Science & Technology Development Journal – Economics - Law and Management 2023, 7(2):4331-4340

Open Access Full Text Article

Research Article

Impacts of Information and Communication Technologies infrastructure development on economic growth: An empirical study of Southeast Asian countries

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ABSTRACT

This article aims to systemize growth models and analyze the impacts of Information and Communication Technologies (ICT) infrastructure development on the economic growth of Southeast Asian countries. Accordingly, growth models are developed with ICT inputs, including mobile cellular subscriptions, fixed telephone subscriptions, fixed broadband subscriptions, and Internet users. Using data from World Bank, the author collected 220 observations of 10 ASEAN members during the 2000-2021 period. To evaluate how ICT infrastructure factors affect the economies, the author used various panel analysis and estimation methods: Panel unit-root test, panel cointegration test, and the Generalized Method of Moments (GMM) estimator. The results showed that all the variables were stationary and had cointegration relationships. Additionally, the Ramsey test results showed that there were no omitted variables in the models, which proved the fitness of the models. The study found that 3 ICT variables significantly improved economic growth: mobile cellular subscriptions, fixed broadband subscriptions, and Internet users; while fixed telephone has negative effects on the sample. The author also found that economic growth is significantly improved by labor force, gross fixed capital formation, and trade openness. Theoretically, this article built a growth equation with a vector of different ICT factors, including Mobile cellular subscriptions, fixed telephone subscriptions, fixed broadband subscriptions, and Internet users. Furthermore, when using the system GMM estimator which controls bias such as endogeneity, heteroskedasticity and auto correlation, effects of explanatory variables on economic growth were significant. Practically, the research results provided an overview of the contributions of ICT factors to Southeast Asian economies, which are consistent with the current situation of ICT development in the region. From these results, the article gave policy implications for Vietnam in developing ICT aspects as well as in applying ICT in socio-economic activities.

Key words: ICT infrastructure, economic growth, ASEAN, Vietnam

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History

- Received: 06-01-2023
- Accepted: 28-4-2023
- Published: 31-5-2023

DOI :

https://doi.org/10.32508/stdjelm.v7i2.1178

INTRODUCTION

In the era of digitalization, Information and Communication Technologies (ICT) are considered an important driving force of economies. By attracting higher investments and improving infrastructure, ICT has provided nations, especially developing economies, with opportunities to increase affordability to reach the population in developing countries that currently lives outside of ICT networks, to expand access to more advanced, affordable ICT services such as broadband for high-speed internet, to leverage the new ICT infrastructure to improve service delivery and build on it as a source of economic growth, and to develop and to align people skills relevant to the information technology-enabled services industry[1]. In the Southeast Asia region, ICT aspects have been considerably invested and developed since the 21st century and are expected to contribute to growth rates of the digital economy at 363 billion USD in 2025 and about 1000 trillion USD in 2030[2]. These opportunities also raise the question whether ICT development has significant impacts on members of The Association of Southeast Asian Nations (ASEAN). However, not many researches have fully analyzed how ICT factors contribute to ASEAN members' economic growth.

Since the 21st century, ICT development has been one of the most popular research topics, especially its contributions to economic aspects. In previous empirical studies, it is expected that ICT development significantly contributes to countries' growth, and one of the most significant channels is ICT infrastructure. However, not many studies have fully and deeply analyzed how ICT affects developing economies, particularly in Southeast Asia countries. When it comes to developing countries, there have been controversial results of ICT infrastructure factors' impacts on

Cite this article : Anh N D V. **Impacts of Information and Communication Technologies infrastructure development on economic growth: An empirical study of Southeast Asian countries**. *Sci. Tech. Dev. J. - Eco. Law Manag.;* 7(2):4331-4340.

economic growth. For example, two ICT variables (fixed broadband and Internet) were found to significantly improve economies in Central Asia [3], and economic growth in South Asian countries are positively affected by three ICT factors (fixed telephone, mobile cellular, and Internet) [4]. Meanwhile, when examining the effects of ICT development on African nations, studies found negative and/or insignificant impacts of ICT infrastructure variables on economic growth of the samples [5–7]. Even in some studies on the ASEAN, samples were only small parts of the region. For instance, Yong Jing and Ab-Rahim only used 5 ASEAN nations for their sample, which later showed that insignificant effects of fixed broadband on economic growth [8], while Sapuan and Roly found significant contribution of ICT variables on 8 ASEAN countries [9].

