Telecommunications Infrastructure Consequence to Economic Growth in Malaysia: Time Series Analysis

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***Abstract*— The main objective of this study is to evaluate the contribution of telecommunications infrastructure towards Malaysia's economic growth. An econometric time series method for 1996-2014 was used to study the impact of telecommunications development on the nation's economic growth involving internet users, broadband, mobile phones, and literacy rate in Malaysia. The analysis from the selection of the best model using SAS9.1 software determined that broadband and internet users contributed to the country's economic development, similar with previous studies. These findings showed that the growth of broadband users, with investments starting in early 2000, had an impact on the nation's economic growth.**

***Keywords*— telecommunications, time series, GDP, broadband.**

I. Introduction

Developments and investments in telecommunications infrastructure have assisted and improved access to the country, which accelerates the process of economic development. Datta and Agarwal (2004) stated that investments in telecommunications sector have strong potentials to improve overall productivity. Productivity refers to skills in technology that minimize the gap of a highly skilled labor force with the application of technology. A study on the impact of information technology by Parker and Benson (1988) showed that competitions between companies, manufacturers, and heavy industries have shifted from low cost operation to increase of quality, service, and time reduction through technology development. There are still gaps in the study regarding the role of telecommunications infrastructure in accelerating gross domestic product (GDP) of Malaysia through broadband, fixed-line internet, and mobile phone users variables in the economic growth. Azlina and Fatimah (2007) studied the contributions of telecommunications to economic growth by improving the model from the study by Datta and Agarwal (2004) through additional penetration rate of mobile and fixed-line variables. The results showed that developments of mobile lines were higher than fixed line. Their study also noted that the return of telecommunications infrastructure investments had given negative contributions to growth but increased returns to scale as stated by the theory of critical mass. Nafis and Ibrahim (2010) concluded that the lack of efficiency in the infrastructure was the main reason for the slowdown in the implementation of banking technology in Sudan in the 1990s. It was also due to the lack of skilled manpower in the field of online banking among banking staff, especially in terms of management, development, and application of internet banking because of productivity. Therefore, it is necessary to show the contributions of telecommunications sector and internet globalization without restraining their impacts to the nation's economic growth rate.

II. Literature Review

Investment in technology in order to help the development of diversity spur the economic growth as mentioned by Mahdi and Mehrdad (2010) as they described the existence of this type of technology in the banking sector gives an impact in terms of economic benefits from the bankers' and consumers' points of view. Their studies underlined the contributions of information technology infrastructure to the Malaysians using the contributions of telecommunications infrastructure to economic growth basic model as introduced by Datta and Agarwal (2004). These studies have developed the effect of level of information technology skills based model and have included variables as described in the previous studies to demonstrate the contributions of telecommunications and economic growth in Malaysia. The reasons to analyze IT contributions are based on Kogilah et al. (2011) regarding Malaysia's technology affecting the growth of the country's e-finance. Reports by the Network Readiness Index showed that Malaysia's ranking for 2009 to 2010 was at the 27th place (4.65 score)and unfortunately, ranked lower at the29th place for 2012 to 2013,whereasthe index score increased to 4.82,and Malaysia was categorized as a middle-income country. These data reflect Malaysia's rapid growth in the field of telecommunications.

The contributions of telecommunications to consumers model was developed based on the skills of users in telecommunications-based applications, which will enable the public to see that the existence of telecommunications infrastructure will benefit consumers as well as the economy. This is true, particularly in terms of consumer skills in technology and productivity with the mission of creating an innovative Malaysian society. The real GDP per capita (G) growth rate variable represents an overview of the Malaysian economy per person. Malaysia's economy is growing rapidly, based on the BNM annual report. The average growth rate of post-independence between 1956 and 1960was 4.1%, and rose to 5.0% in 1961 to 1965. In the period of 1976 to 1980, Malaysia had a growth rate of 8.6%,where there was an average decline in growth in the early 1980s due to the global economic recession, which had caused the fall of mining industries: 1981 (6.9%), 1982 (5.9%) and 1983 (6.3%). In 1985, there was a decline by 1.0% negative. Rapid growth of the Malaysian economy was seen in 1988 and 1995, when the growth rate went above 8.0%. Based on the expectations of strong economic growth, it resumes at a rate of 7.0% up to 2020, which reflects the country's GDP and is expected to increase from RM115,000 million (1990) to RM920,000 million (2020). The GDP variable included in the study is an important indicator for the economic cycle in Malaysia.

