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The Relationship Between Energy Consumption and Economic Growth

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ABSTRACT

Using a neo-classical one-sector aggregate production where energy is used as one inputs, the paper develops a vector error-correction (VEC) model to test for the existence and direction of causality between output growth and energy consumption in Malaysia. Using the Johansen co-integration technique, the empirical findings indicate that the long-run movements of output and energy do not exist by one co-integrating vector. Then using a VEC specification, the short-run dynamics of the variables indicate that Granger-causality is not running in both directions between output growth and energy consumption. Hence, those findings conform the presence of "neutral hypothesis theory" which imply Malaysia's economic growth is not dependent highly upon energy consumption, and energy cannot be considered as a limiting factor to output growth in Malaysia.

Keywords: granger causality, output growth, energy consumption, Malaysia.

INTRODUCTION

The Government Transformation Programme (GTP) was officially designed to be an ambitious programme of change aiming to transform the very foundation of Malaysian Government. GTP is derived into seven Numbers Key Result Areas (NKRA), namely (1) addressing the rising cost of living, (2) reducing crime, (3) fighting corruption, (4) improving student outcomes, (5) raising living standards of low income households, (6) improving rural basis infrastructure, and (7) improving public transport. The implementation of the GTP is in part a response to request from the people, who were demanding more from the government. In addition, it is vividly a recognition of the fact that the impetus to become a high-income nation by 2020 is fast approaching. Given such policy, for sure, Malaysian government would be pushing the income generated over all citizens in order to accelerate and signify with the GTP aspiration.

Economically, it is very interesting to tie up GTP goal with current Malaysian Economy. According to quarterly update on Malaysian Economy in 4th quarter 2012, published by Ministry of Finance, the Malaysian economy registered a robust growth of 6.4% in the fourth quarter of 2012 (Q3 2012: 5.3%) led by strong performance in all sectors. The services and manufacturing sectors remained the key drivers of growth. The services sector recorded a growth of 6.3% (Q3 2012: 7%) spurred by the finance and insurance, wholesale and retail trade as well as communication subsectors. In line with higher industrial production index (IPI), the manufacturing sector expanded 5.8% (Q3 2012: 3.3%) driven by the stronger performance of the transport equipment, petroleum and chemical products as well as electrical and electronic subsectors. The agricultural sector made up a higher growth of 5.6% (Q3 2012 : 0.5%) and eventually mainly attributed to strong growth in the oil palm, livestock and fishing subsectors. Meanwhile, growth in the mining sector rebounded strongly by 4.3% (Q3 2012: –1.2%) on account of increased production of crude oil and natural gas. For whole year, the economy expanded 5.6% surpassing the forecast of 4.5–5% in October 2012. In other words, the pro-growth policies were pushed by government in the sake for inclining towards long term goal (Table 1).

Meanwhile, in terms of energy formation, Jacobsen (2007) did the input-output tables for Malaysia in 2000 and the energy goods domestically supplied as well as imported. His study took three energy commodities/sectors in the Malaysia's input-output tables. According to Table 2, we extract that crude petrol, natural gas, and coal as the main contributors for output formation, accounted for RM 46 billion, meanwhile electricity and gas is a small amount, around RM 15 billion. Interestingly, those three energy commodities/sectors are mainly impetus for Malaysian growth since they are used to supply either for domestic intermediate or domestic final goods. In other words, Malaysian economic growth is highly dependence on the energy consumption, particularly crude oil, natural gas, coal, petrol, and coal product. This phenomenon was explained by Ang (2008) who explores long run relationship and causality among output, energy consumption and pollutant emissions for Malaysia over the period 1971-1999. He found pollution and energy consumption positively affect output in the long run. The causality runs from economic growth to energy consumption growth, both in the short and the long-run. More specifically, Shaari *et al* (2012) concluded that there is a long-run relationship between energy consumption and GDP. However, once the granger causality model is used, the oil and coal consumption do not granger cause economic growth and vice versa. A unidirectional relationship exists between gas and economic growth in Malaysia.

