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Is Digital Economy a Good Samaritan to Developing Countries?

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Abstract: It is no surprise that the digital economy (DE) has raised expectations and it is still raising them. The aim of this study is to implement testing which will indicate how much the digital economy can help the less developed countries to overcome the economic lag. In order to come up with an answer, the study is based on provocative hypotheses which will elaborate on the development paradox by which the digital economy cannot help the less developed countries. The argument that supports the main hypothesis of this study declares that GDP growth is not equivalent to the growth of investment in DE infrastructure and, therefore, DE is contributing to the increase in inequality instead of reducing it. The paradox is confirmed with the implementation of the SEM modelling on high-income countries (HIC) and middle-income countries (MIC). Moreover, the study measured, i.e., determined, the relative importance and impact of each DE component on the economic growth in HIC and MIC countries. According to the results of this research, in MIC the most significant DE factor which has an impact on GDP growth is the investment in education, whereas in HIC countries infrastructure has the leading part when it comes to economic growth. The final part of this study includes a proposition of a set of guidelines relating to the direction of public policy development in order to make the most of DE's impact on the creation of a fairer and better system and society. Due to the comprehensive range of questions that come from this study, several topics for future research have been recommended.

Keywords: digital economy; developing countries; economic growth; inequality; public policies

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1. Introduction

During the COVID-19 pandemic, the importance and potential of the digital economy (DE) in the functioning of modern society came to the fore. For more than two decades, this economy has existed not only as a form of doing business but increasingly as a new form of market structure, rules, and principles [1]. In this sense, a number of world-renowned authors with their works and books have significantly contributed to the conceptual and essential understanding of the DE [2–6]. Nevertheless, there are still a lot of unknowns associated with the DE and this was the main motive for conducting this research.

Even though the number of companies participating in the DE is growing constantly, and the total turnover generated by the DE globally is 15.5% of the world GDP [7], the scientific and professional public still does not have enough empirical evidence regarding whether these potentials of DE are equally used in developed and underdeveloped countries. The contradictory views and conclusions available in the existing literature impose the need for additional research that will once again test Steinmueller's [8] 'leapfrogging' hypothesis but also make a step forward in terms of a larger sample regarding the number of analysed countries.

In 2014, the European Commission estimated that the DE is growing seven times as fast as the rest of the economy [9].

At the same time, the DE has a greater impact on growth and the overall economy than traditional statistics is able to identify because the analytical/methodological tool that can capture all the effects that the DE achieves is still not developed [10]. Therefore, regarding the DE, GDP becomes a peripheral economic indicator [11]. This problem is at the centre of many research works and articles with interesting proposals, and some of them are focused on the new insights for measuring the digital economy in order to provide insight into the integration of national accounts with product-oriented micro-analysis efforts [12,13].

However, after reviewing those research results, it becomes absolutely clear that further investigation should go in the direction of finding the right methodology to measure the importance and the impact of DE on modern society through the technological, economic, and social dimensions. In order to achieve this goal, the new study should provide a systematic view of the list of indicators that can measure the impact of DE on the productivity of countries and especially the productivity of countries with different development levels.

Regarding the fact that developing countries should be helped to cope more easily with the specific challenges imposed by DE (which may differ from those in more developed countries), the authors believe that this article should provide an answer to the question: Whether and to what extent DE can help developing countries and contribute to building a better, fairer, and more humane society, and what needs to be done in conducting public policies (developmental, economic, and social) to achieve the best possible effects in that regard. This complex question can be 'broken' into questions, such as: Has the DE helped middle-income countries (MIC) accelerate economic growth and thus enable them to catch up with developed countries? The authors present the answer to this question in the form of an analysis and interpretation of the development challenges of the DE.

After the available literature sources were reviewed, authors come to the conclusion that this would be the first research that simultaneously puts the digital economy, differences in economic development, a large set of indicators, and a wide time frame in a single framework of analysis.

In this article, the main methodology was based on the SEM analysis. SEM analysis allows identification of the DE factors on the basis of the joint influence of a group of certain variables but also allows individual impact measurement of each of the identified DE factors on the economic growth for a specific group of countries with a certain level of development. Classical regression analysis and logistic regression, i.e., methodological approaches used in the analysis of the impact of DE on economic growth in most research articles, result in assessing the impact of a particular variable on the economic growth of the country, but this approach does not allow measurement of the joint impact of a group of variables. Therefore, the assessment and comparison of the impact of each of the measurable factors on DE and consequently on the economic growth of a group of countries is more complex, and the conclusions of such an analysis are not precise. The advantage of applying SEM analysis is reflected in the easier application of comparative analysis of model evaluation results from the aspect of the impact of a certain group of DE factors on the economic growth for a specific group of countries with a certain level of development.

Taking into account the research gaps from the previous studies, the objectives of this research were to:

1. Provide a systematic review of the available literature in order to help the authors of this research to identify the expectation from DE and to test the hypothesis that the DE has an impact on the economic growth.
2. Identify a comprehensive set of DE indicators.
3. Examine whether the SEM method can effectively identify key DE factors which affect economic growth.
4. Examine the differences in the impact of the identified indicators on economic growth.
5. Analyse the differences of their influence in countries with different levels of economic development.

6. Provide appropriate recommendations to ICT (information communication technology) policy makers in order to maximize the potential of DE in developing countries.

The study is comprised of five parts. After the introduction, the second part of this study identifies the research task, main hypotheses, and research goals based on the initial discussions and review of the literature. A description of methodology and data sources are described in the third part, whereas the fourth part clarifies research results as well as their achievements based on the discussion. The final part of this study presents conclusions and recommendations for further research.

2. Initial Considerations, Literature Review, and Hypotheses

At the very beginning of this study, the authors investigated the systematic review to assess what was expected from DE, and they asked whether DE has any impact on economic growth regarding the defined study objectives. The concept of the DE is new and has only been in use for one decade. Therefore, the literature and research articles are limited cross-sectional studies that cover a long period of time. The authors of this study found the possible solution to this problem in the fact that the ICT predecessor of the DE and this study can, in some degree, rely on the ICT literature and research which investigate the impact of ICT on economic growth.

The potentials of the DE, or the network market, were very promising, and expectations arose from a number of assumptions, advantages, and opportunities offered by this type of economy. The authors present some of the main opportunities and specifics in the following groups.

(a) A new concept of the market, production, and work organization. The DE achieved its expansion with general support. Both workers and employers welcomed it with open arms. As Barbook [14] optimistically and euphorically announced, the neoclassicists were bored with their dream of finally creating a kind of free capitalism. In other words, 'high-tech neoliberalism' is emerging, in which everyone will be able to buy and sell in cyberspace. The state will not interfere because it will not be able to control electronic trade, which is not hindered by state borders. The network will provide workers with more autonomy in their jobs and more freedom in their private lives.

Although Barbrook wrote about the DE at the beginning of its inception, and the work could not have had a convincing empirical dimension, he pointed out that the network, as a specific form of market, allows entrepreneurs, artisans, ordinary workers, and the middle class to take advantage of economies of scale, which was earlier reserved only for large companies. In this market, everyone has an equal chance, and in the DE nothing is more precious than human ingenuity. That is why digital entrepreneurs are the pioneers of 21st-century social democracy.

The development of the network was also expected to confirm Benkler's [2] position that good work can be performed by individuals (knowledge workers) who cooperate with each other, more as human and social beings than as market actors through the price system. Production is organized according to the principle of 'commons-based peer production', i.e., in a decentralized and collaborative manner.

(b) A low level of investment is needed to start a business, obtain a job, and participate in the market. To participate in the digital market, at first glance, the individual company (knowledge worker) does not need huge investments as in the traditional economy. It was expected, generally speaking, that with many fewer resources in the DE compared to the traditional one, one could obtain (invent) a job and improve one's quality of life, social status, and competitiveness.

