Modelling the Economic Cycle between GDP and Government Spending on Technological Innovation

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ABSTRACT

Gross Domestic Product (GDP) is a key indicator of a country's economic growth and its well-being. Technological innovation on the other hand is an important driver of growth for productivity and revenue. This paper examines the relationship between GDP per capita and government spending on technology innovation in Malaysia. on in Malaysia. It employs Augmented Dickey-Fuller (ADF) test, Vector Autoregression (VAR) model and variance decomposition to measure the estimation models. The results point to a strong positive relationship between GDP per capita and the expenditure on technology innovation. Furthermore, GDP has a large impact on Malaysia's government spending on technology innovation.

Keywords: Augmented dickey-fuller test, gross domestic product, technology innovation, variance decomposition, vector autoregression mode

INTRODUCTION

Malaysia, an emerging economy, is (Borji, 2015) ranked as the third largest economy in Southeast Asia and ranked 14th most competitive country in the world in 2015. According to the International Monetary Fund (2016), Malaysia also ranked 36th in the world for its nominal GDP, worth USD309.262 billion.

The GDP is an important indicator of a country's economic health (Association for Investment Management and Research, 2003). It is a monetary measure of the market value of a country's goods and services over a specific time period. The GDP

reflects personal consumption expenditure, investment, government spending and exports. An increase of consumption raises GDP and may induce new investment because it improves investors' expectation of future demand. Additionally, an increase in GDP means higher average income for a consumer resulting in higher expenditure. Meanwhile, an excess of imports over exports may contribute to deficits (Ghosh & Ramakrishnan, 2012).

The GDP is a total market value of all final goods and services produced within the national boundaries and its excludes the net property income from the abroad countries. Nevertheless, fluctuation of oil prices affect GDP figures and the mature economy. The pace of economic development is measured by percentage increase of real GDP over the previous years or quarters. Thus, GDP can measure a nation's growth or decline, as well as its recession (Harris & Roach, 2014).

GDP can be defined as the monetary value of all the finished goods and services produced within a country's borders in a specific time period (Bureau of Economic Analysis, 2017). GDP is the value obtained from the measurement of all public and private consumption, investments, government outlays, inventories, construction costs and the foreign balance of trade. According to Singh, Mehta, & Varsha (2011), GDP affects the return of all portfolios and has a positive relationship with share prices.

The GDP in Malaysia was USD 230.81 billion from 2006 to 2008 (World Bank Group, 2016). This increased by 41.87% compared with 2006. In 2009, GDP fell to USD 202.26 billion or decreased by 12.37% compared with the previous year. The shrinking of GDP value was due to the Global Financial Crisis in 2008. From the 2010 to 2014, Malaysia's GDP value increased steadily to reached USD 338.10 billion or 0.55% of the world economy in 2014. However, it began to decline in 2015, valued USD 296.28.

Technological innovation is important and Malaysia needs active Research and Development (R&D) and innovation in order to stay competitive. The innovative products and services in Malaysia included ROAD-I system, horticulture food crops, medicinal plants and etc. To spur the technological innovation, Malaysia must provide various incentives and grants to encourage more research and development activities. The main factors to encourage development of technology optimising warehouse efficiency and social marketing and sales. All these can lead to greater profits or revenue. Additionally, the government should invest in businesses and higher education.

The primary objective of this paper is to assess whether the government spending t on R&D has an effect on Malaysia's GDP. In particular, this study examines the economic relationship between GDP per capita and government spending on technology innovation. Additionally, the structure of the present paper is as follows: Section 2 is a review of the extant literature on GDP and government spending on technology innovation. Section 3 describes

the methodology while Section 4 discusses the findings. Lastly, the conclusion and implication of this study will be discussed in section 5.

LITERATURE REVIEW

Malaysia is now moving rapidly towards achieving its developed country status in line with its Vision 2020. Thus, its GDP value is crucial to attract foreign investors (Callen, 2012).

Malaysia has achieved a stable real GDP growth of 6.2% per annum since 1970 (Eleventh Malaysia Plan, 2015). It had enjoyed one of the best economic growth record over last five years and had moved from a low-income economy in 1970's to a middle-income economy. Malaysia's national per capita also increased over 25-fold from USD 402 in 1970 to USD10,796 in 2014 and it's well on track to achieving better growth.