Therefore, looking at the fact that composition of energy towards output formation is attributable a large portion in Malaysian economic growth, it is relevant to look into detail empirically to what extent its contribution. However, although past study mentioned there existed a long term relationship between economic growth and energy consumption, the study which is concern with direction whether economic growth affects energy consumption affects economic growth is no consensus judgment or not clearly stated. As noted by Jumbe (2004), amongst others, if causality runs from energy consumption to GDP then it implies that an economy is energy dependent and hence energy is a stimulus to growth implying that a shortage of energy may negatively affect economic growth or may cause poor economic performance, leading to a fall in income and employment. In other words, energy is a limiting factor in economic growth (Stern 2000). Whereas, if causality only runs from GDP to energy consumption this implies that an economy is not energy dependent hence, as noted by Masih and Masih (1997) amongst others, energy conservation policies may be implemented with no adverse effect on growth and employment. If, on the other hand, there is no causality in either direction (referred to be as the "neutrality hypothesis"), it implies that energy consumption is not correlated with GDP, so that energy conservation policies may be pursued without adversely affecting the economy (Jumbe 2004).

The aim of this paper is to empirically investigate the causal interactions between energy consumption and output growth in the case of Malaysia. More specifically, the paper tries to trace the direction of causality within the neo-classical aggregate production model. Thus the significant contribution of this study is to enrich the literature particularly related to energy growth nexus in the case of developing countries and favor Malaysian Government in achieving a high income nation policy by 2020 via analyzing the dynamic between the economic growth and the source of growth (energy consumption). Thus, it might provide policy makers some more complete plan for ensuring such noble goal in track. Table 3. shows the overview of selected studies which emanates numerous methods of related study on energy consumption-growth nexus.

Table 1. Real Gross Domestic Product (% Annual Change)
Supply Side

Sector	2011	2012	2012				2013
			Q1	Q2	Q3	Q4	Q1
GDP	5.1	5.6	5.1	5.6	5.3	6.4	4.5–5.5
Agriculture	5.9	0.8	2.1	–4.7	0.5	5.6	2.4
Mining	–5.7	1.4	0.3	2.3	–1.2	4.3	2.7
Manufacturing	4.7	4.8	4.4	5.6	3.3	5.8	4.9
Construction	4.6	18.5	15.5	22.2	18.3	18.1	11.2
Services	7.0	6.4	5.7	6.6	7.0	6.3	5.6

Source: Department of Statistics, Malaysia

Table 2. Energy Input Domestically Supplied
and Imported in 2000

(1000 RM)	Imported Intermediate Use	Imported Final Demand	Total Import	Domestic Intermediate	Domestic Final	Total Domestically Supplied	Total Use Including Export
Crude Petrol, Natural Gas, and Coal	4,875,477	125,144	5,000,621	12,660,572	28,659,788	41,320,360	46,320,981
Petrol and Coal Poduct	9,016,995	282,860	9,300,855	14,668,060	17,809,985	32,478,045	41,778,900
Electricity and Gas	1,174	0	1,174	12,051,610	3,402,012	15,453,662	15,454,796

Source: Jacobsen, 2007

Table 3. Overview of Selected Studies

Study	Method	Countries	Result
Kraft and Kraft (1978)	Bivariate Sims Causality	USA	Growth → Energy
Yu and Choi (1985)	Bivariate Granger Test	South Korea and Philippine	Growth → Energy Energy ← Growth
Erol and Yu (1987)	Bivariate Granger Test	USA	Energy ↮ Growth
Yu and Jin (1992)	Bivariate Granger Test	USA	Energy ↮ Growth
Masih and Masih (1996)	Trivariate VECM	Malaysia, Singapore, and Philippines India Indonesia Pakistan	Energy ↮ Growth Energy → Growth Growth → Energy Energy ← Growth
Glasure and Lee (1998)	Bivariate VECM	South Korea and Singapore	Energy ↔ Growth
Masih and Masih (1998)	Trivariate VECM	Srilanka and Thailand	Energy ← Growth
Asafu-Adjaye (2000)	Trivariate VECM	India and Indonesia Thailand and Philippines	Energy → Growth Energy ↔ Growth
Hondroyiannis *et al*. (2002)	Trivariate VECM	Greece	Energy ↔ Growth
Soytas and Sari (2003)	Bivariate VECM	Argentina South Korea Turkey Indonesia and Poland Canada, USA, and UK	Energy ↔ Growth Growth ← Energy Energy → Growth Energy ↔ Growth Energy ↔ Growth
Fatai *el al*. (2004)	Bivariate Toda Yamamoto (1995)	Indonesia and India Thailand and Philippines	Energy → Growth Energy ↔ Growth
Oh and Lee (2004b)	Trivariate VECM	South Korea	Energy ↔ Growth
Wolde-Rufael (2004)	Bivariate Toda and Yamamoto (1995)	Shanghai	Energy → Growth
Lee (2005)	Trivariate Panel VECM	18 Developing Nations	Energy → Growth
Al-Iriani (2006)	Bivariate Panel VECM	Gulf Cooperation Countries	Growth → Energy
Lee and Chang(2008)	Multivariate Panel VECM	16 Asian Countries	Energy → Growth
Lee et al (2008)	Trivariate Panel VECM	22 OECD Countries	Energy ↔ Growth
Narayan and Smyth (2008)	Multivariate Panel VECM	G7 Countries	Energy → Growth
Apergis and Payne (2009b)	Multivariate Panel VECM	11 countries of the commonwealth of independent states	Energy ↔ Growth
Apergis and Payne (2009b)	Multivariate Panel VECM	6 Central American Countries	Energy → Growth
Lee and Lee (2010)	Multivariate Panel VECM	25 OECD Countries	Energy ↔ Growth

