastructure governance could strongly increase public investment efficiency, which has been clearly demonstrated by experience in the South Asian region (Bizimana & Jaramillo, 2021).

The EU already provides finances for development and infrastructure projects in the Western Balkans through the EBRD and the EIB loans. Using the Western Balkans Investment Framework and the recent Growth plan could help WB countries get funding for important investments. On the one hand, the EU loans come with quite strict conditions and procedures, but on the other, they guarantee the financial and environmental sustainability of infrastructure projects, good labor conditions, and transparency of procedures. The EU financing mechanisms for infrastructure investments are active in the region, but are they enough to meet the significant infrastructure investment demands of the region? However sizable EU loans might be, Chinese loans could always be an attractive alternative (Đorić, 2021).

Environmental standards and environmental sustainability are important standards that most European financial institutions use as criteria for funding. All Western Balkan countries should be aware of this regarding infrastructure projects. The EU has very often refused to support polluting (coal) projects in the region. As the region gets closer to the EU, it will have to strictly adhere to the EU environmental rules, and with the increasing importance of the Green Deal, overcome what could be considered a great challenge to successful integration.

Finally, state aid and its usage should be a special concern for the Western Balkans, where countries are obligated under the Stabilization and Association Agreement (SAA) and the Energy Community Treaty not to introduce state aid measures that could distort competition. It means that extensive state aid programs that prioritize some energy sources, like coal, over others are in conflict with the agreed SAA and, potentially, EU treaties. WB countries must reduce governmental intervention in the economy due to such stringent EU regulations on state aid.

Conclusion

This study makes several key contributions to the existing literature on infrastructure and economic growth. First, it addresses a significant gap by focusing specifically on the unique economic and infrastructural challenges of the Western Balkans, a region that has been underrepresented in previous research. Second, our study introduces a novel combination of indicators—including internet access, government burden, and electric power transmission and distribution losses—which have not been widely explored in the context of the Western Balkans. Third, we provide a comprehensive analysis that elucidates the relationship between infrastructure development and economic growth, offering valuable insights into how targeted investments can drive sustainable growth in the region. Finally, we employ a dynamic Generalized Method of Moments (GMM) approach, which distinguishes our study from the static models commonly used in similar research. This methodological choice allows us to address potential endogeneity issues and capture the dynamic nature of economic growth, thereby enhancing the robustness and reliability of our findings.

The paper argues that infrastructure investment is a key priority for the Western Balkans in accelerating its convergence speed, which was proven in our model and goes along with the most recent research findings (Ari, 2020; Lachert & Kamiński, 2019). In addition to that, the development of infrastructure and the scaling up of public investments can play a key role in increasing an economy's long-term productive potential, as well as having an important transformative effect of speeding the shift to a greener and more digital economy in the region, which could have an additional large multiplier effect on the ground. According to projections from the IMF (Ari, 2020) and the European Commission (2023), public investments that increase regional connectivity and are associated with increased efficiency might eventually double the region's GDP.

Our model results suggest that policymakers in the EU and the region should focus on infrastructure investments in the energy and IT sectors, and then on road infrastructure, to facilitate infrastructure development. The increasing importance of energy and digital sector

for the WB region comes from the changed environment, since 2020. The regional economies have been strongly affected by COVID-19, which increased public debt to an unsustainable level in the mid-term and was accompanied by an energy crisis affected by the War in Ukraine.

Indeed, achieving economic security could be a challenging task in the Western Balkan countries in the new, evolving geopolitical environment. Particularly, having in mind the EU's (demanding) financing mechanisms for infrastructure investments in the region and China's comment on building a comprehensive partnership with WB countries (Jacimovic et al., 2023). Financing instruments from international organizations and institutions, like Germany's state-owned development bank, KfW, or the European Bank for Reconstruction and Development (EBRD), can be a good way to mobilize private savings and boost productivity. At the same time, it could balance EU standards on infrastructure development and the current strong need for capital from the region, which answers our second question (Frey, 2024).

