Remeikiene, R., Gaspareniene L., Fedajev, A., & Vebraite, V. (2021). The role of ICT development in boosting economic growth in transition economies. *Journal of International Studies, 14*(4), 9-22. doi:10.14254/2071-8330.2022/14-4/1

Journal of International Studies

Scientific Papers



# The role of ICT development in boosting economic growth in transition economies

**Rita Remeikiene**
*Law Faculty, Vilnius University, Lithuania*
*rita.remeikiene@tf.vu.lt*
*ORCID 0000-0002-3369-485X*

**Ligita Gaspareniene**
*Law Faculty, Vilnius University, Lithuania*
*ligita.gaspareniene@tf.vu.lt*
*ORCID 0000-0002-5535-6552*

**Aleksandra Fedajev**
*Technical Faculty in Bor, University of Belgrade, Serbia*
*afedajev@tfbor.bg.ac.rs*
*ORCID 0000-0002-6974-6631*

**Vigita Vebraite**
*Law Faculty, Vilnius University, Lithuania*
*vigita.vebraite@tf.vu.lt*
*ORCID 0000-0003-4351-061X*

**Abstract**. During the last decades, the substantial development of information and communication technologies (ICTs) has led to a number of economic and non-economic changes in all countries worldwide. The ICT progress can significantly influence macroeconomic outcomes and it is widely recognized as an important factor of the transition toward a new economic system. This transition was especially challenging for former command economies. Since these economies are characterized by relatively low standards of living, poor infrastructure and continuous changes in economy structure and regulatory framework, the ICT development can have adverse effect on economic activities. In that sense, this study addresses the role of ICT development in enhancing the economic growth in 11 EU transition economies over the 2000-2019 period, using the linear regression analysis. The obtained results suggest

**Received:** January, 2021
**1st Revision:** August, 2021
**Accepted:** October, 2021

DOI: 10.14254/2071-8330.2022/14-4/1

that ICT development has a positive impact on economic growth in the countries under consideration. However, only the link between the number of internet users and economic growth is statistically significant.

**Keywords:** ICT development, economic growth, transition economies, macro and microeconomic effects, legal environment.

**JEL Classification:** C33, E22, J24, O30, O47

## 1. INTRODUCTION

Having irreversibly transformed individuals' habits, lifestyle, forms of work, communication, business and even governance processes, the ICT sector plays an important role in creating new jobs, new sources of income, new business models and reducing the cost of access to public services.

According to Jorgenson and Vu (2016), the development of ICT infrastructure as well as the use of this infrastructure have a significant impact on economic growth, especially in regions where communication, access to information, learning, research and innovation are the key drivers of economic progress. It is argued that investment in ICTs not only generates lower future costs but also contributes to higher productivity and sales potential. Maximum benefits come from modifying and modernizing business processes and exploiting ICT capacities.

The development of the ICT sector affects economic growth at both macro and micro levels. At the macro level, this influence mainly manifests through contribution to productivity, effectiveness, innovation, and the efficiency of financial markets, while at the micro level, rapid access to information, knowledge and social networks accelerates communication, paves the way for new markets, reduces production and capital costs, and promotes business sustainability.

There is a growing body of research in scientific literature focused on the analysis of the relationship between the ICT sector, ICT infrastructure development and investment in ICTs and national or regional economic growth. Based on the results of previous empirical studies, many researchers see ICT development as one of the key drivers of economic growth. Nevertheless, some researchers (Hodrob et al., 2016; Toader et al., 2018; Myovella et al., 2020, etc.) note that economic growth largely depends on the level of national economic development and population's ICT skills, which implies that ICT development can bring greater economic benefits to developed than developing or transition economies.

Although previous literature is rich in the studies addressing the relationship between ICT development and economic growth, the researchers mainly focus on large economic regions (Vu, 2011; Farhadi et al., 2012; Majeed and Ayub, 2018, etc.), developed (Spiezia, 2012; Toader et al., 2018, etc.) and/or developing economies (Andrianaivo and Kpodar, 2011; Amiri and Woodside, 2017, etc.), while the situation in transition economies has hardly been considered separately, though economic characteristics of transition economies may significantly differ from those possessed by either developed or developing economies. The EU transition economies have undergone the arduous processes of privatization, liberalization, macroeconomic stabilization as well as the series of legal and institutional reforms aimed at raising their competitiveness and harmonising national economic, legal and institutional framework with the EU policies.

In this study, considering the relevant empirical findings, we research the effects of ICT development on economic growth in the sample of 11 EU transition countries. The major purpose of this study is to empirically research the role of ICT development on economic growth in considered countries over the 2000-2019 period. To fulfil the defined purpose, the following objectives were set: 1) to present the results

obtained in previous studies regarding to the link between ICT development and economic growth; 2) to select the appropriate methodology for the empirical research; 3) to discuss obtained results.

The research methods cover systematic and comparative literature analysis and linear regression analysis.

