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THE IMPACT OF ICT ON THE GDP GROWTH OF WESTERN BALKAN COUNTRIES

*Arta Ejupi Ibrahimi
PhD candidate, Faculty of Business and Economics,
South East European University, Tetovo, North Macedonia,
artaejupiibrahimi@gmail.com

Besnik Fetai
Full Professor, Faculty of Business and Economics,
South East European University, Tetovo, North Macedonia,
b.fetai@seeu.edu.mk

ABSTRACT

The aim is to investigate the Information Communication Technology (ICT) on GDP growth in Western Balkan countries from 2000 - 2019. Different econometric techniques were used such as pooled OLS, fixed effects, random effects, and the Hausman Taylor model with instrumental variables (IV). The findings indicate that fixed telephone subscriptions and individuals using the internet have a positive effect on GDP growth, while the fixed broadband subscriptions and mobile cellular subscriptions have a negative effect on GDP growth. The results also show general government final consumption has a negative effect on GDP growth, whereas foreign direct investment has a positive effect on GDP growth, but the coefficient is statistically insignificant. The study will serve for policy makers to invest more in ICT since this will contribute

to the economic growth and welfare benefits. There is no study that has been analyzed about ICT in Western Balkan countries, thus findings will be valuable to the government.

Keywords: Information Communication Technology, GDP growth, Economic growth, Panel data, Western Balkan Countries, Hausman and Taylor.

Paper type: Research paper

JEL Classification: E00, E01

INTRODUCTION

Due to the advancement of information and communication technology (ICT) our lives are changing rapidly. Every day, people are using different technological tools that enable to reach information rapidly. Based on Nair et al., (2020) the ICT consists of telephones, mobile phones, fixed broadband, and internet, which are an inevitable part of our daily life,thus in this study are used these ICT indicators as :fixed broadband subscriptions (per 100 people), fixed telephone subscriptions(per 100 people), mobile cellular subscriptions (per 100 people),individuals using internet.

There is an increasing number of studies about ICT on GDP and economic growth, and several papers that analyzed the impact of ICT investment on GDP growth (Madden and Savage, 1998; Jorgenson, 2001; Colecchia and Schreyer, 2001; 2002; Ahmed and Ridzuan, 2013; and Pohjola, 2001) and also other studies for ICT on GDP or economic growth (Jacobsen, 2003; Albimanand Sulong, 2016; Chakpitak et al., 2018, and Adedoyin et al., 2020).

Several papers have been authored about the impact of ICT in some developed and developing countries.Yousefi (2011) stated that ICT has positive effect on high income countries rather than in those low income countries.Similarly, many researchers studied the positive effect of ICT on developed countries (Pohjola, 2001; Dimelis and Papaioannou, 2010; Jung et al., 2013; Portillo et al., 2020, and Nair et al., 2020).On the other hand, few studies showed contradictory results, where the impact of ICT was positive in developing countries (Jacobsen, 2003; Bahrini and Qaffas, 2019; Maneejuk and Yamaka, 2020, and Solomon and Klyton, 2020).

Thus, most of the studies confirmed positive impact on economic growth, since ICT will enable effective and rapid communication, hence a study of Lee et al., (2017) pointed out that in the last

decade, society also reached broader connectivity. Hence, this study aims at finding an answer the following questions: Does ICT indicators impact GDP growth? Therefore, the main goal of the study is to examine if ICT has an impact on the GDP growth.

There are not many studies that have been analyzed if ICT indicators, such as fixed telephone subscriptions (per 120 people), mobile cellular subscriptions (per 120 people), fixed broadband subscriptions (per 120 people), and individuals using the internet, have an impact on GDP growth in Western Balkan countries during the period of 2000-2019, so this study aims to fill a gap in the literature of this region, because the study used four indicators of ICT. Also, most of studies used cross countries regression (Choi & Yi, 2009; Farhadi, et al., 2012), fixed and random approaches that lead lack of robustness of the results due to the endogeneity problems (Fetai,2018). Considering the econometric issues this study employs pooled OLS, fixed, random effects and Hausman Taylor instrumental variables (IVs). Additionally, the study also includes two macroeconomic control variables as foreign direct investment and general government final consumption expenditure. All the data were taken from World Bank (WB).

