CITIZEN: Jurnal Ilmiah Multidisiplin Indonesia
Vol. 6 No. 1, 2026
ISSN: 2807-5994
https://journal.das-institute.com/index.php/citizen-journal

IMPACT OF DIGITAL INFORMATION TECHNOLOGY ON INDONESIA'S ECONOMIC GROWTH

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DOI: 10.53866/jimi.v6i1.1249

Abstract

The advancement of information technology has boosted standard of living among societies. This research tries to find the impact of manufacture growth in information technology on Indonesia's economic growth. It is a time series analysis with data from the 1st quarter 1994 until 3th quarter 2016. Data used are GDP (Gross Domestic Products), the exchange rate rupiah over USD, and manufacture in information technology. The method of VECM is used to describe bi-directional relationship among variables, and it also enables us to pose endogenity with the exception to specific variable. Empirical results conclude that manufacture's growth in the information technology has a significantly positive influence on Indonesia's economic growth, both in the short-term and the long-term. Meanwhile variable exchange rate only has influence in the short term, not in the long term. This finding suggests that the improvement of information technology can boost economic growth nicely. Indonesia as a developing country, should tackle good regulation and promote innovation in this sector to face strict global competitiveness. Innovation in information technology is a high-cost project, so all requirements must be provided proportionally and put it as the top priority. By improving manufactures in information technology, many jobs can be opened; to recruit new employees. This will decrease the unemployment and poverty rates.

Keyword: Information Technology, Economic Growth

1. Introduction

The advancement of information technology has made everything easy. Looking for current news and or hot issues is not a difficult task. Any information can be found quickly. Fast access to online transaction had cut many logistical costs. The impacts of digital technology in business have made all matters as simple as possible and cheap. Digital technology apparently succeeds in minimizing marginal cost, so that producers and consumers get more benefit. Innovation in information technology continues to improve, never being stagnant for a moment. All people around the world always compete to create better technology to produce better and more outstanding results. The importance of information technology is very obvious in the modern human being.

Some researchers, such as Iqbal *et.al*, (2022) shows evidence that information communication technology (ICT) contributes to global social change, politics and sustainable economic development growth. These changes made several improvements of social welfare. Interestingly, their findings also prove that the use of ICT in various countries in the world is able to encourage an increase in Foreign Direct Investment (FDI) in the long term, and stimulate green economic growth with support for endogenous economic growth theory. The high increase in ICT innovation can stimulate trade between countries and encourage increased economic activity.

We must realize that the digital economy has disseminated countless aspects in world economy, influences various sectors such as banking, retail, energy, transportation, education, publishing, media and health (OECD, 2015). That ease was based on the result of improvements and breakthroughs in information technology. We live now in modern society. We cannot escape from this phenomenon.

Human civilization always advances gradually. Once, years ago, people had to calculate anything with their bare hands. But now we can use a computer to solve any sophisticated mathematical calculation. The economists find that the impact of computers on boosting the USA's economic growth (Oliver & Sichel, 1994). Jorgenson & Stiroh (2000) conclude that the new economy, namely information technology (IT), has altered many things in the USA, especially in the business sector. IT is really driving

the USA's economic performance. Edwards (2002) has an interesting thought that investment in information and communication technology (ICT) never incurs many gains, if and only if, fundamental aspects in developing countries are not being resolved first. His research involves some developing countries in Latin America. Before one nation invests in advancing ICT, there is a necessity to invest ultimately in complementary areas, including research and development, education, and infrastructure, so that investment in information and technology will have a great effect on economic growth. Especially, institutional and economic reform is very needed in order for investment in ICT to produce expected outcomes. Indonesia, as a developing country, should consider this to succeed in developing the ICT sector.

