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The Impact of Investments in Communication Infrastructure on Economic Growth

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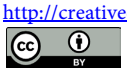

Abstract

Investments in communication infrastructure have a significant impact on economic growth. Communication infrastructure enables people and organizations to connect and communicate quickly and efficiently, which can improve productivity and drive innovation. Increasing investment in communications infrastructure can boost economic growth in several ways: Improving access to information, enhancing communication infrastructure, and fostering digitalization can raise business efficiency and overall economic performance. This improves economic growth and encourages the expansion of business activities in various sectors. Stimulating innovation, improving communication infrastructure provides a new platform for innovation. With improved technologies, new applications and services can be developed that can help organizations be more competitive in the market. Overall, investments in communication infrastructure play a key role in stimulating economic growth. This is important for all countries that want to improve their competitiveness in the global market and achieve long-term economic prosperity. Therefore, the main goal of this final paper is to determine, the impact of investments in communication infrastructure on economic growth, primarily in Bosnia and Herzegovina, but also in other countries from its surroundings (Serbia, Montenegro, Albania, Kosovo, North Macedonia, Croatia and Slovenia), in order to identify possible directions and recommendations for stimulating economic growth based on the research results.

Keywords

Investments, Communication Infrastructure, Western Balkans

1. Introduction

Since the 1990s onward, it has been increasingly recognized that the fundamental

drivers of economic growth are technological change, improvements in innovation, and the education of a workforce capable of managing new technologies. In this context, the ICT sector plays a crucial role in economic growth. Numerous academic and professional studies in this field have shown that a lower level of investment in ICT leads to a weaker and slower transformation of society towards a digital economy, a slower rate of change, and ultimately slower overall economic growth.

The new era of informatization brings about changes on a global scale. Today, global companies are able to separate their business operations and locate them practically anywhere in the world, leveraging the comparative advantages of each destination. Services and/or tasks can be contracted in distant countries using ICT.

As previously mentioned, globalization and the influence of ICT are a natural and necessary process in shaping a new economic order, led by new market rules and international economic policies. With this in mind, it can be stated that the process of (accelerated) globalization significantly determines the growth dynamics and development of the ICT sector, as well as the degree to which the latest solutions in this field are applied. Information and communication technologies are of a generic nature, meaning they act as a stimulus for the development of all processes within a country. Only through them is it possible to obtain accurate, high-quality, and timely information on market conditions around the world. ICT is of exceptional importance for the economic growth of any country.

In order to fulfil their role in the market, investments in communication infrastructure are not only a necessity but also an imperative. These investments are recognized as one of the key factors of economic growth and innovation in the modern economy. Therefore, the primary objective is to harness the potential offered by advancements in digital technologies. All countries should emphasize the economic and social impact of information and communication technologies, while also defining regulatory and incentive measures that can enhance the influence of quality and purposeful ICT implementation on economic growth.

In today's business environment, the development gap between countries is directly proportional to the gap in the degree of ICT adoption. The collection, processing, and analysis of data have become key components of modern economies, and none of this is possible without high-quality communication infrastructure. For this reason, investment in such infrastructure directly stimulates economic growth. The development and upgrading of communication infrastructure—designed to deliver higher speeds and improved coverage—ensures access to a wide range of new services for the entire population across all territories, which will undoubtedly accelerate economic growth and improve quality of life, especially in remote rural areas.

This paper work will provide a detailed analysis of the impact of investments in communication infrastructure on the economic growth of Bosnia and Herzegovina, as well as neighbouring countries such as Serbia, Montenegro, Albania,

Kosovo, and North Macedonia, in order to enable an adequate comparison and propose recommendations for advancement.

Previous research shows a significant economic impact of investments in communication infrastructure. For instance, in Croatia—one of the more digitally developed countries in the region, an investment of 100 million euros in this infrastructure results in the creation of 3848 new jobs and 47 million euros in new tax revenues, as well as an increase in GDP growth rate by 0.25%.

Given the above, the main research question posed in this study is as follows: Does the volume of investment in communication infrastructure influence economic growth?

2. Review of Research on Investments in Communication Infrastructure in the Western Balkans

Investments in communication infrastructure are essential for the development and advancement of any country, and this is particularly true for the Western Balkan countries, which are in a phase of transition and development. Communication infrastructure encompasses all types of telecommunication networks, including fixed telephony, mobile telephony, broadband internet, as well as satellite and cable television. In recent years, the Western Balkan countries have made significant progress in developing their communication infrastructure, but there is still room for further improvement. Some of the key challenges facing these countries include insufficient coverage in rural areas, a lack of fast and reliable broadband internet, and a shortage of digital skills and knowledge.

For this reason, governments in the Western Balkans must invest in the development of communication infrastructure to provide their citizens with access to fast and reliable internet and other telecommunication services. This includes building new infrastructure projects, upgrading existing networks, increasing rural coverage, and educating the population about digital technologies. With the support of international organizations and donors, Western Balkan countries can make significant strides in the development of their communication infrastructure and thereby create favourable conditions for further economic growth and societal progress.

