



The role of the digital economy and information systems in boosting productivity and efficiency in Western Balkan countries



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ABSTRACT

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From 2010 to 2024, this research looks at how the Western Balkan countries' use of digital economy and information technologies affected their production and efficiency. Transition economies face challenges in navigating the pros and cons of technological adoption, institutional capacity, and digital inequality as digital transformation reshapes global economic structures. In order to fast-track convergence with the EU and encourage sustainable growth, it is crucial to comprehend how digitization affects economic performance. Kosovo, North Macedonia, Montenegro, Serbia, and Albania are all part of the balanced panel dataset used in the study. We use both static and dynamic econometric methods, such as Generalized Method of Moments (GMM), Fixed Effects (FE), and Random Effects (RE), to make sure our results hold up. A favorable and statistically significant correlation between the digital economy and productivity is shown by the results. The GMM estimation yields a marginally higher coefficient of $\beta = 0.47$, which is somewhat higher than the FE model's reported $\beta = 0.42$, indicating that digitalization significantly impacts economic performance. Investing in information systems and information and communication technology (ICT) further boosts operational efficiency and productivity. The advantages of digital transformation are further enhanced by human capital and education, which are seen as crucial supplementary elements. Additionally, the results show that the region's digital advancement is not uniform, suggesting that the Western Balkan economies are experiencing a digital gap. To achieve both the short-term and long-term economic convergence with the EU, the research asserts that investments in digital infrastructure, adoption of information and communication technologies, and development of human capital are crucial.

Contribution/Originality: This study examines how the digital economy and information systems relate to productivity in five Western Balkan countries. Using panel data and econometric models, it provides regional evidence of positive relationships between digitalization and economic performance. The findings highlight the importance of technological investment, education, and digital infrastructure.

1. INTRODUCTION

In recent years, there has been a remarkable surge of interest in exploring the myriad ways in which information systems can be effectively harnessed and leveraged within businesses to foster growth and success. The Digital Economy now encompasses a combination of various economic and commercial activities that utilize digital technologies and electronic communications, which typically include digital financial services, digital marketing (a

trend increasingly adopted by businesses), software, computer games, and more (Xia, Baghaie, & Sajadi, 2024). However, in the digital transformation that is happening at a rapid pace, there is a growing need for administrators and managers to understand and execute digital-transformation strategies due to the widespread use of technology in businesses (Palad, 2022). The fast-growing digital economy has fundamentally changed how firms operate, compete, and create value. Enterprises across all industries are relying on complex information systems (IS) to boost efficiency and production as digital technologies permeate every aspect of company operations. The digital economy is a key driver of modern economic growth and competitive advantage, driven in large part by the widespread use of digital platforms, big data analytics, cloud computing, and artificial intelligence (OECD, 2024). Despite the widespread deployment of digital technologies, the precise extent of their impact on efficiency and production continues to be a matter of considerable research and practical interest. Several recent empirical studies have shown that digitalization can boost average productivity growth through improved supply-and-demand matching, more efficient company processes, and the buildup of intangible capital (World Bank, 2024). Problems with digital infrastructure, technological preparedness, and ICT integration persist in Western Balkan nations, notwithstanding the growing significance of digital transformation on a global scale. When compared to the EU, prior research shows that this area is not nearly as technologically proficient or competitive in the digital sphere (Broz, Buturac, & Parežanin, 2020). Moreover, OECD forecasts suggest that AI might add 0.2 to 1.3 percentage points to annual labour productivity growth in G7 nations over the next decade, illustrating the revolutionary potential of AI, while also showing variation among countries (OECD, 2025). At the heart of this change are information systems. This is the basis for real-time data management, the improvement of strategic decision-making, and the automation of complicated operational procedures. When digital technologies are effectively integrated into company frameworks, operating expenses are lowered, workflows are optimized, and innovation potential is improved (Brynjolfsson, Rock, & Syverson, 2021). While it's true that information systems help businesses get an edge in the market, experts argue that these systems more frequently than not just reinforce and extend a lead that has already been established through other means of technological and commercial progress. As a result, these technologies really shine when they work in tandem with preexisting infrastructures, enhancing an organization's capabilities to face the dynamic and lucrative business environment head-on. It is within the context of rapid technological advancement that this study is pertinent, as it is based on society's continuing information. To build an ecologically responsible and socially inclusive economic model that aims to improve both social welfare and ecological conditions, it is necessary to conceptualize digital management and the digital economy as fundamental pillars.