(c) Network potentials and easier access to the global market. The network itself generally offers easier access to the global market compared to the case in traditional conditions. This opens up the space for greater competitiveness, as well as faster economic growth. The DE offers a chance for success and rapid development not only to individuals but also to underdeveloped regions and countries. The effects and benefits of digitalization are felt much earlier than was the case with earlier technologies [15]. Cheap information technology, its ease of use, and free access to the internet were a special challenge but also an opportunity for underdeveloped and developing countries. In support of this is the fact that in the DE there is the phenomenon whereby the degree of application of ICT (or consumption of ICT services) is not directly proportional to the living standard of the population. This view is best confirmed by the fact that studies and research show [15] that in 20% of the poorest households, 7 out of 10 people have a mobile phone. Moreover, it turns out that the poorest households want to have access to a mobile phone more than electricity, a toilet, or clean water. The paradox, but also the opportunity, is that this 'unquenched thirst' for ICT offers the opportunity for them to be able to join the global digital market, despite the huge lag of developing countries. The emerging digital market is 'eager' for new products and services (applications), some of which have a regional character and are related to culture, tradition, and the local environment. Furthermore, digital promoters from developing countries are better off than 'foreign' initiators.

The widespread use of DE and ICT devices contributes to overcoming poverty (see Sen's Capability Approach [16]) because rural areas are provided with communications, which offer the opportunity to raise literacy levels and the like. In less developed countries, thanks to online solutions, it is much easier to include women, vulnerable groups, and people with disabilities as active participants in the labour market [17]. Some articles also emphasize that there is a direct link between ICT and the quality of life and that digital connectivity reduces the social and economic inequalities present in society [18]. It is rightly stated that the effects of the application of ICT depend on the context in which they are applied [19]. In this sense, ultimately, it should not be forgotten that the socio-economic position of users dominantly influences the degree and impact on development that ICT will achieve [20].

The opportunities offered by the DE have motivated researchers to anticipate and test possible economic leaps for the underdeveloped and the poor countries, relying on ICT characteristics to support a 'technology leap' strategy that successfully narrows the productivity and production disparities that separate industrial and developing countries [8]. In that sense, Kozma [21] concludes that the combination of education, technology, and innovation gives countries great opportunities for dynamic development.

However, the previous elaboration did examine the preconditions and potential but never managed to answer the question of whether DE fulfilled expectations and, if not, what were the causes and the alternatives for reaching those expectations when it came to less developed countries. Different approaches can be found in the following topics: (1) what is the level of impact of DE, i.e., ICT on growth in developed compared to less developed countries, (2) which components or indicators to include to measure that impact, (3) what is the importance of ICT factors (components) in developed and less developed countries. Nevertheless, the question of the reliability of the data and indicators used to measure DE is inevitable. This is an extremely important methodological requirement because the lack of comparable statistical data and other measurement difficulties increase with the expansion and scope of digital economy analysis [7].

(1) ***The level of impact of DE, i.e., ICT on growth in developed compared to less developed countries***

In general, there is no disagreement among the authors that ICT as well as technological progress affects growth and development (World Bank report [22], Pradhan, Arvin and Norman [23]). It should be kept in mind that some studies have the general conclusion that digitalization has a positive impact on the economic development, regardless of the level of a country's development [24,25].

On the other hand, the level of impact which ICT has on the economic growth in less developed and underdeveloped countries compared to developed countries has been treated through the literature and research articles with different and very often opposite conclusions. The range of attitudes vary from those by which there is an enormous potential from ICT (i.e., DE) that less developed countries can achieve to others who claim that the impact of ICT in these countries is almost negligible.

Thus, the previously mentioned Steinmueller's [8] conclusion about the '*leapfrogging*', i.e., the chances of the less developed countries using ICT (i.e., DE) in order to have higher and faster growth than the developed countries and thus reduce the lag in development, is very often cited in the literature. This approach was also approved by Sassi and Goaied [26], who found a positive and statistically significant impact of ICT on the economic growth in developing countries, as well as the authors Adeleye and Eboagu [27] who concluded that the underdeveloped countries can use the ICT potential to 'leapfrog' some of the stages in the development. Appiah-Otoo and Song [28] did the extensive research based on the sample of 123 countries and they approved that ICT increases economic growth in rich and poor countries, but poor countries benefit more from the ICT revolution.

Nevertheless, it should be taken into account that this approach is very often denied in the literature. Thus, Niebel [29] analysed the importance of ICT for economic growth based on a sample of 59 countries over the period 1995–2010 and concluded that there is no clear statistical indication that developing and emerging economies benefit more than developed economies when it comes to the investments in ICT. The macroeconometric validity of the argument that these countries are 'leapfrogging' through ICT is called into question. Niebel further argues that developing and emerging countries may lack absorption capacities, such as an adequate level of human capital, or other complementarity factors, such as R&D expenditure; therefore, they have a lower level of return on ICT investments compared to the developed countries. A similar conclusion was previously made by Yousefi [30] and Hofman [31], who claims that the role of ICT is actually major when it comes to the level of growth of high and upper-middle income group countries, but, for the lower-middle income group countries, the ICT fails to contribute to the growth.

Dewan and Kraemer [32] found the positive effect of the returns from IT capital investments on GDP growth, whereas the same ICT return on investment coefficient for the developed countries was not statistically significant. Papaioannou and Dimelis [33] indicated that the impact of ICT capital goods on the productivity growth is higher in the developed countries compared to the developing countries. Finally, the possibilities for structural changes as a result of digitalization were analysed by Matthess and Kunkel [34]. In their research, they concluded that the impact of digitalization on the positioning of developing countries in global markets is not that clear. As they stated in their research, on one side, the digitalization facilitates, but on the other, it narrows the scope for the participation and upgrading opportunities in global value chains.

Regarding the previous research, there are different study and research approaches and results of the impact of ICT and DE on economic growth in developed and less developed countries. Therefore, the authors believe that each new, additional study and empirical test can help them to obtain a scientific and professional answer and a confirmation or rejection of the stated views on this issue, i.e., in solving the problem of the research gap. This was the main challenge for this research.

(2) ***Components or indicators to include to measured impact of DE, i.e., ICT on growth and their importance***

It is very often emphasized, and there is considerable agreement about it, that not just the fixed telephone, but also other ICTs such as mobile phone, Internet usage, and broadband adoption are the main ICT drivers of economic growth (Bahrini and Qaffas [35]).

Thereby, identification of the positive correlation between income and Internet penetration presented in the available literature has proven to be the simplest way to confirm attitudes that ICT affects GDP growth. Therefore, Mariscal [36] examines if the countries with similar levels of income may have divergent penetration levels through analyses of the relation between economic growth, regulation, level of urbanization, and telecommunications penetration using a panel data analysis.

A positive correlation between ICT and GDP was shown by Huarng [37], which focused on only two essential variables in measuring ICT developments, including the number of Internet subscribers (from a technological perspective) and the gross domestic product, GDP (from an economic perspective).

Another suggestion made by the authors in this field of study was that the analysis should be expanded by including more indicators in the model. Papaioannou and Dimelis [1] have noted that the ICT has a positive and significant impact on productivity growth, by decomposing the overall ICT effect, concluding that hardware and communications, as the largest parts of ICT capital, have a positive impact of ICT on productivity growth. According to their research, possible extensions to the study should include a deeper examination of software impact on productivity growth and a more systematic analysis of the relationship and causality between individual components of ICT and how they as a whole affect productivity growth. They pointed out the necessity for expanding the indicator list and suggested the analysis of its relationship for some further research.