Numerous studies and research papers have addressed investments in communication infrastructure in the Western Balkans.

"World Bank" (2019)—This paper analyses the current state of ICT sector investments in the Western Balkan countries and proposes measures for further development and investment growth. "ICT" refers to Information and Communication Technologies, and the Western Balkans include Albania, Bosnia and Herzegovina, Kosovo, Montenegro, North Macedonia, and Serbia. In 2019, numerous opportunities for ICT investments emerged as these countries transitioned from post-socialist societies to modern and competitive economies. This led to growth in IT markets, especially in areas such as e-commerce, e-banking, software engineering, and information security services. However, several challenges may hin-

der ICT investment in the region, including political instability, a shortage of ICT professionals, inconsistent legislation, and underdeveloped infrastructure. Moreover, the relatively low level of economic development in some countries may limit investment capacity. Still, considering the ICT sector's rapid growth, there are many opportunities for investors willing to take risks and adapt to specific market conditions. Many countries in the region offer incentives and subsidies for ICT sector investors, including corporate tax relief, free or subsidized business consulting and support services, and access to favourable loans and development funds. Ultimately, ICT investments in the Western Balkans can bring substantial benefits to both investors and host countries. However, to fully capitalize on these opportunities and overcome challenges, it is essential to invest in education, infrastructure, and the overall business environment.

"Investments in Digital Infrastructure in the Western Balkans" (2020)—This paper focuses on investments in digital infrastructure in the Western Balkans, including broadband internet, mobile networks, and satellite communication. In 2020, investments were directed toward expanding broadband internet, improving mobile network coverage, and increasing the use of satellite communication. Accordingly, governments and international organizations invested considerable funds in developing digital infrastructure. These investments aimed to enhance economic growth, increase productivity, and improve residents' quality of life. Broadband internet investments were particularly significant, as they provide better access to information, business opportunities, and educational resources. Many countries also invested in expanding mobile network coverage, improving access to mobile internet and mobile app use. Satellite communication investments played an essential role, particularly in remote rural areas where traditional networks are unavailable or underdeveloped. Satellite technology ensures better connectivity and access to digital resources and services. In summary, digital infrastructure investments in the Western Balkans in 2020 were aimed at broadband development, mobile network enhancement, and satellite communication, with the overarching goal of improving economic performance and living standards.

"Reliability of Telecommunication Services in the Western Balkans" (2021)—This study analyses the reliability of telecommunication services in Western Balkan countries, focusing on network quality, coverage, and pricing. The study presents examples of good practices as well as challenges faced by telecom companies in the region. Network quality varies significantly among countries. For example, Serbia and Montenegro have relatively good network quality, while Bosnia and Herzegovina and Albania face periodic issues. Network coverage is best in Serbia, with Montenegro also performing well. Prices differ across countries: Bosnia and Herzegovina and North Macedonia have relatively high prices, while Serbia and Albania offer lower prices, although Albania lags in network quality and coverage. The study also identifies key challenges for telecom providers, including increased competition, the need for infrastructure and technology upgrades, and issues related to unpaid user bills. In conclusion, the paper provides an overview

of the reliability of telecommunication services in the Western Balkans, highlighting various issues and challenges related to network quality, coverage, and pricing.

"Comparison of Telecommunication Infrastructure Status in the Western Balkans" (2018)—This paper compares the development level of telecommunication infrastructure across the region and offers recommendations for future development. According to this 2018 study, the state of telecom infrastructure varies across the region. Serbia and Montenegro have the most advanced infrastructure, with good mobile and broadband coverage, while Bosnia and Herzegovina, Kosovo, and Albania lag behind. Challenges noted include inadequate regulatory frameworks, lack of investment, and difficulties with spectrum allocation for mobile networks. The authors recommend improving regulatory frameworks, increasing infrastructure investment, and enhancing regional cooperation to achieve shared goals. It is important to note that telecom sector conditions may have changed since the publication of this study, and some of its findings may no longer fully reflect current realities.

"Development of Communication Infrastructure in the Western Balkans" (2020). This paper explores the current state and potential for communication infrastructure development in the region and provides recommendations for improvement. The study emphasizes that modernizing communication infrastructure is critical for economic progress and improving quality of life. It identifies significant room for improvement, especially in rural areas. It also analyzes trends in the use of technologies such as mobile telephony and broadband internet, and underlines the importance of 5G network development for future digital economy growth. Recommendations include increasing investments in optical fibre networks and supporting local internet service providers. The paper stresses the need for cooperation between public institutions and the private sector in advancing infrastructure development.

Overall, these studies and others provide valuable insights into the current state and investment potential of communication infrastructure in the Western Balkans—an essential factor for continued economic growth and societal advancement in the region.