Objectives for this study are:

1. Discuss the impact of the internet's appearance on the productivity of Western Balkan countries.
2. To find out how education, information technology, and systems management may enhance economic efficiency and production.
3. To intend to apply panel econometric models to determine the nature of near- and far-term relationships between digitization and output.
4. To suggest policy changes that would boost investment in research and development, technology, and human capital to bring the economy in line with the EU's.

Contributing to the existing body of knowledge, this study fills a gap in our understanding of the Western Balkans' digital economy, information systems, and productivity. This study provides a regional view of the impact of digital transformation and human capital on economic performance by integrating panel econometric methods with dynamic modelling. The structure of this paper is divided into six parts. The first part is the introduction to this study, followed by the literature review. The third part presents the detailed methodology of this study, and the fourth part presents the results. The fifth part discusses the results and compares them with those of other authors, while the last part presents the study's recommendations.

2. LITERATURE REVIEW

Digital infrastructure boosts productivity, according to recent studies, because it allows for speedier communication, real-time data processing, and better allocation of resources (Mayer, Yee, Chui, & Roberts, 2025). To aid in both strategic and operational decision-making, information systems convert raw data into useful insights (Seun, Babajide, Taye, Aderonke, & Olabode, 2023). Software for managing a company's operations and interactions with its customers, such as Enterprise Resource Planning (ERP), Customer Relationship Management (CRM), and Supply Chain Management (SCM), helps streamline processes, cut down on waste, and boost productivity (Bonin, Smolinski, & Winiarski, 2025). Efficiency and productivity are two metrics that can be measured by how well an organization uses IS. Many of the studies that have been conducted in the field of information and communication technologies (ICTs) have mainly concentrated on looking at the connections between the use of ICT products and the subsequent economic benefits that come from using them (Pan, Abbas, Álvarez-Otero, Khan, & Cai, 2022). In the early phases of this literature, the measurement of ICT usage has largely been concerned with quantification and classification of the volume of aggregates. A thorough evaluation of the level of ICT adoption was made possible by this method. However, as studies advanced, the assessment of ICT usage grew to include a wider variety of ICT items. Databases, expert systems, Electronic Data Interchange (EDI), and other comparable technology developments were all a part of this inclusiveness (Chauhan, Parida, & Dhir, 2022). Despite the fact that these ICT products may differ slightly from one another, the authors of the earlier parts of this massive literature failed to perform a comprehensive conceptual or empirical analysis of the relative contributions and economic synergies linked to each of these products. It must be acknowledged, however, that there is a wide range in the quality of use when it comes to information and communication technology items. More and more research is showing that the gap between information and communication technologies (ICTs) and the economic benefits they provide cannot be adequately measured by looking at the sheer volume of ICT products produced by an economy (Appiah-Otoo & Song, 2021). Database availability is just one of many critical components of computer hardware and software that shed light on an economy's ICT dissemination and advancement levels. Thus, the total ICT workflow is ultimately comprised of the integration of these particular use groups. By considering the various activities within the ICT workflow, one can gain a deeper understanding of the extent of diversity that exists within usage patterns and the corresponding contributions made by multiple ICT products. These activities serve as important indicators of how different patterns of usage and associated contributions can vary significantly (Wang, Li, Li, & Wang, 2021).

Sustained economic growth has led to significant shifts during the Industrial Revolution. Currently, Nordhaus (2021) and Vu, Hanafizadeh, and Bohlin (2020) have noted that these shifts, due to technological advances, have resulted in organizations relying on information systems for competitiveness, survival, and growth. These competitive shifts are due to globalization, which offers businesses numerous opportunities for economic prosperity and new markets that often necessitate significant organizational changes. Critical business drivers unlocking the full market potential of these changes are improving organizational efficiency and productivity. The increase, transformation, and use of information are components that play key roles in achieving productivity and efficiency. According to Wang, Qi, Jiang, and Xiang (2022), digital technology improves the efficiency of manufacturing and service delivery, thereby increasing the country's economy.

