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Causality analysis among electricity consumption, consumer expenditure, gross domestic product (GDP) and foreign direct investment (FDI): Case study of Malaysia

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The current paper attempts to examine the causal relationship between electricity consumption (EC), consumer price index (CPI), gross domestic product (GDP) and foreign direct investment (FDI). Time series data were used for these variables for 1971 to 2009 period. The vector error correction model (VECM) was employed to estimate the causal relationship between electricity consumption with respective independent variables. All variables were found to be co-integrated indicating the existence of long run relationship among them. Furthermore, the result for long run causality from electricity consumption to FDI, GDP growth and inflation was found to be significant. The results suggest that electricity consumption is an important element determining economic growth in Malaysia and a powerful tool in executing government policy for energy saving. Policy makers should be aware of the importance of stable electricity supply in order to achieve sustainable economic growth.

Key words: Electricity consumption, unit root test, co-integration, vector error correction model, Malaysia.

INTRODUCTION

Over the past two decades, the topic of causal relationship between energy consumption and macroeconomics variables has been analyzed by many researchers. Numerous studies have examined the causal relationship between energy or electricity consumption and several independent variables such as economic growth, price, employment and foreign direct investment (FDI). However, the empirical finding was found either inconsistent or conflicting not only across countries but also across the methodologies used within the same country. Masih and Masih (2007) pointed out that there was no causal relationship between energy consumption and gross domestic product (GDP) in Malaysia. Chen et al. (2007) revealed that there was unidirectional causality from electricity consumption to GDP in Malaysia, while Tang (2009) showed that there was bidirectional causality between electricity consumption and income in Malaysia.

Moreover, the majority of previous studies have focused on the causal relationship between electricity consumption (energy consumption) and economic growth (Masih and Masih, 2007; Yoo, 2006; Ho, 2007; Chandran, 2010; Bekhet and Yusof, 2009). Hondroyiannis, et al (2002) used energy consumption (in general), real GDP and price development. Halicioglu (2007) used residential energy, income, price and urbanization. From the best of our knowledge, only Tang (2009) investigated the causal relationship between FDI and electricity consumption. He also examined the causal relationship between electricity consumption and other independent variables. Based on the above reasons, the current study attempts to re-examine the causal relationship between electricity consumption and real GDP. Also, the relationship between electricity consumption, total expenditure, GDP and FDI, will be investigated.

Historically, results from previous studies can be categorised into three types (Akinlo, 2008); unidirectional causality, second bidirectional causality, and finally, no causality. The causality results are very useful in

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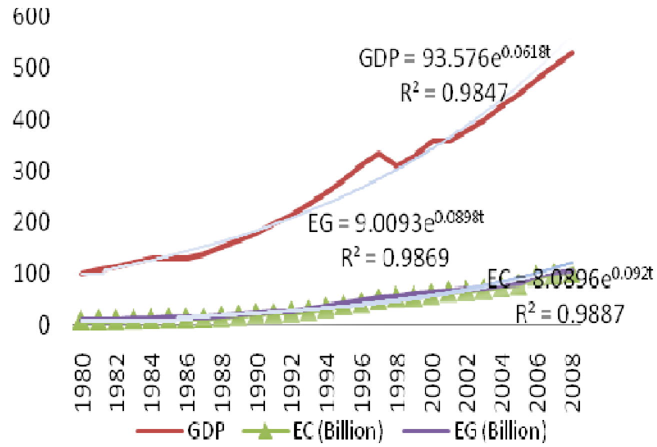

Figure 1a. Electricity consumption, electricity generation and GDP of Malaysia (1980 to 2009).

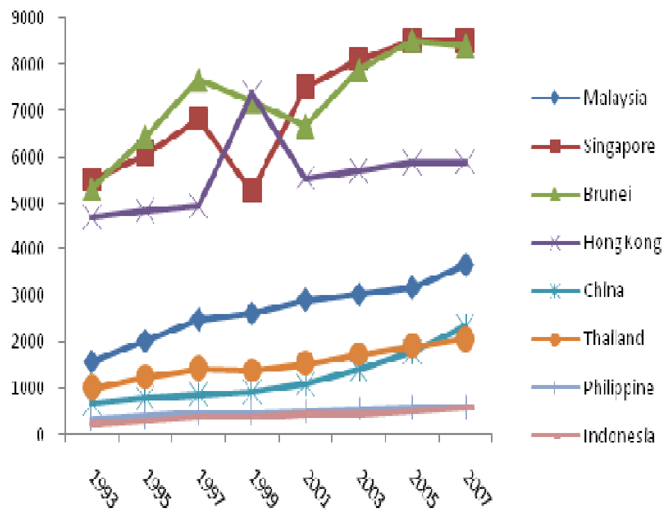

Figure 1b. Electricity consumption in kilowatt hour per capita in ASEAN countries.