Studies have focused on the relationship between GDP and government spending on technological innovation as the latter is a key factor for driving growth. According to Ulku (2004), the value of GDP per capita and technological innovation for both developed and developing countries are positively related. Additionally, there is a relationship between R&D stock and innovation in the developed countries with large markets. This study also found that innovation does ensure consistent economic growth. Fixed-effects and Arellano-Bond General Method of Moments (GMM) have been used to evaluate this.

Bozkurt (2015) showed a positive relationship between R&D expenditure and GDP in Turkey by using Johansen Co-Integration and Vector Error Correction models. He also pointed to a unidirectional causal relationship between GDP and technological innovation. Additionally, Peng (2010) revealed GDP has a positive relationship with the R&D expenditures in China. Others studies that showed a positive relationship between technology innovation and GDP include Sadraoui, Ali and Deguachi (2014); Taban and Sengür (2013). Meanwhile, Gu, Terefe and Wang (2012) pointed out that the R&D expenditure has a small impact on GDP and labour productivity in Canada.

According to OECD (2007), the investment in research and development is linked up with high rates of recurrence. The R&D may create new and groundbreaking products or it could add fresh features to the old products, in addition to improving strategies to lower prices and reduce time. The government spending on technological innovation has also contributed significantly to business performance and economic growth. The findings show that since 1995 technological innovation contributed to one third of United States, Netherlands, Denmark, Sweden and France's GDP growth .

Studies show R&D and innovation activities contribute to a stable and continuous economic growth. Akinwale, Dada, Oluwadare, Jesuleye and Siyanbola (2012) studied the impact of R&D and

innovation, labour and capital on economic growth in Nigeria. Their findings showed that the expenditure on R&D has significant impact on economic development. They opined that government must be committed to R&D and innovation finding in order to bolster and diversify the economy. Mitchell (2005) evaluated the impact of government spending on economic performance by discussing the theoretical arguments, reviews and and other academic research. Akinwale et al. (2012) and Mitchell (2005) had different conclusion with latter (2005) that most government spending has a negative economic impact. Other related studies can referred to Fan and Rao (2003); James (2011); Ketema (2006); Wu, Tang and Lin (2010). These studies can be concluded that the composition of government expenditure and public expenditure reforms matter for economic growth.

METHODS

This study investigates the impact of Malaysia's spending on technology innovation and in turns its contribution to the country's GDP. The Vector Autoregression (VAR) model is used to analyse and forecast the macroeconomic and financial variables, including consumer price index and economic cycle.

Sadorsky (1999) reported the impulse response functions in VAR model is able to measure economic and financial variables, since it can be used to estimate the endogenous variable's response when a shock occurs. The VAR model is an econometric model, which captures the

linear interdependencies among multivariate time series (Stock & Watson, 2001).

The general equation of the VAR model of order r is

$$y_t = c + \alpha_1 y_{t-1} + \alpha_2 y_{t-2} + ... + \alpha_p y_{t-r} + u_t \quad (1)$$

where c represents the vector of constant, α_i is the ($m \times m$) coefficient matrices for endogenous variable, μ_t denotes the vector error and t represents the time.

A VAR technique is used to analyse data; if there is more than one endogenous variable in the estimated model, it will exhibit stochastic behaviour. In this study, two endogenous variables: GDP per capita and government spending, were used to study their impact on technology innovation. Data was obtained from DATASTREAM. Data was screened, cleaned and checked with multiple sources, including Yahoo Finance and Malaysia Department of Statistics, to increase its reliability and validity.

RESULTS AND DISCUSSION

In real life application, inflation or depression may lead to structural changes or breaks in the time series variables. Therefore, a stationarity test is crucial in economic and time series variables to identify the attributes of the variables in the calculated model. According to Phoong, Ismail, Phoong and Rosmanjawati (2016), the linear model is no longer suitable to evaluate the time series variables, if non-stationary behaviour exists in the variable's series. Spurious regression and a bias result may occur if the wrong

statistical method is employed in estimating the economic variables.