METHOD

In many situations, some researchers are interested in the proximate determinants of growth. The Solow model is one of among growth theories in neo-classical economics school of thoughts which focus on several input variables, namely capital, labor, and knowledge. The central assumptions of the Solow model concern the properties of the production function and the evolution of the observable inputs into production over time. The model's critical assumption concerning the production function is that it has constant returns to scale in its two arguments. For instance, doubling capital and effective labor, with keeping technology constant, the amount of production doubles. The assumption of constant returns theoretically can be thought of as a combination of two separate assumptions. The first is that the economy is big enough that the gains from specialization have been exhausted. In very small economy, there are probably enough possibilities for further specialization that doubling the amounts of capital and labor more than doubles output. The Solow model assumes, however, that the economy is sufficiently large that, if capital and labor double, the new inputs are used in essentially the same way as the existing inputs, and thus that output doubles.

The second assumption is that inputs other than capital, labor, and knowledge are relatively unimportant. In particular, the model neglects land and other natural resources. If natural resources are important doubling inputs could be less than double output. In practice, however, the availability of natural resources does not appear to be a major constraint on growth. Assuming constant returns to capital and labor alone therefore appears to be a reasonable approximation.

In addition, we often want to know how much of growth over some period is due to increases in various factors of production, and how much stems from other forces. Growth accounting, which was pioneered by Abramovitz (1956) and Solow (1957), provide a way of tackling this subject. To see how growth accounting works, consider again the production function:

$$Y_{(t)} = F(E)_{(t))} \quad \text{.........} \quad (1)$$

Where Y = aggregate output or real GDP; E is total energy consumption, and the subscript t denotes the time period. Taking differential of Eq. (1) we obtain:

$$dY_t = YEdE_t \quad \text{.........} \quad (2)$$

Where Y_t is the partial derivative of Y with respect to equation 1. On dividing equation 2 through by Y_t and rearranging the resulting expression, we obtain the following growth equation.

$$Y_t = aE_t \quad \text{.........} \quad (3)$$

Where a dot on the top of a variable means that the variable is now in a growing rate from. The constant parameter *a* is representing the elasticity of output with respect to energy. The relationship between output and energy input described by production function in Eq. (1) suggests that their long-run movement may be related. Furthermore, if we allow for short-run dynamics in factor-input behavior, the analysis above would also suggest that past changes in energy could be a useful information for predicting the future change of current output, ceteris paribus. This implication can be easily exercised using tests for bivariate co-integration and granger causality.

Testing for Co-Integration

If we test for short run dynamic of the variable in Eq (1), then we can articulate the intertemporal interaction within a VAR specification as follows :

$$Z_t = \Phi_1 Z_{t-1} + \Phi_2 Z_{t-2} + ... + \Phi_t Z_{t-1} + \mu + \Phi_t,$$
$$t = 1, ..., T \quad \text{.........} \quad (4)$$

Where l is the lag-length and Z_t is a $2X_1$ vector containing Y, and E. the two variables will be measured by their by their natural logarithm so that their first difference approximate their growth rates.

