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RELATIONSHIP AMONG POPULATION, ENERGY CONSUMPTION AND ECONOMIC GROWTH IN MALAYSIA

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Abstract

This paper aims to examine the relationship among population, energy consumption and economic growth. First, a unit root test was conducted, in which data were shown to be non-stationary in all levels, and stationary in the first difference for all variables. The co-integration model was applied, and the results indicated that one co-integrating equation exists, suggesting the long-term relationship among population, energy consumption and economic growth in Malaysia. Finally, Granger causality model was conducted, and the results showed that population has an effect on energy consumption and energy consumption contributes to economic growth in Malaysia.

Keywords: *population, energy consumption, economic growth*

1.0 Introduction

Most of previous studies only focus on the impact of energy consumption on economic growth or the environment. An increase in energy consumption can harm the environment (Jalil &Mahmud, 2009; Apergis & Payne, 2009). Therefore, a policy to reduce energy consumption is necessary (Menyah & Rufael, 2009; Islam et.al., 2009; Shahiduzzaman & Alam, 2012). Other previous studies argue that a reduction in energy consumption can affect economic growth
Beleke et al., 2011; Francis et al., 2010; Squali, 2006)

Previous studies are less concerned about the relationship among population, energy consumption and economic growth. The world population exhibits a large increase since 1950 and global energy consumption also shows the same trends especially in emerging countries such as China and India (BP statistical Review, 2011). China and India are among the highest energy consumers in the world and the most populous countries in the world. A growing energy demand as the industrialization,

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urbanization and population intensify and thus posing a big challenge to economists and policy makers to deal with various issues. Energy is largely used in most populated areas. The densely-populated areas bring more economic activities such as transportation and business activities. However, higher population density can trigger environmental problems such as pollution. A crowded metropolitan area, traffic congestion, and great industrial activities can harm the environment and cause public health problems Darmstadter (2004).

Population is inextricably connected with energy consumption (Barliwala & Reddy, 1993). Limited and exhausted resources cause all countries to struggle for the great economic growth. Every year, the world population increase and the energy resources are increasingly needed in numerous human's activities. However, the limited resources of energy can limit the economic activities and thus hindering the economic development. People consume energy for various activities such as transportation, agriculture, and industries. We are unable to imagine that if exhausted energy occurs in the world; it can certainly cripple all countries economy. Lower population can probably reduce the demand in energy but a reduction in energy consumption can affect the economic growth. Shaari, et.al (2013), Ighodaro (2010) Lise & Monfort, (2006) stated that if a decrease in energy consumption can affect economic growth. Therefore energy consumption is a strong determinant of economic growth. This study is to examine the relationship among population, energy consumption and economic growth.

2.0 Literature Reviews

The relationship between energy consumption and economic growth has been widely discussed in numbers of past studies (Abosedra and Bangestani, 1991; Yu and Choi; Belke, et al. 2011; Cheng, 1996; Hong 2010; Ji, et.al., 2011). Absodra and Baghestani (1991) used the Granger causality test for the period of 1947-1987. The results explained that no evidence of the relationship running from energy consumption to GNP but GNP has an effect on energy consumption. Ighodaro (2010) used various types of energy consumption such as coal, electric, oil and gas consumption as determinants of economic growth. Their results disclose that electric consumption can influence economic growth. Yu and Choi (1985) employed various methods but found that no causal relationship and it is affirmed by Cheng (1996) by using Engle and Granger and the results gave the same answers. Manufacturing sector contributes to GDP, Soytas and Sari (2006) found that energy consumption influences the sector. Hong, (2010) carried out an empirical study on the long term equilibrium and short term dynamic between GDP and energy consumption in China. Co-integration test, Granger causality test and ECM were used in the study. The results showed that energy consumption and GDP have long term equilibrium relationship. GDP were found to be connected with total of energy production and energy consumption. Ji, et.al. (2011) analyzed the effect and sensitivity from the energy consumption of energy to economic growth. Multiple linear regression was employed and found that the energy consuming indexes, total consumption of coal, total consumption of gasoline, total consumption of diesel oil, total consumption of power have effects on GDP in Beijing.

Belke, et.al. (2011) studied in OECD countries and found that energy consumption cause economic growth to increase. Narayan and Prasad (2008) also studied in OECD countries but examined causality between electricity consumption and economic growth. Their findings showed that electricity consumption has an effect on economic growth in case of Australia, Iceland, Italy, the Slovak Republic, the Czech Republic, Korea, Portugal, and the UK. Economic growth does influence electricity consumption in Finland, Hungry.

Some policies have been suggested by previous studies such as Shahiduzzaman and Alam (2012) that a policy on energy consumption should be created because of bi-directional causality between GDP and energy use in Australia. However, Lise and Montfort (2006) stated that policy on energy consumption is not necessary in Turkey. Halicioglu (2009) agreed there is no causal relationship energy consumption and gross national product in Turkey. Hongwei (2011) examined the causality relationship between GDP and coal consumption or coal production in China for the period 0 1978-2008. The

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results showed that coal consumption and production do not influence economic growth. However economic growth coal consumption. therefore policies to be balance between economic growth and CO2 emission are important.

3.0 Methodology

Data from 1991 to 2011 were collected to examine the relationship among population, energy consumption and economic growth.

3.1 Unit Root Test

Unit root test is to determine the stationary and non-stationary property of each variable. All variables must be tested in the levels and in the first difference. Consider the equation below:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha \sum_{i=1}^{p} \Delta Y_{t-1} + u_t \quad (1)$$

where Y is our variable of interest, Δ is t the time trend and the difference operator, t is the time trend, P is the number of lagged term and u is the white noise residual of zero mean and constant mean and constant variance. $(\alpha_1,\alpha_2,\beta_1,...\beta_m)$ is a set of parameters to be estimated.

