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Information and Communication Technology (ICT) and Economic Growth in Malaysia

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Abstract

This study aims to examine the impact of information and communication technology (ICT) on economic growth in Malaysia. The motivation of this study is to estimates the impact of ICT advancement towards the performance of the Gross Domestic Product (GDP) in Malaysia. The domestic GDP is selected as the dependent variables while the labour force participation, the contribution of ICT, the mobile cellular subscriptions and the individual usage of internet are utilised as the independent variables for this study. The time-series data collected for this study is for the period of 25 years, which is from the year 1994 until year 2018. The data set is then being further tested by using the unit root test which include the Augmented Dickey-Fuller (ADF) test and the Kwiatkowski-Philip-Schmidt-Shin (KPSS) test. Meanwhile, estimating the cointegration and relationship between the variables will tested using the Johansen and Juselius (J&J) Cointegration Test, the Vector Error Correlation Model (VECM) and the Granger Causality test. Based on the result of this study, the mobile cellular subscriptions and individual usage of internet are estimated to have a significant and positive relationship with the Gross Domestic Product (GDP) in Malaysia. The findings of this study show that the contribution of Information and Communication Technologies (ICT) assist to enhance the Gross Domestic Product (GDP) of Malaysia. The estimations from this study hopefully will support the active role played by the government in creating the network society by prioritizing the policies that will become the enablers in the advancement of ICT environment in the country and eventually support the economic growth of Malaysia.
Keywords: Information and Communication Technology, Economic Growth, Malaysia

Introduction

Economy and digital technology are now becoming an inter-related discipline that work in tandem to ensure the continuous progress in both of the fields respectively. Malaysia is one of the countries whose aspire to become a technological-driven economy by leading some of the key areas such as the digital entrepreneurship, innovation and digital adoption in order to achieve the 2030 agenda of sustainable development goals (SDG). Although SDG have no direct and specific goals toward the ICT development, some of the goals are used as a reference and highly dependent with the advancement and growth of ICT. ICT elements are becoming more crucial as people are becoming more dependent towards technology particularly the advancement in the internet connection in their daily activities. Majority of the nation's key economic activities are moving towards digitalization through the ICT advancement thus encourage the studies on the impact of ICT towards the global economy setting.

Digital economy brings a huge impact for multiple countries including Malaysia. Due to the advancement of the technology, the contribution of the information and communication technology (ICT) on the digital economy is consider as vital. For this reason, we can see the improvement in different aspect of the country especially in term of ICT driven policies sets by the government to encourage the technological infrastructure in Malaysia. ICT can be used as a measurement tools in measuring the improvement of digital economy. The contribution by ICT sector will support the improvement of productivity, the economic growth of a country and eventually develop a better working opportunities for the domestic labour market. The improvement in the creation of new job opportunities and sources of income will successfully support the ever-growing supply of labour in Malaysia. Between the year 2010 to 2016, digital economy managed to increase the labour force participation in Malaysia and recorded a 9% value-added due to the advancement of ICT.

With the improvement of the ICT, it became an important tool for every sectors especially in improving the process of generating income. In the production sectors, advancement of ICT will assist the detection of error in the production line and cut down the slow and tedious process of manual checking. Besides that, ICT is also being fully utilize by entrepreneurs to manage their business. It increases the efficiency of their production and stock management and at the same time help to promote the goods and services offered. Aside from assisting in the management aspect of the business, improvement in ICT would also help to improve the competitiveness of the business among all of the competitors.

The ICT sector as the vital component in the digital economy is also playing an important in the economy growth of Malaysia. It is a useful tool to increase the Malaysia's gross domestic product (GDP). According an article in the International Trade Administration (2019), ICT is being identify as the key element for the sectors in Malaysia because the stable and continuous performance of 9% of Annual Average Growth Rate (AARG) for 7 years straight. Due to this, Malaysia also has become the popular destination for the market expansion strategies of ICT companies particularly from the United State. Therefore, this study is conducted to improve the understanding on the importance of ICT in the growth of a country by testing relationships between the gross domestic product (GDP) as a dependent variable and the four selected other independent variables including ICT.

Past Studies

Dausa and Abidin (2018) analysed the relationship between digital development and economic growth in using the small sample data. The dependent variable selected in this study is real GDP per capita and independent variables is mobile cellular subscription, real gross fixed capital formation, fixed broadband subscription and labour force participation rate. The data of this study has been separated into two set, which is different with the sample size. Model 1 are using the sample size of data for 30 years (1986 – 2015) while model 2 is using the sample size data for 15 years (2001 – 2015). The study will adopt the F-test of cointegration technique to run for the test. Hence, the study proves the relationship between the digital variables and the economic growth is positive in the long-run, but also found that there is a negative relationship in the short run.