Empirical results by Houben & Kakes (2002) conclude that there is a strong relationship between the ICT sector and the structure of financial institutions. The differences in financial structure become important elements in order for the performance of ICT to be a trigger of productivity. This difference can be seen from one country to another. Innovation and investment in new firms are always related to transparency in using funds. It is because of the liberalization of the financial market to fund themselves easily. Therefore, the gains of increasing productivity of the new economy in the USA can be attributed to the impact of liberalization in the past periods. However, empirical evidence of Houben & Kakes (2002) was rejected by Iscan (2012) with the case of Turkey's economic growth, where the financial sector does not have a relationship with the rise of ICT in the long-term. Nevertheless, his research shows that other variables such as industry, manufactures, construction, and the trade sector clearly have a close relation with the improvement of ICT.

Farhadi *et.al* (2012) explain their finding that ICT without doubt has a significant impact on the economic growth of all nations in the world, not only developed countries but also less and middle developing countries. Nonetheless, it must be realized that the usage of ICT in developed markets is higher than in developing countries, so that the impact will be bigger.

Information technology changes many developing countries' ability to resolve socioeconomic problems. By positioning information technology as a vehicle to support ultimate development, India as a second biggest population in the world that succeeded in getting into digitalization effectively, and India's economy grows rapidly with higher GDP growth (Ishmeet & Kaur, 2017). India is one of the successful development examples through improving its capacity in information technology. In this context, it is obvious that the importance of innovation in information technology for development country to achieve higher prosperity. Ortega-Argilés (2012) explores some factors producing the productivity gap between the European economy and the United States of America's economy, and finds that the obvious trigger is the different concentration in the new economy. The USA spends more to build a system of R&D in the knowledge economy sector, so that it incurs its economic growth marked by fast acceleration.

Research on the causal relationship between ICT diffusion, innovation diffusion, venture capital investment, and economic growth for 25 countries in Europe with a period from 1989 to 2006, shows that there are differences in influence in the long term and short term (Pradhan *et.al*, 2020). In the long term, venture capital investment, ICT diffusion, and innovation diffusion have a significant impact on economic growth in Europe. Meanwhile, in the short run, the direction of the causal influence varies depending on the specific measures of ICT and innovation diffusion.

Heeks (2010) clearly explains the role of information technology for sustainable economic growth in the future, with some notes that must be noticed as a benchmark for the input-output model for ICT development, namely: *first,* the readiness of the nation to undertake any ICT initiatives for developing economy. The first ultimate thing to be considered is the systematic prerequisite for developing ICT in order to support economic activities among the people; *second*, availability. ICT must be available to the public as a facility provided by the government; *third*, uptake. In the process of developing economy ICT cannot be relied on sole usage in several times, but also continuing and sustainable over time; *fourth*, impact which can be divided into three elements: output (usage at the micro level: household and firms), outcomes (profit can be obtain due to usage of ICT), and development impact (contribution from accelerating ICT that can be traced widely at macroeconomic level). These differences signify benefits that can be achieved in each level of usage.

Information and communication technology (ICT) is undoubtedly considered a driver of the Chinese economy (Huang & Khan, 2022). It can help broaden export expansion and increase domestic demand. Their findings show that the ICT sector has a prominent strength in connecting the supply and demand sides, which has an impact on improving the Chinese economy. From their findings, it can be said that the ICT sector is the engine of China's economic growth; Increasing the ICT sector can play a role in stimulating sustainable economic growth.

Meanwhile, China has sought to expand the reach of its foreign trade by building the Belt and Road Initiative (BRI), through improving infrastructure and strengthening trade and investment relations between the economic powers involved (Shurong *et.al*, 2024). From empirical research in Eastern Africa, it was found that improving the ICT infrastructure network is one of the factors that drives increased bilateral trade and the economy in the Eastern Africa region. This finding reinforces that the ICT sector is very crucial in advancing trade capacity between countries.

Research conducted by Kitole *et.al*, (2023) shows that the emergence of digital technology has had a serious impact on the welfare of people throughout the world. Research conducted in Tanzania involving many Nile perch fishermen in Lake Victoria in Mwanza, showed an increase in the welfare of fishermen, especially their income. The adoption of digital technology has made several breakthroughs by opening up wider markets, competition, and improving life.

Our research tries to answer several questions on how important the role of information technology is for human life, with a focus on Indonesia's economic growth. It is because research on the ICT sector and economic growth in developing countries is still rare (Farhadi *et.al*, 2012).