The practical contribution would be for the government to know the importance and the usage of ICT indicators with the intention of increasing the economic growth in the Western Balkan countries.

The paper is organized in a few sections: Section 2 analyze the literature; Section 3 describes and interprets research methodology and data; Section 4 gives results; Section 5 gives conclusion.

LITERATURE REVIEW

A vast majority of empirical studies about the ICT impact on GDP growth which concluded that ICT has positive impact on economic growth (Oliner and Sichel, 2000; Jorgenson and Vu, 2005; Sassi and Goaied, 2013, and Lee and Brahmasrene, 2014).

Datta and Agarwal (2004) investigated the 22 OECD countries by using dynamic panel data, and found positive impact of ICT on GDP. Ahmed and Ridzuan (2013) studied Asian countries (Malaysia, Thailand, Singapore, Indonesia, Philippines, Japan, Korea and China) during 1975-2006 by using fixed and random effects and showed that capital, labor and telecommunication investment have positive impact on GDP. Hodrab and Maitah (2016) examined the ICT on GDP growth in 18 Arab countries during the period of 1995-2013 by applying OLS,

fixed and random effects model and concluded that ICT has a positive effect. Likewise, Pohjola (2001) conducted a study of ICT in 39 OPEC countries for the period of 1980 -1995, in which he used panel data and found that ICT have a crucial role in economic growth in those countries.

The study of Farhadi, et al., (2012) which examined 159 countries from 2000-2009 by using panel data using the GMM method, claimed that there is a positive relationship of ICT and GDP. Similarly, Bahrini and Qaffas (2019) studied many countries in the Middle East, the North Africa (MENA) region and the Sub-Saharan Africa (SSA) and were investigated during the period of 2007-2016. They used the GMM method and showed that internet usage, broadband adoption, and mobile phones are the main factors of economic growth. Also Toader et al., (2018) analyzed 28 countries of European Union from 2000 to 2017 by using panel data with GMM method, and the findings revealed positive effect of ICT infrastructure on economic growth. Another researcher, Haftu (2019) investigated 40 countries during the period 2006-2015 by using the GMM model, and his results showed that mobile phone and internet access have positive impact on GDP.

Further, Roller and Waverman (2001) analyzed 21 OECD countries for the period 1970-1990 to reveal the impact of telecommunication infrastructure on economic growth and showed a positive impact on economic growth. However, Portillo et al., 2020 stated in their study that there are other investigations that the impact is limited or mixed. On the other hand, Lee at al., (2005) investigated ICT in 20 countries for the period of 1980-2000 by using time series analysis and found out that ICT has positive impact on economic growth for new industrialized countries and not in developing countries. Dimelis and Papaioannou (2010) also investigated ICT in 42 developed and developing countries within the period of 1993-2001 by using fixed effect model and showed that ICT has more impact in developed countries. According to Cheng et al., (2021) the effect of ICT is ambiguous in middle- and low-income countries, which may be due to the fact that in developing countries, the accessibility of ICT is lower and they have poor infrastructure.

Furthermore, Koutroumpis (2009) analyzed 22 OECD countries within period of 2002-2007 and used the indicator of ICT as broadband penetration and economic growth and resulted positively related. In contrast, the study by Bojnec & Fertő (2012) examined 34 OECD countries for the period 1998-2009 by using a dynamic panel model with the GMM model, and it did not find a positive effect of broadband per inhabitant on GDP growth.

Recently, Kurniawati (2021) studied 25 Asian countries and middle-income countries during the period of 2000-2018 by using co-integration and estimation procedures and found that Asian countries have a positive impact on economic growth from the internet, whereas the middle-income countries have had a positive impact from telephone line and mobile phone. Another study done by Maneejuk and Yamaka (2020) also showed that the telephone line and mobile phone have positive effects on economic growth. As seen from literature review, a smaller number of studies showed the negative impact of ICT on economic growth, including Freeman and Soete (1997) who stated that ICT can have a negative impact on employment because it can reduce the labor force.