For this reason, the EU and the Western Balkan countries have to provide creative and viable financing solutions for infrastructure financing with serious consideration. For example, bilateral financial assistance can be a significant possibility, and diaspora bonds can be helpful under the right circumstances. Although the region hasn't had much experience with PPPs, this is something that is expected to change in the near future. Due to several issues, such as the small size of national markets, insufficient institutional and regulatory frameworks, and perceived regional political dangers, there hasn't been much experience with PPP projects (Martijn et al., 2023)

However, more is not always better. Ultimately, good public infrastructure investment raises productivity and potential output and, if appropriately financed, should not compromise debt sustainability over the medium and long term. Maintenance costs of wasteful infrastructure can be very significant, draining fiscal resources away from more productive uses. Weak institutions, inefficient governments, and widespread corruption are often associated with wasteful spending and the misallocation of scarce public resources to projects with low economic viability. Thus, robust institutional frameworks to ensure the proper selection, execution, and monitoring of projects are a critical precondition for infrastructure development - to be conducive to stronger economic performance (Egert et al., 2009).

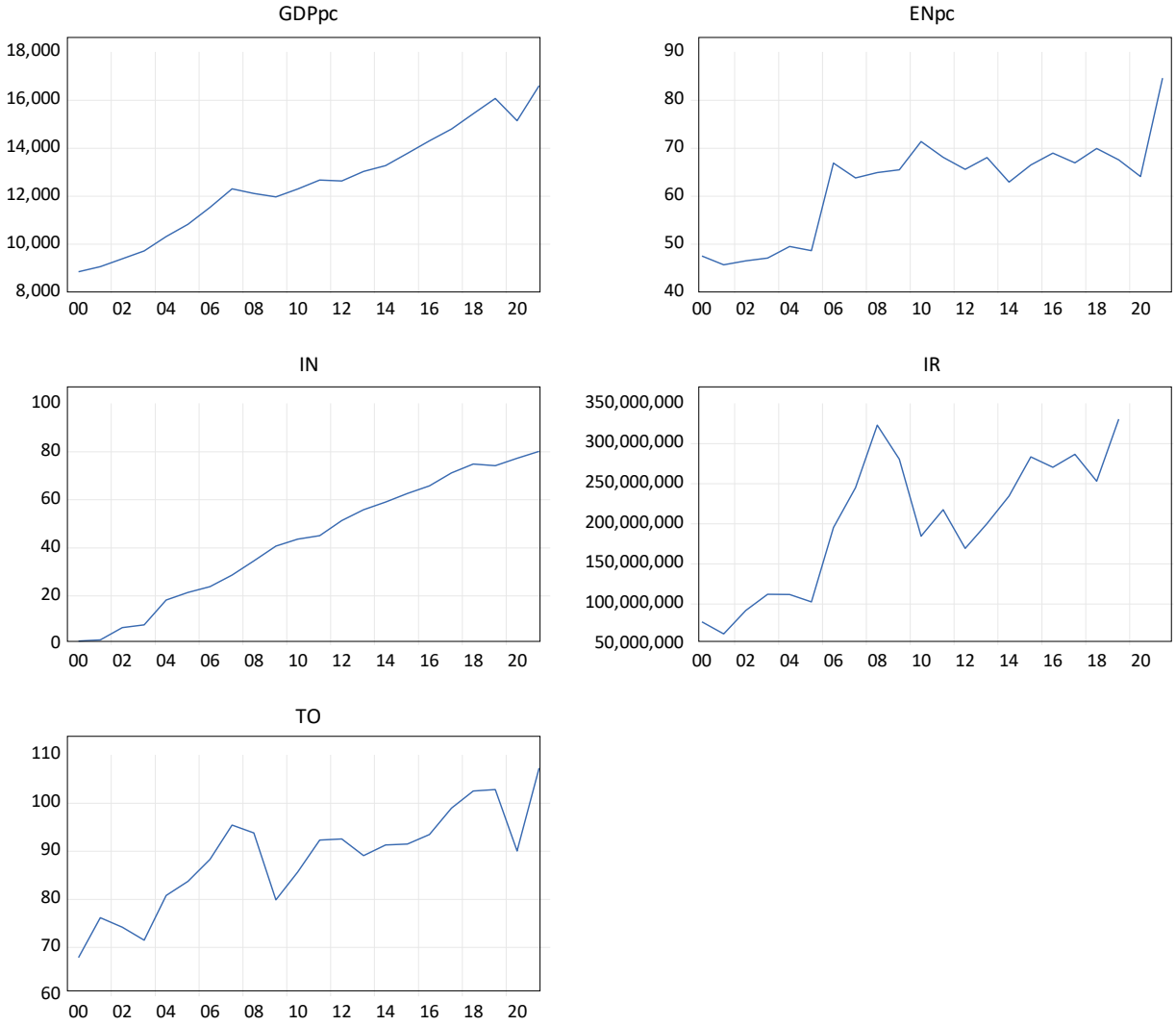
That is why public infrastructure investments need to be complemented by strong policies and renewed reform momentum. Future EU membership of the region will require closing large income gaps between Western Balkan countries, which will require far more than simply closing infrastructure gaps (Kammer, 2023). Sustainable growth could be boosted by increased government investment in infrastructure, but the benefits can vary depending on how it is