3. Methodology

The empirical research on the impact of investments in communication infrastructure was conducted using secondary data on economic growth and investments in communication infrastructure in Bosnia and Herzegovina and neighbouring countries for the period 2005-2021. In order to perform a comparative analysis of the obtained results, the study included five additional countries from the region alongside Bosnia and Herzegovina: Serbia, Montenegro, Albania, Kosovo, and North Macedonia. Starting from the main research hypothesis, which tests the significance of the impact of the volume of investments in communication infrastructure on economic growth, and based on the defined auxiliary hy-

potheses according to which economic growth is operationalized through GDP per capita and employment, both dependent and independent variables were defined, along with their respective indicators.

The independent variable—investments in communication infrastructure—was observed through four indicators: investments in telecommunication services (as a percentage), availability of broadband access (internet services, fibre connections, wireless internet) (as a percentage), broadband user penetration rate (as a percentage), and share of investment in total revenue of the telecommunications industry (as a percentage).

The dependent variable was operationalized using ratio-scale indicators of gross domestic product per capita (in US dollars) and the employment rate (as a percentage) in the countries covered by the research.

Secondary data were processed using statistical techniques and methods of descriptive and inferential statistics. The analysis and processing of collected data were conducted using appropriate software tools, namely Microsoft Excel and the statistical software IBM SPSS Statistics. The results obtained from the analysis will be presented in the following section.

For the purpose of this research, we constructed our own database by collecting secondary data from several reliable sources. Specifically, we relied on the *World Bank* (World Development Indicators) for economic indicators such as GDP per capita and employment rate, as well as selected digital indicators. In addition, data were obtained from the official websites and reports of the *National Statistical Offices* in the Western Balkan countries, namely: the Agency for Statistics of Bosnia and Herzegovina, the Statistical Office of the Republic of Serbia, the Statistical Office of Montenegro (MONSTAT), INSTAT Albania, the Kosovo Agency of Statistics, and the State Statistical Office of North Macedonia.

The time frame selected for the analysis is 2005-2021, ensuring harmonization and consistency of data across all observed countries. This choice is further justified by the fact that, following the COVID-19 pandemic, significant diversification in data collection practices has been observed, resulting in challenges related to data sufficiency and availability.

4. Results and Discussion

Given that the measurement of variables and indicators used in the research was conducted using a ratio scale, a descriptive statistical analysis was performed at the initial stage, and the results will be presented in the following section. Specifically, for all variables and indicators, the values of descriptive statistical measures were calculated, including the minimum and maximum, mean, median, and standard deviation.

Regarding the indicators of investments in communication infrastructure, the descriptive statistics for all countries included in the study are presented in Table 1.

Table 1. Descriptive statistics of communication infrastructure investment indicators.

Indicators	Country	Min.	Max.	Average	Median	Standard deviation
Investments (expenditures) in telecommunication services (%)	BiH	5.00	35.00	16.41	15.00	9.80
	Serbia	7.00	50.00	20.24	11.00	14.81
	Montenegro	2.00	32.00	13.47	8.00	11.32
	Albania	2.00	20.00	9.06	6.00	6.46
	Kosovo	1.00	10.00	4.35	4.00	2.96
	S. Macedonia	6.00	40.00	20.71	20.00	13.53
Availability of broadband access—internet services, optical connection, wireless internet (%)	BiH	17.70	94.50	49.95	43.30	28.91
	Serbia	20.50	99.90	65.32	70.90	26.47
	Montenegro	19.90	98.80	50.21	35.50	29.92
	Albania	17.80	55.50	35.09	37.80	13.42
	Kosovo	17.60	54.50	35.99	40.40	12.98
	S. Macedonia	20.50	64.40	46.29	48.30	12.94
Penetration of broadband access users (%)	BiH	5.70	21.40	14.00	13.80	5.34
	Serbia	8.90	40.20	28.53	35.50	12.94
	Montenegro	5.70	38.20	20.47	17.70	12.11
	Albania	6.70	19.90	12.99	12.80	4.39
	Kosovo	6.40	18.70	12.74	12.50	4.49
	S. Macedonia	5.50	35.50	19.89	17.78	11.24
Share of investments in relation to the total revenue of the telecommunications industry (%)	BiH	15.60	34.40	22.16	21.20	4.54
	Serbia	18.80	56.60	38.29	39.90	12.67
	Montenegro	14.50	45.50	29.03	27.70	10.39
	Albania	11.20	33.30	21.45	20.10	7.30
	Kosovo	7.80	23.50	14.66	14.40	5.04
	S. Macedonia	15.70	44.40	29.06	26.70	10.14

Author's calculation.

When it comes to the results of our analysis, as presented in Table 1, it can be concluded that Bosnia and Herzegovina demonstrates a relatively good level of investment in communication infrastructure compared to neighbouring countries. Specifically, based on the ranking of mean values, Bosnia and Herzegovina ranks third out of the six countries included in our research in terms of investment in telecommunication services and availability of broadband access (including internet services, fibre connections, and wireless internet). In contrast, regarding broadband user penetration and the share of investments relative to total telecommunications industry revenue, Bosnia and Herzegovina ranks fourth.