This study complements the previous literature addressing the effects of ICT development on economic growth according to most recent available data on ICT progress and economic growth in transition economies. During the observed period, these economies implemented a number of reform processes that significantly changed their business environment, economic structure and growth strategies. Although the transition process began at the end of the last century, over the past two decades the process of implementing market-oriented reforms has intensified, so it is necessary to pay special attention to analysing the role of ICT development in the development path of these countries in such conditions. Taking into account that these economies experienced significant transformation of their economy structure, authors also included the level of ICT goods export as one of the independent variable in the model.

## 2. LITERATURE REVIEW

According to Piatkowski (2004), future growth potential and prospects in transition economies depend to a large extent on ICT development, investment in ICTs and the ability to ensure the efficient use of ICT infrastructure by the population at both macro and micro levels.

Based on the report of the United Nations (2011), a positive macroeconomic impact of ICTs can arise as a result of:

- higher productivity of the ICT sector itself;
- ICT investment across the economy that raises labour productivity;
- contribution of ICTs to business innovations and overall efficiency.

Research at the micro level helps to better understand what incentives drive investment in ICTs in businesses, how ICTs are incorporated into business processes and models, and how ICT development affects business performance, productivity, return on investment and flexibility of other factors (e.g. organizational structure, human resources, customer interface, etc.) (Bartelsman et al., 2013).

The positive impact of ICT development on economic growth at the macro level was confirmed in a substantial part of previous empirical studies (see Table 1).

The studies focused on the relationship between ICT development and economic growth in developed economies largely confirm the existence of a positive relationship between these variables. Fernandez-Portillo et al.'s (2020) findings suggest that the use and deployment, i.e. bringing ICT resources into effective action, contribute to economic growth in developed EU countries that are members of the OECD. Their results also indicate that the number of the Internet users is the key determinant of the contributory effects of ICTs on economic progress; reading news and social networks is the second most influential determinant.

Toader et al. (2018) based their study on the panel-data estimation to explore the effect of using the ICT infrastructure on economic growth in EU-28 and disclosed that in terms of the influence of ICT development, economic progress in the EU member states is mainly driven by developing ICT infrastructures. Although the authors note that the effects of different types of technology may vary depending on which set of types is selected for examination, fixed-broadband subscriptions and mobile cell subscriptions are recognised as being most conducive to economic growth in the sample countries with the former contributing to a 0.0767 percent, and the latter – to a 0.396 percent of GDP per capita growth. The research also confirms that in the macroeconomic context, the impact of using the ICT

infrastructure is accompanied by such macroeconomic factors as inflation, unemployment rate, the degree of trade openness, government expenditures and foreign direct investment.

Table 1

Review of some previous findings regarding the relationship between ICT development and economic growth at the macro level

| Author(s), year | Research method | Country(ies), period | Findings |
|---|---|---|---|
| Fernandez-Portillo et al., 2020 | Partial Least Squares | OECD EU countries,- | ICT deployment and use contribute to economic growth |
| Toader et al., 2018 | Panel-data estimation techniques | EU-28, 2000-2017 | The use of ICT infrastructure has a strong positive effect on economic growth in the EU countries |
| Cioaca et al., 2020 | Two panel data regression models | EU-28, 2008-2018 | Increasing access to the Internet promotes economic growth, while enlargement of the ICT sector leads to inequality reduction |
| Adeleye & Eboagu, 2019 | Pooled ordinary least squares, random and fixed effects, system generalised method of moments | 54 African countries, 2005-2015 | The expanding use of ICTs promotes economic growth |
| David & Grobler, 2020 | In-depth descriptive statistical techniques | 46 African countries, 2000-2016 | ICT penetration positively affects economic growth |
| Rath & Hermawan, 2019 | Autoregressive distributed lag cointegration technique, an augmented neoclassical growth model | Indonesia, 1980-2014 | ICT development has a positive impact on economic growth in both the short and long run |
| Hodrob et al., 2016 | Panel regression, ordinary least square (OLS) model, random effects model, fixed effects model | 18 Arab countries, 1995-2013 | ICT positively affects economic growth in the sample countries |
| Piatkowski, 2004 | The aggregate production function | 8 transition economies in CEE, 1995-2001 | ICT development promotes national economic progress through capital deepening and TFP growth in the ICT sector |
| Samoilenko & Osei-Bryson, 2008 | Cobb-Douglas production function | Transition economies, - | Interaction between ICTs and labour force has a statistically significant effect on economic growth |
| Samoilenko & Ngwenyama, 2011 | A longitudinal panel data study, data envelopment analysis (DEA), multivariate regression | 8 transition economies, 1993-1997, 1998-2002 | Interaction between ICTs and labour force has a positive effect on economic growth |
| Ishida, 2015 | Autoregressive distributed lag | Japan, 1980-2010 | ICT investment does not promote an increase in GDP |

*Source:* compiled by the authors

Cioaca et al. (2020) investigated the impact of various ICT indicators on sustainable development of the EU member states including their economic growth and inequality reduction. The empirical results disclosed that the level of the Internet access statistically significantly and positively affects GDP per capita representing economic growth, while an enlargement of the entire ICT sector leads to a decrease in income inequality representing social development. Thus, it can be stated that ICT development contributes to sustainable development of the EU.