determining the appropriate strategies to stimulate growth and to control the level of consumption of the respective countries. For example, if it is found unidirectional causality exists, running from energy consumption to real GDP, it may be implied that the economy will grow if policy makers increase the amount of energy consumption in a country. On the other hand, if unidirectional causality is found to run from real GDP to energy consumption, this would imply that any strategy to increase or decrease the energy will not affect the economic growth. The aim of this paper is to carry out causality tests among electricity consumption, and total expenditure, CPI, GDP and FDI in Malaysia for 1971 to 2009 period. Based on the finding, it would then be possible to determine, which policy is the most appropriate for Malaysia scenario. Furthermore, this can be decided either by concentrating on electricity generation or controlling the electricity usage. In other words, this study will enable us to better understand the role of electricity towards Malaysia economics.

OVERVIEW OF ELECTRICITY SECTOR IN MALAYSIA

In the past three decades, the role of electricity sectors has been viewed as a vital concern in accelerating Malaysian economy. Several studies have found a positive connection between electricity consumption and the economic growth (Ghosh, 2002; Hondroyiannis, et al, 2002; Yoo, 2006; Tang, 2008; Athukorala and Wilson, 2009; Chandran, 2010 and Bekhet and Othman, 2011). These studies reached the conclusion that there was a causal flow from electricity consumption to economic growth. Figure 1a shows the growth rate of the electricity consumption and GDP in Malaysia. The total electricity consumption recorded a growth rate of 9.2% for 1980 to 2009 period. Meanwhile, the GDP recorded RM100.29 million in 1980, increasing by 6.2% per year for 1980 to 2008 period. The main reason for the growth of electricity demand was due to the development of transport sectors such as the railway system, particularly the light rail transit in Klang Valley and inter-city commuter train service and tremendous development of Information Communication Technology, ICT (National Energy Balance, 2007).

The strong growth in manufacturing activity (which is 4.5% within the year 2006 to 2008), supported by the increased in export (which is 4% within the year 2006 to 2008), strong domestic demand, higher tourism activity (it's growth is 33.5% within the year 2006 to 2008) and the opening of new retail outlets have also contributed to the growth in electricity consumption (National Energy Balance, 2007). To this point, electricity consumption per capita in Malaysia was found to be among the highest in ASEAN countries (Figure 1b).

Besides the appearance of positive trend for electricity consumption and GDP in Figure 1a, the same trend was also found for total consumption expenditure made by the Malaysian population, consumer price index (CPI) and FDI. The total consumption expenditure consists of aggregate expenditure for electricity and non electrical goods and this witnessed an increase by 5.4% per year for 1980 to 2009 period. The FDI and CPI increased by 4.3 and 2.8% respectively for the same commencement period.

Unfortunately, the growth in electricity consumption was found to be higher than the growth in electricity generation for the 1980 to 2009 period (Figure 1a). In order to meet the demand of electricity from various sectors, the government invested hugest amounts of money in mega projects such as Bakun hydroelectric project. In this way, the government invested RM41.1

billion in electricity supply industry (8th Malaysia plan). This project is expected to be completed by 2010 with a capacity of 2400 megawatt (Oh et al., 2010). The completion of Bakun project will accelerate the growth in electricity generation and the hydroelectric is expected to account for about 30 to 35% of the generation mix by 2030 (Oh et al., 2010). In addition, there are more projects that have been identified for increasing the generation of the electricity (for more details, (Oh et al., 2010).