For the reasons above, the author acknowledges certain research gaps in previous studies. First, there have not been many studies on the effects of ICT development on ASEAN members, and previous studies have only covered small samples of the Southeast Asia region or other regions of the Asia. Second, results of ICT infrastructure factors' effects on different economies are still controversial. Therefore, there needs to be further research on the impacts of ICT aspects on economic growth, especially in the region of ASEAN.

In acknowledgment of ICT's importance in ASEAN economies, the author chooses the topic **"Impacts of Information and Communication Technologies infrastructure development on economic growth: An empirical study of Southeast Asian countries"**. This paper analyzes the impacts of ICT infrastructure development on economic growth in Southeast Asia so that policies can be suggested for Vietnam to apply ICT aspects in socio–economic activities. This paper is divided into 5 main parts, not including Abstract and References.

LITERATURE REVIEW

ICT infrastructure definition

ICT is defined as a diverse set of technological tools and resources used to transmit, store, create, share, and exchange information [10]. For example, computers, Internet devices, live and/or recorded broadcasting technologies, and telephony are technological tools of ICT infrastructure. More simply, ICT infrastructure covers all advanced resources, tools, and types of equipment that help to send information.

According to the latest UN E-Government Survey in 2022, ICT infrastructure has 4 components: mobile cellular telephone, Internet, fixed broadband, and active mobile-broadband [11]. To measure development levels of these components, the number of subscriptions or users in each component is calculated yearly.

Review of ICT infrastructure factors' impacts on economic growth

Mobile cellular subscriptions

The International Telecommunication Union (ITU) defines mobile cellular subscriptions as subscriptions to a public mobile telephone service using cellular technology, which provide access to the public switched telephone network using cellular technology [12]. This includes postpaid and prepaid subscriptions and includes analogue and digital cellular systems. Yong Jing and Ab-Rahim claimed that the variable "Mobile Cellular Telephone Subscriptions" positively and significantly contributes to the economic growth of ASEAN-5 countries [8]. Meanwhile, Albiman and Sulong proved that mobile cellular subscriptions have negative effects on economic growth in the short run and positive effects in the long run [7]. Similarly, Hussain *et al.* found positive and significant long-term impacts of mobile cellular subscriptions on the GDP per capita of South Asian economies [4]. From these previous results, it is more likely that mobile cellular contributes to economic growth in the long run rather than the short run.

Fixed telephone subscriptions

Fixed telephone subscriptions refer to the sum of active number of analogue fixed telephone lines, voice-over-IP subscriptions, fixed wireless local loop subscriptions, Integrated Services Digital Network (ISDN) voice-channel equivalents, and fixed public payphones. Albiman and Sulong found insignificant and negative effects of this factor on Sub Sahara African countries' economic growth, which was also proved when using the sum of fixed telephone lines and mobile phone subscriptions [7]. Similarly, examining the effects of ICT development on African nations but with a larger sample, Adeleye and Eboagu found positive but insignificant results of fixed telephone subscriptions [5]. However, Majeed and Ayub found positive and significant impacts of fixed telephone subscriptions on the sample of 149 countries [13].

Fixed broadband subscriptions

ITU mentions fixed broadband subscriptions as subscriptions to high-speed access to the public Internet, including cable modems, digital subscriber lines,

home fibers, other fixed (wired) broadband subscriptions, satellite broadband and terrestrial fixed wireless broadband[12]. Sapuan and Roly found that economic growth is positively and significantly improved by fixed broadband subscriptions[9]. However, Yong Jing and Ab-Rahim found insignificant coefficients of this variable on GDP of ASEAN-5 countries, which can be explained by differences in analyzing methods and data collection[8]. In addition, it was found that different income groups have different effects of fixed broadband subscriptions. Albiman and Sulong found that while fixed broadband subscriptions have positive and significant coefficients on upper-middle-income countries, this variable has no significant effects on lower-middle-income countries[7].

Internet users

Internet users are people who access the internet from any location. Sapuan and Roly found that GDP per capita in ASEAN-8 countries is positively affected by Internet users[9]. Similarly, results by Adeleye and Eboagu showed that Internet users have positive and significant impacts on the economic growth of 54 African countries[5]. Meanwhile, when analyzing the impacts of ICT factors on Sub-Saharan African countries, Albiman and Sulong found that Internet subscriptions have positive but insignificant effects on economic growth in the short run, but significantly contribute to GDP in the long run[7].

RESEARCH METHODS

Model specification and hypotheses

Based on growth models with ICT inputs[5,13], the author proposes the growth function as follows:

$GDP_{it} = A_{it} L_{it}^{\beta_1} K_{it}^{\beta_2} X_{it}^{\beta_3} ICT_{it}^{\beta_4} e^{u_{it}} = f(A_{it}, L_{it}, K_{it}, ICT_{it})$ (*)

Where GDP_{it} is the total GDP; A_{it} is the technological parameter; L_{it} is the total labor force; K_{it} is the gross fixed capital formation; X_{it} is the vector of control variables; ICT_{it} is the vector of ICT variables; u_{it} is the random disturbance.