funded and managed, including all relevant parties, such as the non-governmental sector and local communities. Try constant monitoring and evaluation of infrastructure projects in order to produce the intended and long-lasting development outcomes for the (IMF, 2014, Egert et al., 2009) Western Balkans economies. In that regard, structural policies play an important role: by strengthening governance via better anti-corruption frameworks countries can durably attract investment domestically and from abroad. As part of these efforts toward energy infrastructure, improving the overall regulatory conditions for attracting private investment would be necessary, primarily by ensuring regulatory and procedure transparency and expediting the licensing process (i.e. issuing energy infrastructure permits at both the national and local levels) (Udovički & Erić, 2021).

To conclude, the Western Balkans should take into consideration cost-effective infrastructure investment alternatives that offer significant economic and environmental benefits taking into account the effects of the recent crisis and the high costs associated with traditional physical infrastructure projects. Prioritizing infrastructure projects based on thorough cost-benefit analysis can help ensure sustainable and long-term development. Focusing on energy and digital infrastructure presents a viable solution. Infrastructure investments in energy and digital sectors, rather than in the road, and transportation industry, have great potential to attract domestic and foreign private investors, with the right policy mix.

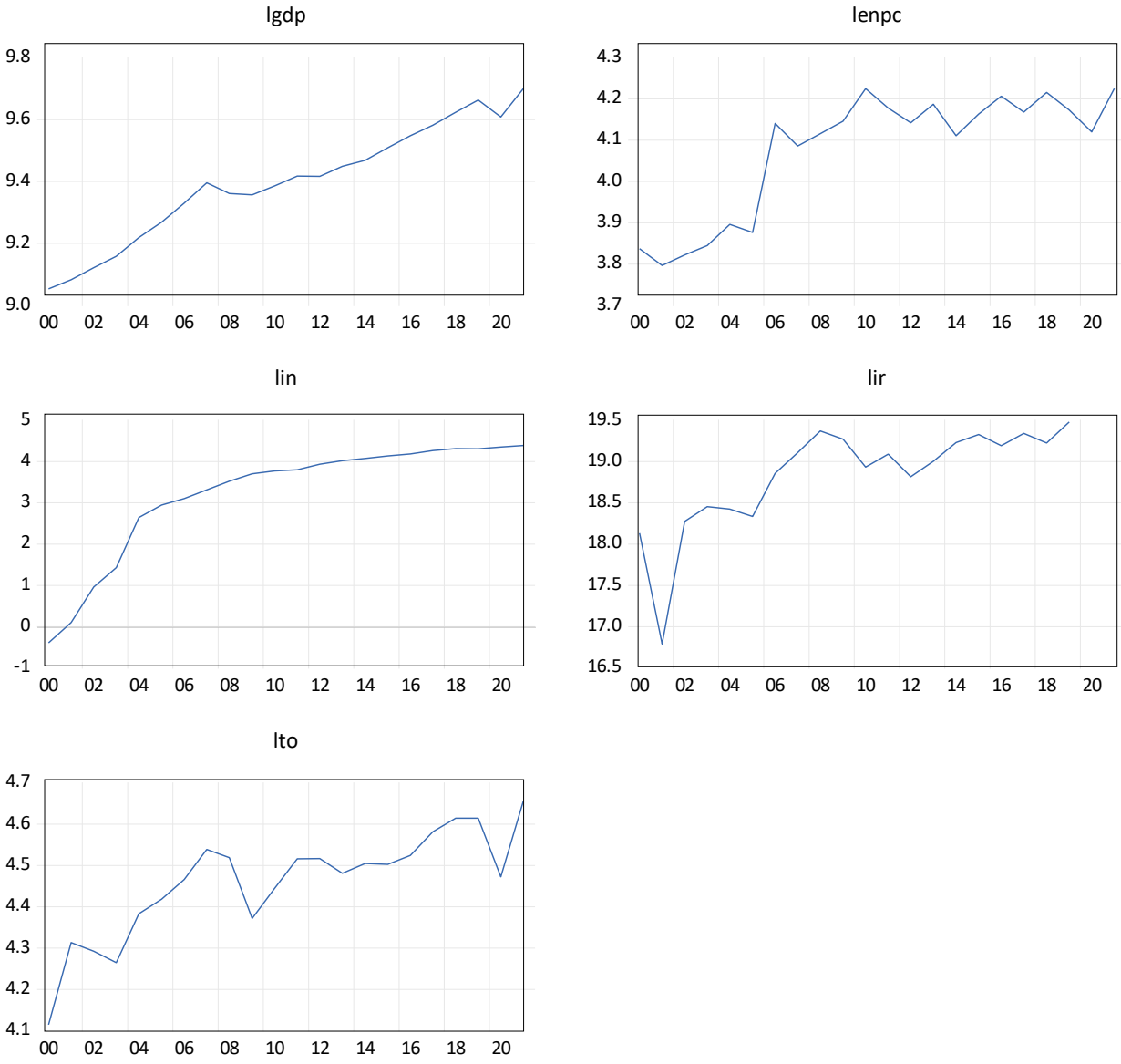
Appendix

Figure A1: Graphical presentation of the used variables, in levels



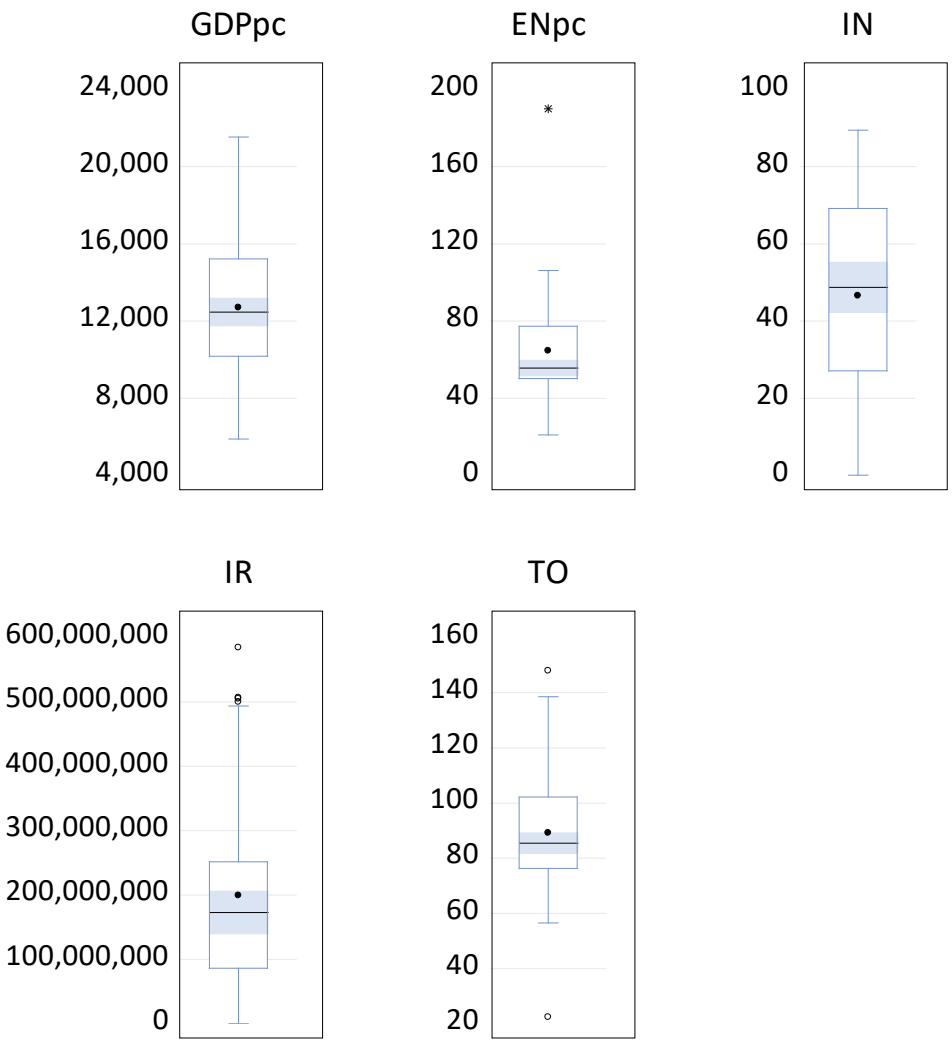
Source: Author' calculations are performed in STATA

Figure A2: Graphical presentation of the variables used, in logarithms



Source: Author' calculations are performed in STATA

Figure A3. Box plot for key variables in the models



Source: Author' calculations are performed in STATA

Figure A4. Coefficient Stability Across Different Time Periods (2005-2015)

```
Dynamic panel-data estimation, one-step system GMM
------------------------------------------------------------------------------
Group variable: Country                         Number of obs      =        27
Time variable : Year                            Number of groups   =         3
Number of instruments = 27                      Obs per group: min =         9
Wald chi2(5)  =    226.29                                      avg =      9.00
Prob > chi2   =     0.000                                      max =         9
------------------------------------------------------------------------------
             |               Robust
        lgdp |      Coef.   Std. Err.      z    P>|z|     [95% Conf. Interval]
-------------+----------------------------------------------------------------
        lgdp |
         L1. |   .6541025   .0742223     8.81   0.000     .5086295    .7995755