Some studies present an attempt of creating an integral model for testing the impact of more indicators. Zhao, Collier, and Deng [38] define 'the Bagchi model' that contains four types of indicators: economic (e.g., GDP per capita); social (e.g., secondary education average); ethno-linguistic (e.g., ethnic heterogeneity); and infrastructural indicators (e.g., electricity).

Furthermore, in order to provide a more holistic approach, Pradhan, Mallik, and Tapan [39] attempt to connect more variables and test their level of cointegration. The authors mentioned above used panel cointegration to analyse long-run relationships hypothesized to be present among per capita real GDP, information, and communication technology (ICT) infrastructure, consumer price index, labour force participation rate, and gross fixed capital formation.

The selection of the ICT indicators can, very often, unnecessarily complicate the analysis and measurement of their impact on economic growth. Fernández-Portillo, Almodóvar-González, and Hernández-Mogollón [40] concluded in their study that not all the indicators which have been used to measure the deployment of ICT are significant in economic development and that investments in ICT must be evaluated concisely and individually, in terms of cost/benefit, to obtain the desired results.

This implies that in addition to a comprehensive approach, the existence of each individual indicator and their aggregate groups should be evaluated separately.

It was evident that the impact and the importance of ICT components on economic growth and development vary in different countries. Habibi and Zabardast [41] concluded that the ICT is positively associated with economic growth in different countries, whereby in the countries where the effect of internet users is minimal, the impact of mobile subscription is higher. They suggest that countries should invest more in ICT, along with other infrastructure, so they can benefit from ICT and gain significant economic growth.

There is a suspicion that different and even contradictory findings of conducted studies are often the result of preferred models which usually overemphasize the importance and influence of individual components. Mayer, Madden, and Wu [42] believe that model misspecification results in a substantial overstatement of the economic impact of broadband. Indeed, when the penetration rate is included in preferred dynamic growth equation as a separate argument, it is statistically insignificant. Interestingly, all static model specifications fail tests of over-identifying restrictions. On the other hand, the authors stated that the increased speed is more important for countries with lower penetration and that returns expected from the ambitious targets are neither immediate nor universally assured. They also conclude that the magnitude of the benefit relies on the initial level of national economic development.

The objectivity and applicability of the results suggest that this process needs a comparable data series on the measures of ICT across different nations [1].

Likewise, it can be noted that research is often based on a selected group of countries and individual components of ICT and not the entire scope of DE which can cause the applied methodology and results may be disputed. Thereby, the truth is that majority of developing and underdeveloped countries do not have a stable methodology for monitoring some of the DE indicators, such as DESI (Digital Economy and Society Index) and NRI (Network Readiness Index), which is one of the reasons why this topic is even more demanding.

In addition to the previous discussions, one more problem which can raise the question about the validity of the research results is the breadth of coverage, i.e., the number of countries included in the analysis. Niebel [1] opens up this dilemma by stating that the data sets cover most of the developed countries and emerging and developing countries are available and presented to a limited extent. He suggests that a broader set of indicators should be selected, covering not only economic but also social aspects, in order to make assessments more objective and maintain a true picture of the impact of ICT in specific groups of countries.

Based on the literature review and previous analysis, it can be concluded that most of these studies very often focus on a specific technology, usually the Internet, and, therefore, do not include all of the ICT extents. Regarding this problem, most of the authors in their final remarks appeal that the list of indicators for measuring the impact of digitalization on economic growth should be expanded. Finally, the investigation of the individual evaluation of indicators should bring the answers to the question of which components, under which conditions, have the greatest effects on economic growth. These are some of the reasons why future research on this topic is valuable for creating the path of a new knowledge or upgrades, i.e., further confirmation or rejection of previously cited views and approaches. Because this gap was the starting point of this research, the focus of this study was on the whole DE area.

In this context, in summary, two levels of research arise from the existing literature gap, which the authors of these studies point out in their recommendations for future research. The first approach covers more complex analysis of a larger group of HIC and MIC countries of different levels of development in order to further test the impact of ICT, i.e., DE on economic growth. The second one is based on the model which includes as many indicators that have an impact on DE and economic growth in order to make a more comprehensive and reliable approach and at the same time measure the individual importance and impact of indicators in different groups of countries. Based on these two approaches, the authors defined the research hypotheses and research goals that are conducted in this article.

Hypotheses and research objectives. Regarding the elaboration given in the previous section of this article, the two main research hypotheses were defined:

H1. *DE did not achieve the expectations in overcoming inequalities between countries of different levels of development because it has a much greater impact on economic growth in HIC compared to MIC countries.*

H2. *DE infrastructure development is the most important component for economic growth in MIC countries, whereas education is the crucial indicator in HIC countries.*

According to the defined hypotheses, and as the authors have already emphasized, the order of realization of the research goals is defined as follows:

R1. Identify as wide a list of measurable DE components which have an impact on economic growth as possible;

R2. Select the broadest group of HIC and MIC countries and identify a relevant source that can provide the longest series of data on DE indicators affecting GDP;

R3. Select and apply a valid econometric model that can measure and quantify these impacts and their relations;

R4. Based on the results, make an adequate analysis and define recommendations for decision makers in the areas of public policy, as well as propose topics for future research.

3. Data Sources and Methodology

In this article, the authors used World Bank data (https://databank.worldbank.org/, accessed on 15 January 2022), for two groups of countries: high income and middle income. The analysis covered the period 2010–2020, and 4 factor categories: Economy and Growth, Education, Infrastructure, and Science and Technology. Data were extracted from the database in October 2021. According to the World Bank data, the high-income group covers 79 world countries, whereas the middle-income group covers 110 countries. In the analysis, the authors decided not to take into account countries from the low-income group, because of the lack of the valid data for the period covered with the research. This lack of data for the low-income countries would not allow a valid comparison of results between three groups of countries, and therefore the research would not give the correct results.

In covering this topic, there are numerous indexes used in the literature, such as the NRI index (https://networkreadinessindex.org/) or the DESI index (https://digital-strategy.ec.europa.eu/en/policies/desi). Different international organizations have their own methodology and use their own criteria to measure the digital economy. For example, OECD publishes reports annually, in which they measure and highlight how OECD countries and partner economies are taking advantage of ICTs and the Internet to meet their public policy objectives. International Telecommunication Union is focusing more on the infrastructure aspects necessary for the digital economy.

However, all these indicators and reports provide a limited amount of data and factors for the analysis, as well as the time frame covered with the data, especially if the tendency is to analyse all countries around the world in a significant time frame, in order to make the right conclusions about the impact of different factors during that time. The technology is developing fast, and it is very important to have consistent data which, will show the movement and impact of the chosen factors. In addition, studies conducted by different international organizations, very often under the influence of the rapid technological development, from year to year, cover some new indicators, so it is difficult to ensure comparability and consistency of the research. It is precisely this consistency that is important in order to gain insight and a better overview as to whether it resulted in a positive or negative influence or if there was simply no influence. That is why the authors in this article decided to use and analyse World Bank data, as a reference, with the aim to provide a reliable series of data for a significant number of countries, and which will give an overview and analysis of the trends in the movement of the chosen factors.

According to Lazović and Đuričković [43], for the development of the digital economy, it is necessary to have the following five elements equally represented and developed: physical/technological infrastructure, normative and institutional infrastructure, educational infrastructure, security infrastructure, and business and entrepreneurial infrastructure.

Starting from these elements, in analysing the impact of GDP on the level of digital economy development, the authors have, in this analysis, covered four factors, not diminishing the importance of the development and existence of the fifth factor, the normative infrastructure. This factor is important in setting the foundations of the digital economy, as well as for the implementation and application of all other elements of the so-called digital ecosystem. However, because this article examines the importance of the GDP in high- and middle-income countries, the focus of this research was set on these factors that can have a direct impact on the economic development. Of course, examining the impact of the level of development of the normative infrastructure might be one of the challenges, although it largely depends on the political issues in one country, so it is much harder to quantify and thus compare.