We want to fill the gap in research in the developing countries. Besides, as an emerging market, Indonesia still struggles to develop the capacity of the internet and other information technology to boost social welfare. By conducting this research, we believe we can show the importance of ICT in boosting economic growth. We also use the exchange rate as a variable to capture its impact on economic growth.

Some researchers, such as Shaik & Gona (2021) show that exchange rate significantly affects economic growth in India, not just in the long term, but also there is a unidirectional relationship between exchange rate and economic growth in the short term. Lartey (2017) shows us that a more flexible exchange rate can stimulate a greater increase in economic growth through remittance. Missio *et al.*, (2015) find that the real exchange rate has a positive impact on economic growth. They state that maintaining a competitive level of real exchange rate can be powerful enough to sustain a positive effect on economic growth

The exchange policy coordinated with public infrastructure policy can contribute to empowering economic growth in terms of increasing productivity of trade and reducing inflation (Neto & Lima, 2017). The stable exchange rate becomes a competitive currency that has role in making better production.

2. Methodology

This research aims to find the impact of information technology on economic growth. By considering Indonesia as an open and developing country, we choose to involve the exchange rate as an important variable in relation with transfer the high technology from other countries. It was conducted with period from the first quarter of 1994 until the third quarter of 2016. We use secondary data, namely: Gross Domestic Product (GDP), which is taken from the Asian Development Bank (ADB, 2018), exchange rates (rupiah over American dollar), which are taken from the Federal Reserve (FRED, 2018), and manufactures in information communication technology, which are taken from the OECD website (OECD, 2018). All data was transformed into natural logarithm in accordance to analyze easily.

This research uses VECM (Vector Error Correction Model), which attempts to find short-term and long-term relationships among variables (Lütkepohl & Krätzig, 2004). We consider VECM because it can fulfil the requirements for our research focus, as it is able to see a bi-directional relationship among variables. It can also provide a test of the impulse response that tries to forecast regarding shocks in the future, and also to test the variance decomposition that is directed to obtain the variation of shocks among variables.

By considering this study, which is an analysis of time series, before estimation of VECM, we should test stationary data. Our finding empirically proves that two data series unless GDP is not stationary at the level. Therefore, all data must be transformed into first differences. The data have proven stationary. The brief table of estimation can be seen below:

Table 1. Test of Stationarity

Variable	t-statistics	Prob.*
GDP	-6.664948	0.0000
Exchange Rate	-7.068789	0.0000
Manufacture in ICT	-4.745701	0.0002

Source: *Calculation by Author*

The test of stationarity above signifies that the data are in accordance with scientific rules, which means that the data can be considered reliable. If the data is not stationary, the analysis cannot proceed, because the result of the analysis will be spurious regression. Stationarity signifies that the error term is constant all the time.

VECM analysis urges us to run a cointegration test. It is very important so that we can find whether there is a long-term relationship among variables or not. In practice, VECM is developed from VAR method. If the result of the cointegration test shows a long-term relationship, VECM is chosen as an ideal model. If there is no relation, VAR can be an appropriate model. Detail result of the analysis can be seen below:

Table 2. Cointegration Test

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.429603	46.10754	35.19275	0.0023
At most 1	0.142024	11.29937	20.26184	0.5135
At most 2	0.028650	1.802264	9.164546	0.8167
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Source: *Calculation by Author*

From the result of the cointegration test we find that there is a long-term relationship at 1 variable. Therefore, we choose VECM in this research. The arrangement of estimation as follows:

1) $\Delta G_t = \delta_1 + \gamma_1 e_{t-1} + \tau_{11}\Delta G_{t-1} + \cdots + \mu_{1u}\Delta G_{t-u} + \sigma_{11}\Delta X_{t-1} + \phi_{11}\Delta Z_{t-1} + \cdots + \sigma_{1v}\Delta X_{t-v} + \phi_{1w}\Delta Z_{t-w} + \varepsilon_{1t}$
2) $\Delta X_t = \delta_2 + \gamma_2 e_{t-1} + \tau_{21}\Delta X_{t-1} + \cdots + \sigma_{2v}\Delta X_{t-v} + \mu_{21}\Delta G_{t-1} + \phi_{21}\Delta Z_{t-1} + \cdots + \mu_{2u}\Delta G_{t-u} + \phi_{2w}\Delta Z_{t-w} + \varepsilon_{2t}$
3) $\Delta Z_t = \delta_3 + \gamma_3 e_{t-1} + \tau_{31}\Delta Z_{t-1} + \cdots + \phi_{3w}\Delta Z_{t-w} + \sigma_{31}\Delta X_{t-1} + \mu_{31}\Delta G_{t-1} + \cdots + \sigma_{3v}\Delta X_{t-v} + \mu_{3u}\Delta G_{t-u} + \varepsilon_{3t}$

information:
$e_{t-1} = G_{t-1} - \beta - \beta X_{t-1} - \beta Z_{t-1}$; or e_{t-1}= residual of simple linear regression
G_t = GDP at period t
X_t = Exchange Rate at period t
Z_t = Manufacture in ICT at period t
$\gamma, \tau, \mu, \sigma, \phi$ = Coefficient of each independent variable
δ = Vector of Cointegration
Δ = symbol of first difference
ε = error term of VECM

In the first equation we set GDP as a dependent variable. In the second, we use the exchange rate as a dependent variable. Meanwhile, in the last equation, we place the manufacture of ICT as an endogenous variable. From the above three variables, we can obtain not only detailed information about the past situation, but also forecasting or prediction in the future, namely analysis concerning shock of them.

3. Result and Discussion

3.1. Result

The progression of digital information technology lies in the ability of stakeholders to provide resources that are needed by the people. ICT helps economic agents to avoid the risk of lateness, and it triggers competition among them. Economic activities become more competitive. Now we test the empirical result of this research. Based on the calculation, we get the information below:

$$\Delta \ln GDP_t = -0.05834 - 0.19562\Delta \ln Xrate_t + 6.903005\Delta \ln Man_t$$
$$s.e. \quad (0.01412) \quad (0.38985) \quad (1.66785)$$
$$t-stat \quad [-4.13091] \quad [-0.508187] \quad [4.13886]$$

The calculation above is the long-run result. It shows us that only the manufacture in information technology has a positive and significant impact on economic growth. For every one percent increase of the manufacture of ICT, GDP will increase 6.9 percent. It is proven by the value of the t-statistic 4.138, which is bigger than the t-table in 5 percent or 10 percent, which are 1.67 and 1.29. It signifies that improvement in the manufacture of information technology is very important for Indonesia's economic growth.

We see the calculation in the short-term as follows:

Table 3. Short-Term Analysis

Error Correction:	D(LGDP)	D(LXRATE)	D(LMAN)
CointEq1	-1.361516	1.230953	-0.138956
	(1.09598)	(0.31421)	(0.13402)
	[-1.24228]	[3.91761]	[-1.03679]
D(LGDP(-1))	0.419912	-1.391384	0.153900
	(1.10657)	(0.31725)	(0.13532)
	[0.37947]	[-4.38582]	[1.13730]
D(LGDP(-2))	0.935888	-1.601484	0.123286
	(1.10562)	(0.31698)	(0.13520)
	[0.84648]	[-5.05239]	[0.91185]
D(LGDP(-3))	0.831053	-1.469993	0.104958
	(1.02137)	(0.29282)	(0.12490)
	[0.81366]	[-5.02010]	[0.84033]
D(LGDP(-4))	0.491036	-1.356974	0.067790
	(0.92664)	(0.26566)	(0.11332)
	[0.52991]	[-5.10792]	[0.59823]
D(LGDP(-5))	0.479677	-1.252636	0.056555
	(0.82394)	(0.23622)	(0.10076)
	[0.58218]	[-5.30289]	[0.56130]
D(LGDP(-6))	0.227744	-1.053824	-0.004166
	(0.71292)	(0.20439)	(0.08718)
	[0.31945]	[-5.15598]	[-0.04778]
D(LGDP(-7))	0.245752	-0.828401	-0.002995
	(0.58296)	(0.16713)	(0.07129)
	[0.42156]	[-4.95662]	[-0.04201]
D(LGDP(-8))	0.067329	-0.536272	-0.017931
	(0.42231)	(0.12107)	(0.05164)
	[0.15943]	[-4.42927]	[-0.34720]
D(LGDP(-9))	0.098397	-0.324103	-0.015344
	(0.27024)	(0.07748)	(0.03305)
	[0.36410]	[-4.18319]	[-0.46429]
D(LGDP(-10))	0.281843	-0.181568	-0.023951
	(0.15750)	(0.04515)	(0.01926)
	[1.78948]	[-4.02108]	[-1.24354]
D(LXRATE(-1))	-1.979162	-0.614717	-0.012402
	(0.50984)	(0.14617)	(0.06235)
	[-3.88192]	[-4.20555]	[-0.19891]
D(LXRATE(-2))	-1.339597	-1.523971	-0.003439
	(0.77718)	(0.22281)	(0.09504)
	[-1.72366]	[-6.83970]	[-0.03619]
D(LXRATE(-3))	-1.043564	-1.488776	-0.069751
	(1.00841)	(0.28911)	(0.12332)
	[-1.03486]	[-5.14960]	[-0.56563]
D(LXRATE(-4))	-0.630067	-1.671376	-0.008604
	(1.07258)	(0.30750)	(0.13116)
	[-0.58743]	[-5.43532]	[-0.06560]
D(LXRATE(-5))	-0.260476	-1.152905	-0.060571
	(1.04131)	(0.29854)	(0.12734)
	[-0.25014]	[-3.86187]	[-0.47567]
D(LXRATE(-6))	0.095503	-1.121530	-0.001371
	(0.92024)	(0.26383)	(0.11253)
	[0.10378]	[-4.25103]	[-0.01218]
D(LXRATE(-7))	0.118762	-0.677252	-0.120556
	(0.87058)	(0.24959)	(0.10646)
	[0.13642]	[-2.71346]	[-1.13239]

D(LXRATE(-8))	-0.264863	-0.504024	-0.181009
	(0.79668)	(0.22840)	(0.09742)
	[-0.33246]	[-2.20674]	[-1.85795]
D(LXRATE(-9))	-0.063546	-0.150748	-0.181980
	(0.68996)	(0.19781)	(0.08437)
	[-0.09210]	[-0.76210]	[-2.15683]
D(LXRATE(-10))	-0.705273	0.129425	-0.096641
	(0.55151)	(0.15811)	(0.06744)
	[-1.27881]	[0.81855]	[-1.43293]
D(LMAN(-1))	8.341960	-6.940602	-0.305138
	(6.95347)	(1.99351)	(0.85032)
	[1.19968]	[-3.48159]	[-0.35885]
D(LMAN(-2))	6.441606	-4.578354	-0.343560
	(6.15579)	(1.76482)	(0.75278)
	[1.04643]	[-2.59423]	[-0.45639]
D(LMAN(-3))	7.287466	-3.445463	-0.501548
	(5.45745)	(1.56462)	(0.66738)
	[1.33532]	[-2.20212]	[-0.75152]
D(LMAN(-4))	8.668727	-2.044367	-0.329198
	(4.81228)	(1.37965)	(0.58848)
	[1.80138]	[-1.48180]	[-0.55940]
D(LMAN(-5))	5.934216	-0.842682	-0.283594
	(4.01074)	(1.14985)	(0.49047)
	[1.47958]	[-0.73286]	[-0.57821]
D(LMAN(-6))	6.881701	-1.267261	-0.383419
	(3.39141)	(0.97229)	(0.41473)
	[2.02916]	[-1.30337]	[-0.92451]
D(LMAN(-7))	5.629771	-1.089574	-0.341247
	(2.89009)	(0.82857)	(0.35342)
	[1.94795]	[-1.31500]	[-0.96555]
D(LMAN(-8))	3.198105	-0.566668	-0.038299
	(2.08913)	(0.59894)	(0.25548)
	[1.53083]	[-0.94612]	[-0.14991]
D(LMAN(-9))	3.528160	-0.937864	-0.122803
	(1.59984)	(0.45866)	(0.19564)
	[2.20532]	[-2.04478]	[-0.62769]
D(LMAN(-10))	1.895677	-0.324694	-0.042492
	(1.07535)	(0.30830)	(0.13150)
	[1.76285]	[-1.05319]	[-0.32313]
R-squared	0.804344	0.761453	0.908318
Adj. R-squared	0.615000	0.530601	0.819593
Sum sq. resids	0.949951	0.078079	0.014206
S.E. equation	0.175053	0.050187	0.021407
F-statistic	4.248051	3.298445	10.23746
Log likelihood	41.55867	119.0179	171.8441
Akaike AIC	-0.340602	-2.839287	-4.543359
Schwarz SC	0.722965	-1.775719	-3.479792
Mean dependent	-0.042491	0.006335	0.001686
S.D. dependent	0.282124	0.073251	0.050399
Determinant resid covariance (dof adj.)		2.60E-08	
Determinant resid covariance		3.25E-09	
Log likelihood		341.9826	
Akaike information criterion		-7.902666	
Schwarz criterion		-4.574730	