By taking natural logarithms, the equation (*) is rewritten as follows:

$\ln GDP_{it} = \beta_0 + \beta_1 \ln L_{it} + \beta_2 \ln K_{it} + \beta_3 \ln X_{it} + \beta_4 \ln ICT_{it} + u_{it}$ (**)

Where $\ln GDP_{it}$ is the natural logarithm of total GDP; $\ln L_{it}$ is the natural logarithm of total labor force; $\ln K_{it}$ is the natural logarithm of gross fixed capital formation; $\ln X_{it}$ is the natural logarithm of control variables (in this case, the author chooses the trade openness, measured by total exports and imports as percentages of GDP); $\ln ICT_{it}$ is the natural logarithm of ICT variables.

In this article, the author chooses 4 different components to measure the variable of ICT infrastructure, namely mobile cellular subscriptions, fixed telephone subscriptions, fixed broadband subscriptions, and Internet users. To avoid the error of multicollinearity, each ICT variable is included in different estimation equations. Therefore, growth equations with ICT factors are written as follows:

$\ln GDP_{it} = \beta_0 + \beta_1 \ln L_{it} + \beta_2 \ln K_{it} + \beta_3 \ln trade_{it} + \beta_4 \ln mob_{it} + u_{it}$ (1)

$\ln GDP_{it} = \beta_0 + \beta_1 \ln L_{it} + \beta_2 \ln K_{it} + \beta_3 \ln trade_{it} + \beta_4 \ln ft_{it} + u_{it}$ (2)

$\ln GDP_{it} = \beta_0 + \beta_1 \ln L_{it} + \beta_2 \ln K_{it} + \beta_3 \ln trade_{it} + \beta_4 \ln fbb_{it} + u_{it}$ (3)

$\ln GDP_{it} = \beta_0 + \beta_1 \ln L_{it} + \beta_2 \ln K_{it} + \beta_3 \ln trade_{it} + \beta_4 \ln inte_{it} + u_{it}$ (4)

Where: $\ln GDP_{it}$ is the natural logarithm of GDP; $\ln K_{it}$ is the natural logarithm of gross fixed capital formation; $\ln L_{it}$ is the natural logarithm of total labors; $\ln trade_{it}$ is the natural logarithm of trade openness; $\ln mob_{it}$ is the natural logarithm of Mobile Cellular subscriptions; $\ln fbb_{it}$ is the natural logarithm of Fixed Broadband subscriptions; $\ln ft_{it}$ is the natural logarithm of Fixed Telephone subscriptions; $\ln inte_{it}$ is the natural logarithm of Internet individual users.

Based on previous results of ICT infrastructure factors on economic growth[5,7,9], the author suggests the following hypothesis:

H_1: Mobile cellular subscriptions have positive impacts on economic growth.

H_2: Fixed telephone subscriptions have positive impacts on economic growth.

H_3: Fixed broadband subscriptions have positive impacts on economic growth.

H_4: Internet individual users have positive impacts on economic growth.

Data collection

The author used secondary data from the World Bank[14]. The sample includes 10 ASEAN countries: Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, the Philippines, Singapore, Thailand and Vietnam, with the yearly time range from 2000 to 2021. Table 1 summarizes variables and data sources.

Unit-root test and cointegration test methods

The panel unit-root test is conducted to check whether the variables are stationary or non-stationary. In this research, the author used the Levin-Lin-Chu

Table 1: Summary of data sources

Variable	Explain	Unit	Data sources
GDP_{it}	Total GDP	USD	World Bank data
K_{it}	Gross fixed capital formation	USD	World Bank data
L_{it}	Total labor force	People	World Bank data
$trade_{it}$	Total export and import values	USD	World Bank data
mob_{it}	Mobile cellular subscriptions	Subscriptions	World Bank data
fbb_{it}	Fixed broadband subscriptions	Subscriptions	World Bank data
ft_{it}	Fixed telephone subscriptions	Subscriptions	World Bank data
$inte_{it}$	Internet individual users	People	World Bank data

Source: Author's compilations

unit-root test, which assumes that all panel variables have identical first-order partial autocorrelation, while other parameters in the error process vary across individuals [15].

The cointegration test aims to detect any false regression relationships between variables in all suggested models. In this research, the author used the Kao test, which is based on the residual of cointegrating regression [16].