Ahmed and Ridzuan (2013) conducted a study which investigate the impact of ICT on economic growth based on the standard production in Malaysia. The dependent variables of this study is economic which take value of GDP as the proxy. Besides that, the independent variables are capital, telecommunication investment and the labour. The period of this study is 32 years, which is starting from year 1975 until year 2006. There is various method used for this study such as panel cointegration, panel unit root test, generalised least square method and Hausman test. The findings of this study is the capital, labour and telecommunication investment have a positive relationship toward the gross domestic product (GDP).

Karlsson and Liljevern (2017) conducted a research on with the objective to investigate the effect of the improvement in the ICT towards the output growth four different income groups. 20-years of data from 101 countries were used in the study. They concluded that the advancement in ICT only contributed significantly towards the economic growth in the top three richest countries and a few of the middle-income countries. According to a study by Sepehrdoust in 2017, the impact of ICT advancement and financial development on the developing economies of the petroleum exporting countries (OPEC) is also significant due to the ability of ICT in supporting and improving the production line and the oil rendering process. Similar result was estimated in the study conducted by Nasab (2009) among the OPEC member countries.

Ortiz, Sosa and Diaz (2015) analysed the long run relationship in between of the economic growth and access to telecommunication services, fixed telephony, comprising mobile telephony and broadband. It is use to investigate the different impact on this economic growth by using a sample for twelve different countries. The dependent variable of this study is the economic growth which take the gross domestic product (GDP) as a proxy while the telecommunications and the education level is the independent variables. The data was taken in period of 1980 to 2013 with the data for 187 countries, which comprise to the average education level. The evidence of this study has been prove that there is existence of various impact for the telecommunications on economic growth and hence to educational levels.

Kuppusamy, Raman and Lee (2009) investigated the effect of ICT investment undertaken by the private and public sectors in Malaysia which eventually drive the economic growth for Malaysia. The variables observed for the study are the ICT investment from both private and public sector of the country and the gross domestic product (GDP). The observation is made based on the 15 years of date, which is from year 1992 to 2006. The methodology used for this study is ARDL method. This study concluded that the ICT investment made by the private sector is the main driver of the economic growth in Malaysia especially among the manufacturing and wholesale private companies.

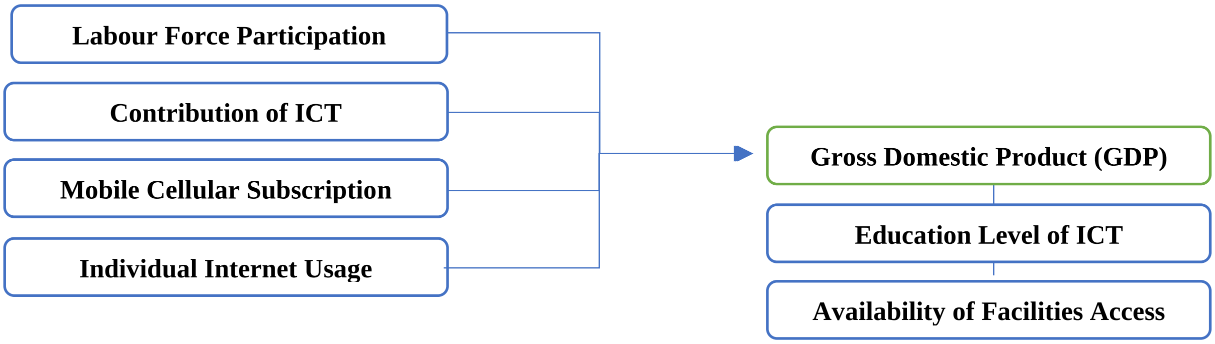

Figure 1: Conceptual Framework

The main purpose of this study is to investigate the relationship between the ICT development and the economic growth of Malaysia for the period of 25 years. Based on the theoretical framework stated above, this study is focusing on four independent variables that specifically selected based on the common variables used in the previous literature i.e. the labour force participation, contribution of ICT, mobile cellular subscription and also the individual usage of internet to while the dependent variable is represented by the value of the GDP in Malaysia during the 25 years of observation. One the other side, the labour force participation can count as a control variable to the gross domestic product (GDP) while control variables for ICT are such as the education level of ICT and the availability of facilities access. Both of this can indirectly influence the gross domestic product, which is the dependent variable of this study.