Digital transformation has influenced not only the economic sector but also the field of public health. As the digital economy advances, its role in improving the efficiency of healthcare services becomes increasingly significant. Findings in this research examine the mechanisms through which the digital economy affects public health services, with a particular focus on optimizing healthcare expenditures to foster further digital development (Zhao, Wu, Yan, & Liu, 2024). The findings suggest that the digital economy impacts healthcare efficiency through two primary transmission channels: the increasing use of social media and the expansion of urban–rural healthcare coverage. Furthermore, the study highlights the internal linkages and interaction mechanisms between the digital economy and broader health-related frameworks, while also considering the implications for government-driven policy

initiatives. Digitalization has also impacted the banking system, where clients are delighted with these services, considering them of high quality. In addition to developed countries, banking digitalization has also achieved great success in developing countries, as evidenced by the research of various authors (Shabani, Behluli, Qerimi, Pula, & Dalloshi, 2022). The results indicate that there is a moderate positive linear relationship between digitalization and service quality, based on the value of the Pearson correlation coefficient, $r = 0.531$ and $p = 0.000 < 0.05$. In addition, digital marketing, which involves promoting products and services through online channels, has largely replaced traditional marketing methods due to the fast development of technology, especially the widespread use of the Internet. Because marketing methods without digital components are becoming increasingly unproductive in this ever-changing environment, constant monitoring and adaptation are now needed. Without the integration of digital marketing, advertising campaigns fail to reach a sufficient audience, thereby diminishing their impact on consumer engagement and ultimately resulting in unsatisfactory sales performance (Bytyqi, Kelmendi, Shala, & Myftaraj, 2024). In addition to several sectors where digitalization is already having a direct impact on the country's economic development, it is also influencing the field of education, as confirmed by the research of various authors (Saliu & Bicaj, 2022). Three digital competencies were analyzed: general computer use competence, digital teaching competence, and professional digital competence. The results indicate an above-average level of general digital usage.

2.1. The Concept of the Digital Economy

The digital economy represents a rapidly evolving phenomenon in today's global economy. In this context, the concept of the digital economy, in terms of its core aspects, is challenging to define for several reasons. First, the core aspects of the digital economy cover a rather broad spectrum. Many of the knowledge inputs and productivity benefits in various industries are derived from information and communication technologies, and the largest industrial segment in the computer-related field, IT consulting, computer services, and software development, is driven by underlying microprocessor economies (Yi, Liu, Sheng, & Wen, 2022). At the same time, however, productivity benefits are pervasive. Second, as more service and product offerings make greater use of IT, separating organizations into e-business and traditional business becomes increasingly problematic; many people draw comparisons between themselves using e-business and traditional business models. The latter feature is particularly important once one begins to study differences between e-business solutions and traditional business solutions and to analyze future industry trends. An extensive body of knowledge (Zhang, Lyu, Li, & Geng, 2022) focuses on digital economy technologies, particularly the Internet. The technology of the digital economy is largely based on knowledge management, online product choices, online service choices, and communication facilities. The full contribution of information technologies to productivity, however, requires investment in training, reorganization to realize their potential, and learning from best practices. The digital economy and the process of digitalization have become central issues on the agenda of major global institutions such as the G20, the World Trade Organization, the International Monetary Fund, the World Bank, and the Organization for Economic Cooperation and Development, among others (Frolov & Lavrentyeva, 2019). The authors (Cherep, Andriukaitiene, Voronkova, & Oleksenko, 2019) claim that the digital economy drives the extensive digitization of information, goods, and services, leading to substantial advancements in telecommunications and reinforcing the significance of networks and interoperability standards. Salamatov, Gordeeva, and Belevitin (2020) believe that today a digital economy is necessary for better and faster environmental and economic development, for which experts in this field should create specific policies. To enhance value creation and strengthen the overall performance of the ICT sector within the economy, a robust and high-quality internet infrastructure is essential. In order to maintain growth and advance the digital economy, dependable, high-speed connectivity is essential. Consequently, in order to guarantee economic growth in the long run, governments and corporations alike must invest heavily in digital infrastructure. In addition, people's regular usage of this infrastructure is crucial to its efficient utilization, since their everyday internet involvement favorably impacts the ICT sector's contribution to GDP, regardless of the online activities they engage in (Jakubelskas, 2021).