Source: *Calculation by Author*

In the short term, there is little difference because the exchange rate has a significant negative

influence on economic growth. At lag-1, the impact recorded -1.97 per cent, and at lag-2, it becomes -1.33 per cent. Meanwhile manufacture of information technology also has a significant positive effect on economic growth. At lag-4, we see the effect of information technology at 8.66 per cent, then it decreases smoothly to 6.88 per cent at lag-6. The impact decreases at lag-7 to 5.62 per cent and then continues decreasing until 1.89 per cent at lag-10. The value adj. R^2 is 0.61 signifies that the impact of the independent variable on the dependent variable is 61 percent. The rest is explained by other factors out of model.

The impact of GDP on the exchange rate is clear with a significant sign. At lag-1, that influence is -1.39 per cent. The value continues fluctuating over the period until lag-10, namely -0.18 per cent. The variable of ICT has a significantly negative impact on the exchange rate. At lag-1, the value is -6.94 per cent. It thus rises at lag-3 to -3.44 per cent, and at lag-9 to -0.93 per cent. The adj. R^2 which is 0.53 means that all independent variables can explain the variation of the dependent variable at 53 per cent. The other factors out of the econometric model explain the rest.

From the result, we know that GDP does not influence ICT at all. From the first lag until the last, there is no significant sign. Meanwhile, the exchange rate seems to be starting to show its impact on ICT at lag-8 and lag-9, which are consecutively at -0.18 per cent. Adj. R^2 which is 0.81, means that all independent variables can explain the variation of the dependent variable at 81 per cent. The rest is explained by other factors out of the econometric model.

Impulse Response

The analysis of impulse response is directed to find how the shock of one variable influences the other variables in a specific period. In this study, we limit it to 30 quarters. The table as follows:

Table 4. Impulse Response Analysis

Response of LGDP:			
Period	LGDP	LXRATE	LMAN
1	0.175053	0.000000	0.000000
5	-0.035072	0.014070	0.004021
10	-0.041033	0.010600	0.008993
15	0.180826	-0.041596	-0.016061
20	-0.166939	0.072519	0.054555
25	0.001249	-0.050714	-0.014339
30	0.356634	-0.049935	-0.080395
Response of LXRATE:			
Period	LGDP	LXRATE	LMAN
1	-0.014458	0.048059	0.000000
5	0.009208	-0.000426	0.002524
10	0.033354	-0.004146	0.005594
15	-0.055567	0.018806	0.020662
20	0.030826	-0.010610	-0.011637
25	0.029014	0.009730	-0.004700
30	-0.112073	0.022138	0.034398
Response of LMAN:			
Period	LGDP	LXRATE	LMAN
1	0.002131	0.009307	0.019160
5	-0.008986	0.006577	0.005537
10	0.009816	-0.001239	-0.007602
15	0.000799	0.005309	-0.001642
20	-0.008261	0.005222	0.006904
25	0.015842	-0.001789	-0.003317
30	-0.014322	0.009231	0.002870
Cholesky Ordering: LGDP LXRATE LMAN			