LITERATURE REVIEW

The relationship between electricity consumption and economic growth has been widely discussed by many researchers around the world. Unfortunately,the empirical finding was found to be inconsistent across countries and including the methodology used. Jumbe (2004) studied the causality between electricity consumption, agriculture income and non agriculture income. He used error correction model (ECM) and Granger causality analysis for 1970 to 1999 period in Malawi. The Granger causality analysis results showed that agriculture and non agriculture income cause electricity consumption and at the same time the electricity consumption causes the total income. The ECM analysis results showed unidirectional causality from agriculture and non agriculture income to electricity consumption. Narayan and Smyth (2005) used the same methodology with Jumbe (2004) to Australia and found that the growth affected electricity consumption and employment in the short run. Mozumder and Marathe (2007) used the Granger causality analysis to analyze causality direction between GDP and electricity consumption. He found that GDP affected electricity consumption and no causality was found from electricity consumption to GDP.

Asafu (2000) studied the causality between energy consumption, income and price for a number of Asian developing countries such as India, Indonesia, Philippine and Thailand. He used Granger causality analysis data for 1971 to 1995 period. The results showed that the directions of causality were different for different countries in Asia. He found a unidirectional causality from energy consumption to income in India and Indonesia whereas a bidirectional causality between energy consumption and income was found in Philippine and Thailand.

Similarly, Masih and Masih (2007) studied the causality between energy consumption and GDP in Asian countries using vector error correction model (VECM) and VAR analysis. They used annual data over 1955 to 1999 period. They drew the conclusion that there was no causal relationship between energy consumption and GDP in Malaysia, Singapore and Philippine. They also found that there was bidirectional causality between energy consumption and GDP in Pakistan, unidirectional causality from energy consumption to GDP in India and unidirectional causality from GDP to energy consumption in Indonesia.

Ciarreta, et al. (2010) used a panel data from 1970 to 2007 to analyze the causality relationship between electricity consumption, real GDP and energy price. They revealed the long run equilibrium relationship between variables. The causal relationship running from electricity consumption to GDP is revealed. Also, they found a bidirectional relationship between energy price and GDP. Apergis et al. (2011) also used a panel data from 1990 to 2006 for 88 countries. They found a bidirectional relationship between electricity consumption and growth in the short run and long run.

Chen et al. (2007) used different types of energy consumption (electricity) to test the causal relationship with GDP in Asian countries. They used data for 1971 to 2001 period to conclude that there was a unidirectional causality from GDP to electricity consumption in the short run in Malaysia. Furthermore, they found different results as compared to Masih and Masih (2007) and Chandran (2010). They also found unidirectional causality from electricity consumption to GDP in Indonesia. The result in Philippine was conflicting with Masih and Masih (2007). However, they found a unidirectional causality from GDP to electricity consumption. Causality relationship between electricity consumption and other variables in Malaysia was found conflicting with Lean et al. (2010). They found bidirectional causality between aggregate output and electricity consumption. Lang (2010) found bidirectional causality among total electricity consumption, industrial electricity consumption and real GDP in Taiwan for 1971-2006 period.

Yoo (2006) used different types of methodology (Granger causality) to test the causal relationship between electricity consumption and growth in Asian countries for 1971 to 2002 period. He found bidirectional causality between variables. This result is consistent with Tang (2009) who used a similar methodology for 1970 to 2005 period. Furthermore, he found unidirectional causality from growth to electricity consumption in Indonesia and Thailand, which is consistent with Masih and Masih (2007) results. Ho (2007) investigated the causal relationship between electricity consumption and GDP in China. He used ECM analysis for 1966 to 2002 period and found unidirectional causality from electricity consumption to GDP. Shiu and Lam (2004) used the same method in China and also obtained the same result. Tang (2009) used ECM and Granger causality analysis to test causality relationship between electricity consumption, income, population and FDI. He used data for 1970 to 2005 period. He found bidirectional causality between electricity consumption, income and FDI in the short run. On the other hand, Chandran (2010) used ARDL analysis to measure the causality relationship on the same variables which he found the same result. In appendix 1, we summarize the results of the previous causality studies.