More precisely, the highest average levels of investment in telecommunication services were recorded in North Macedonia (20.71%) and Serbia (20.24%), fol-

lowed by Bosnia and Herzegovina in third place with an average investment value of 16.41% during the 2005-2021 period. Lower average values were recorded in Montenegro (13.47%), Albania (9.06%), and Kosovo (4.35%), indicating a lower level of investment in telecommunications services during the observed period.

The indicator of broadband access availability, as the second investment indicator, divided the six countries into two groups based on their average values. The first group, characterized by high average availability, includes Serbia, Montenegro, and Bosnia and Herzegovina, with broadband availability rates of 99.90%, 98.80%, and 94.50%, respectively. The remaining three countries have considerably lower average values: North Macedonia (64.40%), Albania (55.50%), and Kosovo (54.50%).

The third indicator, broadband user penetration, showed the most significant average result in Serbia (28.53%). Montenegro (20.47%) and North Macedonia (19.89%) also reported notable results. Bosnia and Herzegovina ranked fourth with an average of 14%, while the lowest averages were recorded in Albania (12.99%) and Kosovo (12.74%).

The final indicator within this variable refers to the share of investment relative to the total revenue of the telecommunications industry. Once again, Serbia achieved the highest average value (38.29%), followed by North Macedonia (29.06%) and Montenegro (29.03%). In Bosnia and Herzegovina, the average share of investment over the 17-year period was 22.16%, while Albania recorded 24.45%, and Kosovo 14.66%.

Regarding the dispersion of data, the lowest variability in telecommunication service investments was recorded in Kosovo (2.96%); for broadband access availability, it was North Macedonia (12.94%); for broadband penetration, Albania (4.39%); and for the share of investments relative to total telecommunications revenue, Bosnia and Herzegovina (4.54%).

On the other hand, the highest variability in telecommunication service investments, broadband user penetration, and investment share relative to revenue was observed in Serbia (14.81%, 12.94%, and 12.67%, respectively), while Montenegro had the highest variability in broadband access availability (29.92%).

Descriptive statistical indicators were also calculated for the indicators of the dependent variable in our research. Namely, since economic growth, as the dependent variable of the main research hypothesis, is operationalized through GDP per capita and employment in the auxiliary hypotheses, Table 2 presents the results of the descriptive statistical indicators for these two measures.

Table 2. Descriptive statistics of economic growth indicators.

Indicators	Country	Min.	Max.	Average	Median	Standard deviation
BDP per capita (US$)	BiH	2741.10	7143.10	4927.71	4955.20	1051.90
	Serbia	3724.20	9455.10	6408.19	6279.20	1333.49
	Montenegro	3678.20	9456.10	6879.38	7033.20	1545.26

Continued

	Albania	2673.20	6412.10	4381.32	4312.40	892.27
	Kosovo	2744.10	5269.10	3625.67	3546.20	717.49
	S. Macedonia	3072.20	6698.10	5007.49	5012.10	945.19
Employment (%)	BiH	33.40	47.30	39.85	39.60	4.41
	Serbia	46.60	52.20	47.71	47.20	1.42
	Montenegro	31.30	53.30	42.78	45.50	7.07
	Albania	44.00	52.00	47.24	47.00	2.17
	Kosovo	23.00	29.30	26.25	26.80	2.03
	S. Macedonia	42.00	47.30	43.61	43.00	1.28

Author's calculation.

Based on the results presented in the previous table, we can conclude that the highest average GDP per capita for the period 2005-2021 was recorded in Montenegro (US$ 6879.38) and Serbia (US$ 6408.19). During the same period, North Macedonia had an average GDP per capita of US$ 5007.49, while Bosnia and Herzegovina ranked fourth among the observed countries, with an average GDP per capita of US$ 4927.71. The lowest results were recorded in Albania (US$ 4381.32) and Kosovo (US$ 3625.67). A slightly different ranking can be observed when considering the results of the second economic growth indicator. As was the case with the previous indicator, the highest average employment rate among the analyzed countries was recorded in Serbia (47.71%), while Kosovo, with an average employment rate of only 26.25%, ranked last once again. However, in contrast to the order based on GDP per capita, Albania ranked second in terms of employment, with an average rate of 47.24%, followed by Montenegro in third place with 47.11%. North Macedonia came fourth with 43.61%, while Bosnia and Herzegovina ranked fifth, with an average employment rate of 39.85%.

4.1. Testing of Research Hypotheses

As part of the research methodology of this study, a main research hypothesis was formulated, along with two working hypotheses. The main research hypothesis is as follows:

The volume of investment in communication infrastructure has a significant impact on economic growth.

The working hypotheses are formulated as follows:

H1: Investment in communication infrastructure significantly affects the increase in GDP per capita.

H2: Investment in communication infrastructure significantly affects the increase in employment.

4.1.1. Testing the Impact of Investment in Communication Infrastructure on the Increase in GDP per Capita

The first working hypothesis focuses on testing the impact of investment in com-

munication infrastructure on the growth of gross domestic product per capita (GDP per capita). It is stated as follows: Investment in communication infrastructure significantly affects the increase in GDP per capita.