The population growth (POP) variable was included in the study to show the relationship of population's impact to economic growth based on the national policy, which is toachieve70 million population, with a mission to improve local labor without relying on foreign labor. But, according to the endogenous growth theory (Romer, 1986), increase in population is not expected to reduce economic growth because it enables the supply of skilled labor and entrepreneurs and new ideas are born out of an important input in the process of technological progress. Literacy rate (EDU) variable plays an important role in eliciting the productivity of the Malaysian population. According to Azlina and Fatimah (2007),literate labor, knowledgeable, and skilled with productivity contribute to economic growth, which is related to increase of new ideas and innovations. Consumers who have these skills will be able to use the technology and know the positive effects from the existence of alternative applications to increase productivity. Alan D. Smith et al. (2003) mentioned that users will not be affected by the aspects of intuition, family, friends, advertising, and idol but will be influenced by the aspects of situations and emotions which are not limited to consumer needs. Those who have high knowledge have the potential to create innovation in the financial aspect as mentioned by Adel M.Aladwani (2001), university students have high potential to use banking technology because of good access to internet banking. Pasharibu and John (2012) also found that individuals with higher education background have good views on the benefits of innovation in banking technology such as internet banking.

Broadband is also an important variable in the study because of its role in the New Economic Model (NEM). According to the findings from James (2013) from the U.S, broadband users in rural areas have access to internet and telephone costs compared to those in urban areas. Studies by Mayo and Wallsten (2011) showed that broadband can bring side effects to the economy. Arne et al. (2013) mentioned that the factors that have slowed the development of broadband in Asia are awareness and affordability, lack of smart phones, and broadband network capabilities and quality. Econometric method consists of several stages of build model, estimation model, assessment, and evaluation model, forecasting the power of a model (Maher 1988). The study was done to observe the effects of broadband, mobile phone, and literacy rate as instruments of development, where the use of internet acts as the platform that gives impact to the Malaysia's economic growth.

III. DATA AND MODEL ESTIMATION

There are many previous studies that demonstrated strong relationships between public expenses and revenues. This study uses a basic model relating to hypotheses tax(revenue) expense, as presented by Friedman(1978); Buchanan and Wagner(1978):

$$GS_t = \propto + \beta_1 TR_1 + \varepsilon_t \quad (1)$$

Where, GS is cost (tax)and TR is fiscal revenue or expense. In this study, expenses are developed as innovation in telecommunications infrastructure in Malaysia. This involves broadband subscribers, internet users, literacy rate, mobile phone subscribers and the population of Malaysia. This section gives an overview on the formation process of estimation regression model involving independent and dependent variables. The analysis uses annual time series data from the years 1996 to 2014,data for the year 2014 were predicted by assuming a linear trend 'doing nothing scenario'. Analysis of trends in time series data for communications and independent variables showed a general movement in long-term time series. Data were obtained from sesric.org (the Statistical, Economics and Social Research and Training Centre for Islamic Countries). The data collected were analyzed using analysis of SAS 9.1. Modeling studies that formed the basis (2).

$$G = \alpha + \beta_1 brod + \beta_2 int + \beta_3 lit + \beta_4 mob + \beta_5 pop + \mu \quad (2)$$

G= Gross Domestic Product (GDP) per capita
brod = Broadband users' (per 100 person)
int = Internet users' (per 100 person)
lit = Literacy Rate
mob =Mobile cellular users'(per 100 person)
pop= population
μ = error term

Unit Root Test

Before doing the analysis of causality for GDP per capita growth rates and variables, stationary test was done on each variable to avoid spurious regression problems. Stationary variables referring to mean, variance, and covariant are constant through time, which means they are not random. The ARDL test was done based on the assumption that the variables are I (0) or I (1). Unit root test GDP to time series Y_t:

$$Y_t = \mu_0 + f_t(\theta)'\gamma + x_t \quad (3)$$

Error term x_t obtained from AR(p) progress represented $\alpha(L)(1 - pL)x_t = \mu_t$ where $\alpha(L) = 1 - \alpha_1 L - .. - \alpha_{p-1} L^{p-1}$ and $u_t \sim iid(0, \sigma^2)$. Parameter p are -1< $p \leq 1$ and $p = 1$ to show unit root test. In first differentiation form

$$\Delta y_t = \Delta f_t(\theta)'\gamma + v_t \quad (4)$$

Where $v_t = \alpha(L)^{-1}\mu_t$.