Source: *Calculation by Author*

At the first table we get information that shock of digital information technology (LMAN) on GDP (Response of LGDP) tends to fluctuate. At the first quarter there is no impact. The shock is getting start in second period which is -0.020 per cent. It then turns down to 5th period which start to increases

to 0.004 per cent. At 6th period the value falls until minus. Then it rises again to positive at 7th until 10th period. But the value keeps fluctuating until 30th period to -0.080 per cent. It signals the importance of information technology for continuing a sustainable Indonesian economy in the future. We should consider this due to the population of this country who work by utilizing information technology as a main proponent. Therefore, a bit of shock happened, which will interrupt their business survival. The government needs to support strengthening of investment in information technology, to develop its own products in various information technologies to their full potential.

Based on the table 4, the shock of the exchange rate (LXRATE) on GDP (Response of LGDP) does not show any sign. But at 5th period, it records 0.014 per cent. The value goes up and down, until at 30th period, which is -0.049 per cent. It shows a fluctuation of the exchange rate as Indonesia has a floating regime. The exchange rate can influence economic growth up and down.

From the estimation of impulse response, we get that the shock of GDP (LGDP) was being responded by ICT (Response of LMAN) at 0.002 per cent in 1st period. The value then fluctuates gradually until below zero, with the lowest point at 7th and 19th period, which is successively at -0.017 per cent. The value goes up and down, until reach positive point at the highest one at 0.015 per cent in 25th period. In the last period, the projection of value comes down to -0.014 per cent. It mirrors that we have to keep ideal and stable economic growth in order for information technology to become an activator of optimal growth in the long-term. There is no doubt that continuity of ICT depends very much on a nation's ability to maintain stability of economic growth in the long-run. Any nation succeeding in providing basic needs for its people can concentrate to move industries in information technology forward. Without the capability, no matter how much we invest in ICT, the result cannot be in line with the development of the economy in the long-run.

Variance Decomposition

Analysis of variance decomposition aims to detect anything which can affect each variable. In this context, we use 30 quarters to depict how the extent of its influence each variable. The table as follows:

Table 5. Variance Decomposition Analysis

Variance Decomposition of LGDP:				
Period	S.E.	LGDP	LXRATE	LMAN
1	0.175053	100.0000	0.000000	0.000000
5	0.261116	71.95944	13.83297	14.20759
10	0.338695	72.28709	11.34684	16.36607
15	0.440281	75.71662	11.46129	12.82209
20	0.552561	77.80792	10.89422	11.29785
25	0.722911	83.19669	8.488467	8.314842
30	1.122069	85.61941	7.747241	6.633348
Variance Decomposition of LXRATE:				
Period	S.E.	LGDP	LXRATE	LMAN
1	0.050187	8.299369	91.70063	0.000000
5	0.087954	23.72153	37.79639	38.48209
10	0.106192	43.65334	27.64370	28.70296
15	0.137804	52.12474	25.97901	21.89625
20	0.165079	56.52082	20.17806	23.30112
25	0.221733	74.24960	12.42089	13.32951
30	0.326570	76.41911	12.09447	11.48642
Variance Decomposition of LMAN:				
Period	S.E.	LGDP	LXRATE	LMAN
1	0.021407	0.990529	18.90267	80.10680
5	0.026331	18.02569	19.75749	62.21682
10	0.035908	42.93695	12.19029	44.87277
15	0.038268	42.35004	14.36424	43.28571
20	0.048303	54.29403	12.70298	33.00299
25	0.053952	59.55565	11.74955	28.69480
30	0.061285	64.74363	12.14240	23.11397
Cholesky Ordering: LGDP LXRATE LMAN				

Source: *Calculation by Author*

From the calculation in table 5, we know that the most conclusive variable in explaining the variation of GDP is GDP itself. Afterwards, the exchange rate only affects at 2nd and 3rd period. At 4th period until 20th, the impact of ICT outmatches the exchange rate. This condition ceases at 21th until 30th period, where the exchange rate occupies second position after GDP.