In addition, if these variables have unit roots, then we can express the idea that there may exist co-movements in their behavior and possibilities that they will trend together towards a long run equilibrium state. Then, using the Granger representation theorem, we may posit the following testing relationships that constitute a VEC model for output growth :

$$\Delta Z_t = \tau_1 \Delta Z_{t-1} + \tau_2 \Delta Z_{t-2} + ... + \tau_{t-1} \Delta Z_{t-1+l} + \Pi Z_{t-l} + \mu + \pi_t, \; t = 1, ..., T \quad \text{.........} \quad (5)$$

Where ΔZ_t contains the growth rates of the variables. The τ's are estimable parameters, Δ is a difference operator, πt is a vector of impulses which represent the unanticipated movements in Z_t with πt-niid (0,ε) and Π is the long run parameter matrix. With r cointegrating vectors (1 < r < 4), Π has rank r and can be decomposed as Π = αβ, with α and β both 2Xr matrices. On expanding out Eq (5), the model can be expressed as follows:

$$\Delta Y_t = \mu_1 + \sum_{k=1}^{r} \alpha_{1,k} \upsilon_{k,t-p} + \sum_{s=1}^{p} \gamma_{1,s} \Delta Y_{t-s} + \sum_{s=1}^{p} \gamma_{2,s} \Delta E_{t-s} + \pi_{1,r} \quad \text{.........} \quad (6)$$

$$\Delta E_t = \mu_2 + \sum_{k=1}^{r} \alpha_{2,k} \upsilon_{k,t-p} + \sum_{s=1}^{p} \delta_{1,s} \Delta Y_{t-s} + \sum_{s=1}^{p} \delta_{2-s} \Delta E_{t-s} + \pi_{2,r} \quad \text{.........} \quad (7)$$

Where, p = l–1. The parameters αl.k are the adjustment coefficient, vk, t–p are the cointegrating vectors, and μ_{1-2} are intercepts.

In addition to being consistent with the specifications in Eqs. (2) and (3), the model in Eqs. (6)-(7) describes the intertemporal interaction between output and the factor input included in the production function. Once the equilibrium conditions represented by the cointegrating relations are imposed, the VEC model describes how, in each time period, output growth is adjusting towards its long-run equilibrium state. Since the variable are supposed to be cointegrated, then in the short term, deviation of output from its long-run equilibrium path will feed back on its future changes in order to force its movement towards the long-run equilibrium state. The cointegrating vectors from which the error-correction terms are derived are each indicating an independent direction where a stable, meaningful long run equilibrium state exists. The coefficients of the error correction terms, however, represent the proportion by which the long-run disequilibrium in the dependent variables is corrected in each short-term period.

The Johansen (1988) approach estimates the long run or cointegrating relationships between the non stationary variables using a maximum likelihood procedure which tests for the cointegrating rank r and estimates the parameters α and β.

Data and Variables Definitions

Data used in the analysis are annual time series on real GDP and energy use for Malaysia during the period 1980-2010. The variables' notations and definitions are as follows.

E : Total Energy consumption in Kj

Y : Real GDP in US Dollars

All variables are transformed into their natural logarithm so that their first differences approximate their growth rates. The data were retrieved from World Bank Database and Energy Information Administration from US Government.

RESULTS

Test Results for Unit Roots

Since, the VEC specification in Eqs. (6) to (7) requires that some or all the variables are integrated of order one, we herein investigate the stationarity status of the variables using both the augmented Dickey-Fuller (ADF) and the Philips-Perron (PP) tests for unit roots. The null hypothesis tested is that the variable under investigation has a unit root against the alternative that it does not. In terms of lag length, we choose the Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), and Hannan-Quinn Information Criterion (HQ) to determine the optimal lags after testing for first and higher order serial correlation in the residuals.

Table 4. Test Results for Unit Roots

Variable	Y	E	ΔY	ΔE
ADF	–2.250472	–1.217121	–4.753211***	–5.075368***
PP	–2.250472	–0.377800	–4.699245***	–8.939518***

*** denotes for 1% significant level.

Table 4. reports the results of testing for unit roots in the level variables as well as in their first difference. In the first half of the table 4.1, the null hypothesis that each variable has a unit root cannot be rejected by both tests. However, after applying the first difference, both tests reject the null hypothesis. Since the data appear to be stationary in first differences, no further tests are performed. We, therefore, maintain the null hypothesis that each variable is integrated of order one.