The main idea of the hypothesis tested in this research claims that the development of the digital economy has a great impact on overall economic development. This is also one of the main sources for having greater inequality between developing and developed countries, as was pointed out in the literature review section of this article.

The measurement items are developed based on a comprehensive review of the literature and analysed regarding the following conceptual model.

The first step in creating the conceptual model in this research was the identification of important factors that are representing the baseline of the digital economy development. Chen [44] was investigating influencing factors of digital economy development in Chinese cities and came to the conclusion that the differences in education, economic development, information infrastructure construction, relevant government policies, and social culture are the deep and fundamental factors that impact the digital divide. On the other hand, authors such as Lazović and Đuričković [43] describe the importance of the digital and non-digital factors in explaining economic development. In their research, digital economy foundation is based on four factors—Infrastructure, Education, Science and Technology, and Economy and Growth.

Comparing the results of the research published so far and the relevant data, the authors created the conceptual model presented in Figure 1. According to the conceptual model factors, such as Education, Economy and Growth, Infrastructure, and Science and Technology, are important for defining the digital economy baseline and its impact on economic growth. Every factor was defined by certain variables. The factor that represents Education consists of the following variables: proportion of GDP that represents government expenditures on education, the proportion of total government expenditures that goes to expenditures on education, total adult and youth literacy rate, population size of people aged from 0 to 14 and from 15 to 64, and unemployment rate. The Economy and Growth factor are represented by related variables: annual growth of national income per capita represented in percentage and in US current prices, the proportion of service exports and imports that go on trading computers, communications, etc., and the proportion of total service exports that represent ICT service export. Infrastructure was defined by the following variables: the value of fixed phone subscription, fixed-broadband subscription and mobile cellular subscription, the value of exports and imports that represent ICT goods, the proportion of the population that are using the Internet, and the number of industrial design applications registered by residents and non-residents. The Science and Technology factor is defined by the proportion of the value of manufactured exports that belongs to high-technology exports.

After defining the relevant variables and factors of the digital economy, the next step in the analysis was to decide which methodological concept should be used. Based on the conceptual model and the relevant data, two methods were applicable: panel data regression and structural equation modelling. Keeping in mind that the main goal of this research is to test whether the digital economy has a greater impact on economic development in developed countries compared to developing countries, the model should include as many variables and countries as possible. The decision was made in favour of structural equation modelling. The reasons are as follows:

1. In order to include as many countries as possible in this analysis, the data series are no longer panel data;
2. Even if the panel data series was analysed, estimating the structural equation model can define the impact of specific factors as an integral impact of variables on economic development, whereas the panel data regression can estimate the impact of one variable on economic growth;
3. It is more appropriate to compare the differences between the impact of the specific factors on economic growth between developed and developing countries because there are only four of them in the suggested conceptual model. By estimating panel data regression, the comparison would include the results of estimation for 22 variables.

Therefore, the validity of the main research hypothesis as well as the presented conceptual model is tested with the application of the structural equation model (SEM).

Structural equation modelling (SEM) is a multivariate technique used in scientific research in order to estimate direct and indirect effects on pre-assumed causal relationships [45]. Structural equation modelling consists of two main statistical methods: confirmatory factor analysis and path analysis. Confirmatory factor analysis (CFA) is a type of structural equation modelling (SEM) that deals specifically with measurement models—that is, the relationships between observed measures or indicators and latent variables or factors [46]. The path analysis is used to specify and examine directional relationships between observed variables, whereas data reduction is applied to uncover (unobserved) low-dimensional representations of observed variables, which are referred to as latent variables [47].

By estimating the structural equations, we are able not only to test the hypotheses but also to measure the contribution of each of the digital economy constructs for economic development. The SEM is estimated with the use of SmartPLS software, with a graphical user interface for variance-based structural equation modelling using the partial least squares path modelling method.

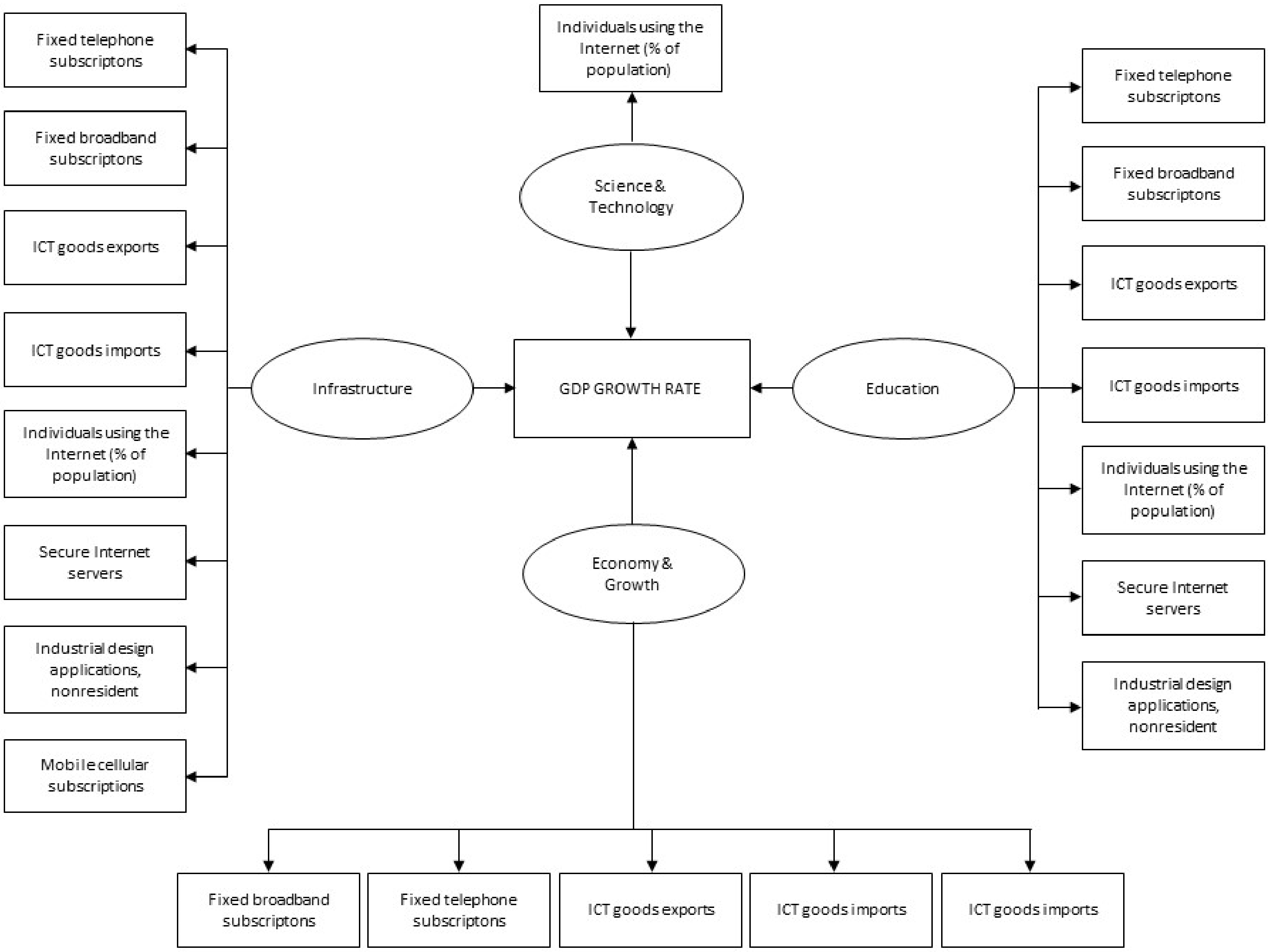

Figure 1. Conceptual model of GDP growth rate significant factors.