Estimation method

The author chose the system Generalized Method of Moments (sys-GMM) to evaluate the impact of ICT infrastructure variables on the dependent variable. This estimator is expected to control the bias of omitted variables, heteroscedasticity and autocorrelation, as well as to generate reliable results in the presence of endogeneity and heterogeneity. In addition, the GMM estimator is designed for short-panel analysis and assumes that the data-generating process can be dynamic.

According to Arellano and Bond [17], the dynamic-panel equation for the GMM estimation is written as follows:

$$Y_{it} = \alpha Y_{it-1} + \beta X_{it-1} + \gamma Z_{it} + \varepsilon_{it}$$

Where Y_{it} is the dependent variable; Y_{it-1} is the first-level lagged value of the dependent variable; X_{it-1} is a vector of lagged level and differenced predetermined and endogenous variables; Z_{it} is a vector of exogenous variables; and α, β, γ are parameters. Therefore, the suggested growth models can be rewritten as follows:

$\ln GDP_{it} = \alpha_0 + \beta_0 \ln GDP_{it-1} + \beta_1 \ln L_{it} + \beta_2 \ln K_{it} + \beta_3 \ln trade_{it} + \beta_4 \ln ICT_{it} + \varepsilon_{it}$

Where: $\ln GDP_{it}$ is the natural logarithm of GDP; $\ln GDP_{it-1}$ is the natural logarithm of GDP at the time t-1; $\ln K_{it}$ is the natural logarithm of gross fixed capital formation; $\ln L_{it}$ is the natural logarithm of total labors; $\ln trade_{it}$ is the natural logarithm of trade openness; $\ln ICT_{it}$ is the natural logarithm of ICT variables (Mobile cellular subscriptions, fixed telephone subscriptions, fixed broadband subscriptions, Internet users).

RESULTS AND DISCUSSION

Sample descriptive statistics results

The results of sample summary are given in Table 2. Overall, after taking natural logarithms, standard errors of the variables are much lower than the mean values. Accordingly, the dependent variable has the mean value of 25.236 and the standard deviation of 1.530. Among the ICT infrastructure variables, fixed telephone subscriptions witness the lowest standard error at about 0.332. Other explanatory variables have standard errors ranging from 1.0 to 1.6.

Unit-root test and cointegration test results

7 out of 8 variables are found to be stationary at level with statistical significance levels at 1%, 5% or 10% (Table 3). Meanwhile, the variable of Internet users (ln_inte) is the only to be stationary at the 2nd difference level.

Additionally, all ICT infrastructure variables have unit-root at level. Accordingly, mobile cellular subscriptions (ln_mob) and fixed broadband subscriptions (ln_fbb) are stationary with the 1% significance level. Fixed telephone subscriptions (ln_ft) and Internet users (ln_inte) are statistically significant at 10% and 5% respectively.

The results of the Kao test (Table 4) show that all 4 models are statistically significant at 1%. These prove that there are cointegration relationships between variables in each model. Also, residual

Table 2: Sample descriptive statistics

	ln_gdp	ln_l	ln_k	ln_trade	ln_mob	ln_ft	ln_fbb	ln_inte
Mean	25.236	16.234	23.767	4.850	17.327	15.240	13.608	16.151
Median	25.838	16.752	24.339	4.843	17.862	15.099	14.231	16.299
Maximum	27.695	18.751	26.578	4.952	18.355	15.805	15.628	18.036
Minimum	22.329	11.960	20.504	4.733	14.608	14.726	10.328	14.142
Std. Dev.	1.530	1.782	1.622	0.055	1.139	0.332	1.683	1.049
Observatioı	220	220	220	220	220	220	220	220

Source: Author's compilations

Table 3: Levin-Lin-Chu test results

Levin-Lin-Chu test	t-statistic	Stationary level
ln_gdp	-4.452***	Level
ln_L	-3.365***	Level
ln_K	-3.981***	Level
ln_trade	-1.943**	Level
ln_mob	-6.498***	Level
ln_ft	-1.382*	Level
ln_fbb	-22.778***	Level
ln_inte	-1.697**	2nd difference

*Note: *** is significant at 1%; ** is significant at 5%; * is significant at 10%.*
Source: Author's compilations

Table 4: Kao test for cointegration results

Model	ADF-t	Residual variance	HAC variance
(1)	-3.410***	0.001	0.003
(2)	-3.684***	0.002	0.003
(3)	-3.352***	0.001	0.002
(4)	-3.474***	0.001	0.002

Source: Author's compilations
*Note: *** is significant at 1%.*

variance and heteroskedasticity-and-autocorrelation-consistent (HAC) variance values are relatively low, at about 0.001-0.003.