DATA AND VARIABLES

In this paper, time series data of electricity consumption (EC), CPI (P), total consumption expenditure (C), real gross domestic product (Y) and FDI for the 1971 to 2009 period for Malaysia will be used. CPI (P), total consumption expenditure (C), real gross domestic product (Y) and foreign direct investment (FDI) as the independent variables will be employed. All of the data were obtained from World Bank and have also been cross-checked with the Department of Statistics of Malaysia (DSOM) and Energy Information administration-EIA (www.eia.doe.gov). Below are more details including its definition:

(i) Electricity consumption (EC) which was measured in million kilowatts.
(ii) Consumer price index (P) was used as a proxy of price. It was used to measure the reaction of electricity consumption towards the changes in price level.
(iii) Total consumption expenditure (C) consists of total expenditure made by the government and private sectors on goods and services. It was used to clarify the role of electricity consumption as a major contributor to total consumption or not.
(iv) Real gross domestic product (Y) was used as a proxy of income. It was used to measure the elasticity of electricity consumption towards the changes in income.
(v) Foreign direct investment (FDI) which is outflow and inflow of FDI. In this analysis, we considered the net value of inflow FDI. The positive value indicated that the value of inflow is greater that the outflow value and vice versa.

All variables are expressed in logarithmic form in order to obtain more stationary behaviour (Vogelvang, 2005). Total consumption expenditure (C), GDP (Y) and FDI were measured in US dollar million and using 2005 as the based year.

METHODOLOGY

The electricity consumption (EC) can be expressed in general as a function of GDP, total consumption expenditure (C), CPI and foreign direct investment (FDI). The electricity consumption is the dependent variable and the rest are the independent variables which expected to influence the level of electricity consumption. The function of electricity consumption can be expressed in Equation (1).

$$EC_t = f(Y_t, C_t, P_t, F_t) \tag{1}$$

where EC, Y, C, P and F represent electricity consumption, GDP, consumption expenditure, CPI and FDI respectively. We can represent this function in a mathematical model as shown in Equation (2):

$$EC_t = Y_t^{\rho_1}\ C_t^{\rho_2}\ P_t^{\rho_3}\ F_t^{\rho_4} \tag{2}$$

To apply this model, we transformed it to be linear as shown in Equation (3):

$$lec_t = \rho_0 + \rho_1 lY_t + \rho_2 lC_t + \rho_3 lP_t + \rho_4 lF + e_t \tag{3}$$

where, ρ_0 is a constant and ρ_1, ρ_2, ρ_3 and ρ_4 are the coefficients estimate. The above model (3) provides the information on long run effect.

The analysis of Granger causality will involve the process of examining the stationarity of the time series and verifying the order of co-integration by using the Engle-Granger test. In order to conduct the Engle-Granger test, the series of variables are required to be stationary. This is done by testing for unit root test by using ADF and P.P tests at level $I(0)$. If we failed to reject the null hypothesis [H_0: $Y_t \sim I(0)$], we have to proceed with stationarity test at first difference $I(1)$ (Studenmund, 2006). If once again we failed to reject null hypothesis [H_0: $Y_t \sim I(1)$], we will proceed to test stationarity at second difference. Usually, the macroeconomics data will achieve stationarity at first or second difference. The function of stationarity is to avoid from spurious regression results.

The co-integration can be capture by analyzing the stationarity of the residual for estimate model by OLS method. If the residual is stationary, this indicates that there is long run equilibrium among variables (Vogelvang, 2005) and all the variables are accepted by macroeconomics theory to analyze the elasticity of electricity consumption. If the variables are not co-integrated at level [failed to reject null hypothesis H_0: $ect_t \sim I(0)$] we ought to test for co-integration at first and then second difference until they are co-integrated. The decision whether to reject or not is depended on the value of ADF statistic for residual. If this value is smaller than the critical value of ADF we have to reject the null hypothesis which means there is no co-integration (Hamilton, 1994; Fuller, 1976; Volgelvang, 2005). This procedure is crucial because the elasticities are valid only if the variables have the same order of integration. ADF and P.P tests for co-integration will be used to investigate the degree of integration.

In order to examine the direction of causality between EC and the respective macroeconomics variables, the dynamic Granger causality test is used. Granger causality was employed due to it's ability to response for both large and small sample size (Odhiambo, 2009). The multivariate Granger causality model between EC, GDP, CPI, C and FDI based on the ECM is specified as follow:

$$\Delta lec_t = \alpha_0 + \sum_{i=1} \alpha_1 \Delta lec_{t-1} + \sum_{i=1} \alpha_2 \Delta lY_{t-1} + \sum_{i=1} \alpha_3 \Delta lP_{t-1} + \sum_{i=1} \alpha_4 \Delta lC_{t-1} + \sum_{i=1} \alpha_5 \Delta lF_{t-1} + \alpha_6\, ect_{t-1} \tag{4}$$