The opposite results were, however, delivered by Ishida (2015) whose research provided that although the investment in ICT *ceteris paribus* moderately contributes to reduction in the use of energy, it does not promote a GDP growth, i.e. the long-run relationship between the ICT development and economic growth was not confirmed.

The positive impact of ICT development on economic growth was also confirmed in a number of studies analysing the samples of developing countries. For instance, Rath and Hermawan (2019) confirmed the existence of the positive relationship between the factors under consideration in Indonesia in both the short and long run. Adeleye and Eboagu (2019) found that ICT development statistically significantly affects economic growth in developing African countries. In the latter study, ICT development was represented by a number of Internet users (i.e. individuals using the Internet), a number of mobile telephone connection subscribers and a number of fixed connection telephone subscribers. The results revealed the significantly different output elasticities delivered by the above-mentioned ICT development indicators. A number of mobile telephone connection subscriptions was found to have the largest output elasticity and thus most contributing to economic development in the countries under consideration. In accordance with the research results, the authors conclude that economic growth in developing countries can be promoted by expanding the use of ICT through cost reduction (e.g. reducing the cost of purchasing mobile phones for individuals, diminishing the Internet access fees, etc.).

Very similar results were obtained by David and Grobler (2020) who confirmed that ICT penetration positively affected economic growth in the sample countries, and additionally distinguished between the impact of ICT on economic growth and economic development: their research revealed that the positive impact of ICT penetration is greater on economic growth, referred to as the increment in the amount of products and services produced by an economy, rather than on economic development, referred to as an improvement in the population's quality of live and living standards.

For comparing the effects of ICT development on economic growth in developed and developing economies, we can refer to Stanley et al.'s (2018), Majeed and Ayub's (2018), and Hodrob et al.'s (2016) research results. Stanley et al.'s (2018) meta-analysis of 58 papers, focused on the nexus between ICT development and economic growth, indicated that ICTs generally make a positive contribution to economic progress in both developing and developed states. Similar results were provided by Majeed and Ayub (2018) who researched the effect of diverse ICT indicators on economic progress in the sample of 149 countries and found that the ICT indicators accelerated economic growth in these countries. These results imply that ICT development can contribute to economic growth in the countries with different levels of economic prosperity. Hodrob et al. (2016) researched the impact of ICT development on economic growth in 18 Arab countries for the period between 1995 and 2013 through regression analysis and confirmed that ICT development is a promoter of national economic development. Nevertheless, the authors admit that the degree to which ICTs contribute to prosperity in developing African economies is lower than the degree of the ICT effects in emerging and developed countries. These findings are in line with the report of the United Nations (2011) which proposes that a direct link between ICT advancement and economic growth in developed economies is largely determined by the value added generated by the former, while in developing economies, ICT networks are only recently deployed, so an extensive macro-economic analysis cannot be conducted because of insufficiency of data series. According to the authors, a reliable analysis of the impact of ICTs on economic growth in developing economies will only be possible when a certain level of ICT penetration is attained.

The situation in transition economies has earned little scientific attention thus far. One of the few studies that is worth mentioning in this context is the study by Piatkowski (2004) focused on the impact of ICTs on economic growth in 8 transition economies situated in Central and Eastern Europe (Bulgaria, the Czech Republic, Hungary, Poland, Romania, Russia, Slovakia and Slovenia). The results of the research at

the macro level indicate that ICT development particularly significantly contributes to national economic growth through capital deepening and total factor productivity (TFP) growth in ICT-producing sector (which boosted economic growth in five of the sample countries - the Czech Republic, Hungary, Poland, Slovakia and Slovenia). The author also notes that ICT-driven national economic progress is accelerated when the economic, institutional and regulatory framework is developed in parallel.

Samoilenko and Osei-Bryson (2008) investigated the combined effect of ICTs and labour force on economic growth in transition economies. In their study, ICTs were represented by the investment in telecommunication companies, and labour force - by the full-time staff in these telecommunication companies. The research results revealed a statistically significant relationship between the ICT-labour force interaction and economic growth in the sample countries.

Assuming that human capital is one of the main factors affecting ICT development and its macroeconomic impact, Samoilenko and Ngwenyama (2011) investigated the impact of the human capital dimension of ICTs on economic growth in 8 transition economies. Their results revealed that if the interaction between investment in ICTs and the ICT staff is negative, then an efficiency change has a greater impact on growth than a technology change, i.e. growth is driven by investment in the human capital dimension of ICTs rather than in the dimension of technologies. Conversely, if the interaction between investment in ICTs and the ICT staff is positive, then an efficiency change has a smaller impact on growth than a technology change, i.e. growth is driven by investment in the dimension of technologies rather than investment in the dimension of human capital. The major options, related to the development of the human capital dimension of ICTs, suggested for strengthening ICT macroeconomic outcomes, are enlargement of the size of the ICT labour force and increasing productivity of this labour force.