So, before applying this test, we determined the order of integration of all variables using the test root test. The aim is to ensure that the variables are not I (2) to avoid false results. For this study, the conventional ADF Test, Philips-Perron tests by Phillips and Perron (1988) and Dickey-Fuller Generalised Least Square(DF-GLS) at level of five percent.

TABLE I
UNIT ROOT TEST ADF AND PP

Instrument	Statistic ADF		Statistic PP	
	Intercept	Tren & intercept	Intercept	Tren & intercept
GDP	-0.96 (2)	-4.21*	-0.48	-2.53*
Brod	-0.23 (1)	-2.08*	-0.23	-2.08*
Int	-0.31 (3)	-2.35*	-0.19	-1.30
Lit	-0.76 (3)	-2.59*	-0.63	-2.62*
Mob	-0.51 (3)	-3.36*	-0.51	-3.37*
Pop	-0.34 (3)	-3.47*	-0.33	-3.99*
1st difference				
Gdp	-1.59 (3)	-3.76*	-1.09	-4.06**
Brod	-0.73 (1)	-2.84*	-0.74	-2.84*
Int	-0.66 (3)	-2.85*	-0.68	-2.85*
Lit	-1.19 (1)	-4.56**	-1.19	-4.56**
Mob	-1.18 (1)	-4.57*	-1.18	-4.57**
Pop	-2.94 (2)	-2.45*	-0.38	-1.92

Bracket value of optimum lat
*significant value 5%.
**significant at value 0.05

The results of immobilization Augmented Dickey-Fuller (ADF) as introduced by Said and Dickey(1984) and Philip-Perron test(PP) as introduced by Philips and platform(1988), are shown in the table 1. The results show data in different levels, namely at level I (0) or first distinction I (1). The optimal lag for the ADF test was determined using Scwarz (SC) criteria where the interval that produces the smallest SC is considered as the optimal interval. The results of both tests show all-time series variables achieved stationary after being distinguished once. To ensure long-term relationships exist, ARDL co integration tests were used in this study. Johansen(1988) identified the distributed lag model for the vector variable Y as follows:

$$Y_t = \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} + \cdots + \Pi_k Y_{t-k} + \varepsilon_t;\ t = 1,2,.,n \qquad (5)$$

Where Y_t is Nx1 vector of stochastic variables. Π_1 Π_2....Π_k is nxn unknown parameters and ε_t is Gaussian error vector with zero mean assumption.

IV. RESULT AND DISCUSSION

Table 2 shows the results for regression analysis for telecommunications sector contribution to Malaysia's economic growth for 1996-2014. Four models were established, and the best model was model 3, with the value of $R^2$was 98.95%. All Durbin Watson test results were in the vicinity of no autocorrelation and did not require other tests. The analysis fulfilled the assumptions for estimated regression model intercept, and no variables was in the stationary form as independent variables were in the estimated regression models. In addition, there was no missing observations and non-stochastic independent variables. Durbin Watson test was conducted because it was appropriate for cases with small sample size, in this case 19 years. The analysis of t-test in bracket for model 3 showed that broadband users and internet users were significant. Negative t value indicated that the trend was going upward for the variables of interest, and the rate of increment was great. This indicates an increasingly important variable over time.

TABLE III
TECHNOLOGY DEVELOPMENT IN MALAYSIA 1996-2014

Variable	Model 1	Model 2	Model 3	Model 4
Intercept	482511 (1.25)	-13.86 (-0.49)	18.31 (6.53)**	-6452 (-1.78)
Mobile cellular	255.84 (0.37)	0.918 (2.66)*	0.005 (1.03)	99901 (2.28)*
Fixed broadband	12292 (2.04)*	-0.08 (-1.36)	0.12 (2.74)*	-18002 (-2.33)*
Internet Users	819.69 (0.94)	-0.014 (-0.03)	0.017 (2.51)*	19237 (0.38)
Literacy Rate	-5172.31 (-1.44)	-4.56 (-1.41)	-0.045 (-1.72)	-96301 (-2.35)*
Population	0.00022 (0.02)	2.47 (1.44)	-1.59 (-1.63)	6096 (-2.80)*
R^2	0.9867	0.9855	0.9895	0.9844
Durbin-Watson D	1.757	1.809	1.783	2.117

model (1) Y=X1 X2 X3 X4 X5;
model (2) LY=LX1 LX2 LX3 LX4 LX5;
model (3) LY=X1 X2 X3 X4 X5;
model (4) Y=LX1 LX2 LX3 LX4 LX5;
t-value in bracket
*significantat0.05 level
**significant at 0.10level