As previously mentioned, investment in communication infrastructure is operationalized through the following four indicators: Investment in telecommunication services (%), Availability of broadband access—internet services, fibre-optic connections, wireless internet (%), Broadband user penetration (%), and Share of investment relative to total telecommunications industry revenue (%). The dependent variable, GDP per capita (in US$), was measured using a ratio scale, and hypothesis testing was conducted through the application of regression analysis.

The complete results of the regression analysis are provided in the appendix of this thesis. However, due to the volume of data, and in order to maintain clarity and structure, the key results are presented in the following section. Accordingly, Table 3 shows the evaluation results of the model measuring the impact of investment in communication infrastructure on GDP per capita in Bosnia and Herzegovina.

Table 3. Evaluation of the impact model of investments in communication infrastructure on GDP per capita in Bosnia and Herzegovina.

(a)

Summary of model

Model	R	Coefficient determinacies	coefficient determinacies	Standard breaks of proceed
1	0.944a	0.892	0.856	399.5625

a. Predictors: Share of investments relative to the total revenue of the telecommunications industry in Bosnia and Herzegovina (%), availability of broadband access (internet services, optical connection, wireless internet) in Bosnia and Herzegovina (%), penetration of broadband access users in Bosnia and Herzegovina (%), investments (expenditures) in telecommunication services in Bosnia and Herzegovina (%). b. Dependent variable: GDP per capita in Bosnia and Herzegovina (US$).

(b)

ANOVA

Model		sum	df	average	F	Sig.
1	regression	15788167.220	4	3947041.805	24.723	0.000
	Residual	1915802.457	12	159650.205		
	Total	17703969.678	16			

Author's calculation.

The coefficient of determination indicates the proportion of variance in the dependent variable explained by the model. When regression analysis is conducted on a small sample, as is the case in our study, the coefficient of determination tends to be an overly optimistic estimate of the true population value. Therefore, the adjusted coefficient of determination corrects this value and provides a better estimate for the population. In our case, we can state that the model explaining the impact of investment in communication infrastructure on GDP per capita in

Bosnia and Herzegovina accounts for 85.6% of the variance in GDP per capita. The statistical significance of this indicator is presented in the ANOVA table (Sig. = 0.000 < 0.05), indicating that the model is statistically significant. The next aspect to consider is how much each variable in the model contributes to predicting the dependent variable, which is indicated by the beta coefficients in Table 4, presenting the standardized coefficients.

Table 4. Regression coefficients of the model examining the impact of investments in communication infrastructure on GDP per capita in Bosnia and Herzegovina.

Model		Unstandardized coefficients		Standardized coefficients	t	Sig.
		B	St. breaks	Beta		
1	(Constanta)	122.914	690.593		0.178	0.862
	Investments (expenditures) in telecommunication services in BiH (%)	−88.710	49.994	−0.827	−1.774	0.101
	Availability of broadband access (internet services, fibre optic connection, wireless internet) in BiH (%)	20.498	17.520	0.563	1.170	0.265
	Penetration of broadband access users in BiH (%)	95.311	75.978	0.484	1.254	0.234
	Share of investments relative to the total revenue of the telecommunications industry in BiH (%)	176.117	47.821	0.760	3.683	0.003

Author's calculation.

Whether a variable makes a statistically significant unique contribution to the equation depends on the significance value calculated in the last column of the coefficients table. If the significance value is less than 0.05, the variable makes a significant unique contribution to predicting the dependent variable. In our case, the share of investment relative to the total revenue of the telecommunications industry makes a significant unique contribution to predicting GDP per capita in Bosnia and Herzegovina. Based on the above, the formulated research hypothesis that investment in communication infrastructure significantly affects the increase in GDP per capita is accepted.

In the same manner as for Bosnia and Herzegovina, the impact of investment in communication infrastructure on GDP per capita was examined for the other five countries included in our study. The key results of the regression analysis are presented in Table 5.

Model 2 refers to the results of testing the impact of investment in communication infrastructure on GDP per capita in Serbia, model 3 in Montenegro, model

Table 5. Results of the regression analysis of the model on the impact of investments in communication infrastructure on GDP per capita in Serbia, Montenegro, Albania, Kosovo, and North Macedonia.

Summary model					ANOVA	Coefficient		
Model	R	Coefficient determinacies	Coefficient determinacies	Standard breaks of proceed	Sig.		Beta	Sig.
2	0.787[a]	0.619	0.492	950.5996	0.014	(Constanta)		0.182
						I_1—Serbia	−0.224	0.632
						I_2—Serbia	0.134	0.922
						I_3—Serbia	−1.423	0.116
						I_4—Serbia	2.089	0.124
3	0.736[a]	0.541	0.388	1208.6162	0.040	(Constanta)		0.030
						I_1—Montenegro	−1.172	0.216
						I_2—Montenegro	−2.417	0.151
						I_3—Montenegro	5.164	0.089
						I_4—Montenegro	−1.069	0.491
4	0.871[a]	0.758	0.677	506.9720	0.001	(Constanta)		0.482
						I_1—Albania	−0.838	0.466
						I_2—Albania	−0.183	0.563
						I_3—Albania	0.180	0.897
						I_4—Albania	1.651	0.480
5	0.968[a]	0.937	0.915	208.7411	0.000	(Constanta)		0.000
						I_1—Kosovo	0.066	0.664
						I_2—Kosovo	0.209	0.493
						I_3—Kosovo	−1.083	0.059
						I_4—Kosovo	1.776	0.009
6	0.956[a]	0.913	0.884	321.9329	0.000	(Constanta)		0.123
						I_1—S. Macedonia	0.047	0.931
						I_2—S. Macedonia	1.193	0.003
						I_3—S. Macedonia	−0.159	0.899
						I_4—S. Macedonia	−0.139	0.898