Thus, previous findings concerning the links between various dimensions of ICT development and economic growth generally indicate a positive relationship between the variables. Nevertheless, the micro-level results are less consistent. Micro-level studies commonly focus on the impact of a number of variables, representing ICT development (e.g. the use of computers, mobile phones, the Internet, broadband, etc.), on a firm's performance. The results of such studies generally show that ICTs positively affect corporate performance (United Nations, 2011). For instance, Hernando and Núñez (2004) researched the consequences of ICTs on the output and labour productivity growth in 1300 firms in Spain between 1991 and 2000 by employing regression analysis and uncovered that the use of ICTs positively contributed to a larger output and higher labour productivity in the firms under consideration. However, this may vary among individual businesses. For example, Bilan et al. (2019) investigated the interaction between ICT development and economic growth in 163 countries in 2017 and found a positive relationship between the variables. The authors also noted that steep development of ICTs could provide a stronger impetus for economic progress in developing states, which was proved by the results of their correlation analysis and modelling the effects of ICTs on the major financial indicators. Their micro-level analysis, however, revealed that ICT development can cause more significant effects on economic growth if the number of individuals, households and businesses that have an access to the Internet and efficiently use web technologies is larger, in particularly in the area of e-commerce. These findings are in line with Piatkowski's (2004) arguments suggesting that realising the potential of ICTs is only possible by transforming traditional business models and raising the quality of human capital, and with the report of the United Nations (2011) which proposes that ICT-driven development of particular entities depends to a large extent on accompanying factors, such as skills, innovation and complementary investment in human capital, management, organizational change and other forms of intangibles (Tóth et al., 2020). In fact, advanced skills of ICT usage are important for economic development and can shift tendencies in economic growth due to migration of highly skilled employees (Oliinyk et al., 2021) and constantly high demand for the innovative professionals in the economy (Lewandowska & Stopa, 2020). The current

patterns of economic growth and its changes in European countries confirm the high impact of ICT-based technology (Braja & Gemzik-Salwach, 2020; Kharlamova et al., 2018) due to the steep diffusion of ICT and emerging network effects (Lechman, 2018).

In addition, the same report of the United Nations (2011) provides that ICT spread alone cannot generate significant benefits to businesses without an appropriate support. It is also noted that some elements of ICTs, for instance, the Internet, are far less accessible to poor communities in developing economies, so the use of ICTs for more advanced applications, such as e-commerce, is still rare. For this reason, the potential of ITCs to generate higher value added is not exploited.

There is hardly any research that associates ICT development with negative economic effects. The negative impact of ICT is commonly linked to substantial financial losses borne on account of privacy and security problems (Feng and Hughes, 2009; Garg, 2018, etc.), system failures (Nakamura and Kijima, 2011), data loss and breaches (often through cyber-attacks) (Al Balushi et al., 2016) and, sometimes, lower productivity of employees using the Internet in their workplaces (United Nations, 2011). The only possible indirect negative impact of ICT is a so-called productivity trap, i.e. unreasonably frequent updating of ICTs when ICTs are used for an insufficiently short time to generate efficient gains (United Nations, 2011).

*On balance, vast majority of previous studies confirm that ICT development and penetration positively affect economic growth. Since many studies cover large samples, the general results apply to the countries with different levels of development either in the short or long run. Nevertheless, some studies disclose that developed economies commonly obtain more gains from the investment in ICTs than emerging and, especially, developing economies where ICTs are far less accessible to poor communities, which diminishes the potential of ICTs to generate higher value added. Thus, the magnitude of the effect may differ given the level of the ICT infrastructure as well as the type of technology examined. The only possible indirect negative impact of ICT is a so-called productivity trap, i.e. unreasonably frequent updating of ICTs impeding generation of efficient gains. Although the findings concerning the interrelationship between ICT development and economic growth generally indicate that the variables are positively correlated, the micro-level results are less consistent: despite the fact that a part of the studies confirm the positive effects of ICTs on corporate performance, others show that this may significantly vary among businesses because ICT-driven development at the micro level depends to a large extent on accompanying factors, such as skills, innovation and complementary investment in human capital, management, organizational change and other forms of intangibles.*

## 3. METHODOLOGY

### 3.1. Data

The study investigated the growth effect of ICT development in 11 EU transition economies for the 2000-2019 period through linear regression analysis. The dependent variable of economic growth was proxied by GDP per capita PPP in constant prices estimated by the World Bank (2021). On the other side, the independent variable of ICT development was represented by mobile cellular subscriptions (per 100 people), individuals using the Internet (% of population) and ICT goods exports (% of total goods exports). All the variables were annual, and dataset consists of panel data for period 2000-2019 in order to capture the most accurate trends in this area.

The sample for analysis comprised the following countries: Bulgaria, Croatia, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, and Slovenia. The linear regression analysis was conducted by employing the *SPSS 22.0* software. In order to take first insight in analysed issue, the descriptive statistics is presented in Table 3.