             |
       lenpc |   .1063568   .0264859     4.02   0.000     .0544454    .1582681
         lin |   .0245967   .0114465     2.15   0.032     .0021621    .0470314
         lir |   .0098614   .0025329     3.89   0.000     .0048969    .0148258
         lto |   .1339471   .0043118    31.07   0.000     .1254962    .1423981
       _cons |   1.974495   .5772424     3.42   0.001      .843121     3.10587
------------------------------------------------------------------------------
Instruments for first differences equation
  Standard
    D.(lsc lell Governmentbourden)
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    L(1/10).L.lgdp
Instruments for levels equation
  Standard
    lsc lell Governmentbourden
    _cons
  GMM-type (missing=0, separate instruments for each period unless collapsed)
    D.L.lgdp
------------------------------------------------------------------------------
Arellano-Bond test for AR(1) in first differences: z =  -1.57  Pr > z =  0.117
Arellano-Bond test for AR(2) in first differences: z =  -1.29  Pr > z =  0.199
------------------------------------------------------------------------------
Sargan test of overid. restrictions: chi2(21)   =  23.20  Prob > chi2 =  0.333
  (Not robust, but not weakened by many instruments.)
Hansen test of overid. restrictions: chi2(21)   =   0.00  Prob > chi2 =  1.000
  (Robust, but weakened by many instruments.)
```

Source: Author' calculations are performed in STATA

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