4. Results and Discussion

The structural equation model is estimated for high- and middle-income countries.

The first step in the analysis is testing the reliability and validity of the model indicators by calculating the value of Cronbach's Alpha, rho_A, and Composite Reliability coefficient (Table 1).

Table 1. Test of the model reliability and validity.

Factors	Cronbach's Alpha		rho_A		Composite Reliability	
	MIC	HIC	MIC	HIC	MIC	HIC
Economy and Growth	0.790	0.860	0.826	1.008	0.734	0.857
Education	0.796	0.679	0.930	0.754	0.657	0.855
Infrastructure	0.764	0.794	0.969	0.779	0.901	0.783
Science and Technology	0.897	0.984	0.936	0.985	0.902	0.900

The reliability and validity of estimated SEM models for high-income (HI) and middle-income (MI) countries in Europe are given in the Table 2. Those values were compared with the following SmartPLS quality criteria.

Table 2. Reliability and validity criteria.

Reliability Parameters	Values Criteria
Cronbach's Alpha	>0.7
rho_A	>0.7
Composite Reliability	>0.6

Regarding the evaluation of constructs, they were all of quality, and once the indicators with the lowest scores were refined, the results were consistent.

The next step of the analysis is the estimation of the appropriate SEM model based on the conceptual path diagram, using Ordinary Least Squares and Principal Components Analysis. The path diagram for every estimated SEM shows the impact of the analysed factors (latent variables), which represent Education, Economy and Growth, Infrastructure, and Science and Technology, on the GDP growth. Latent variables are variables that are unobserved but whose influence can be summarized through one or more indicator variables. Latent variables are presented with the oval shape on the path diagram. Measurable elements of the SEM are indicator variables, and they are presented with a rectangular shape. The precondition of the SEM estimation is fixing the loadings for one factor per latent variable to one. If this step is skipped, then the scale of the latent variable is undetermined. Every measurable factor or indicator variable has a random error with the 'e' notation. For example, random error for the indicator variable fixed telephone subscription represents the ability of a variable fixed telephone subscription to fully explain the variance factor of the latent variable infrastructure, etc. Based on the path diagram, the SEM is estimated and the standardized values of the regression coefficients were obtained from indicator variables to a certain factor. The higher the value of the estimated regression coefficient is, the more a specific indicator variable can be considered a good representative of a given factor.

The first diagram in this section (Figure 2) represents the estimated SEM model for the middle-income countries. The values of the standardized regression coefficients are given above the straight lines in the path diagram. The higher their value, the more the specific factor is considered a good indicator of the GDP growth rate. In order to justify the results of the SEM analysis, we examined whether the regression coefficients in SEM are statistically significant, as well as the validity of the specification of the defined model. To test the hypotheses, we performed bootstrapping of 10,000 iterations. The sign of the path coefficient must be positive in order to validate the research hypothesis. A positive sign of the path coefficients will indicate that the results have the same direction as the hypothesis proposed. Statistical significance is measured by the 't' coefficient and the fact that confidence intervals do not contain zeros.

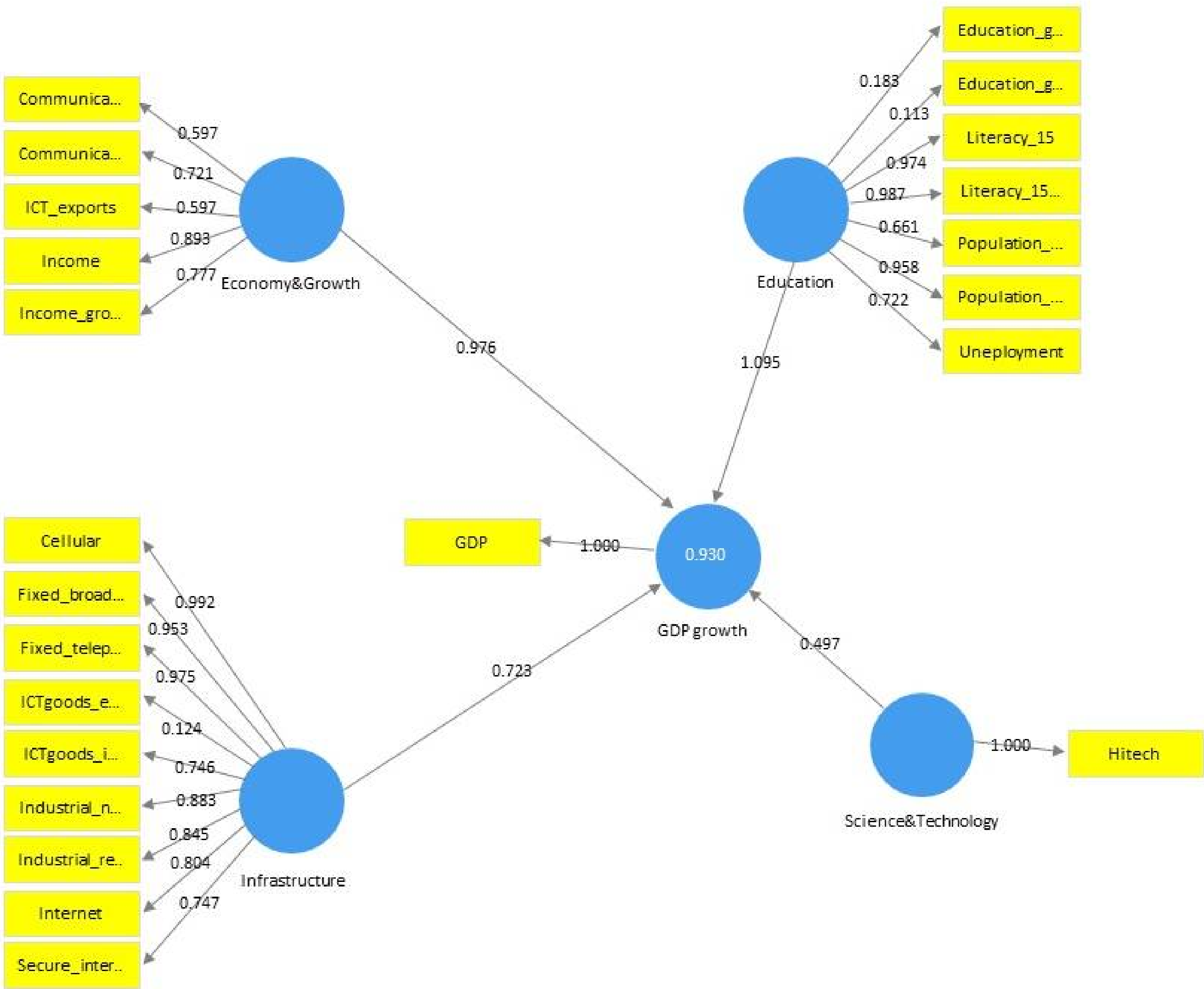

Figure 2. Structural equation modelling results for middle-income countries.

The data available for the middle-income countries enable us to estimate the SEM model of GDP growth under the influence of four factors: Economy and Growth, Education, Infrastructure, and Science and Technology (Table 3).

Table 3. Results of hypothesis testing for middle-income countries using the PLS technique.