Table 2

Data description

| Variables | Description | Source |
|---|---|---|
| GDP_per_capita_PPP_CO | GDP per capita, PPP (constant 2017 international $) | World bank (2021) |
| MOBILE | Mobile cellular subscriptions (per 100 people) | |
| INTERNET | Individuals using the Internet (% of population) | |
| ICT_EXPORT | ICT goods exports (% of total goods exports) | |

*Source:* compiled by the authors

Table 3

Summary statistics of the dataset

| Indicators | Mean | Std. Deviation | N |
|---|---|---|---|
| GDP_per_capita_PPP | 25077.50 | 6487.42 | 220 |
| INTERNET | 53.42 | 23.73 | 220 |
| MOBILE | 103.11 | 36.03 | 220 |
| ICT_EXPORT | 7.63 | 6.57 | 220 |

*Source:* calculated by the authors

According to data presented in Table 3, it can be concluded that the average GDP per capita PPP amounts 25077.50 international $ and, considering the value of standard deviation, the differences across analysed countries are relatively high. The average share of individuals using the Internet in total population is 53.42%, while the average of mobile cellular subscriptions per 100 people amounts 103.11. However, both mobile cellular subscriptions and the Internet penetration varies considerably in the sample. The average share of ICT goods export amounts 7.65%, indicating that these countries on average do not rely considerably on export of these products. It is interesting to note that the standard deviation amounts only about 1%, indicating that there are some kind of polarization among these countries to those with two-digit share of these products in total export and those that have significantly lower value of these indicator.

## 4. EMPIRICAL RESULTS AND DISCUSSION

As the first step in analysis, the checking of assumptions for linear regression was performed. The first of them is multicollinearity, which can be perceived by identifying level of correlation among considered variables and values of Variance Inflation Factors (VIF) and tolerance. The correlation coefficients are presented in Table 4.

The values of Pearson correlation coefficient indicate that there is relatively high correlation between GDP per capita and number of internet users and mobile subscriptions, while correlation with ICT export is low. There is also high correlation between number of internet users and mobile subscriptions as the independent variables, which can be indicator of multicollinearity. In order to check this assumption more detailed, the values of VIF and tolerance are presented in Table 5.

Table 4

Correlations among considered variables

| | | GDP_per_capita_PPP | INTERNET | MOBILE | ICT_EXPORT |
|---|---|---|---|---|---|
| Pearson Correlation | GDP_per_capita_PPP | 1,000 | ,766 | ,635 | ,208 |
| | INTERNET | ,766 | 1,000 | ,813 | ,200 |
| | MOBILE | ,635 | ,813 | 1,000 | ,097 |
| | ICT_EXPORT | ,208 | ,200 | ,097 | 1,000 |
| Sig. (1-tailed) | GDP_per_capita_PPP | . | ,000 | ,000 | ,001 |
| | INTERNET | ,000 | . | ,000 | ,001 |
| | MOBILE | ,000 | ,000 | . | ,075 |
| | ICT_EXPORT | ,001 | ,001 | ,075 | . |
| N | GDP_per_capita_PPP | 220 | 220 | 220 | 220 |
| | INTERNET | 220 | 220 | 220 | 220 |
| | MOBILE | 220 | 220 | 220 | 220 |
| | ICT_EXPORT | 220 | 220 | 220 | 220 |

*Source*: calculated by the authors

Table 5

Collinearity statistics

| | Tolerance | VIF |
|---|---|---|
| INTERNET | 0.323608 | 3.090158 |
| MOBILE | 0.333882 | 2.995072 |
| ICT_EXPORT | 0.947455 | 1.055459 |

*Source:* calculated by the authors

Taking into account values of collinearity statistics and thresholds defined in literature (tolerance value higher than 0.1 and VIF lower than 10) it can be concluded that problem of multicollinearity is not present in this case (O'brien, 2007; Aljaaıdı et al., 2021; Salmerón Gómez et al., 2020).

Besides multicollinearity, the assumptions that should be tested are normality, linearity, homogeneity of variance and independence of residuals. All these assumptions can be checked by insight in two graphs - Normal Probability Plot (P-P) of the Regression Standardized Residual and Scatterplot (see Figure 1 and Figure 2).

From the Normal P-P Plot diagram presented in Figure 1, it can be seen that the all points lie in an approximately straight diagonal line from the lower left to the upper right corner of the diagram. It indicates that there are no major deviations from normality. In the scatter diagram of the standard residues - Scatterplot (Figure 2), it can be seen that the residues are approximately rectangular and that most of them are grouped in the center (around point 0). Both figures indicate that the initial assumptions of multiple regression were not violated.