Data and Methodology

To study the impact of ICT on the economic growth in Malaysia, the GDP value is used as the dependent variable while the independent variables selected are the labour force participation, the contribution of ICT, the mobile network subscription and the individual usage of internet. The econometric form of equation for this study in the log-log function form will be shows as: -

$$(\mathrm{LGDP})_t = \beta_0 + \beta_1(\mathrm{LLFP})_t + \beta_2(\mathrm{LCICT})_t + \beta_3(\mathrm{LMCS})_t + \beta_4(\mathrm{LIUI})_t + \varepsilon_t \ldots Eq.(1)$$

Where, LGDP is represent for logarithm of the gross domestic product (GDP), as the dependent variable for this study. The independent variables off this study are LLFP is the logarithm of the labour force participation, LCICT is the logarithm of the contribution of the information and communication technology (ICT), LMCS is the logarithm of the mobile cellular subscription and the LIUI is the logarithm for the individual usage of internet. From the equation above, β_0 is the constant term for this study, ε_t is an error term, and the t represent the time series of the study. Although β_0 is the constant term for the study, $\beta_1, \beta_2, \beta_3$ and β_4 are the estimated coefficient for the respective independent variables of this study.

Description of Variables

Table 1: Data and Variables

Data/ Variables	Measurement	Source of Data
Gross Domestic Product	US Dollar (US $)	World Bank
Labor Force Participation	People (unit)	World Bank
Contribution of ICT	US Dollar (US $)	The Conference Board
Mobile Cellular Subscription	People (unit)	World Bank
Individual Usage of Internet	People (unit)	World Bank

The table above shows the variables that will be use in this study and its measurement. The measure for the gross domestic product and the contribution to information and communication technology (ICT) are measure by using the US Dollar (US $). On the other side, the other three variables such as labor force participation, mobile cellular subscription and individual usage of internet was measure by using the people in unit.

Methodology

The data that apply and being to use for this study is a time series data. All of the data and the observation can be collected by using various secondary resources such as World Bank and the Conference Board. The time series data set use for this study are from the year 1994 to 2018.

The Augmented Dickey-Fuller (ADF) test was developed by the Dickey and Fuller (1981), which is a type of unit root test for testing the stationarity of the selected data. Usually, the unit root test can cause an unpredictable result in the time series analysis. The Augmented Dickey-Fuller (ADF) test can be use together with the serial correlation. The Augmented Dickey-Fuller (ADF) test could handle a more complex model as compared with the Dickey-Fuller test. The null hypothesis of Augmented Dickey-Fuller (ADF) test can be separate into three different forms for the empirical model such as a constant, a constant with trend, or neither in the test regression. The alternative of Augmented Dickey-Fuller (ADF) test is depend on the type of test is being to use, but it is usually either stationary or trend stationary. The lagged differences are added by Augmented Dickey-Fuller (ADF) test in the regression model is shows as: -

No constant, no trend : $\Delta Y_t = \delta Y_{t-1} + \sum_{i=1}^{m} ai\ \Delta y_{t-1} + \varepsilon_t$ $\quad ... Eq. (2)$

Constant, no trend : $\Delta Y_t = \beta_1 + \delta Y_{t-1} + \sum_{i=1}^{m} ai\ \Delta y_{t-1} + \varepsilon_t$ $\quad ... Eq. (3)$

Constant with trend : $\Delta Y_t = \beta_1 + \beta_2 + \delta Y_{t-1} + \sum_{i=1}^{m} ai\ \Delta y_{t-1} + \varepsilon_t$ $\quad ... Eq. (4)$

Kwiatkowski-Philip-Schmidt-Shin (KPSS) test was developed by Kwiatkowski, Phillips, Schmidt and Shin (1992) is use to figure out whether a time series is stationary throughout the linear trend or mean or it is non-stationary because present of a unit root. In this test, a stationary time series is count as one, which the statistical properties such as variance and mean are consider constant over the time. The Kwiatkowski-Philip-Schmidt-Shin (KPSS) test is formulated on the linear regression which later are divided into three parts which are a random walk, stationary error, and deterministic trend, which with the regression equation as below:

$$x_t = r_t + \beta t + \varepsilon_t \quad ... Eq. (5)$$

Johansen and Juselius (J&J) cointegration test is a multivariate time series test that is use to analyses the number of time series that can be used to form a cointegration relationship. The Vector Autoregressive Models (VAR) is part of the test. A general vector autoregressive model is use as the coefficients. The general form of the VAR (p) model is show as below: -

$$x_t = \mu + A_1 x_{t-1} + \cdots + A_P X_{T-P} + w_t \qquad \ldots Eq.(6)$$

Vector error correlation model (VECM) was developed by the Granger and Newbold (1974). It is used to regulate the direction between the causality between the variables after examining the long-run relationship between variables in the same model.