GMM estimation results

Results of the GMM estimation (Table 5) show that all ICT variables have significant coefficients on the dependent variable (ln_gdp). Among the ICT infrastructure factors, there are 3 of 4 variables that significantly contribute to economic growth, which have positive and significant coefficients.

The variable ln_inte has the highest coefficient on ln_gdp (0.095) and has the 1% statistical significance level (t = 5.134). ln_fbb has positive effects on economic growth with the coefficient of 0.028 and also has the 1% statistical significance level (t=3.550). The coefficient of ln_mob is 0.020, but found to be significant at 5% (t=2.344). Meanwhile, ln_ft is the only ICT variable to have negative effects on economic growth, with the coefficient of -0.074.

Among other independent variables, labor force (ln_L) and gross fixed capital formation (ln_K) are found to significantly contribute to economic growth in all models. Noticeably, the coefficients of ln_L are higher than those of ln_K, which implies that labor forces still have stronger effects on GDP of the sample

Table 5: GMM estimation results

Model	(1)	(2)	(3)	(4)
	Dependent variable:			
$lnGDP_{it-1}$	0.793***	0.785***	0.792***	0.784***
	(0.019)	(0.019)	(0.019)	(0.020)
	[42.37]	[41.61]	[42.50]	[40.14]
lnL_{it}	0.835***	0.980***	0.730***	0.499***
	(0.073)	(0.069)	(0.075)	(0.069)
	[11.436]	[14.110]	[9.757]	[7.262]
lnK_{it}	0.426***	0.455***	0.406***	0.367***
	(0.030)	(0.026)	(0.031)	(0.033)
	[13.989]	[17.724]	[13.004]	[11.213]
$lntrade_{it}$	0.099***	0.085**	0.104***	0.117***
	(0.018)	(0.047)	(0.017)	(0.018)
	[5.527]	[1.830]	[6.242]	[6.342]
$lnmob_{it}$	0.020**			
	(0.008)			
	[2.344]			
$lnft_{it}$		-0.074***		
		(0.015)		
		[-4.873]		
$lnfbb_{it}$			0.028***	
			(0.008)	
			[3.550]	
$lninte_{it}$				0.095***
				(0.019)
				[5.134]
R-squared	0.995	0.996	0.995	0.996
RMSE	0.104	0.101	0.103	0.098
Hausman Chi-square	0.000	0.000	0.000	0.000
Wald test F-statistic	3166.871***	2690.450***	2765.049***	2736.392***
Ramsey test F-statistic	0.73	1.83	3.00	1.79

Source: Author's compilations

*Note: *** is significant at 1%; ** is significant at 5%; * is significant at 10%.*

Standard errors are given in parentheses (); t-statistics are given in brackets.

than gross fixed capital formation. All these effects are statistically significant at the 1% level. Meanwhile, although trade openness is found to have significant effects on the dependent variable, the coefficients are much lower than those of labor force and gross fixed capital formation.

The determination coefficients (R^2) of all 6 models are greater than 0.99, which means that in each model, more than 99% of the variation in the dependent variable are explained by chosen independent variables. These statistics also prove that the collected data well fits the chosen models. Also, the RMSE values of all models are relatively low at about 0.1, indicating a good fit between chosen models and datasets.

The Hausman chi-square values are close to 0, which proves that random effects are not significant and not appropriate for the chosen equations. Therefore, the model has the presence of endogeneity, which could be solved by using the GMM estimator. The GMM estimator also controls bias of heterogeneity, as mentioned in the Research methods. In addition, the author used the Wald test to prove the significance of

explanatory variables, which had F-statistic values to be significant at 1%. Results of the Ramsey test show that the model has no omitted variables, which means that all chosen variables are important. These results also support the model's stability.

In addition, the indicators of Variance Inflation Factors (VIF) are lower than 10, which means that the models have no phenomenon of multicollinearity. The results of VIF are presented in Table 6.

DISCUSSION

As mentioned in the estimation results, mobile cellular subscriptions, fixed broadband subscriptions, and Internet users significantly improve ASEAN economies. These results are consistent with previous findings by Yong Jing and Ab-Rahim[8], implying that ICT infrastructure investment would promote the ICT industry, then contribute to economic growth. Also, with ICT infrastructure advantages, nations can attract diverse investment sources, including those from international organizations and multinational companies. These opportunities are also expected to help ASEAN nations rapidly access to advanced digital technologies, promote the process of digital transformation as well as enhance economic aspects. Furthermore, if the study by Ahmed and Ridzuan only found contributions of ICT development to ASEAN economies through spending on ICT infrastructure,[18] then the results of this study imply that nations need to focus on different aspects such as infrastructure development, penetration, and even quality of ICT human resources in the era of digital economy.