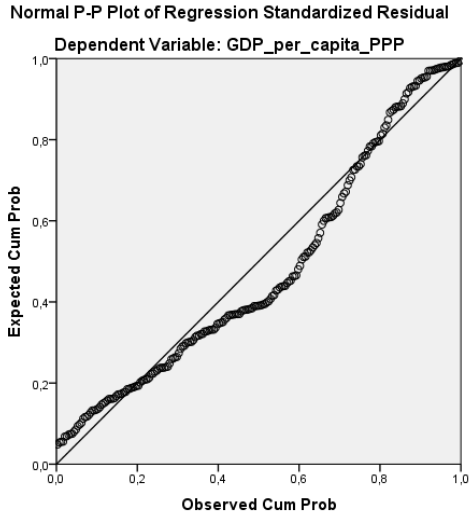


Figure 1. Normal Probability Plot (P-P) of the Regression Standardized Residual
*Source:* author's compilation

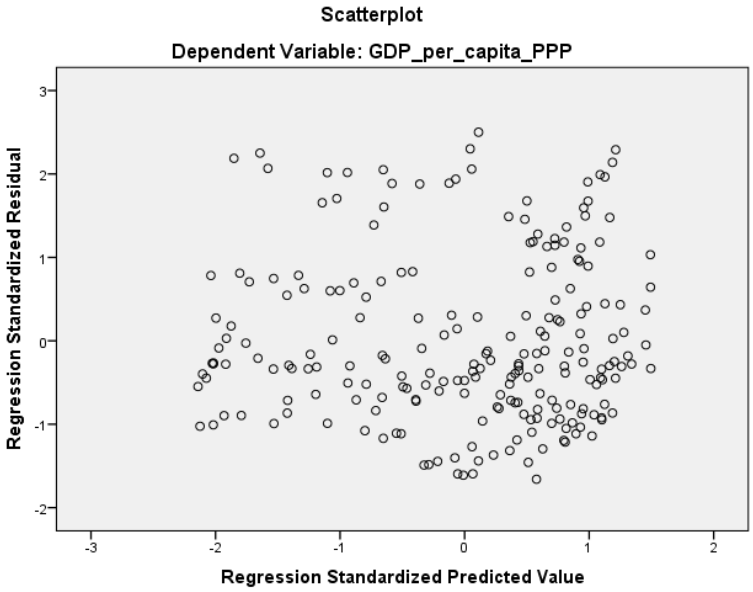


Figure 2. Scatterplot
*Source:* author's compilation

The next step in the analysis is the model valuation, which is based on R2 value presented in Table 6.

Table 6

Model summary

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate |
|---|---|---|---|---|
| 1 | ,769[a] | .591 | .585 | 4177.141 |
| a. Predictors: (Constant), ICT_EXPORT, MOBILE, INTERNET; b. Dependent Variable: GDP_per_capita_PPP | | | | |

*Source:* calculated by the authors

In this case $R^2$ amounts 0.769, meaning that the model explains 76.9% of the variation of the variable GDP per capita PPP, which is a relatively large percentage. In order to assess the statistical significance of this indicator, it is necessary to consider the results shown in the Table 7.

Table 7

ANOVA results

| Model | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| 1 | Regression | 5448086730.94 | 3 | 1816028910.31 | 104.079 | ,000[b] |
| | Residual | 3768878398.90 | 216 | 17448511.11 | | |
| | Total | 9216965129.84 | 219 | | | |

a. Dependent Variable: GDP_per_capita_PPP

b. Predictors: (Constant), ICT_EXPORT, MOBILE, INTERNET

*Source:* calculated by the authors

According to the data in Table 7, it can be concluded that R2 is statistically significant at the level of $p < 0.05$. Finally, the contribution of each independent variable should be evaluated, according to results presented in Table 8.

Table 8

Results of linear regression analysis

| Model | | Unstandardized Coefficients | | Standardized Coefficients | t | Sig. | 95.0% Confidence Interval for B | |
|---|---|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | | Lower Bound | Upper Bound |
| 1 | (Constant) | 13303.332 | 895.975 | | 14.848 | .000 | 11537.357 | 15069.306 |
| | INTERNET | 196.107 | 20.910 | .717 | 9.379 | .000 | 154.893 | 237.321 |
| | MOBILE | 8.185 | 13.556 | .045 | .604 | .547 | -18.534 | 34.904 |
| | ICT_EXPORT | 59.462 | 44.146 | .060 | 1.347 | .179 | -27.551 | 146.474 |

*Source:* calculated by the authors

The results presented in Table 8 suggest that all observed independent variables have positive impact on GDP per capita PPP, as the indicator of economic growth. However, only regression coefficient for internet users have statistically significant impact on economic growth. This results coincide with results obtained by Cioaca et al. (2020) and Adeleye and Eboagu (2019), which suggested that level of Internet access statistically significantly and positively affects GDP per capita as an indicator of economic growth. According to this, it can be concluded that promotion of Internet diffusion in transition countries is one of the most important and most urgent task for policymakers in these countries. In order to complete this task successfully, policymakers should ensure sufficient investment in broadband infrastructure, transformation of education system for efficient preparation of citizens for the information age, and greater usage of Internet-enabled services, including e-commerce and e-government that should be of among the top priorities in development strategies. The remaining two independent variables have positive impact on economic growth, but their influence is rather modest.