[a]. Predictors: (const.), investments (expenditures) in telecommunication services (%)—I1, availability of broadband access—internet services, fibre optic connection, wireless internet (%)—I2, penetration of broadband access users (%)—I3, share of investments relative to total telecommunications industry revenue (%)—I4. [b]. Dependent variable: GDP per capita (US$). Author's calculation.

4 in Albania, model 5 in Kosovo, and model 6 in North Macedonia. The obtained results demonstrate statistical significance of the coefficient of determination in all five analysed models/countries, as the significance values for all models are below 0.05. Specifically, the model explains 49.2% of the variance in GDP per capita in Serbia, 38.8% in Montenegro, 67.7% in Albania, 91.5% in Kosovo, and 88.4%

in North Macedonia.

The evaluation of independent variables (predictors) shows a significant unique contribution of some of them in predicting GDP per capita in Kosovo and North Macedonia. More precisely, the share of investment relative to the total revenue of the telecommunications industry makes a significant unique contribution to predicting GDP per capita in Kosovo, while broadband availability (internet services, optical connection, and wireless internet) significantly contributes to the prediction of GDP per capita in North Macedonia.

Supporting the confirmation of the research hypothesis are the results of testing the impact of digitalization on GDP per capita, presented below. The mentioned index consists of sixteen indicators divided into six groups or categories of digitalization: accessibility, infrastructure reliability, network access and capacity, usage, and human capital.

Accessibility measures the relative costs of access for telephone, mobile, and fixed broadband networks. Infrastructure reliability derives from the level of telecommunications investment adjusted by the number of users in the country. Network access refers to device ownership enabling access, as well as adoption of mobile and broadband networks. Capacity measures broadband access speed and internet bandwidth. Usage encompasses both public and private use of digitalization, while human capital represents the skills necessary for the development of digital transformation.

The impact of digitalization was also tested individually for each of the six countries included in the study. Table 6 presents the key part of the obtained results. Model 1 shows the results for Bosnia and Herzegovina, model 2 for Serbia, model 3 for Montenegro, model 4 for Albania, model 5 for Kosovo, and model 6 for North Macedonia.

Table 6. Regression analysis results of the impact of digitalization on GDP per capita in Bosnia and Herzegovina, Serbia, Montenegro, Albania, Kosovo, and North Macedonia.

Model		Model			ANOVA	Coefficient		
Model	R	Coefficient determinacies	Coefficient determinacies	Standard breaks of proceed	Sig.		Beta	Sig.
1	0.788[a]	0.620	0.595	669.4854	0.000	(Constanta)		0.008
						ID—BiH	0.788	0.000
2	0.638[a]	0.408	0.368	1059.9822	0.006	(Constanta)		0.169
						ID—Serbia	0.638	0.006
3	0.513[a]	0.263	0.214	1370.1973	0.035	(Constanta)		0.098
						ID—Montenegro	0.513	0.035
4	0.850[a]	0.723	0.705	484.7346	0.000	(Constanta)		0.000
						ID—Albania	0.850	0.000
5	0.653[a]	0.427	0.388	561.1438	0.004	(Constanta)		0.058

Continued

						ID—Kosovo	0.653	0.004
						(Constanta)		0.071
6	0.873[a]	0.761	0.745	476.9564	0.000	ID—S. Macedonia	0.873	0.000

[a]. Predictor: (const.), Digitalization Index—DI. [b]. Dependent variable: GDP per capita (US$). Author's calculation.

As can be seen from the presented results, the significance values obtained for all countries confirmed the statistical significance of the model, i.e., the coefficient of determination. Specifically, the significance values for all six countries were below 0.05. The model explains 59.5% of the variance in GDP per capita in Bosnia and Herzegovina, 36.8% in Serbia, 21.4% in Montenegro, 70.5% in Albania, 38.8% in Kosovo, and 74.5% in North Macedonia. Furthermore, results evaluating the independent variable—the digitalization index—also strongly support the confirmation of the first working hypothesis, as a significant unique contribution of this variable to the prediction of GDP per capita was confirmed in all six countries. The Digitalization Index used in this study consists of sixteen indicators grouped into six categories of digitalization: 1) Accessibility—measures the relative cost of access for telephone, mobile, and fixed broadband networks. 2) Infrastructure Reliability—derived from the level of telecommunication investments in a country adjusted for the number of users. 3) Network Access—refers to the ownership of devices enabling network access and the adoption of mobile and broadband networks. 4) Capacity—measures broadband access speed and internet bandwidth. 5) Usage—captures both public and private use of digitalization. 6) Human Capital—reflects the skills necessary for the development of digital transformation. Each category is composed of multiple indicators, standardized and combined to form a composite index that reflects the overall level of digitalization in a country. Data for these indicators were collected from national statistical offices and other relevant sources. The Digitalization Index (DI) was constructed in this study using data collected from the World Bank—*Digital Progress and Trends Report*, the Regional Cooperation Council—*Western Balkans Digital Economy and Society Index* (*WB DESI*), and the OECD—*Digital Transition in the Western Balkans*. These sources served as the basis for developing the index, which measures digital transformation across six key categories: accessibility, infrastructure reliability, network access, capacity, usage, and human capital.