However, this study found insignificant contributions of fixed telephone subscriptions to economic growth. This finding is consistent with results by Albiman and Sulong, which suggested that the effects of fixed telephone lines on developing nations may be significant over a long period instead of in the short run[7]. Meanwhile, significant effects of other ICT factors, including mobile cellular subscriptions, fixed broadband subscriptions, and Internet users, imply that ASEAN economies can adapt to short-run development of these infrastructure components and quickly improve economic growth. Also, the lack of ICT policy formulation and unequal penetration may prevent developing countries from receiving the effectiveness of digital technologies in short periods. This assumption can be supported by the facts in the ASEAN region, where large gaps between countries in developing ICT infrastructure have remained. Therefore, it is vital for nations to make policies that support ICT infrastructure development both in the short and long terms.

CONCLUSION AND POLICY IMPLICATIONS

Conclusion

This research aims to build growth models and evaluate impacts of ICT infrastructure factors on ASEAN countries' economic growth. Research results show that economic growth in ASEAN is significantly affected by infrastructure aspects of mobile cellular, fixed broadband, and the Internet. However, fixed telephone lines have no significant short-run effects on economic growth. Also, ASEAN members' economic growth is found to be well improved with the presence of labor force, gross fixed domestic capital, and trade openness.

The research has theoretical contributions in developing growth models with ICT inputs. First, the author builds different growth models with different ICT variables, which are found to have significant effects on economic growth. Also, when employing the GMM estimator for the sample of ASEAN nations, ICT variables have positive coefficients on the dependent variable. These results are contrary to some studies on sub-samples of the region that show almost insignificant effects of ICT development when using traditional panel estimation techniques[8,18]. This suggests that when controlling bias such as omitted variables, heteroskedasticity, endogeneity, and auto correlation, the effects of explanatory variables are statistically significant. From these results, it is possible to evaluate the general situation of ICT factors' impacts on economic growth in Southeast Asia, then policy implications for nations are given.

Policy implications for Vietnam

First, besides opportunities to access to advanced ICT technologies and foreign sources, Vietnam will have to compete with different nations in inventing, producing, and selling ICT products. At present, although the revenue of the ICT industry reached more than 110 billion USD in 2022, only less than 30% of these are contributed by domestic ICT products[19]. Therefore, the nation needs to provide programs and strategies to develop domestic enterprises and domestic ICT products. Marketing campaigns and promotion of domestic ICT products or special offers and price discounts are ideal solutions to encourage people to choose "made in Vietnam" ICT products, leading to the expansion of the domestic ICT industry. Also, investments and supports from government, authorities, and organizations are essential, especially aids in infrastructure development and research activities.

Table 6: Variance Inflation Factors results

Model	(1)	(2)	(3)	(4)
lnL_{it}	1.98	2.48	1.79	1.72
lnK_{it}	9.35	9.04	9.51	9.9
$lntrade_{it}$	6.17	6.69	6.21	6.16
$lnmob_{it}$	3.58			
$lnft_{it}$		7.43		
$lnfbb_{it}$			3.17	
$lninte_{it}$				3.89

Source: Author's compilations

Second, it is necessary to create favorable institutions and environments for ICT enterprises. For example, the Law on Digital Technology Industry will be added to the Law and Ordinance Development Program in 2023, which will overcome previous inadequacies in the development of the ICT industry. Also, there needs to be other supportive policies such as policies on digital technology industrial infrastructure, policies on promoting the development of new products and services, policies on forming a modern infrastructure system necessary for the development of the ICT industry, etc. In addition, authorities can deploy made-in-Vietnam ICT products and services development policies, which stipulate a number of priority and preferential policies, such as priority in procurement of state agencies; government support, ordering research and development, mastering core, key and dual-use products and technologies, as well as supporting the commercialization of research and development results of digital technology products and services.

Third, besides infrastructure aspects, Vietnam needs to develop ICT human resources that play a decisive role in the digital economy. To improve the quality of ICT human resources, the Government and authorities need to research and propose the National Digital Technology Skills Framework that is consistent with international standards, then create a practical training mechanism at enterprises and other organizations. In addition, to encourage ICT students to gain practical experiences, universities and educational systems can recognize results of internship, work, participation in digital products and services development projects at ICT firms as credits in training programs. Furthermore, it is necessary to have policies to attract excellent domestic and foreign digital human resources, especially in terms of salary, bonus, and remuneration. This will enable Vietnam to build a network of ICT specialists in the future. Therefore, these recommendations also imply further researches on different ICT aspects beside infrastructure development, such as ICT human capital or ICT skills.