Test Results for Cointegration

Given the results of unit roots, we now use the Johansen (1988), Johansen (1991), Johansen (1992) and Johansen and Juselius (1990) techniques to test for cointegration between the variables within a VEC model as specified in eqs (6) and (7). The results of testing for the number of cointegrating vectors are reported in Table 4. which presents both the maximum eigenvalue (λmax) and the trace statistics, 1% and 5% critical values as the corresponding λ values.

According to Table 5, we can see that both tests suggest there is no cointegration between observed variables at both 1% and 5% levels. Thus, there is no evidence for the presence of a long run relationship between the variables in all system we estimate.

Test Results for Granger-Causality

Table 6. reports the results of the granger causality tests. These tests are conducted using a joint F-statistic for the exclusion of one variable from one equation as illustrated above. The results of these tests indicate that granger causality is no longer running in both directions between output growth and energy use.

Table 5. Testing the Rank of Cointegration

Trace					λmax				
H0	H1	Stat	1%	5%	H0	H1	Stat	1%	5%
R=0	r>1	10.50477	18.17	23.46	R=0	r>1	7.790349	16.87	21.47
R<1	r>2	2.714417	3.74	6.40	R<1	r>2	2.714417	3.74	6.40

Table 6. Test Results for Granger Causality

Null Hypothesis	F(2,28)	99% Critical Value
LNGDP does not Granger Cause LNEC	0.98473	0.32984
LNEC does not Granger Cause LNGDP	1.31308	0.26189

According to Table 7., the results suggest that the proportion of energy use attributable to output formation is increasing. In the second period, its contribution is around 5.7% and becomes 32.67% in the 30 period. Meanwhile, the contribution of output formation towards energy consumption is roughly 4.9% in the second period and jumps to 25.77% in the 30 period.

DISCUSSION

The results of the granger causality tests of this research are in line with findings by Erol and Yu (1987), Yu and Jin (1992), and Masih and Masih (1996), who obtained similar results on other countries as well as Malaysia case. The granger causality tests conducted above indicate only the existence of causality. They do not, however, provide any indication on how important is the causal impact that energy has on output formation. For example, when there is a shock to energy supply, it would also be interesting to gauge by how much this shock will affect the output formation. In addition, it is very important to know how long the effect of such a shock will last. In order to provide such explanation, we decompose the variance of the forecast-error of output into proportions attributable to innovations in variable energy in the system including its own. Impulse response analysis is taken into account to further capture temporal responses of a variable to its own innovation and innovations in other variables in the system. The function can observe whether the response of observable variables is temporal or persistent in nature.

Even though there is no longer co-integration between two variables, the Table 5. indicates either energy or future growth of output in Malaysia has moderate impact each other. At least, in the short run, the shock both in energy use and output formation would create instability or disturbances on demand for energy and generated output. Stabilization policy through fiscal policy could be one proposed exercise for maintaining and monitoring the level of stability in the economy. Those findings ultimately confirm on what assumptions posed by Solow model that in the case of small economy, natural resources (energy consumption) is not a substantial factor led to output growth and therefore Malaysia cannot gain much on energy sector for driving its output. Given such condition and looking at mentioned assumptions, specialization idea in energy formation should be then put as a negligible portion upon GTP roadmap since it does really hamper the long run growth in the country.

CONCLUSION

This paper attempted to analyse the causal relationship between energy and output growth in Malaysia. Based on the neo-classical one sector aggregate production. By using time series data, the findings suggest that no cointegration exists over the observation, particularly between energy use and output growth. In addition, the short-run dynamics of the variables show that the flow of causality is not running in both directions between observable variables. With this, our results seem to significantly comply the neo-classical assumption that energy is neutral to growth. Consequently, we deduce that energy is not a limiting factor to output growth in Malaysia, and hence, shocks to energy supply will not have a negative effect to output. In addition, due to unbirectional between growth to energy use exists, it implies the output growth is not only dependent upon energy consumption. All in all, Malaysia government has a wide range of creative policy measure to respond the dynamic of energy prices with respect to growth. The vision 2020 achievement is finally and totally in the hand of government regardless energy use volatility.