	T Statistics (∣O/STDEV∣)	*p* Values
Economy and Growth → GDP growth	1.63	0.106
Education → GDP growth	2.58	0.011
Infrastructure → GDP growth	1.97	0.051
Science and Technology → GDP growth	1.68	0.096

The results of the estimated SEM model and the validity of the path coefficient values are given in the path diagram and the table below (Table 4). The coefficients of the model are statistically significant with a probability of 90%. Analysing the estimated SEM model for the middle-income countries, we can make the following conclusions:

1. The most significant factor is Education, because the path coefficient of this factor has the positive and the highest value. The positive sign of the path coefficient means that the incensement of all the Education variables with the positive sign, such as government expenditure on education, adult and youth literacy rate, and the size of

the population, will lead to the incensement of economic growth. On the other hand, the variable which is the part of the Education and Growth factor and has a negative path coefficient sign (unemployment rate) will increase the value of GDP growth rate when its own value decreases;

2. The next factor which significantly increases the GDP growth rate is Infrastructure. Taking into account that all the variables of the Infrastructure factor (ICT goods exports and imports, rate of individuals using the Internet, non-resident and resident industrial design applications, mobile cellular subscriptions, and secure internet servers) have a path coefficient with the positive sign, their incensement will lead to the higher value of GDP growth. The impact of Infrastructure on GDP growth is not as strong as in the case of Education and Growth but is very strong and noticeable. The factors Economy and Growth and Science and Technology have almost the same positive impact on the GDP growth;
3. The path coefficients of the latter two factors are almost equal (1.68 and 1.63). The variable which is the part of those factors (annual growth of net national income per capita, net national income per capita in current US$, share of communications, computer, etc. in service exports and imports, ICT service exports, and high-technology exports) are influencing the increment of GDP growth by increasing its own values.

Table 4. Evaluation of the R^2 level of the middle-income countries model.

Relationship between Constructs	R^2	Path Coefficient	Correlation
Economy and Growth → GDP growth		0.976	0.904
Education → GDP growth		1.095	0.874
Infrastructure → GDP growth		0.723	0.855
Science and Technology → GDP growth		0.497	0.585
	0.930		

The estimated SEM model for the middle-income countries has a very high value of the coefficient of determination. Roughly 93% of all variations of GDP growth are explained by the independent variables in this model. Correlation coefficients are very high, and this means that the relationship between GDP growth and the constructs is very tight. The relationship between factors and GDP growth is high and direct (positive value of correlation coefficient), which means that Economy and Growth, Infrastructure, Education, and Science and Technology are going in the same direction as the GDP growth.

The last SEM model is estimated for the high-income countries. The data availability made it possible to estimate the SEM model where the authors could examine the relationship between GDP growth and four factors: Economy and Growth, Education, Infrastructure, and Science and Technology (Figure 3).

According to the results of estimation, the most important factor for HIC is Infrastructure, but the impact of Science and Technology on GDP growth is significant too. The value of the path coefficient for those two factors is positive and very high. On the other hand, the path coefficient values for Economy and Growth and Education are positive but not very high and this implies the conclusion that Economy and Growth, as well as Education, do not contribute to the increase in GDP growth at the same level as Infrastructure and Science and Technology (Table 5).

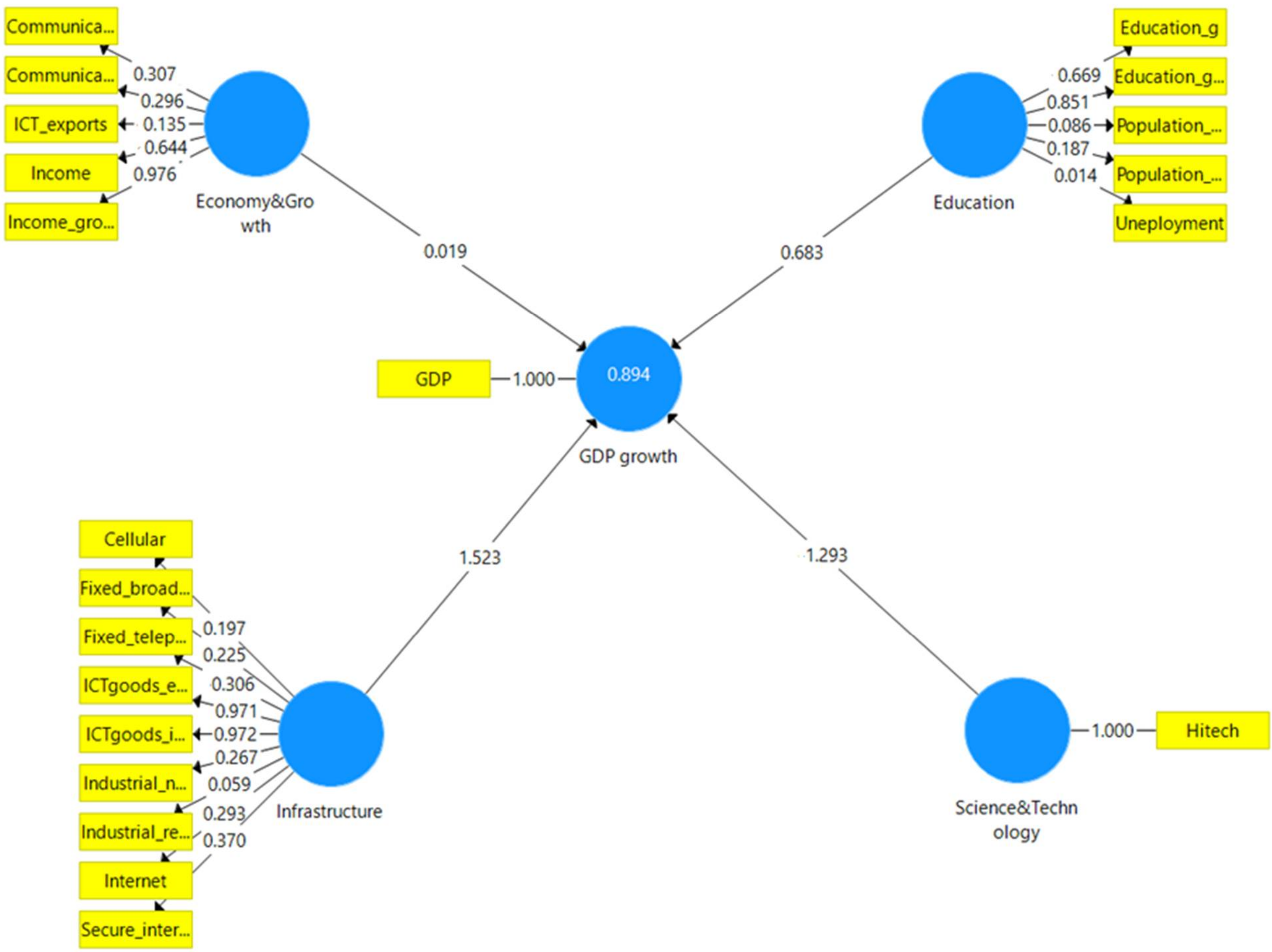

Figure 3. Structural equation modelling results of high-income countries.

Table 5. Results of hypothesis testing for high-income countries using the PLS technique.

	T Statistics (|O/STDEV|)	*p* Values
Economy and Growth → GDP growth	1.905	0.059
Education → GDP growth	1.718	0.088
Infrastructure → GDP growth	2.198	0.031
Science and Technology → GDP growth	1.671	0.097

Evaluation of model quality started with the tests of statistical significance of the path coefficients (Table 6). All path coefficients are statistically significant, with a 90% probability.

Table 6. Evaluation of the R^2 level of the high-income countries model.