4.1.2. Testing the Impact of Investments in Communication Infrastructure on Employment Growth

Testing this hypothesis was conducted, as with the previous working hypothesis, using regression analysis. Investments in communication infrastructure were operationalized using the same indicators as in the first working hypothesis, while the dependent variable was operationalized as the employment rate percentage in the six countries included in our study.

The full results of the regression analysis are presented in the appendix and

form an integral part of this work. The key results, which allow drawing conclusions regarding the impact testing, are shown in Table 7. Specifically, Model 1 refers to the results testing the impact of investments in communication infrastructure on employment in Bosnia and Herzegovina; Model 2 in Serbia; Model 3 in Montenegro; Model 4 in Albania; Model 5 in Kosovo; and Model 6 in North Macedonia.

Table 7. Results of the regression analysis of the impact of investments in communication infrastructure on GDP per capita in Bosnia and Herzegovina, Serbia, Montenegro, Albania, Kosovo, and North Macedonia.

Model				ANOVA	Coefficient		
Model	R	Coefficient determinacies	Coefficient determinacies	Standard breaks proceed	Sig.		Beta	Sig.
1	0.858[a]	0.737	0.649	2.61417	0.002	(Constanta)		0.000
						I_1—BiH	2.037	0.016
						I_2—BiH	−1.761	0.037
						I_3—BiH	1.403	0.038
						I_4—BiH	−1.273	0.002
2	0.816[a]	0.667	0.555	0.94630	0.007	(Constanta)		0.000
						I_1—Serbia	−0.475	0.286
						I_2—Serbia	−0.350	0.784
						I_3—Serbia	−1.805	0.040
						I_4—Serbia	3.071	0.023
3	0.976[a]	0.952	0.937	1.78118	0.000	(Constanta)		0.000
						I_1—Montenegro	−0.039	0.896
						I_2—Montenegro	−1.721	0.005
						I_3—Montenegro	1.977	0.048
						I_4—Montenegro	0.688	0.180
4	0.804[a]	0.646	0.528	1.48868	0.010	(Constanta)		0.000
						I_1—Albania	2.153	0.135
						I_2—Albania	−0.125	0.743
						I_3—Albania	−0.436	0.796
						I_4—Albania	−0.930	0.740
5	0.981[a]	0.963	0.951	0.44937	0.000	(Constanta)		0.000
						I_1—Kosovo	−0.109	0.352
						I_2—Kosovo	0.020	0.929
						I_3—Kosovo	0.776	0.073
						I_4—Kosovo	0.273	0.540
6	0.811[a]	0.658	0.544	0.86538	0.008	(Constanta)		0.000
						I_1—S. Macedonia	1.306	0.239

Continued

I_2—S. Macedonia	−0.767	0.247
I_3—S. Macedonia	−5.615	0.039
I_4—S. Macedonia	5.744	0.018

[a]. Predictors: (const.), investments in telecommunication services (%)—I1, broadband access availability—internet services, optical connection, wireless internet (%)—I2, broadband user penetration (%)—I3, share of investments in total telecommunications industry revenue (%)—I4. [b]. Dependent variable: employment (%). Author's calculation.

Based on the results presented in the previous tabular overview, it can be concluded that the coefficient of determination is statistically significant in all six analysed models, i.e., countries, as the significance value for all was below 0.05. The model explaining the impact of investments in communication infrastructure on employment accounts for 64.9% of the variance in employment in Bosnia and Herzegovina. The evaluation of independent variables, shown by significance values below 0.05 in the last column of the table, indicates a significant unique contribution of all four indicators of investments in communication infrastructure to the prediction of employment: investments in telecommunication services, availability of broadband access (internet services, optical connection, wireless internet), penetration of broadband access users, and the share of investments relative to the total revenue of the telecommunications industry. Accordingly, the second working hypothesis is accepted, confirming that investments in communication infrastructure significantly affect employment growth.