According to obtained results, the equation for predicting the value of GDP per capita PPP can be expressed as follows:

GDP per capita PPP = 13303.332 + 196.107*INTERNET + 8.185*MOBILE + 59.462*ICT_EXPORT

## 5. CONCLUSION

The dynamic progress of ICT sector during the last two decades have transformed the world and increased the influence of globalization and liberalization on doing business and competitive position of each economy in the world market. Such developments, motivated researchers to investigate relationship between the development and economic growth, so body of literature on this topic has been increasingly growing. To contribute the investigation of this important issue, this paper is dealing with assessment of ICT development impact on economic growth in the sample of 11 EU transition economies for the period 2000-2019, using the linear regression.

The obtained result suggested that all observed independent variables (number of internet users, number of mobile subscribers and ICT goods exports) have positive impact on economic growth in transition countries. However, the impact of Internet users number is the largest and statistically significant, indicating that Internet penetration should be one of the top priority in the development strategies in transition countries. Government of these countries should foster the Internet penetration and promote usage of internet in everyday life and business, as a first and most important step towards information age. The increased usage of ICT, especially Internet, can boost economic growth through fostering the technology diffusion and innovation, usage of e-government and e-commerce, improving decision-making in firms, households and economy as a whole, increasing demand, lowering the production costs, transforming the structure of economy and foreign trade. Considering that all observed economies are New Member States, it can be assumed that ICT usage will foster their convergence to the economic, technological, and organizational practices and standards of Old Member states, contributing to balanced regional development of the EU and improving its competitive position on the world market.

## REFERENCES


Adeleye, N., & Eboagu, C. (2019). Evaluation of ICT development and economic growth in Africa. *NETNOMICS: Economic Research and Electronic Networking*, 20, 31–53. https://doi.org/10.1007/s11066-019-09131-6

Al Balushi, T., Ali, S., & Rehman, O. (2016). Economics of cyber security and the way forward. *International Journal of Cyber Warfare and Terrorism*, 6(4), 41-57. doi: 10.4018/IJCWT.2016100104

Amiri, S., Woodside, J. M. (2017). Emerging markets: the impact of ICT on the economy and society. *Digital Policy, Regulation and Governance*, 19(5), 383-396. doi: 10.1108/DPRG-04-2017-0013

Andrianaivo, M., & Kpodar, K. (2011). *ICT, financial inclusion, and growth: Evidence from African countries.* IMF Working Paper No. WP/11/73. International Monetary Fund, Washington.

Bartelsman, E., Hagsten, E., & Polder, M. (2013). *Cross-country analysis of ICT impact using firm-level data: micro moments database and research infrastructure*. Retrieved from: https://www.law.northwestern.edu/research-faculty/clbe/events/roundtable/documents/Bartelsman_esslait_mmd_final.pdf

Bilan, Y., Mishchuk, H., Samoliuk, N., & Grishnova, O. (2019). ICT and economic growth: links and possibilities of engaging. *Intellectual Economics*, 13(1), 93-104.

Braja, M., & GemzIk-Salwach, A. (2020). Competitiveness of high-tech exports in the EU countries. *Journal of International Studies, 13*(1), 359-372. doi: 10.14254/2071-8330.2020/13-1/23

Cioaca, S.I., Cristache, S.E., Vuta, M., Marin, E., & Vuta, M. (2020). Assessing the impact of ICT sector on sustainable development in the European Union: an empirical analysis using panel data. *Sustainability*, 12(2), 592, 1-16. doi: https://doi.org/10.3390/su12020592

David, O.O., & Grobler, W. (2020). Information and communication technology penetration level as an impetus for economic growth and development in Africa. *Economic Research-Ekonomska Istraživanja*, 33(1), 1394-1418. https://doi.org/10.1080/1331677X.2020.1745661

Farhadi, M., Ismail, R., & Fooladi, M. (2012). Information and communication technology use and economic growth. *PLoS One*, 7, 1-7. doi: 10.1371/journal.pone.0048903

Feng, J. X., & Hughes, J. (2009). Analyzing privacy and security issues in the information age – an ethical

perspective. *WSEAS Transactions on Information Science and Applications*, 6(1), 126–135. http://dl.acm.org/citation.cfm?id=1534460

Fernandez-Portillo, A., Almodovar-Gonzalez, M., & Hernandez-Mogollon, R. (2020). Impact of ICT development on economic growth. A study of OECD European union countries. *Technology in Society*, 63, 101420. https://doi.org/10.1016/j.techsoc.2020.101420

Garg, R. (2018). *Open data privacy and security policy issues and its influence on embracing the Internet of things*. Retrieved from: https://firstmonday.org/ojs/index.php/fm/article/view/8166/7211

Hernando, I., & Núñez, S. (2004). The contribution of ICT to economic activity: a growth accounting exercise with Spanish firm-level data. *Investigaciones Económicas*, 28(2), 315-348.

Hodrob, R., Maitah, M., & Smutka, L. (2016). The effect of information and communication technology on economic growth: Arab world case. *International Journal of Economics and Financial Issues*, 6(2), 765-775.