Granger causality was developed by the Clive Granger in 1969. It is a causality test with a statistical hypothesis test to regulate whether the time series is beneficial for forecasting of another time series, which means that the direction of causality among the variables. According to Granger (1998) mentioned that the ganger causality ca be used for measuring the ability of prediction for the future values of a time series just by using a prior value of another time series. Additionally, the granger causality can only being test once the cointegration s identified in the Johansen and Juselius (J&J) cointegration test to avoid the misspecification problem as the lagged error-correlation term is included. The linear regression model that granger causality use for running the test are show as below: -

$$X_1(t) = \sum_{j=1}^{p} A_{11,j} X_1(t-j) + \sum_{j=1}^{p} A_{12,j} X_2(t-j) + E_1(t) \qquad \ldots Eq.(7)$$

$$X_2(t) = \sum_{j=1}^{p} A_{21,j} X_1(t-j) + \sum_{j=1}^{p} A_{22,j} X_2(t-j) + E_2(t) \qquad \ldots Eq.(8)$$

Empirical Results

The relationship between the dependent variable and the independent variables will be discussed further in this section. All the empirical result is obtained by running the selected time-series date in E-views system. The test used in this study are Augmented Dicker-Fuller (ADF) Unit Root Test, Johansen and Juselius Cointegration Test, Vector Error Correction Model (VECM) and finally the Granger Causality Test.

Table 2: Augmented Dickey Fuller (ADF) test

Variables	Level		First Difference	
	Intercept	**Trend & Intercept**	**Intercept**	**Trend & Intercept**
LGDP	-0.584461 (0)	-1.803042 (0)	-4.384652 (0)***	-4.267955 (0)**
LLFP	-1.036220 (3)	-5.312684 (2)***	-3.974877 (2)***	-4.078249 (2)**
LCOICT	-1.314856 (2)*	-2.695626 (2)	-5.559895 (0)***	-5.193440 (1)***
LMCS	-3.475923 (2)**	0.232874 (3)	-2.674482 (0)*	-5.670169 (1)***
LIUI	-6.940039 (0)***	-3.630391 (0)**	-2.026351 (0)	-3.408042 (0)*

In this study, the Augmented Dickey Fuller (ADF) test shows that the null hypothesis will not be rejected at 5% of level of significance. This result shows that all of the variables are non-stationary if the probability value is greater or higher than the significance level of 0.05 or 5%. Based on result tabulated in Table 2 above, at 5% of significance level, the variables of mobile cellular subscription (LMCS) and individual usage of internet (LIUI) of the trend and intercept at the level, I(0) are stationary. While at the first difference I(1), all the variables in the trend and intercept are stationary except for the variable of individual usage of internet (LIUI). Hence, the null hypothesis is not rejected at level but is rejected at the first difference.

Table 3: Kwiatkowski-Philip-Schmidt-Shin (KPSS) test

Variables	Level		First Difference	
	Intercept	Trend & Intercept	Intercept	Trend & Intercept
LGDP	0.694466 (3)**	0.097024 (3)	0.101430 (3)	0.101275 (3)
LLFP	0.731761 (3)**	0.071773 (3)	0.169909 (3)	0.067933 (3)
LCOICT	0.593212 (2)**	0.113456 (0)	0.479167 (22)**	0.479167 (22)***
LMCS	0.681180 (3)**	0.199703 (3)**	0.823927 (2)***	0.386101 (17)***
LIUI	0.582539 (3)**	0.174326 (3)**	0.489481 (3)**	0.149743 (3)**

Kwiatkowski-Philip-Schmidt-Shin (KPSS) test shows that the null hypothesis will not be rejected at 5% level of significance. This result estimated that all of the variables are non-stationary if the probability value is greater or higher than the significance level of 0.05 or 5%. From the result in Table 3, the intercept for all of the variables are non- stationary at level. Meanwhile at level the trend and intercept were estimated to be non-stationary for all variables except for the mobile cellular subscription (LMCS) and the individual usage of internet (LIUI). Hence, the null hypothesis is rejected at level. At the first difference of Kwiatkowski-Philip-Schmidt-Shin (KPSS) test, the variables of contribution of information communication and technology (LCOICT), mobile cellular subscription (LMCS) and individual usage of internet (LIUI) were estimated to be non-stationary, which the probability is less than the significance level of 5%. Hence, the null hypothesis is rejected at the first difference.