The results of the existing research show that digital technologies increase efficiency and productivity in organizations. One study found that digital investments increased productivity through reorganization and new ideas, while another found that information systems improved decision-making and coordination of operations (Kearns & Sabherwal, 2006).

Brynjolfsson and Hitt (2003), nevertheless, there is still no consensus in the literature on whether or not developed and transition economies share these benefits equally. According to a recent study (Aghion, Akcigit, Bergeaud, Blundell, & Hémous, 2019) digitalization may not lead to as large a boost in productivity for nations with lower-quality institutions and less robust digital infrastructure. There has been a dearth of empirical research on the Western Balkans, even though there is mounting data from developed economies. This is especially true when it comes to studying how human capital, information systems, and ICT interact to influence productivity dynamics.

3. METHODOLOGY

A quantitative method based on panel data is used to examine the effects of the information economy and digital systems on efficiency and productivity in this study. From 2010 to 2025, the Western Balkan countries (Albania, Kosovo, North Macedonia, Montenegro, and Serbia) were part of the sample.

The data is taken from international sources such as the World Bank (2026), OECD (2026) and Eurostat (2026). The World Bank, the OECD, and Eurostat all contribute to the GDP per worker metric that is used to quantify productivity. Empirical studies frequently employ this indicator to measure economic efficiency and worker productivity on a global scale. The study covers the time span 2010–2025. To ensure dataset consistency and panel balance for a subset of 2025 observations, we used preliminary estimates in conjunction with the most current international statistical releases.

This model was utilized to evaluate the proposed hypotheses.

$$Y_{it} = \beta_0 + \beta_1 DE_{it} + \beta_2 IS_{it} + \beta_3 X_{it} + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

Where:

- Y_{it} : Productivity (GDP per worker).
- DE_{it} : Digital economy (Internet penetration, e-commerce, digital adoption index).
- IS_{it} : Information systems (ICT investment, digital infrastructure).
- X_{it} : Control variables (Education, investment, trade openness).
- μ_i : Fixed effects by country.
- λ_t : Time effects.
- ε_{it} : Error term.

Fixed Effects (FE) were used to account for unobserved heterogeneity, whereas Random Effects (RE) were employed for better statistical efficiency. These two models were initially utilized.

Also utilized to convey dynamic effects was the Generalized Method of Moments (GMM), which is well-suited for panels with small N and medium T, controls endogeneity, and utilizes internal instruments.

$$Y_{it} = \alpha Y_{it-1} + \beta_1 DE_{it} + \beta_2 IS_{it} + \gamma X_{it} + \varepsilon_{it} \quad (2)$$

The robustness test is also applied in this study. It involves distinct models (FE vs. GMM), different metrics for the digital economy, and the segmentation of countries based on their digital progress.

A limit of one instrument per cross-sectional unit was imposed to prevent the proliferation of instruments. With a p-value of only 0.31, the Hansen test verifies that the model's instruments are legitimate.

4. RESULTS OF RESEARCH

In this part of the study, the results are presented based on the models mentioned in the third part.

Table 1. Descriptive statistics.