Ishida, H. (2015). The effect of ICT development on economic growth and energy consumption in Japan. *Telematics and Informatics*, 32(1), 79-88. https://doi.org/10.1016/j.tele.2014.04.003

Jorgenson, D.W., & Vu, K.M. (2016). The ICT revolution, world economic growth and policy issues. *Telecommunications Policy*, 40(5), 383-397. doi: https://doi.org/10.1016/j.telpol.2016.01.002

Kharlamova, G., Stavytskyy, A., & Zarotiadis, G. (2018). The impact of technological changes on income inequality: the EU states case study. *Journal of International Studies, 11*(2), 76-94. doi: 10.14254/2071-8330.2018/11-2/6

Lechman, E. (2018). Networks Externalities as Social Phenomenon in the Process ICT Diffusion. *Economics and Sociology, 11*(1), 22-43. doi: 10.14254/2071- 789X.2018/11-1/2

Lewandowska, A., & Stopa, M. (2020). The impact of innovative professional qualifications on the sense of employment security: Evidence from Poland. *Economics and Sociology, 13*(3), 72-83. doi: 10.14254/2071-789X.2020/13-3/5

Majeed, M.T., & Ayub, T. (2018). Information and communication technology (ICT) and economic growth nexus: a comparative global analysis. *Pakistan Journal of Commerce and Social Sciences*, 12(2), 443-476.

Myovella, G., Karacuka, M., & Haucap, J. (2020). Digitalization and economic growth: A comparative analysis of Sub-Saharan Africa and OECD economies. *Telecommunications Policy*, 44(2), 101856.

Nakamura, T., Kijima, K. (2011). *Method for visualizing risk factors of system failures and its application to ICT systems.* Retrieved from: https://journals.isss.org/index.php/proceedings55th/article/view/1720/660

Oliinyk, O., Bilan Y., Mishchuk, H., Akimov, O., & Vasa, L. (2021). The Impact of Migration of Highly Skilled Workers on The Country's Competitiveness and Economic Growth. *Montenegrin Journal of Economics*, *17*(3), 7-19.

Piatkowski, M. (2004). *The impact of ICT on growth in transition economies*. TIGER Working Paper Series, No. 59, Transformation, Integration and Globalization Economic Research (TIGER), Warsaw. https://www.econstor.eu/bitstream/10419/140711/1/394315499.pdf

Pradhan, R.P., Arvin, M., Nair, M., Bennett, S., & Bahmani, S. (2017). ICT-finance-growth nexus: Empirical evidence from the Next-11 countries. Cuadernos de Economía (40), 115-134 https://doi.org/10.1016/j.cesjef.2016.02.003

Rath, B. N., & Hermawan, D. (2019). Do information and communication technologies foster economic growth in Indonesia? *Bulletin of Monetary Economics and Banking*, 22(1), 103-122. doi: https://doi.org/10.21098/bemp.v22i1.1041

Rossi, L. (2015). Proposal for the Reform of the Regulation of Digital Services. Robert Schuman Centre for Advanced Studies Research Paper No. RSCAS 2015/49, 7-14. http://dx.doi.org/10.2139/ssrn.2637402

Samoilenko, S., & Osei-Bryson, K.M. (2008). An exploration of the effects of the interaction between ICT and labor force on economic growth in transition economies. *International Journal of Production Economics*, 115(2), 471-481.

Samoilenko, S., & Ngwenyama, O. (2011). Understanding the Human Capital Dimension of ICT and Economic Growth in Transition Economies. *Journal of Global Information Technology Management*, 14(1), 59-69. doi: 10.1080/1097198X.2011.10856531

Spiezia, V. (2012). ICT investments and productivity: measuring the contribution of ICTS to growth. *OECD Journal: Economic Studies*, 2012/1, 1-15. doi: http://dx.doi.org/10.1787/eco_studies-2012-5k8xdhj4tv0t

Stanley, T.D., Doucouliagos, C., & Steel, P. (2018). Does ICT Generate Economic Growth? A Meta-Regression Analysis. *Journal of Economic Surveys*, 32(3), 705-726. https://doi.org/10.1111/joes.12211

Toader, E., Firtescu, B.N., Roman, A., & Anton, S.G. (2018). Impact of Information and Communication Technology Infrastructure on Economic Growth: An Empirical Assessment for the EU Countries. *Sustainability*, 10, 1-22. doi: 10.3390/su10103750

Toth, A., Juhász, T., & Kálmán, B. (2020). The role of innovation and human factor in the development of East Central Europe. *Montenegrin Journal of Economics*, 16(1), 251-274.

United Nations. (2011). *Measuring the impacts of information and communication technology for development*. Retrieved from: https://unctad.org/system/files/official-document/dtlstict2011d1_en.pdf

Vu, K. M. (2011). ICT as a source of economic growth in the information age: empirical evidence from the 1996–2005 period. *Telecommunications Policy*, 35, 357–372. doi: 10.1016/j.telpol.2011.02.008