Table 4: Johanson and Juselius Cointegration test

Null	Alternatives	k = 1		r = 2	
		Trace Statistic	Critical Value	Max-Eigen Statistic	Critical Value
r = 0	**r = 1**	165.0822***	30.1811	9.16743***	66.12313
r ≤ 1	**r = 2**	69.91477***	52.14387	33.73557***	72.41566
r ≤ 2	**r = 3**	36.17920***	70.20293	22.81057**	78.86838
r ≤ 3	**r = 4**	13.36863	84.50529	11.58707	85.73540
r ≤ 4	**r = 5**	1.781558	96.15853	17.781558	96.158534

The null hypothesis (R = 0, R ≤ 1, R ≤ 2, R ≤ 3) for both the Maximum Eigenvalue test and the Trace test are rejected when the adjusted test statistic is lower than 95% of critical value. Hence, there are cointegrating equation exist at the 5% level of significant between the mobile cellular subscription (LMCS) and individual usage of internet (LIUI). Both variables are estimated to have a long-run relationship.

Figure 2: VECM Normalised Equation

$$LGDP = -21.37697 - 1.682988\,LLFP + 1.076560\,LCOICT - 1.421429\,LMCS + 1.482456\,LIUI$$

$$(0.81097) \qquad (0.12650) \qquad (0.24999) \qquad (0.08242)$$

From the normalized equation in Figure 2, two of the variables were estimated to have a positive relationship towards the economic growth of Malaysia i.e. 1) information communication and technology (LCOICT) and 2) the individual usage of internet (LIUI). Meanwhile the other two of the variables i.e. 1) the labour force participation (LLFP) and 2) the mobile cellular subscription (LMCS) is estimated to have a negative relationship with the GDP of the country between the 25 years of observation. Hence, with a 1% increase in the contribution of information communication and technology (LCOICT) and individual usage of internet (LIUI) will improve the GDP (LGDP) by 1.076560% and 1.482456% respectively. While an increase of 1% in the labour force participation (LLFP) and the mobile cellular subscription (LMCS), it will reduce the economic performance of Malaysia by 1.682988% and 1.421429% respectively.

Table 5: Vector Error Correlation Granger Causality test

Dependent Variable	X^2 – Statistics					ECT	
	ΔLGDP	**ΔLLFP**	**ΔLCOICT**	**ΔLMCS**	**ΔLIUI**	**Coefficient**	**T-Statistic**
ΔLGDP		2.857817 (0.0909)*	0.130970 (0.7174)	0.588029 (0.4432)	0.649735 (0.4202)	-0.023583	- 0.71359
ΔLLFP	0.032394 (0.8572)		5.72E-10 (1.000)	0.650946 (0.4198)	0.004514 (0.9464)	0.000113	0.06910
ΔLCOICT	0.000019 (0.9966)	0.618998 (0.4314)		1.604793 (0.2052)	3.972657 (0.0462)**	-0.146098	- 0.88137
ΔLMCS	0.003764 (0.9511)	0.020845 (0.8852)	0.013698 (0.9068)		0.652822 (0.4191)	-0.032555	- 1.12667
ΔLIUI	2.570348 (0.1089)	1.098335 (0.2946)	1.153918 (0.2827)	0.010575 (0.9181)		-0.316977	- 9.88982

The estimation in Table 5 is referring to the null hypothesis with the 5% of significance level. The estimation from the Granger causality test reject the hypothesis of causal relationship between the variables except for the relationship between the individual usage of internet (LIUI) and the contribution of information communication and technology (LCOICT) and labour force participation (LLFP) and gross domestic product (LGDP). As estimated by the test above, the labour force participation (LLFP) will influence to the gross domestic product (LGDP) and the individual usage of internet (LIUI) will eventually influence the contribution of information communication and technology (LCOICT).

Conclusion

From this study it is concluded that in the long run, the individual usage of internet and mobile cellular subscription will influence the economic performance of Malaysia. Both of the variables has an impact toward the economic growth of the country. Therefore, any changes or improvement focusing on these two aspects of ICT will eventually affect the economy either positively or negatively. The policies in ICT should be directed clearly towards the improvement of individual usage of internet in Malaysia as it is estimated to positively influence the ability of the domestic economy to grow. The government should take the initiative to increase the budget allocation to improve the accessibility of the population with internet connection or ICT. The advancement in ICT sector will support the vision of Industrial Revolution 4.0 aspired by the government. For that reason, the understanding on different elements of ICT will assist the smooth transition in the economy. Various domestic sectors are expected to benefit from the advancement of ICT and economic growth of the country.

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