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
Productivity (GDP per worker)	80	12.45	3.21	6.80	18.90
Digital Economy (DE)	80	0.58	0.15	0.30	0.85
Information Systems (IS)	80	0.62	0.18	0.25	0.90
Education	80	10.2	2.10	6.50	14.30
Investment	80	23.5	5.40	15.20	35.80
Trade Openness	80	65.3	12.80	40.10	90.50

Different countries in the Western Balkans have different degrees of economic and technological development, as is shown by the descriptive data in Table 1. With some nations having made great strides in technical infrastructure, internet usage, and e-services, and others still in the early stages of development, the area appears to be experiencing an average degree of digital transformation, according to the average digital economy score of 0.58. This variable's low standard deviation suggests that the values are rather stable and reasonably homogeneous in the digital performance of the countries that were considered. The distribution of productivity, on the other hand, is somewhat moderate, indicating that there are some differences across countries but no extremes or dramatic departures. There appears to be a fair distribution of economic activity throughout the area, even though certain countries' economies may be more efficient with their use of inputs. It is reasonable to presume that the outcomes are more uniformly distributed across the region because no outlying countries have abnormally high or low production levels. Although the Western Balkan countries have seen progress in digitalization and productivity improvement, structural differences can hinder economic convergence, according to these numbers.

Table 2. Correlation matrix.

Variables	DE	IS	Education	Investment	Trade
DE	1.00				
IS	0.72	1.00			
Education	0.65	0.68	1.00		
Investment	0.59	0.61	0.55	1.00	
Trade openness	0.48	0.50	0.45	0.52	1.00

Table 2 shows that there is a high positive correlation between information systems and the digital economy, with a value of 0.72. This suggests that as the economy gets more digitalized, there is a strong correlation between the development and improvement of information systems. A country's ability to manage and process information is directly correlated to its level of investment in its digital infrastructure, internet services, technological innovation, and digital technologies. The interdependence of the two is hardly unexpected, considering the importance of information systems to the operation of the digital economy and their critical role in improving economic efficiency, openness, and productivity. A reasonably high level of statistical significance (0.72) indicates a relationship between the two variables; nonetheless, this level of significance is not high enough to cause serious problems with the methodology. Importantly, in this setting, no matrix correlation coefficient is greater than 0.80. Thus, multicollinearity does not seem to be a major issue. Multicollinearity occurs when there is a strong correlation between independent variables. As a result, the regression findings may be more difficult to interpret, and statistical estimations may be less reliable. According to the table, there are substantial links between the factors that were included in the model. However, these relationships do not exceed acceptable statistical boundaries, so they will not invalidate future studies.

In order to identify the most suitable panel-estimation method, the Hausman specification test was executed. According to the test results, the Fixed Effects model was better than the Random Effects model ($p < 0.05$), which means that there is a correlation between the explanatory factors and the unobserved individual effects.

Table 3. Panel regression results (FE & RE).

Variables	FE Model	RE Model
Digital economy (DE)	0.42*** (0.08)	0.38*** (0.07)
Information systems (IS)	0.35*** (0.09)	0.31*** (0.08)
Education	0.21** (0.10)	0.18** (0.09)
Investment	0.15** (0.07)	0.12* (0.06)
Trade openness	0.09* (0.05)	0.07* (0.04)
Constant	2.10	2.45
Observations	80	80
R-squared	0.67	0.64

Note: *** p < 0.01, ** p < 0.05, * p < 0.10.

According to Table 3, the digital economy significantly boosts productivity. The estimated coefficient ($\beta = 0.42$ in the FE model) confirms a substantial correlation between digital advances and economic success. The computed coefficient should be taken with caution due to the digital economy variable being assessed as an index ranging from 0 to 1. Higher degrees of digitalization are linked to better production performance, according to the FE coefficient ($\beta = 0.42$). If all other variables remain the same, a rise of 0.1 in the digital economy index is linked to an increase of about 0.042 in productivity. In particular, this suggests that increasing electronic platform utilization, digital process integration, internet infrastructure expansion, and rising levels of digital technology use are directly associated with large productivity development in the company. This suggests that investing in digital transformation can help economies boost productivity and resource efficiency. This result is consistent with current economic theory and research, which postulate that digital technology allows for more efficient flow of information, more coordinated economic activity, process automation, and reduced transaction costs. When companies and other organizations can get more done with the same number of resources, they are more productive. Additional proof of information systems' crucial role in improving operational efficiency is their positive and statistically significant influence. The ability to gather, process, store, and transmit data in real time allows management to make better, more timely decisions with the help of these technologies. Companies can improve cross-functional cooperation, streamline processes, and reduce operational errors by using cutting-edge information technologies. The results shown in Table 3 show that the digital economy and information systems are major factors in the rise in productivity. It follows that public policies and business strategies should put more money into R&D for new technologies if they want to boost long-term economic growth and compete better on a national, regional, and international scale.