Relationship between Constructs	R^2	Path Coefficient	Correlation
Economy and Growth → GDP growth		0.019	0.805
Education → GDP growth		0.683	0.806
Infrastructure → GDP growth		1.523	0.775
Science and Technology → GDP growth		1.293	0.635
	0.894		

Evaluating the value of the path coefficient between the factors and GDP growth, the following conclusions can be made:

1. The most significant factor, as mentioned above, is Infrastructure. This factor has the highest positive value of the path coefficient. This means that if we increase the value of ICT goods exports and imports, the rate of individuals using the Internet, non-resident and resident industrial design applications, mobile cellular subscriptions, and secure internet servers, the value of GDP growth will rise too;
2. The next factor which significantly increases the value of GDP growth whenever its own value rises is Science and Technology. This means that the increase in the high-technology exports will impact the increase in the GDP growth;
3. The impact of Education on GDP growth is positive and statistically significant but not as high as in the case of the previous two factors;
4. The impact of Economy and Growth on GDP growth is so small, due to the value of the path coefficient, which is almost equal to zero, that it is barely noticeable.

The validity of SEM model estimation was examined by the evaluation of the coefficient of determination and the sign and the value of the correlation coefficients between GDP growth and the four factors mentioned before. The model explained 89.4% of GDP growth variance, which is quite an impressive result. This is not a surprise, taking into account that all correlation coefficients between GDP growth and constructs are positive and very high, which means that relationships are strong and direct. The increase in the value of Economy and Growth, Education, Infrastructure, and Science and Technology indicators is followed by the increase in GDP growth.

Moreover, by evaluating the overall results of the SEM estimation for the middle-income and high-income countries, it can be noticed that the development of economy, education, ICT infrastructure, and science and technology will impact the GDP growth in a positive way, which is also the claim of the main hypothesis. A closer look at the differences between the SEM estimation for the middle-income and high-income countries can lead to the following conclusions:

1. The relationship between four factors and GDP growth is tighter in the case of middle-income countries, due to the higher value of the coefficient of determination (0.93 for MIC > 0.894 for HIC);
2. The middle-income countries need the development of the overall economy to impact the GDP growth, which is not the case for the high-income countries. High-income countries gain certain economic development levels and they benefit more from the development of ICT infrastructure and science and technology;
3. For the middle-income countries, the precondition of the GDP growth rate incensement is further investment in education, economic development, and then ICT infrastructure and science and technology;
4. The possible scenario of this situation, according to the results of the conducted SEM estimation, is that the digital economy development will have a positive impact on both middle-income and high-income countries. However, the impact for the middle-income countries is not as high as in the case of the high-income countries, which can lead to a greater inequality between developing and developed countries.

By evaluating the results of this study, the authors failed to reject the first hypothesis (H1). DE did not achieve the expectations in overcoming inequalities between countries of different levels of development because as it has a much greater impact on economic growth in HIC compared to MIC countries. Thus, once again, similar findings of the authors whose works covered these topics were confirmed, such as Niebel [1], Yousefi [1], and Papaioannou and Dimelis [1].

The findings made in this study suggest that the second hypothesis (H2), that DE infrastructure development is the most important component for economic growth in MIC countries, whereas education is the crucial indicator in HIC countries, should be rejected. This conclusion takes us a step forward in relation to the results of previous research [39,41].

With this analysis, the authors have proven that the most important component of DE, which has the greatest impact on economic development in the MIC, is education, and the second one is infrastructure. At the same time, the results showed that in the HIC indicators, importance is ranked as follows: infrastructure, research and development, and then education.

The results presented in this article indicate the author's attitude that DE has helped the development of MIC countries but has not helped them to reduce the lag behind HIC. This means that DE has not met the promised expectations and that it has greater effects on economic growth in HIC countries, which leads to even greater inequality between MIC and HIC. The interaction that emerges from presented model points to the fact that in policy making in MIC countries, investment in education should be the priority and not the investment in infrastructure as it was previously believed. However, is that enough, why does DE encourage greater inequality, and can anything change in this matter? In the following section, the authors want to point out some of the factors that led to all those previously mentioned conclusions with the affirmation of findings derived from the applied model.

(a) Technology and education, by themselves, encourage inequality. Technology has conditioned the need for new skills and knowledge on the one hand and the elimination of many jobs on the other [48]. All this has contributed to the deepening of divisions in the labour market [49], and thus in society and ultimately between countries that have adopted technological advances. It has also increased productivity and wealth in countries that are not productive and wealthy. New technologies contribute to the concentration of wealth creation by having technologies largely controlled by large multinational corporations with activities not aimed at alleviating poverty. The existing economic inequalities and lack of access to appropriate education and training were significant in Latin America's failure to develop rapidly during the twenty-first century [50]. At the same time, large research and development projects were not helpful because they were managed by multinational corporations based in the most developed countries. If the DE and the new knowledge society give preference to people who have relatively good education and high-level skills, and who live in a global economy that is rich in innovation and information, then it is clear why this gap has widened under the influence of ICT. Even the process of the workforce moving (brain drain) from underdeveloped to developed countries has additionally contributed to this.

Likewise, quality education is still predominantly a privilege of the developed countries and global human capital inequality remains steady, although global education inequality has been declining over the past four decades [51].

Although everything and everyone on the planet felt the effects of this new social structure, global networks included some people and territories while excluding others, thus causing a geography of social, economic, and technological inequality [3].

The impact of technical progress on inequality is one of the open-ended economic issues, which constantly requires empirical confirmation [52].

In general, it should be concluded that in order to overcome the gap, high-quality higher education and training, together with scientific and technological possibilities, would have to be more evenly distributed among countries [50].

The previous statement explains why, apparently, the low level of investment for starting a business and participating in the DE market proved to be an unrealistic expectation. It must not be forgotten that success in the DE requires investment in education and infrastructure and that the fixed costs of digital products are high.

(b) Lack of quality IT infrastructure. The balanced development of all infrastructural elements of the DE is important for connection and participation. A lack of physical infrastructure, a large digital gap, and low IT literacy are the main obstacles to the rapid involvement of developing countries in DE flows. The opportunities remain unused. What is the solution? Investment. However, one could well say: 'it is one thing to say all this, but another thing to actually do it'. Invest, invest, and invest again. Well, if these countries had the funds to invest, they would not be underdeveloped or less developed. These findings and recommendations do not differ from the development recommendations stemming from the Washington Consensus, which are often debated in economic theory, academic, and political circles.

Still, over 40% of the world's population does not have access to the Internet [53], so they cannot participate in the DE at full capacity.

Developing countries are more consumer markets than manufacturing markets for ICT and the DE (generators offering new ICT products, solution innovations, etc.). This is one of the important reasons that there has been less of an effect on economic growth in developing countries. For economic growth, participation on the supply (production) side is much more important than participation only on the consumption side. De [1], who focuses predominantly on India, in his work based on empirical research and data from the first decade of the twenty-first century from the United States, Europe, and China, and a 1995–2005 World Bank study on 115 countries, uses respectable empiricism to construct and show that the growth of the IT manufacturing industry is faster than that of IT-using industries. That means that economies with a higher percentage of high-tech industries are likely to show faster growth and increase their productivity at the aggregate level, whereas the regions with better educational institutions grow faster.

Therefore, the use of information and communication equipment has made and is still making an influence, but this is no greater than what would have been achieved if these were production contributions. This is also the reason why research in developing countries is focused on the user–consumer–user rather than the production dimension and the contributions of ICT. Lwoga and Sangeda [17] review articles on this topic from 1990 to 2017 and note that the majority of research in developing countries is related to the effects achieved through the distribution and spread of ICT. They note that there is limited evidence of a long-term contribution to the use of ICT for people's lives, patterns of economic inequality, human freedoms, and prosperity in developing countries.

Thereby, the import of technology also increases the difference in employment in developing countries [54].