The unit root test is widely used to test for stationary. Others common stationary tests are Dickey-Fuller, Augmented Dickey-Fuller (ADF) test and Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test. The ADF test is used in this paper to analyse the properties of the macroeconomic variables, GDP and government spending on technology innovation. Table 1 contains the findings of the ADF test.

Table 1
Results of augmented Dickey-Fuller test

Variable	Level	First differenced
GDP	0.9685	0.0004
Technology Innovations	0.9958	0.0193

In Table 1, the *p*-values of ADF test for GDP and technology innovation are 0.9685 and 0.9958 respectively. This indicates that both variables are non-stationary and has unit root. A differentiation process is aimed at generating stationarity in the economic variables. The findings of first difference shown in Table 1 represent the *p*-value obtained after a differentiation process.

The first difference is used to transform the non-stationary series to stationary. The variables, GDP and technology innovation expenditure reported the significance of *p*-values as 0.0004 and 0.0193 respectively based on first differentiation.

Next, VAR model is employed to examine the effect of GDP on technology innovations in Malaysia. The VAR model selection with two endogenous variables, GDP and technology innovation, with a deterministic trend are able to provide an accurate result based on smallest standard error in Table 2.

Table 2
VAR output

	GDP	TECH
GDP (-1)	0.836459	0.045912
TECH (-1)	0.196944	0.984968
C	-0.880393	-0.166960
R-squared	0.989241	0.969838
Adj. R-squared	0.988380	0.967425
Log likelihood	37.86345	26.28862
Akaike AIC	-2.490246	-1.663473
Schwarz SC	-2.347510	-1.520737

The R-squared value indicates how close the data are to the fitted regression line. According to Bluman (2014), when the coefficients of determination are near to 1 it means the variables have a better fit. Table 2 shows R-squared for both GDP and technology innovation are 0.9892 and 0.9698 respectively. Thus, the GDP and technology innovation are considered as good fits in the model. The value of log-likelihood obtained is 37.8635 and the Akaike Information Criterion (AIC) is -2.4902. According to Phoong, Ismail and Kun (2013), the most negative value of AIC denotes that the estimated model has a goodness of fit. Therefore, the Vector Autorepression model is suitable for examining the relationship between the changes of GDP and government spending on technology innovation.

R-squared is an estimate of the strength of the relationship between the model and the response variable. The R-squared value in Table 2 points to a strong positive relationship between GDP per capita and innovation expenditure in Malaysia. This finding was consistent with that of Ulku (2004) that innovation and per capita GDP has a strong positive relationship in both developed and developing countries.

The results of VAR model can be generalised and expressed as follows:

$$\widehat{GDP_t} = -0.88 + 0.196944 Tech_t + \varepsilon_t \qquad (2)$$

where the *GDP* represents Gross Domestic Product (per capita), *Tech* denotes expenditure of Technology Innovation, *t* is the time and ε represents the standard error.

Variance decomposition was used in this paper since it can provide information about the relative importance of each random innovation in affecting the variability of the variables in the VAR model. The results are shown in Table 3.

Table 3
Variance decomposition outputs

Period	Variance Decomposition of GDP		
	S.E.	GDP	TECH
1	0.066235	100.0000	0.000000
2	0.093050	96.12855	3.871446
3	0.115785	89.20464	10.79536
4	0.137669	81.28570	18.71430
5	0.159568	73.62671	26.37329
6	0.181688	66.78528	33.21472
7	0.204033	60.90765	39.09235
8	0.226555	55.94782	44.05218
9	0.249211	51.78988	48.21012
10	0.271971	48.30538	51.69462

Table 3 shows the variance decomposition of GDP changes in technology innovation is 52% after 10 periods. The S.E. in Table 3 represents the standard error obtained. The results show that the changes of GDP affect the expenditure of technology innovation in Malaysia.

CONCLUSION

The findings of this study show a strong positive relationship between GDP and expenditure on technological innovation in Malaysia. Based on the results in VAR model, the changes in GDP have a positive relationship with government spending on technology innovation. This study employed variance decomposition to determine the effect of variables. Results indicated that the changes in GDP affect the expenditure of technological innovation in Malaysia. There is growing awareness among economic policy makers that innovative activity is the main driver of economic growth. the findings of this research is useful for policy makers to formulate effective strategies to boost growth by looking at the national production data.

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