To summarize, significant papers have been authored related to the topic of ICT in developed and developing countries, but there is no paper that has been investigated in Western Balkan countries using OLS, fixed, random effects and the Haysman Taylor model. Therefore, this paper attempts to give an empirical model by investigating how the ICT indictors impacts the GDP growth, and how governments can use the results to embrace ICT to its fullest potential.

RESEARCH METHODOLOGY AND DATA

Section 3 contains an empirical econometric model to investigate the impact of ICT on GDP growth in Western Balkan countries (North Macedonia, Serbia, Albania, Bosnia and Herzegovina, Montenegro and Croatia) during the period of 2000-2019. For this purpose, we employed panel data method such as pooled OLS, fixed,random effects and the Hausman-Taylor instrumental IV (Baltagi, 2008). Additionally, the Hausman test were used to choose between three models such as random ,fixed effects and the Hausman–Taylor model and the test presents that Hausman -Taylor model is more effective rather than two other models.

Empirical model

As, the Hausman-Tylor instrumental IV is considered to be more effective than two other approaches, a Hausman-Taylor IV were employed to assess the impact of ICT on GDP growth in Western Balkan countries for 2000-2019. Below are reported the results of the ICT together with macroeconomic control variables. For comparison purposes the results of all models are presented in (Table no.2). In addition, Hausman-Taylor instrumental IV is applied to check and find a solution for endogeneity, since some variables can be endogenous, and this problem is very common (Mitze, 2009).

The specified model of Hausman-Taylor empirical model is:

$$y_{it} = c + \beta_1(ifdi_{it}) + \beta_2(ifbs1_{it}) + \beta_3(iggfc_{it}) + \beta_4(ifts1_{it}) + \beta_5(iindustitern_{it}) + \beta_6(imcs1_{it}) + u_{it} \quad (1)$$

where $y_{it}$is the dependent variable of GDP growth (annual %) for each country *i* and *t* are years; *c* is constant;the independents variables are $ifbs1_{it}$ (fixed broadband subscriptions(per 120 people)),$ifts1_{it}$ (fixed telephone subscriptions(per 120 people)), $iindustitern_{it}$ (individuals using internet% of population),$imcs1_{it}$ (mobile cellular subscription (per 120 people), and the control variables are $ifdi_{it}$(foreign direct investment) and $iggfc_{it}$ (general government final consumption expenditure (% of GDP)); $u_{it}$is the error term (Wooldridge, 2010).

Descriptive statistics

This study used a panel data of Western Balkan countries such as North Macedonia, Albania, Serbia, Montenegro, Bosnia and Herzegovina, and Croatia, for the period 2000-2019. The source of data is from World Bank. The dependent variable is GDP growth following Jacobsen (2003);Ahmed and Ridzuan (2013). Independent variables were adapted by a few empirical literatures such as Albiman and Sulong (2016); Toader et al., (2018); Madden and Savage (1999); Scott (2012); Farhadi et al., (2012); Bahrini and Qaffas (2019); David and Groble r(2020); Kurniawat (2021), which are broadband subscriptions (per 120 people), fixed telephone subscriptions (per 120 people), individuals using internet % of population, and mobile cellular subscription (per 120 people). Also macroeconomic control variables were used to enhance the quality of the results, followed by Dimelis and Papaioannou (2010); Campisi et al.,(2013); Bahrini and Qaffas (2019); Adedoyinet al., (2020), such as foreign direct investment and general government final consumption.

Consequently, the study uses more variables related to the ICT and there is also no paper investigated with Hausman and Taylor model. Summary statistics are provided in Table no.1 and also table AI and AII have all the information of data source.