ACKNOWLEDGEMENTS

This paper is the result of Foreign Trade University student's scientific research activities.

LIST OF ABBREVIATIONS

ADF: Augmented Dickey-Fuller
ASEAN: Association of Southeast Asian Nations
GDP: Gross domestic products
GMM: Generalized Method of Moments
HAC: Heteroskedasticity - and - autocorrelation - consistent
ICT: Information and Communication Technologies
ITU: International Telecommunication Union
RMSE: Root-mean-square error
UN: United Nations

CONFLICT OF INTEREST

The author declares that there are no competing interests in the publication of this article.

AUTHORS' CONTRIBUTION

The entire content of the article is written by the author only.

REFERENCES

1. World Bank. Information and Communication Technologies: Results Profile [Online]. 2013 [cited 2022 Aug 23];Available from: https://www.worldbank.org/en/results/2013/04/13/ict-results-profile.
2. Google. e-Conomy SEA 2021 report - Google [Online]. 2021 [cited 2022 Oct 21];Available from: https://economysea.withgoogle.com/.
3. Shodiev T, Turayey B, Shodiyev K. ICT and Economic Growth Nexus: Case of Central Asian Countries. Procedia Soc Sci Humanit. 2021; (1):155-67;Available from: https://doi.org/10.21070/pssh.v1i.37.

4. Hussain A, Batool I, Akbar M, Nazir M. Is ICT an enduring driver of economic growth? Evidence from South Asian economies. Telecommun Policy. 2021 Sep 1;45(8):102202;Available from: https://doi.org/10.1016/j.telpol.2021.102202.
5. Adeleye N, Eboagu C. Evaluation of ICT development and economic growth in Africa. NETNOMICS Econ Res Electron Netw. 2019 Apr 1;20(1):31-53;Available from: https://doi.org/10.1007/s11066-019-09131-6.
6. Aghaei M, Rezagholizadeh M. The impact of information and communication technology (ICT) on economic growth in the OIC countries. Econ Environ Stud EES. 2017;17(2):257-78;Available from: https://doi.org/10.25167/ees.2017.42.7.
7. Albiman MM, Sulong Z. The linear and non-linear impacts of ICT on economic growth, of disaggregate income groups within SSA region. Telecommun Policy. 2017;41(7-8):555-72;Available from: https://doi.org/10.1016/j.telpol.2017.07.007.
8. Yong Jing AH, Ab-Rahim R. Information and Communication Technology (ICT) and Economic Growth in ASEAN-5 Countries. J Public Adm Gov. 2020 Mar 31;10(2):20-33;Available from: https://doi.org/10.5296/jpag.v10i2.16589.
9. Sapuan NM, Roly MR. The Impact of ICT and FDI as Drivers to Economic Growth In ASEAN-8 Countries: A Panel Regression Analysis. Int J Ind Manag. 2021 Jan 3;9:91-8;Available from: https://doi.org/10.15282/ijim.9.0.2021.5958.
10. UNESCO. Information and communication technologies (ICT) | UNESCO IIEP Learning Portal [Online]. 2009 [cited 2022 Dec 15];Available from: https://learningportal.iiep.unesco.org/en/glossary/information-and-communication-technologies-ict.
11. United Nations. UN e-Government Surveys [Online]. 2022 [cited 2022 Dec 5];Available from: https://publicadministration.un.org/en/Research/UN-e-Government-Surveys.
12. ITU. The ICT Development Index (IDI): conceptual framework and methodology [Online]. ITU. 2017 [cited 2022 Oct 26];Available from: https://www.itu.int:443/en/ITU-D/Statistics/Pages/publications/mis2017/methodology.aspx.
13. Majeed MT, Ayub T. Information and communication technology (ICT) and economic growth nexus: A comparative global analysis. Pak J Commer Soc Sci PJCSS. 2018;12(2):443-76;.
14. World Bank. World Development Indicators [Online]. 2022 [cited 2022 Sep 17];Available from: https://databank.worldbank.org/source/world-development-indicators.
15. Levin A, Lin CF, Chu CSJ. Unit root tests in panel data: asymptotic and finite-sample properties. J Econom. 2002;108(1):1-24;Available from: https://doi.org/10.1016/S0304-4076(01)00098-7.
16. Kao C. Spurious regression and residual-based tests for cointegration in panel data. J Econom. 1999 May 1;90(1):1-44;Available from: https://doi.org/10.1016/S0304-4076(98)00023-2.
17. Arellano M, Bond S. Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations. Rev Econ Stud. 1991;58(2):277-97;Available from: https://doi.org/10.2307/2297968.
18. Ahmed EM, Ridzuan R. The Impact of ICT on East Asian Economic Growth: Panel Estimation Approach. J Knowl Econ. 2012;4(4):540-55;Available from: https://doi.org/10.1007/s13132-012-0096-5.
19. Government of the Socialist Republic of Vietnam. ICT revenue hits nearly US$110 bln in nine months [Online]. en.baochinhphu.vn. 2022 [cited 2023 Jan 5];Available from: https://en.baochinhphu.vn/ict-revenue-hits-nearly-us110-bln-in-nine-months-111221019161521669.htm.