$$\Delta lY_t = \mu_0 + \sum_{i=1} \mu_1 \Delta lY_{t-1} + \sum_{i=1} \mu_2 \Delta lec_{t-1} + \sum_{i=1} \mu_3 \Delta lP_{t-1} + \sum_{i=1} \mu_4 \Delta lC_{t-1} + \sum_{i=1} \mu_5 \Delta lF_{t-1} + \mu_6\, ect_{t-1} \tag{5}$$

$$\Delta lP_t = \beta_0 + \sum_{i=1} \beta_1 \Delta lP_{t-1} + \sum_{i=1} \beta_2 \Delta lY_{t-1} + \sum_{i=1} \beta_3 \Delta lec_{t-1} + \sum_{i=1} \beta_4 \Delta lC_{t-1} + \sum_{i=1} \beta_5 \Delta lF_{t-1} + \beta_6\, ect_{t-1} \tag{6}$$

Table 1. Conditions for causal relationship.

Causal flow			Condition	
			Short run	Long run
Economic growth	→	Electricity consumption	$\alpha_2 \neq 0$	$\alpha_6 \neq 0$
Electricity Consumption	→	Economic growth	$\mu_2 \neq 0$	$\mu_6 \neq 0$
Electricity consumption	→	Inflation	$\beta_3 \neq 0$	$\beta_6 \neq 0$
Inflation	→	Electricity consumption	$\alpha_3 \neq 0$	$\alpha_6 \neq 0$
Electricity consumption	→	Consumption expenditure	$\varphi_4 \neq 0$	$\varphi_6 \neq 0$
Consumption expenditure	→	Electricity consumption	$\alpha_4 \neq 0$	$\alpha_6 \neq 0$
Electricity consumption	→	FDI	$\theta_5 \neq 0$	$\theta_6 \neq 0$
FDI	→	Electricity consumption	$\alpha_5 \neq 0$	$\alpha_6 \neq 0$

Table 2. The results of the unit root test.

Stage	Variables	ADF	P.P
		Trend and intercept	Trend and intercept
At Level	lec	-5.4916*	-2.1007
	lY	-2.2431	-2.4363
	lP	-4.0329	-2.7867
	lC	-2.6001	-2.6001
	lF	-3.2940***	-3.3473***
At 1st difference	Δlec	-3.9796**	-3.9965**
	ΔlY	-4.8261*	-4.7499*
	ΔlP	-4.2282*	4.2282*
	ΔlC	-5.2989*	-5.2704*
	ΔlF	-8.0860*	-8.1108*

*, **, *** Represent the stationary at 1, 5 and 10% significant level, respectively. Source: Output EViews 6.0.

$$\Delta lC_t = \varphi_0 + \sum_{i=1}\varphi_1 \Delta lC_{t-1} + \sum_{i=1}\varphi_2 \Delta lY_{t-1} + \sum_{i=1}\varphi_3 \Delta lP_{t-1} + \sum_{i=1}\varphi_4 \Delta lec_{t-1} + \sum_{i=1}\varphi_5 \Delta lF_{t-1} + \varphi_6 ect_{t-1} \quad (7)$$

$$\Delta lF_t = \theta_0 + \sum_{i=1}\theta_1 \Delta lF_{t-1} + \sum_{i=1}\theta_2 \Delta lY_{t-1} + \sum_{i=1}\theta_3 \Delta lP_{t-1} + \sum_{i=1}\theta_4 \Delta lC_{t-1} + \sum_{i=1}\theta_5 \Delta lec_{t-1} + \theta_6 ect_{t-1} \quad (8)$$

Where lec, lY, lP, lC and lF represent the natural log of electricity consumption, CPI, consumption expenditure and foreign direct investment respectively. ect represents error correction term. The ECM enables us to estimate the long run and short run Granger causality. The coefficient $\alpha_i, \mu_i, \beta_i, \varphi_i$ and θ_i (i=1,….,5) indicate the short run causality if the value is not equal to zero. However, if these coefficients equal to zero, this will indicate that there is no short run causality among respective variables. Furthermore the coefficients $\alpha_6, \mu_6, \beta_6, \varphi_6$ and θ_6 indicate the long run causality if the coefficient is not equal to zero and vice versa. These causal conditions among above variables can be summarized as shown in Table 1.