3.2 Co-integration Test

Co-integration test is used in this study to examine the long-run relationship between all variables. Consider the following levels of VAR, with X_t defined as the log of population, energy consumption and GDP.

$$X_t = c + \sum_{j=1}^{p} \Gamma_j \Delta X_{t-j} + \varepsilon_j \quad (4)$$

If the variables in X_t are I(1), the VAR in Eq. (4) is not stationary. If no co-integration exists, statistical inference is not possible by using the usual tests. Given this condition, the difference of the series should be determined and a first difference VAR of the form should be estimated

$$\Delta X_t = c + \sum_{j=1}^{p} \Gamma_j \Delta X_{t-j} + \varepsilon_j \quad (5)$$

Integration vectors give rise to the stationary variable. If this is the case, the VAR in Eq. (5) can be written as

$$X_t = c + \sum_{j=1}^{p} \Gamma_j \Delta X_{t-j} + \prod X_{t-1} + \varepsilon_t \quad (6)$$

In Eq. (6), II is a rank *r* matrix that can be divided as

$$\prod = \alpha\beta' \quad (7)$$

where α is a 3 × *r* loading matrix and β is a 3 × *r* matrix of co-integrating vectors, *r* being the number of co-integrating vectors. Following the Johansen procedure (Ighodaro, 2010), the number of co-integrating vectors were tested by using the co-integrated VAR as in Eq. (6).

3.3 Granger Causality Test

The Granger causality test is to investigate the causal relationship between two variables. If the p value of the variable Y is significant, it can be concluded that X does have Granger cause to Y and vice versa. The test is based on the equation below.

$$Y_t = \gamma_0 + \sum_{z=1}^{p} \gamma_z Y_{t-z} + \sum_{i=1}^{q} \lambda_i X_{t-1} + \mu_t \quad (8)$$

$$X_t = \varphi_0 + \sum_{z=1}^{p} \delta_z X_{t-z} + \sum_{i=1}^{q} \Psi_i Y_{t-1} + \varepsilon_t \quad (9)$$

where *Yt* and *Xt* are the variables used, μ_t and $\mathcal{E}_t$ are the error terms, and *t* is the time period *z* and *i's* are the number of lags. The null hypothesis is $\lambda_i = \Psi_i = 0$ for all *i*. In the alternative hypothesis that $\lambda_i \neq 0$ and $\Psi_i \neq 0$ for at least some *i's* if the coefficient λ_i are significant but Ψ_i are not significant, then *X* does Granger causal to *Y*. However, if both coefficients are significant, then causality runs both directions.

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4.0 Findings

Unit root test is to examine the stationary properties of the time series data. Table 4.1 shows that all variables used are non stationary at level and stationary in the first difference. Thus, co-integration can be conducted to examine the long run relationship among the variables.

Table 4.1: Unit Root Test

	Intercept		Intercept+trend	
	Level	First diffrence	Level	First diffrence
Energy	-2.0443	-3.8221**	-0.5991	-4.3092**
	0.2671	0.0102	0.9674	0.0153
Population	-1.2783	-4.4895** -2.0287	-4.0374**	
	0.6125	0.0216	0.2728	0.0110
GDP	-0.7403	-5.3428*	-2.8725 -3.7173**	
	0.8142	(0.0001)	0.2971	0.0477

Note: *, ** and *** indicates the rejection of the null hypothesis of non-stationary at 1%, 5% and 10% significant level.

Johansen co-integration is employed to examine the relationship among GDP, energy consumption and population in the long run. Table 4.2 shows that there is one co-integration equation, suggesting that there is long run relationships among the variables. However the co-integration cannot determine the direction of the relationship among the variables. Therefore Granger causality test is carried out to see the causal relationships among GDP, energy consumption and population.

Table 4.2 : Co-integration Test

Rank	Max-Eigen Statistic (Eigen)	Critical Value at 5%	Trace Statistic	Critical Value (Trace) at 5%
None*	48.90479	21.13162	54.61447	29.79707
At most 1	5.680551	14.26460	5.709678	15.49471

L.R test indicates one co-integrating equation at the 0.05 level
Lag 2 is selected based on AIC.

Table 4.3, the results reveal that population does Granger cause energy consumption with no feedback effect, suggesting that an increase in population contributes to rising energy consumption. While energy consumption has an effect on GDP but GDP does not have any effect on energy consumption. Thus, implying that GDP is dependent on energy consumption. Population is also one of the factors influencing GDP.

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Table 4.3 Granger Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
LGGDP does not Granger Cause LGE	19	0.56468	0.5810
LGE does not Granger Cause LGDP		3.81492	0.0410
LGP does not Granger Cause LE	19	4.21167	0.0271
LGDP does not Granger Cause LP		3.92381	0.0444
LP does not Granger Cause LGDP_GDP	19	4.15755	0.0383
LGDP_GDP does not Granger Cause LGDP_P		1.99449	0.1729

Conclusion

This paper aims to examine the relationship among population, energy consumption and economic growth. First, a unit root test was conducted, in which data were shown to be non-stationary in all levels, and stationary in the first difference for all variables. The co-integration model was applied, and the results indicated that one co-integrating equation exists, suggesting the long-term relationship among population, energy consumption and economic growth in Malaysia. Finally, Granger causality model was conducted, and the results showed that population has an effect on energy consumption and energy consumption contributes to economic growth in Malaysia

This paper can be instrumental in the formulation of policies to maintain Malaysian economic growth. A reduction in energy consumption can harm the economic growth. Therefore any policy to reduce energy consumption should be revised. Malaysian government should increase the expenditure on health to always ensure that there is no decrease in population as it indirectly affects the economic growth.

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