The best model in this study (3) was broadband users, which was significant at 0.05 significance level, and similar with earlier studies done by Mayo and Wallsten (2011). Based on their studies, broadband can bring side effects to the economy. In Malaysia, 1% increase in GDP contributes to 0.12% increase in broadband. Model(1) and(3) showed insignificant analysis. The internet also provided a significant analysis of 0.017. That means, with an increase of 1% in GDP, internet users increased by 0.017.

Based on Romer (1986) studies, an increase in population does not reduce economic growth. This shows that population growth does not affect economic growth, and the study highlighted three models which do not provide answers for any of the models above with the exception to model (4). Literacy rates also displayed the same condition, with only model (4) showed a significant analysis. Even the best model (3) was not significant, as the analysis highlights that population and literacy rate did not contribute to an increase in the country's GDP. Mobile phones, one of the telecommunications infrastructures, did not provide significant analysis except for model (2). The best model selected for the study did not show any significant response even though it gave effect to an increase in the use of mobile phones in Malaysia, withalmost2007%subscriptionsfrom 1996 till 2013 (SKMM 2013).

The main objective of the study showed that economic growth was influenced by the development of broadband and internet users. Hence in this case, with continuous development of these aspects, they will give impact to the country in long-term and also as investments in the expansion of internet capabilities, which will lead to the country's proliferation. Contribution to the growth of Malaysia's broadband infrastructure is expanded appropriately to rural areas because Malaysia has poor access constraints and higher cost (Table 3) as the study of James (2013) found that broadband users in rural areas had access to the internet and telephone costs compared to those in urban areas. As shown in Table 3,costs incurred in Malaysia is high compared to other countries in Asia, and this situation needs to be revised. The reduction of state aid for the costs incurred by users will help to improve the telecommunications infrastructure, and this leads to further increase of economic growth.

TABLE IIIII
COST COMPARISON BROADBAND (US DOLLAR)

	Singapore	**Philippines**	**Thailand**	**Vietnam**	**Malaysia**	**Korea**
Fastest Bandwidth/ Cost	100Mbps/ $84.68	3Mbps/ $62.10	8Mbps/ $58.30	3Mbps/ $50.55	4Mbps/ $76.00	100Mbps/ $25.00
Weak Bandwidth / cost	3Mbps/ $19.04	1Mbps/ $20.60	1Mbps/ $17.28	1.5Mbps/ $14.00	400Kbps/ $14.00	20Mbps/ $20.00
Cost / Mbps lower /higher (US$)	$2.70 - $10.20	$15.50 - $20.70	$5.80 - $17..28	$9.30 - $16.85	$19.00 - $35.00	$0.25 - $1.15

Source: New Economics Model Malaysia Part 1

Allen (2003) mentioned that the existence of an edge in information technology on the financial sector is to seek faster financial market growth than the previous banking industry method. In the context of e-business, information technology revolution is considered as the beginning of the industrial revolution from the arising use of railroads for the past 180 years. Shifts in business conditions from physical market to virtual business revolution or online are based on Maruyama (1990),which explained that the world needs a new and effective method other than being dependent on the increase of interest rate in consumer refusal or dishonesty in repayment. This revolution requires a medium for business finance as money rotates in the virtual channel, known as e-banking. If we look at the history of industrial revolution, it was due to transport links, which were the key factors of its development and the existence of internet business revolution is the liaison between business and banking. It is called as self-service system in banking technology, which underlie the economic role of technology. Eriksson et al. (2007) mentioned that confronted interface role of service providers and buyers was replaced by self-service technology, which allows buyers to use the service on their own without having to deal with a firm that provides the service. The philosophy concept of money is that it is not always meant for savings, as it must be transferred and rotated faster in order to increase the economic growth, which means we have to have transaction. Therefore, with the existing technology in business, broadband as platform, and internet as knowledge, development will become faster and money transaction will grow.

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