RESULT ANALYSIS

Table 2 shows the results for the ADF and P.P unit root test for electricity consumption (lec), GDP (lY), CPI (lP), consumption expenditure (lC) and FDI (lF). In this test, we include intercept because it is more appropriate with economic practice (Vogelvang, 2005). The results indicate that electricity consumption and FDI at *I*(0) are stationary at 10% significant level while the remainder variables contain unit root or non stationary. However, the first differences of study variables lead to stationary at least at 5% significant level. These results are consistent with the notion that most of the macroeconomics variables are non-stationary at $I(0)$, but they will become stationary after the first or second difference (Nelson and Plosser, 1982; Tang, 2008).

In order to examine the long run relationship among variables, the co-integration test was conducted by using Engle-Granger Augmented Dickey-Fuller test. The result showed that the value of ADF statistic for residual is smaller than ADF critical value at 5% significant level. The results revealed that there was an evidence of long run relationship among the study variables and it also indicated that all of the variables were accepted by macroeconomics theory to analyze the causal relationship. Likewise, the existence of a co-integrating relationship among electricity consumption, and explanator variables suggested that there ought to Granger causality in at least one direction. The result of long run co-integration relationship between electricity consumption and independent variables showed in Equation (9). It indicated that GDP, total consumption expenditure and FDI have a significant effect to electricity consumption in the long run at 1% significant level. However, it did not indicate any causal flow from one variable to another.

$$lec_t = -5.82 + 1.91 lY_t - 0.47 lC_t + 0.11 lP_t - 1.91 lF_t$$

p.value (0.00) (0.00) (0.31) (0.00)
t= (15.40) (-3.50) (1.03) (-4.57)
R^2 = 0.99 DW = 1.51
F- test = 5896 (0.00) (9)

Since all of the variables were co-integrated, the causality relationship can be examined by using VECM. If equation (9) provides us with the information of long run relationship, the VECM would provide us with the evidence of short run and long run causality relationship as shown that in Equations (10 to14).

$$\Delta lec_t = 0.04 + 0.52\Delta lEC_{t-1} + 0.02\Delta lY_{t-1} - 0.18\Delta lP_{t-1} + 0.12\Delta lC_{t-1} + 0.12\Delta lF_{t-1} - 0.32ect_{t-1}$$

p value (0.02) (0.97) (0.44) (0.52) (0.23) (0.14)
t=(2.54) 0.04) (-0.79) (0.65) (1.20) (-1.50)
R^2 = 0.37 DW = 1.90
F- test = 2.89 (0.02) (10)

$$\Delta lY_t = 0.04 + 0.72\Delta lY_{t-1} - 0.01\Delta lec_{t-1} - 0.19\Delta lP_{t-1} - 0.22\Delta lC_{t-1} - 0.01\Delta lF_{t-1} + 0.99ect_{t-1}$$

p value (0.06) (0.97)(0.40) (0.23) (0.45) (0.02)
t = (1.98) (-0.41) (-0.86) (-1.18) (-0.77) (-2.49)
R^2 =0.25 DW = 1.90
F- test = 1.69 (0.16) (11)

$$\Delta lP_t = 0.02 + 0.40\Delta lP_{t-1} + 0.17\Delta lY_{t-1} - 0.11\Delta lec_{t-1} + 0.09\Delta lC_{t-1} - 0.01\Delta lF_{t-1} + 0.22ect_{t-1}$$

p value (0.01) (0.32) (0.30) (0.41) (0.22) (0.00)
t= (2.97) (1.02) (-1.06) (0.83) (-1.26) (-3.27)
R^2 = 0.57 DW = 1.62
F- test = 6.53 (0.00) (12)

$$\Delta lC_t = 0.04 - 0.32\Delta lC_{t-1} + 0.77\Delta lY_{t-1} - 0.06\Delta lP_{t-1} - 0.11\Delta lec_{t-1} - 0.003\Delta lF_{t-1} + 0.004ect_{t-1}$$

p value(0.32) (0.16) (0.87) (0.70) (0.89) (0.98)
t = (-1.02) (1.45) (-0.17) (-0.39) (-0.14) (0.02)
R^2 =0.10 DW=1.80
F- test = 0.54(0.77) (13)

$$\Delta lF_t = - 0.16 - 0.10\Delta lF_{t-1} - 4.49\Delta lY_{t-1} + 2.54\Delta lP_{t-1} + 2.76\Delta lC_{t-1} + 2.79\Delta lec_{t-1} - 0.59ect_{t-1}$$

p value (0.68) (0.33) (0.47) (0.31) (0.36) (0.05)
t = (-0.41) (-0.99) (0.74) (1.02) (0.93)(-2.06)
R^2 = 0.24 DW = 2.17
F- test = 1.61 (0.18) (14)