Tạp chí Phát triển Khoa học và Công nghệ – Kinh tế-Luật và Quản lý 2023, 7(2):4331-4340

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Bài nghiên cứu

Tác động của phát triển hạ tầng Công nghệ Thông tin và Truyền thông đối với tăng trưởng kinh tế: Nghiên cứu thực nghiệm tại các nước Đông Nam Á

Nguyễn Dương Việt Anh*

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TÓM TẮT

Bài viết này nhằm hệ thống hóa mô hình tăng trưởng và phân tích tác động của việc phát triển cơ sở hạ tầng Công nghệ thông tin và Truyền thông (ICT) đối với tăng trưởng kinh tế của các nước Đông Nam Á. Theo đó, các mô hình tăng trưởng được xây dựng với với yếu tố đầu vào ICT: Thuê bao di động, thuê bao điện thoại cố định, thuê bao băng rộng cố định và lượng người dùng Internet. Sử dụng dữ liệu từ Ngân hàng Thế giới, tác giả đã thu thập 220 quan sát của 10 thành viên ASEAN trong giai đoạn 2000-2021. Để đánh giá mức độ ảnh hưởng của các yếu tố cơ sở hạ tầng ICT đến nền kinh tế, tác giả đã sử dụng các phương pháp phân tích và ước lượng bảng khác nhau: kiểm định nghiệm đơn vị bảng, kiểm định đồng liên kết bảng và Phương pháp ước lượng Tổng quát GMM. Kết quả cho thấy, tất cả các biến đều mang tính dừng và có mối quan hệ đồng tích hợp. Đồng thời, kết quả kiểm định Ramsey cho thấy mô hình không gặp lỗi bỏ sót biến, từ đó chứng minh độ phù hợp của mô hình. Có 3 biến ICT thúc đẩy đáng kể tăng trưởng kinh tế: Thuê bao di động, thuê bao băng thông rộng cố định và người dùng Internet, trong khi điện thoại cố định có tác động tiêu cực đến mẫu nghiên cứu. Đồng thời, tác giả cũng nhận thấy tăng trưởng kinh tế chịu tác động tích cực bởi lao động, tổng vốn cố định, và độ mở thương mại. Về mặt lý thuyết, bài viết đã xây dựng mô hình tăng trưởng với véc-tơ các yếu tố ICT (Thuê bao di động, thuê bao điện thoại cố định, thuê bao băng rộng cố định và lượng người dùng Internet). Đồng thời, khi sử dụng phương pháp ước lượng GMM có thể kiểm soát các khuyết tật như tính nội sinh, phương sai sai số thay đổi và tự tương quan, kết quả tác động của các biến giải thích đối với tăng trưởng kinh tế cho thấy mức ý nghĩa thống kê. Về mặt thực tiễn, kết quả nghiên cứu đã đưa ra cái nhìn tổng quan về ảnh hưởng của ICT đối với nền kinh tế của các nước Đông Nam Á, điều này tương thích với thực trạng phát triển ICT của khu vực. Từ những kết quả này, bài viết gợi ra những hàm ý chính sách cho Việt Nam trong việc phát triển ICT cũng như áp dụng ICT vào các hoạt động kinh tế-xã hội.

Từ khoá: Hạ tầng ICT, tăng trưởng kinh tế, ASEAN, Việt Nam

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Lịch sử

- Ngày nhận: 06-01-2023
- Ngày chấp nhận: 28-4-2023
- Ngày đăng: 31-5-2023

DOI : https://doi.org/10.32508/stdjelm.v7i2.1178

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Trích dẫn bài báo này: Anh N D V. **Tác động của phát triển hạ tầng Công nghệ Thông tin và Truyền thông đối với tăng trưởng kinh tế: Nghiên cứu thực nghiệm tại các nước Đông Nam Á**. *Sci. Tech. Dev. J. - Eco. Law Manag.;* 2023, 7(2):4331-4340.