(c) The complexity of ICT projects and their small degree of success. ICT solutions in developing countries rarely end up as successful projects [55]. Experience shows that there are more failed than successful solutions. Thus, in the analysis carried out by Chipidza and Leidner [56] on 78 studies, as many as 64% of the solutions/projects proved to be partially or completely unsuccessful. In poor countries, ICTs are expected to play a key development role.

Many see this technology as a potential method for transforming uncompetitive industries and dysfunctional public administrations, as well as a provider of invisible opportunities for information-intensive social services, such as health and education. However, it is known that such development advantages have been difficult to achieve for a variety of complex reasons. There are two interrelated problems. First, many organizations have difficulty developing and maintaining complex technology projects over long periods of time, which are usually required. Second, the resulting ICT-based systems often make little impact on the organizational weaknesses they are intended to alleviate [57].

Nevertheless, it could be suggested that DE gives opportunties to the less developed countries if those countries properly dedicate themselves to the dynamic development of components that affect the development of DE, at the forefront of education, as the results of this research show. After all, the examples of individual countries encourage and confirm that this opportunity can be used. Thus, Ayanso, Cho, and Lertwachara [58] state that, thanks to digital technology, labour productivity has increased significantly in some developing countries. Measurements of the level of development and economic growth according to the adopted methodologies show that these countries have managed to use ICT as a basis for their growth and competitiveness and for overcoming the digital gap. Namely, Ayanso, Cho, and Lertwachara stated, in a study of 154 countries in the period 2002–2007, that, among other things, five less-developed countries of Eastern Europe

(Bulgaria, Croatia, Latvia, Lithuania, and Poland) had made significant progress due to the growth of the ICT Development Index (IDI) and their transformation, so that the World Bank classifies them as high-income countries. To this, some examples of the success of the globally competitive software industry in India or the phenomenon of expansion and innovative mobile telephone users in Africa can be added [59].

These individual cases, unfortunately, do not confirm that the 'chance' has been predominantly taken in all underdeveloped and developing countries and that the DE has contributed to reducing the discrepancy and overcoming the gap. Similar research as well as the results obtained in this research can have a significant benefit in this regard.

5. Conclusions

Based on the research results, it can be confirmed that DE has a positive impact on economic growth in both HIC and MIC. This impact is stronger and more pronounced in HIC countries, which ultimately affects the growth of inequality between MIC and HIC. The relationships and relative impact of all components in MIC and HIC countries were measured with the application of the SEM-SmartPLS model. At the same time, by using the individual indicators measurement approach, the authors came to the conclusion that the four key indicators are more strongly related to GDP growth in MIC compared to the same results in HIC. One of the key findings of this article is that HIC benefit more from the development of ICT infrastructure and science and technology, whereas in the MIC it is the investment in education and overall economic development (contrary to what was previously assumed, argued, and emphasized).

According to the obtained results, this study offers theoretical, methodological, and practical implications. In terms of theory, this article has a great impact on raising some important issues regarding the DE debate. Keeping in mind the fact that there is not a large number of articles in this field, and that there is an awareness that DE can be a strong foundation of economic development, as well as the fact that the available findings in the literature are often contradictory, the authors offered findings through this study that can serve to confront different views, develop critical thinking, and also to support a better understanding of this phenomenon or challenge.

In order to ensure a step forward in findings regarding the existing literature, the authors studied the impact of DE on economic growth through a multilayered, i.e., multidimensional, perspective. The results of this study expand the base of empirical research on the impact of DE on economic growth in several ways.

Acknowledging the differences in the degree of economic development between countries, but also the differences in the degree of availability of ICT resources, the contribution of this article lies in the fact that it brings up ideas that emphasize the importance of the development of DE in developing countries on their path to overcoming economic backwardness in an original way. Contrary to the previous studies, which in most cases investigate only one specific group of countries, a small sample, or just one region, this study supports a wider range of analysis. Therefore, this research was based on the World Bank database and the sample consists of data from 79 high-income and 110 middle-income countries.

The specific significance of the research approach presented in this article is based on the fact that in order to validate and overcome the problem of adequate measurement of DE in less developed countries, an extremely wide range of components and indicators of DE was included. Moreover, this study offered empirical evidence regarding the relative importance and impact of each component on the economic growth of selected categories of countries, which, to the best of the authors' knowledge, has not been presented so far.

The obtained findings offer additional value to the existing scientific literature in terms of time frame, because this study covers a recent period (from 2010 to 2020) in which the digital economy has experienced its full affirmation.

Due to the importance of the findings, both obtained and applied, the authors consider this article a useful contribution to the professional study of DE and also to its overall treatment in policy making as a generator of economic growth and prosperity in developing countries.

Based on the conducted analysis, in the developmental and political-economic senses, the authors came to a certain understanding about the possible direction of public policies to overcome this problem. The findings were presented in the form of guidelines based on the following instructions: due to the noticeable growth of inequalities at the global level, the focus should be on effective public policies which can help place the DE in the position to be a leader of faster growth of developing countries and to contribute to reducing disparities both among individuals and among countries.

According to what was previously mentioned, regarding the conclusions made in this research, inter alia, final suggestions would be as follows:

- The efforts of policy makers must primarily be directed towards solving the problem of lack of digital knowledge and skills. Specifically, higher education strategies, innovative educational programs, digital society development strategies, etc. should provide an environment which will increase the level of digital competencies;
- Policy makers should shift their focus to human capital investments instead of priority investments in infrastructure. By applying this approach, individuals with digital knowledge and skills can generate economic benefits which will become a baseline for developing countries to create a base for further necessary investments in ICT infrastructure. These investments should be further harnessed for new IT tools that will increase the productivity of IT professionals and ultimately impact the growth of developing countries;
- In order to avoid dysfunction in the global digital market and to create conditions for spillover effects of DE, economic policy decision makers must increase the share of realized state revenues for ICT diffusion (through the impact on technical, organizational, and environmental factors);
- Because underdeveloped countries cannot afford high infrastructure investments and use them directly as a leading generator of economic growth, they should make greater use of leapfrogging effects (through lower prices of technological innovations which will later come to developing countries, research results already implemented in developed countries, or skipping successive generations of technologies and procuring only the final ones).

From a methodological standpoint, most research in this area has been implemented using panel data analysis and panel regression models. Regression analysis allows, inter alia, to examine the existence of a statistically significant relationship between a particular indicator of DE and economic growth of a specific group of countries. On the other side, the use of regression analysis cannot measure the impact of immeasurable factors on economic growth. This is an advantage of the SmartPLS methodology implemented in this article. Firstly, SmartPLS enables the measurement of the impact of a specific indicator (measurable variables) on the defined factors (unmeasurable or latent variables). The second contribution of SmartPLS implementation is the fact that it can measure and then rank the importance of a particular factor on the economic growth of the specific group of countries.

This study has several limitations that may serve as a motivation for future research. First, the authors used World Bank data for high- and middle-income countries. Due to the lack of valid data for low-income countries, this data category is not included in the analysis. Stronger empirical evidence would certainly be obtained if any future research included valid data for all three categories of countries.

Second, a wide list of DE indicators was used in this study, but the methodological approach was focused on measuring their individual impact on the economic growth of the analysed countries. It would be interesting and useful for future research to offer evidence of their interactive or combined impact in addition to the individual offer. This approach would help obtain the answer to the question—can economic prosperity be achieved through the interactive action of selected indicators, if some indicators do not have the strength of influence individually?

Third, the authors used SmartPLS to measure and then rank the importance of indicators on the economic growth of selected groups of countries for the past time frame. In order to act proactively in the field of public policy, it would be interesting to make a study based on predictive models.

Finally, the authors consider the requirement for further evaluation and validation of the approach presented in this article, implying that data series should cover a longer period.

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