For the other countries included in the study, the results show that the model explaining the impact of investments in communication infrastructure accounts for 55.5% of the variance in employment in Serbia, 93.7% in Montenegro, 52.8% in Albania, 95.1% in Kosovo, and 54.4% in North Macedonia. The evaluation of independent variables (predictors) shows a significant unique contribution of some indicators to the prediction of employment in Serbia, Montenegro, and North Macedonia. Specifically, broadband user penetration and the share of investments relative to the total revenue of the telecommunications industry significantly contribute to employment prediction in Serbia and North Macedonia, while broadband availability (internet services, optical connection, and wireless internet) and broadband user penetration significantly contribute to employment prediction in Montenegro.

Similarly to the first working hypothesis, the impact of digitalization, operationalized through the previously mentioned digitalization index, was also tested on the dependent variable. The key part of the regression analysis results is presented in Table 8, with model numbering corresponding to the country numbering used in all previously presented regression analyses and their interpretations in this study.

Similarly to the testing of the impact of digitalization on GDP per capita, the testing of digitalization's impact on employment in all countries yielded significance values below 0.05, confirming the statistical significance of the model and

Table 8. Results of the regression analysis of the impact of digitalization on employment in Bosnia and Herzegovina, Serbia, Montenegro, Albania, Kosovo, and North Macedonia.

Model				ANOVA		Coefficient		
Model	R	Coefficient determinacies	Coefficient determinacies	Standard breaks proceed	Sig.		Beta	Sig.
1	0.770[a]	0.593	0.566	2.90703	0.000	(Constanta)		0.273
						ID—BiH	0.770	0.000
2	0.515[a]	0.266	0.217	1.25617	0.034	(Constanta)		0.000
						ID—Serbia	0.515	0.034
3	0.909[a]	0.826	0.814	3.04647	0.000	(Constanta)		0.000
						ID—Montenegro	0.909	0.000
4	0.511[a]	0.261	0.212	1.92297	0.036	(Constanta)		0.020
						ID—Albania	0.511	0.036
5	0.785[a]	0.616	0.591	1.29865	0.000	(Constanta)		0.392
						ID—Kosovo	0.785	0.000
6	0.536[a]	0.288	0.240	1.11642	0.026	(Constanta)		0.000
						ID—S. Macedonia	0.536	0.026

[a]. Predictor: (const.), digitalization index—DI. [b]. Dependent variable: employment (%). Author's calculation.

the coefficient of determination. Regarding Bosnia and Herzegovina, the model explains 56.6% of the variance in employment, Serbia 21.7%, Montenegro 81.4%, Albania 21.2%, Kosovo 59.1%, and North Macedonia 24% of the variance in employment. Furthermore, in all six countries, the evaluation results of the independent variable confirmed a significant unique contribution of digitalization to the prediction of employment.

5. Conclusion

The results of this research clearly demonstrate that investments in communication infrastructure have a significant and positive impact on the economic growth of Western Balkan countries. The analysis of data from 2005 to 2021, covering Bosnia and Herzegovina, Serbia, Montenegro, Albania, Kosovo, and North Macedonia, confirmed that investments in telecommunications services, availability and penetration of broadband access, as well as the share of investments in the total revenue of the telecommunications industry, significantly contribute to the increase of GDP per capita and employment in these countries.

Furthermore, it was shown that digitalization, as a broader concept including accessibility, infrastructure reliability, network capacity, digital technology usage, and human capital, further enhances this positive impact on economic performance and the labor market. These findings support the importance of continuing and intensifying investments in communication infrastructure alongside the de-

velopment of digital capabilities as key factors for sustainable economic growth and development in the Western Balkans region.

Based on the obtained results, it is recommended to adopt policies that encourage and facilitate investments in the modernization and expansion of communication infrastructure, as well as the improvement of digital skills among the population, which will contribute to reducing developmental disparities and strengthening the competitiveness of these countries on a global scale in the long term.

We fully agree that there is a possibility of reverse causality between economic growth and investment in communication infrastructure. While our results suggest a positive impact of investment on growth, it is also plausible that higher economic growth creates the conditions for greater infrastructure investment. This point highlights the importance of future research employing methodologies that can better address the issue of endogeneity and the bidirectional nature of causality.

6. Limitations of the Research

In the following section, we also highlight the limitations of this study:

Small sample size—The study covers six Western Balkan countries, which represents a limited sample and may affect the generalizability of the findings to a broader European or global context.

Specific time frame (2005-2021)—The chosen period ensures data consistency but excludes more recent trends in digitalization and economic dynamics after the COVID-19 pandemic (2022-2024), when significant changes in data collection and availability occurred.

Limited data availability and quality—In some Western Balkan countries, statistical data on digitalization and telecommunications are not fully harmonized or readily available, which may affect the accuracy of the measured variables.

Potential causality issue—While the analysis suggests that investments in communication infrastructure positively affect economic growth, reverse causality is also plausible, meaning that higher economic growth could enable greater investment (endogeneity problem).

Omitted variables—Factors such as institutional quality, political stability, education systems, and the pace of technology adoption were not explicitly included in the model, even though they may significantly influence both digitalization and economic growth.

Heterogeneity of countries—Although all countries belong to the same region, there are substantial differences in institutional frameworks, levels of development, and progress in EU integration, which may lead to varying outcomes within the same sample.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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