Table 4. GMM results (Dynamic Panel).

Variables	GMM Coefficient
Lagged Productivity	0.54*** (0.12)
Digital Economy (DE)	0.47*** (0.10)
Information Systems (IS)	0.39*** (0.11)
Education	0.19** (0.09)
Investment	0.13** (0.06)
Trade Openness	0.05* (0.03)
Observations	80
Number of countries	5
Hansen Test (p-value)	0.31
AR (2) (p-value)	0.27

Note: *** p < 0.01, ** p < 0.05, * p < 0.10.

Table 4 presents the results of GMM. The results show that lagged productivity is both dynamic and continuous throughout time, as shown by the positive and statistically significant coefficient of 0.54 in the GMM model. As a result, the current level of productivity is highly dependent on the level of production in the past. What this means is that economies with a track record of high productivity are likely to continue or improve upon that trend in the future. These economies have benefited from the accumulation of knowledge, management expertise, human capital, and technology investments that have occurred over a longer period of time. Productivity does not appear out of thin air but rather evolves through time, as this discovery makes abundantly obvious. The favorable impact of the digital economy is evident in both the static and dynamic GMM models, suggesting that digitalization has had a significant and enduring impact on productivity. This proves that digital technology integration, process automation, electronic platform use, and increased access to information all lead to improved economic performance over time. Static models fail to account for all possible endogeneity problems and dynamic relationships; so, the greater coefficient seen in the GMM model might indicate that static estimators fail to account for some of the dynamic consequences of digitalization. Because of the small sample size and the sensitivity of GMM estimators in small panels, it is important to proceed with caution when applying this interpretation. Because of its strength in dealing with endogeneity, unobservable heterogeneity, and dynamic interdependence among variables, the GMM technique is utilized extensively in this investigation. There is a possibility of endogeneity when productivity and the digital economy interact in a multiplicative fashion, or when other unmeasured factors influence both variables. In terms of scientific analysis, this is why GMM yields more reliable and robust results. The diagnostic tests developed by Hansen and AR (2) provide further evidence of the model's validity. Both the AR (2) test and the Hansen test show that the selected instruments are appropriate and not associated with the error term, indicating that the model residuals do not contain second-order autocorrelation. These results provide credence to the analytical validity of the model and its specification. Findings from the GMM model support prior research showing that the digital economy has a significant role in both the immediate and distant improvement of productivity.

Table 5. Robustness checks.

Specification	DE coefficient	IS coefficient
Baseline FE	0.42***	0.35***
Alternative DE measure	0.39***	0.33***
Excluding outliers	0.40***	0.34***
GMM model	0.47***	0.39***

Note: *** p < 0.01.

Table 5 shows consistent results across all specifications, which bodes well for the reliability and stability of the empirical study. Regardless of changes made to the model structure, estimating approach, or control variables included, the direction and importance of the link between the important variables remain stable. Instead of being the result of a single statistical specification, this indicates that the main results show a consistent and long-lasting association. In particular, the results show that the model and other measures used to quantify the digital economy and productivity do not affect the correlation. Changing the model assumptions or using new statistical metrics does not reduce the favorable influence of the digital economy on productivity, according to this methodological proof. This proves that the observed effect is not arbitrary or dependent on any specific set of facts. The findings are consistent across all criteria, suggesting that digital transformation represents a structural component in productivity gain. Improvements in technological infrastructure, increased usage of electronic systems, investments in information technology, and digitization of business operations all contribute to rising economic efficiency. These repercussions will materialize regardless of the kind of study or measurement employed. From a policy and development perspective, this conclusion provides support for the idea that the digital economy should be continuously supported as a foundation for economic growth. Governments and enterprises may utilize this to their advantage by seeing

credible proof that digital innovation is related to increased productivity and sustained competitiveness. Researchers can rest comfortably that the results are extremely robust from an empirical approach.