Table no.1 Summary statistics

VARIABLES	N	Mean	Std.Dev	Min	Max
igdpGr	120	3.215	2.231	-2.644	6.105
ifdi	120	6.062	2.153	3.408	11.67

ifbs1	120	9.298	7.758	0.00181	22.33
iggfc	120	18.51	1.219	16.54	20.77
ifts1	120	25.15	1.820	22.33	27.71
iindusitern	120	41.29	23.61	2.582	74.79
imcs1	120	88.16	37.41	8.115	119.5

Source:author's calculations

Empirical results

Presented here are the results from all models such as pooled OLS, fixed , random effects, and the Hausman Taylor - IV. The pooled OLS model is biased due to the heterogeneity of unobservable individual-specific effect. Thus, the fixed and random effects models are showed in the Table 2. The Hausman test is used to see the comparison from fixed and random effects (see Appendix, Table no. AIII). The Hausman test's result is 10.52, which means that the null hypothesis is rejected on the side of the fixed effects estimator. Thereafter, the statistical test shows that random effects model is less effective than the fixed effect model, which is more effective. The fixed effect model removes a correlation of unobservable individual-specific effect and explanatory variables, which is not the same case with the random effect estimator.

Furthermore, the Hausman-Taylor is calculated (see table 2) to handle the problem of endogeneity because it can lead to biased coefficients in the regression. The Hausman test is also estimated for Hausman-Taylor and for fixed effects to see if the instrumental variable has removed correlations between the unobservable individual-specific effect and explanatory variables. The result of Hausman test is 5.33, which means that the null hypothesis is not rejected on the side of Hausman-Taylor (IV) (see Appendix Table 3). Also, the Hausman-Taylor (IV) method with instrumental variables removes correlation between variables that have been used in the model and also individual components of the error terms. Additionally, this approach removes the problem with endogeneity. In the end, the Hausman-Taylor instrumental (IV) is the most relevant model than fixed and random effects. (see Appendix Table A3).

Table no.2 Results data of Panel regression

	OLS	Fixed Effect	Random Effects	Hausman Taylor IV

VARIABLES	igdpGr	igdpGr	IgdpGr	igdpGr
Ifdi	0.00361	0.00361	0.00361	0.00361
	(0.0927)	(0.0948)	(0.0927)	(0.0931)
ifbs1	-0.629***	-0.629***	-0.629***	-0.629***
	(0.103)	(0.106)	(0.103)	(0.104)
Iggfc	-1.433***	-1.433***	-1.433***	-1.433***
	(0.190)	(0.194)	(0.190)	(0.191)
ifts1	0.581**	0.581**	0.581***	0.581***
	(0.224)	(0.229)	(0.224)	(0.225)
iindusitern	0.268***	0.268***	0.268***	0.268***
	(0.0504)	(0.0515)	(0.0504)	(0.0506)
imcs1	-0.103***	-0.103***	-0.103***	-0.103***
	(0.0239)	(0.0244)	(0.0239)	(0.0240)
Code				0
				(0.0721)
Constant	18.96***	18.96***	18.96***	18.96***
	(5.165)	(5.284)	(5.165)	(5.195)
Observations	120	120	120	120
R-squared	0.656	0.656		
Number of codes		6	6	6

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Source:author'scalculations

In employing Hausman-Taylor instrumental IV, the variables that can be as exogenous variables are foreign direct investment (ifdi). The variables that can be as endogenous are fixed broadband subscriptions (per 120 people) (ifbs1), fixed telephone subscriptions (per 120 people) (ifts1), mobile cellular subscriptions (per 120 people) (imcs1), individuals using internet (iindusitern), and general government final consumption (iggfc).

The result shows that the coefficients for fixed broadband subscriptions (per 120 people), fixed telephone subscriptions (per 120 people), mobile cellular subscriptions (per 120 people) and

individuals using internet, and general government final consumption are statistically significant, expect the coefficient of foreign direct investment, which is statically insignificant.