Our empirical findings also have cogent proof that the variation of shock at ICT was influenced considerably by itself. However, this situation occurs only since the 1st period until the 16th period which are consecutively at 80.01 and 43.46 per cent. In 17th period, the position turns. ICT influences itself only 39.20 per cent. Meanwhile, GDP affects 47.33 per cent. This situation like this (impact of GDP on ICT) continues until the last period of observation. It is recorded that at 20th, 25th and 30th periods the values are 54.29 per cent, 59.55 per cent, and 64.74 per cent successively. Meanwhile, ICT influences itself at 20th, 25th and 30th only 33, 28.69, and 23.11 per cent consecutively. From this analysis, exchange rate appears not so much influences ICT.

3.2. Discussion

This research has succeeded to make broaden perspective in terms of the discussion on how important ICT in increasing the economic growth of developing countries. The bigger the advancement of manufacturing in ICT, the higher the economic growth. We can say that today, Indonesia can be an example of ICT-driven growth. ICT is a knowledge-based industry that can contribute significantly to the economy in terms of investment, employment, and other opportunities. By improving ICT, there are many changes and opportunities to expand new economic potential sectors. Our research is in line with Huang & Khan (2022); Ishmeet & Kaur (2017) that the ICT sector has a powerful impact on economic growth. New jobs were created because of ICT. The advance of ICT in society is very useful, in the short term and the long term.

On the other hand, the impact of the exchange rate on economic growth was found to be negative in the short term. It signifies that fluctuation of the exchange rate in the short term can hamper economic conditions due to increasing import costs. Some industries must face inflation and reduced purchasing power to fulfil their production input. Such as a study by Toulaboe (2017) that concludes there is a misalignment of the real exchange rate in several developing countries. Misalignment of the exchange rate is a condition where a currency deviates from the value of its efficient condition. When the exchange rate gets into misalignment, consumers will get into trouble due to prices fluctuating unpredictably. Finally, this situation can lead to a reduction in competitiveness on the global market. Our research finding contradicted with Shaik & Gona (2021); Neto & Lima (2017); Missio *et al.*, (2015) where exchange rate regime has a positive impact on economic growth. In our study, there is no impact of exchange rate on economic growth in the long term.

ICT has changed many aspects of social and personal interaction. Culture values in the society also alter piecemeal. Communication among people becomes easier because technology opens unexpected opportunities. All humankind around the world that has been separated by distances can exchange information fast. It is a really incredible information era. The Indonesian government should redirect some investment channels to boost technology in all sectors, because it is important for sustainable economic growth in the future.

4. Conclusion

This study concludes that information technology has a positive role on economic growth in Indonesia, both in the short term and the long term. The bigger the ICT sector, the higher the economic capacities. Nowadays, ICT has become more important due to changes in the world that have forced people to work faster, in line with the need to make an efficient process of business transactions. By the utilization of information technology, efficiency and accuracy can be achieved quickly. Based on our result, Indonesia is one example of information technology-driven growth in developing countries.

From the calculation, we conclude that the impact of the exchange rate on GDP only in the short-term, not in the long-run. The exchange rate is one of the factors that can affect economic growth. It has a prominent role ultimately in international trade.

By this finding, we can consider that Indonesia, as a developing country, should undertake any good regulations and promote innovation of ICT sector due to the fact that it can boost economic growth in the short-run and long run as well. We cannot survive in strict global competitiveness if it depends

only on conventional business. Ofcourse to bolster the ICT sector, we need much funding to finance the innovation projects. But by considering what we will obtain through the ICT sector, namely a stable economy with providing many jobs for labor, all expenses will be paid. Everything that is invested in ICT will produce increasing returns to scale.

From this research government of Indonesia should support specific agendas in improving ICT. Accelerated growth can be reached through the placement of the development agenda as a priority for a better future.

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