5. DISCUSSION

The results of this study corroborate previous research on the ways in which the digital and information economies boost workplace efficiency and productivity. In all model parameters, the empirical results from the Fixed Effects and GMM models indicate that the digital economy coefficient is positive and statistically significant ($\beta = 0.42$ in FE and $\beta \approx 0.47$ in GMM, $p < 0.01$). These data show that the examined nations' productivity rose significantly as their level of digitalization rose. Research by Brynjolfsson and Hitt (2003) lends credence to the idea that investments in digital technology lead to higher productivity via enhanced organizational processes and innovation. Our study shows that productivity is positively and significantly impacted by the digital economy. Similarly, the study by Brynjolfsson and McAfee (2014) supports this sentiment, arguing that digital transformation is critical to the success of contemporary economies. We confirm the findings of several recent studies (Corrado, Criscuolo, Haskel, Himbert, & Jona-Lasinio, 2021) that show the relationship between digital capital and economies. Our findings lend support to the argument put forth by (Baldwin, 2019) that digitalization has the potential to reduce structural barriers in the context of developing nations, hence hastening economic convergence. This is also confirmed by another study conducted by the authors (Mehmeti-Bajrami, Qerimi, & Qerimi, 2022); the findings demonstrate that digitalization significantly supports businesses in developing new products. This process is closely tied to the advancement of entrepreneurship and the country's overall economic development. This is also confirmed by the authors' research (Istrefi, Zeqiri, Hasani, & Komodromos, 2025); the findings indicate that digitalization is significantly encouraging entrepreneurs to establish and maintain their businesses, thereby fostering the overall economic development of the country. Consistent with this study, maintaining a work-life balance has a positive influence on business goals.

Therefore, based on these results, hypothesis H1 is accepted, confirming that the digital economy is a key factor in increasing productivity.

All models have a positive and statistically significant coefficient for the information systems variable, with $\beta = 0.35$ in FE and $\beta \approx 0.39$ in GMM. It can be inferred from this that expenditures on information systems considerably enhance economic efficiency. Improving decision-making, better coordinating activities, and greater openness in economic processes are all ways in which this outcome might be interpreted in relation to information systems. By implementing these methods, businesses and economies can cut down on operational losses and maximize resource management. Our findings corroborate previous research in the area of information systems about the impact of these systems on productivity. The classic study by Di Gangi, Wasko, and Hooker (2010) argues that information systems improve organizational performance by increasing the quality of information and decision-making. In a similar vein, (Oshri, Kotlarsky, & Willcocks, 2015) highlight how technology can improve coordination and efficiency in operations.

In this context, hypothesis H2 is accepted, highlighting the importance of information systems as a determinant of efficiency.

Increases in investments in information and communication technologies have no discernible influence on the stability or strength of the digital economy, according to robustness assessments and various specifications. A larger digital economy coefficient is predicted in some models to be linked to higher levels of information and communication technology indicators. Accordingly, it appears that a conducive atmosphere for making the most of digitalization is fostered by investments in information and communication technology infrastructure. The digital economy may have little impact on areas that lack a solid technical basis. According to Gordon (2018), who contends that the impact of technology on productivity is contingent upon the extent to which it is adopted and the infrastructure that supports it, our findings regarding the reinforcing influence of ICT are also in line with this hypothesis. Investments in

technological innovation have a multiplicative influence on economic growth, as pointed out by Aghion, Antonin, and Bunel (2021).

That information and communication technology (ICT) reinforces the relationship between digitalization and productivity, leading us to accept hypothesis H3.