However, it can be seen that the F statistic for Equation (10) and (12) were significant at 5% significance level, while F statistic for the remainder equations were found to be insignificant. The short-run effects of the past values of electricity consumption was significant at the 5% level (Equation 10), but neither GDP, price, consumption expenditure and FDI was significant. This result indicated that the previous electricity consumption effect the current electricity consumption. Moreover, Equations (11 and 12) showed the same pattern. The results showed that the past values of income growth (price) effect the current income growth (price).

The coefficients for "ect" in Equations (11, 12 and 14) were found significant at 5% level. So, the information of long run causality provided. Equation (11) shown that the unidirectional causality running from electricity consumption to income growth which is consistent with previous studies (Akinlo, 2009; Bekhet and Yusof, 2009; Chandran, 2010) and contrast with Mozumber (2007). However, it was inconsistent with Jumbe (2004), Oh (2004), Yoo (2006) and Tang (2009), where the bilateral causality between electricity consumption and growth were found.

Equation (12) showed the unidirectional long run causality running from electricity consumption to inflation. Meanwhile, Equation (14) showed the long run causality running from electricity consumption to FDI and no short run causality. FDI is the engine for growth and the long run causality was inconsistent with Tang (2009).

POLICY IMPLICATIONS

The results show unidirectional causality running from electricity consumption to growth in FDI. This indicates that electricity consumption may increase the inflow of foreign investment in Malaysia and thus improves the balance of payment (reduce deficit). The growth in FDI and real GDP was seen as a positive indicator. However, the growth in electricity consumption can be seen as a negative indicator as well. The results show the causality running from electricity consumption to CPI. This indicates that the increase in electricity consumption will lead to inflation and as a consequence it will reduce consumer purchasing power.

Also, the results provide us with evidence that Malaysia is an energy dependent country. Thus, the energy policies should aim to increase electricity generation by sustaining the current electricity supply and at the same time exploring the possibilities renewable for electricity generation. Policy makers ought to ensure that the growth of electricity supply is greater than the growth of electricity consumption to boost the economic growth. In other words, better management on energy growth policies is vital in order to ensure sufficient electricity supply to support the Malaysia economic development. Meanwhile, energy saving policy could be inappropriate for economic growth in the long run.

CONCLUSION AND RECOMMENDATION

In current paper, we analyzed the causal relationship among electricity consumption, CPI, total consumption expenditure, GDP and FDI by using VECM. The time series data for 1971 to 2009 period was employed in order to meet those objectives. The co-integration test has proven that there was a long run relationship between the studied variables. Then we proceeded with analyzing the causal relationship among the variables using VECM. But, the result for long run causality from electricity consumption to FDI was found to be significant. This result is inconsistent with Tang result's (2009). Moreover, the result for long run causality running from electricity consumption to inflation was found to be significant at 1% level. This indicates that the increase electricity consumption will affect the major macroeconomics problem (inflation). This result is consistent with the observation in Thailand and Philippine but inconsistent with other developing countries (Asafu et al., 2000).

Furthermore, current paper proves that the electricity consumption is a vital component to stimulate economic growth in Malaysia. Also, the results showed that there was a long run causality running from electricity consumption to economic growth and it is consistent with Chandran (2010), Ho (2007), Yoo (2006) and Jumbe (2004). Unfortunately, economic growth cannot be simply achieved if there is a shortage of electricity supply. In addition, it is a crucial challenge to the policy makers to ensure a sufficient amount of electricity supply within a country. For future research, it is suggested to analyze and explore the possibility of energy sustainable and renewable in a country since it is a necessity in order to ensure smooth implementation of development projects and to stimulating country's economic growth today and thereafter.

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APPENDIX

Appendix 1. Results of the previous causality studies.