As shown in Table no.2, the fixed broadband subscriptions (per 120people) has a negative effect on GDP growth, which means that an increase of 1 % fixed broadband subscriptions (per 120people), ceteris paribus, GDP on average will decrease to 0.629%. The result is in line with Bojnec and Fertő (2012) study. There are few studies that showed positive impact (Koutroumpis, 2009; Scott, 2012) of fixed broadband on GDP growth. Another study conducted by Czernich et al., (2011) also noted that GDP growth will go higher for 3.7 to 3.9 % by having the fixed broadband in OECD countries. The result shows that fixed telephone subscriptions have a positive effect on economic growth and thus an increase of 1% of fixed telephone subscriptions, ceteris paribus, will lead to an increase GDP for 0.581%. The result is in line with the study of (Hardy 1980, Jacobsen 2003, Röller and Waverman 2001, and Sassi and Goaied 2013).The findings show that mobile cellular subscription (per 120 people) has a negative effect on GDP growth, which means that an increase of 1% of mobile cellular subscription (per 120 people), ceteris paribus, GDP on average will decrease to 0.103%. The results are contradictory with other studies that showed a positive effect of mobile cellular on GDP growth (Albiman and Sulong, 2016; Andrianaivo and Kpodar, 2011, and Sridhar and Sridhar, 2007). The results find out that the individuals using internet has a positive effect on GDP growth. Hence, an increase of 1% of individuals using internet, ceteris paribus, will increase GDP for 0.268%. The results are in line with Albiman and Sulong (2016); Choi and Yi (2009), and Sassi and Goaied (2013).

The coefficient of general government final consumption has a negative effect on GDP growth. An increase of 1% of general government final consumption, ceteris paribus, GDP on average will decrease to 1.433%. The result is consistent with studies by Fetai,et al.,(2017) and Bahrini and Qaffas (2019) study. Furthermore, it was found that foreign direct investment has a positive impact on GDP growth; anyway, the coefficient is not statistically insignificant.

CONCLUSION

Employing empirical growth model, we investigated the impact of ICT on GDP growth for Western Balkan countries (North Macedonia, Albania, Serbia, Montenegro, Bosnia and Herzegovina, and Croatia) over the period 2000-2019. Specifically, how ICT indicators affect the GDP growth by applying different econometric models.

The results reveal that all coefficients of ICT variables, which are fixed broadband subscriptions (ifbs1), fixed telephone subscriptions (ifts1), mobile cellular subscriptions (imcs), individuals using internet (iindusitern), and general government final consumption (iggfc), are a significant indicator of the impact on GDP growth, except foreign direct investment which is statistically insignificant. Fixed telephone subscriptions, individuals using internet have a positive impact on the GDP growth. On the other hand, broadband subscriptions, mobile cellular subscriptions, and general government final consumption have a negative impact on the GDP growth.

Finally, the results of the study could be served to the companies' policymaker as a course of action to improve ICT , because using the ICT is so crucial and every person or o company can benefit from it. The governments on the aforementioned Western Balkan nations should further improve and strengthen the technology infrastructure, since some indicators revealed positive impact on GDP growth, and this should be an important objective for them.

The future research would consider the ICT investment, as well as including human development, employment, innovation, and education.

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Appendix

Table no. AI Western Balkan countries

No.	Countries of Western Balkan
1	North Macedonia
2	Albania
3	Serbia
4	Montenegro
5	Bosnia and Herzegovina
6	Croatia

Source: World Bank (https://data.wo119rldbank.org/)

Table no.AII Description of variables

No.	Variables	Code
1	GDP growth	iGDPGr
2	fixed broadband subscriptions (per 120 people),	ifbs1
3	fixed telephone subscriptions(per 120 people)	ifts1
4	mobile cellular subscriptions (per 120 people)	imcs1
5	individuals using internet	iindusitern
6	general government final consumption (% of GDP)	iggfc
7	foreign direct investment(% of GDP)	ifdi

Source: World Bank (https://data.worldbank.org/)

Table no. AIII Hausman Test

Test	Chi 2	Prob > Chi 2	Result
Fixed Effects vs Random Effects	10.5211	0.0311	Reject Ho
Fixed Effects vs Hausman Tylor	0.0176	5.2114	Does not reject Ho

Source: Author's calculation