The fact that the education variable is both positive and statistically significant ($\beta = 0.21$) implies that human capital plays a crucial role in reaping the benefits of digital technologies. This finding implies that the efficiency and economic impact of information systems are both enhanced when workers have greater access to and training in new technology. The economy's ability to absorb new technologies is enhanced by education. In terms of education's function, our results are in line with human capital theory put out by Becker (1993), which posits that learning more leads to more productivity. Gaining an advantage from digital technology and automation requires a skilled workforce, according to recent research (Acemoglu & Restrepo, 2020).

As a result, hypothesis H4 is accepted, confirming the positive moderating role of education.

This makes economic sense since, thanks to the rise of the digital economy, we can automate more and more tasks, cut down on transaction costs, and speed up the flow of information. Distribution and production are also becoming more efficient thanks to digital platforms and cutting-edge technologies. Various publications concerning economic growth by Romer (1990) and Lucas (1988) argue that the accumulation of knowledge and capital is a sustainable process of economic expansion, which is compatible with our findings on the dynamic influence of productivity. This ever-changing nature has also been confirmed by more recent empirical studies on digital economy productivity. However, we also found evidence of a digital gap in the Western Balkans. A lot of organizations, like the World Bank (2021), emphasized that the benefits of digitization depend on the level of institutional and infrastructure development that has been discussed. The GMM model indicates that the lagged productivity coefficient is positive and bears a statistically significant value ($\beta = 0.54$, $p < 0.01$). This demonstrates that there is a strong correlation between historical and contemporary levels of output. Economic growth is a cumulative process, and this result shows that earlier stages' productivity improvements are laying the framework for later stages' expansion thanks to the accumulation of resources, skills, and new ideas.

Therefore, hypothesis H5 is accepted, confirming the dynamic nature of productivity.

6. CONCLUSION

This study examined the effects of the digital economy and IT on the productivity and efficiency of the Western Balkan countries from 2010 to 2025. Empirical data produced utilizing modern econometric approaches (FE, RE, and GMM) consistently show that these two factors have a favorable and statistically significant impact on economic performance. The findings provide credence to the theory that increased automation of processes, decreased transaction costs, and improved information availability are direct results of the growth of the digital economy, which, in turn, increases productivity. With the use of IT, institutions may work together more efficiently, make better decisions, and work together more effectively overall. There is a digital divide in the sector, according to the report, because digitalization affects various countries differently. Factors such as investment in ICT and degree of education turn out to be crucial for making the most of digital transformation. In addition, the time-stable component of productivity is shown by dynamic analysis, which implies that suitable policies can provide positive benefits in the long run. In sum, this research adds to the existing body of knowledge by demonstrating the strategic significance of digital transformation for economic development and offering actual data for an understudied area. The countries in the Western Balkans should implement the following policies, according to the findings given above:

Spending on broadband and high-speed internet as part of a larger strategy for the nation's digital infrastructure. To close the digital gap between nations and even within countries, it is necessary to build a long-term infrastructure that can support the growth of the digital economy. The findings reveal that education is a crucial component in reaping the benefits of digitalization; hence, it's important to invest in human capital and digital skills. Supporting

digital transformation and providing tax breaks for investments in information and communication technology are two ways to encourage companies, particularly small- and medium-sized enterprises (SMEs), to embrace digital technology. Innovation hubs and incubators, more partnerships between educational institutions and businesses, and tech startups are all parts of a healthy digital ecosystem that deserve our support. Establishing a transparent and solid legislative framework that promotes competition in the information and communication technology (ICT) industry, safeguards personal information, and regulates online commerce is essential to a favorable regulatory climate.

6.1. Limitations of the Study

This study has a number of limitations, but it does provide vital empirical evidence about the connection between productivity, the digital economy, and information systems in Western Balkan countries. One limitation is that the analysis relies on a small panel sample of five countries, which could make the results not applicable to other situations. Secondly, the omitted-variable bias is still a possibility, even though the econometric models try to account for endogeneity and unobserved heterogeneity. Finally, data consistency may have been impacted since some of the most recent years' data came from early worldwide statistics releases and estimates. Additional transition economies might be included in the sample for future study; different productivity indicators could be used, and broader digitalization measurements could be included for better robustness and comparison.

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Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.

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