Country	Empirical work	Study period	Methodology	Variables used	Results
India Indonesia Philippine Thailand	Asafu-Adjaye (2000)	1971-1995	G.C	Energy Consumption (EnC), Income and price	-EnC causes income -EnC causes income -Bilateral causality between EnC and income -EnC, income and price are mutually causal. - Bilateral causality between EnC and income - EnC, income and price are mutually causal.
Melawi	Jumbe (2004)	1970-1999	Granger causality (G.C) and ECM	Electricity consumption (EC), Agriculture income (GDP) and non Agriculture income (NGDP)	-EC causes GDP -GDP causes EC -NGDP causes EC -GDP and NGDP causes EC
Korea	Oh and Lee (2004)	1970-1999	VECM and VAR	Energy consumption and GDP	- Bilateral causality between EC and growth in long run. - EC causes growth in short run.
China	Shiu et al .(2004)	1971-2000	ECM	EC and real GDP	EC causes real GDP
Australia	Narayan and Smyth (2005)	1966-1999	GC and ECM	EC, employment and income	- Growth causes EC in short run - Growth causes employment in short run.
Indonesia Malaysia Singapore Thailand	Yoo (2006)	1971-2002	G.C	EC and Growth(g)	-g causes EC -Bilateral causality between EC and g -Bilateral causality between EC and g g causes EC
Bangladesh	Mazumder et al. (2007)	1971-1999	G.C	GDP percapita and EC percapita	-GDP causes EC
India Pakistan Indonesia Malaysia Singapore Philippine	Masih and Masih (2007)	1955-1991	VECM and VAR	Energy consumption (EnC) and GDP	-EnC causes GDP - EC causes GDP, GDP causes EC. - GDP causes EC -No causal relationship - No causal relationship -No causal relationship
China	Chen et al. (2007)	1971-2001	VECM	GDP and EC	-No causality relationship

Appendix 1. Contd.

Hong Kong					- EC causes GDP
Indonesia					-EC causes GDP (LR)
India					-GDP causes EC
Korea					-GDP causes EC, and EC causes GDP
Malaysia					GDP causes EC in Short run (SR)
Philippine					-GDP causes EC
Singapore					-GDP causes EC, and EC causes GDP
Taiwan					-No causality relationship
Thailand					-No causality relationship.
Hong Kong	Ho et al. (2007)	1966-2002	ECM	EC and GDP	-EC causes GDP
Malaysia	Tang (2008)	1972-2008	ARDL ECM	EC and growth	- EC and growth are not co-integrated -Bilateral causality between EC and growth.
Malaysia	Tang (2009)	1970-2005	ECM and GC	EC, Income, population and FDI	-Bilateral causality between EC, income and FDI in the short run. -Income, FDI and Population causes EC
Nigeria	Akinlo (2009)	1980-2006	ECM	EC and growth	- Unidirectional causality from EC to growth.
South Africa	Odhiambo (2009)	1971-2006	Co-integration ECM	EC, growth and employment	-Bidirectional causality between EC and growth in long run. -EC causes growth in long run.
Malaysia	Chandran, et al. (2010)	1971-2003	ARDL	EC and growth	-EC causes growth in the short and long run.
Malaysia	Lean et al. (2010)	1970-2008	Granger causality	Economic growth Electricity generation Export Prices	-Unidirectional causality from economics growth to electricity generation -No causality between price and economic growth.
Malaysia	Lean et al. (2010)	1971-2006	Granger causality	Electricity consumption Aggregate output Export Labor Capital	-Bidirectional causality between aggregate output and electricity consumption.
Taiwan	Lang et al. (2010)	1982-2008	Granger causality	Total electricity consumption Real GDP Residential electricity consumption Industrial electricity consumption	-Bidirectional causality among Total electricity consumption, Industrial electricity consumption and real GDP. -No causality between Residential electricity consumption and Real GDP.

Appendix 1. Contd.

Europe	Ciarreta et al. (2010)	1970-2007 (panel data)	Co-integration VECM	Electricity consumption Real GDP Energy price	-The long run relationship between 3 series (Electricity consumption, real gdp and energy price). -Negative short run and strong causality from electricity consumption to GDP. -Bidirectional relationship between energy price and GDP.
88 selected countries	Apergis et al. (2011)	1990-2006	Granger causality	Electricity consumption Real GDP Real fixed capital formation Total labor force	-Bidirectional causality between electricity consumption and economic growth in short run and long run. -Unidirectional causality from electricity consumption to economic growth.

GC = Granger causality; ECM = error correction model.