Table 7. Results of Variance Decomposition

Forecast Variance of	Forecast Period	Percentage of Forecast Variance due to Innovation in		Forecast Variance of	Forecast Period	Percentage of Forecast Variance due to Innovation in	
		ΔY	ΔE			ΔE	ΔY
	2	94.31525	5.684750		2	95.10014	4.899865
	4	91.47030	8.529698		4	88.74731	11.25269
	8	84.18546	15.81454		8	82.23897	17.76103
	12	78.22102	21.77898		12	78.80246	21.19754
ΔY	16	73.96214	26.03786	ΔE	16	76.81087	23.18913
	20	70.97904	29.02096		20	75.57895	24.42105
	24	68.86316	31.13684		24	74.77383	25.22617
	28	67.33264	32.66736		28	74.22364	25.77636
	30	66.72686	33.27314		30	74.01292	25.98708

REFERENCES

Abramovitz, Moses. 1956. Resource and Output Trends in the United States Since 1870. *American Economic Review,* 46(May): 5-23.

Adjaye, John Asafu. 2000. The Relationship Between Energy Consumption, Energy Prices, and Economic Growth: Time Series Evidence from Asian Developing Countries. *Energy Economics* 22: 615-625.

Al-Iriani, M. 2006. Energy–GDP Relationship Revisited: An Example from GCC Countries Using Panel Causality. *Energy Policy,* 34(17), 3342–3350.

Amiri, Arshia and Mansour Zibaei. 2012. Granger Causality Between Energy Use and Economic Growth in France with Using Geostatistical Models. *MPRA paper,* 36357.

Ang, J. B. 2008. Economic Development, Pollutant Emissions and Energy Consumption in Malaysia. *Journal of Policy Modeling*, 30: 271–278.

Apergis, N. and J. E. Payne. 2009b. Energy Consumption and Economic Growth in Central America: Evidence from A Panel Cointegration and Error Correction Model. *Energy Economics,* 31(2): 211–216.

Asafu-Adjaye, J. 2000. The Relationship Between Energy Consumption, Energy Prices and Economic Growth: Time Series Evidence from Asian Developing Countries. *Energy Economics,* 22: 615-625.

Belke, Ansgar *et al*. 2010. Energy Consumption and Economic Growth: New Insights into the Cointegration Relationship. *Ruhr Economic Papers*.

Bouzid, Amaira. 2012. The Relationship of Oil Prices and Economic Growth in Tunisia: A Vector Error Correction Model Analysis. *The Romanian Economic Journal,* 43.

Chontanawat, Jaruwan *et al*. 2008. Causality Between Energy Consumption and GDP: Evidence from 30 OECD and 78 Non-OECD Countries. *Surrey Energy Economics: Discussion Paper Series*.

Costantini, Valeria, and Chiara Martini. 2009. The Causality Between Energy Consumption and Economic Growth: A Multi-Sectoral Analysis Using Non-Stationary Cointegrated Panel Data. *Working Paper*, 102.

Erol, U., and Yu, E. S. H. 1987. Time Series Analysis of the Causal Relationships Between U.S. Energy and Employment. *Resources and Energy,* 9: 75-89.

Fatai, K., Oxley, L., and Scrimgeour, F. 2001. Modelling the Causal Relationship Between Energy Consumption and GDP in New Zealand, Australia, India, Indonesia, the Philippines and Thailand. *MODSIM*, Australian National University, Canberra: 1091-1096.

Ghali, Khalifa H, and El-Sakka. Energy Use and Output Growth in Canada: A Multivariate Cointegration Analysis. *Energy Economics,* 26: 225-238.

Glasure, Y. U., and Lee, A. R. 1998. Cointegration, Error-Correction, and the Relationship Between GDP and Energy: The Case of South Korea and Singapore. *Resource Energy Economics,* 20: 17-25.

Gylfason, Thorvaldur. 2001. Natural Resources and Economic Growth: What is the Connection?. *Cesofo Working Paper*, 530.

Hondroyiannis, G., Lolos, S., and Papapetrou, E. 2002. Energy Consumption and Economic Growth: Assessing the Evidence from Greece. *Energy Economics,* 24: 319-336.

Hye, Qazi Muhammad Adnan, and Sana Riaz. 2008. Causality Between Energy Consumption and Economic Growth: The Case of Pakistan. *The Lahore Journal of Economics,* 13(2): 45-58.

Islam, Faridul, Muhammad Shahbaz and Mahmudul Alam. 2011. Financial Development and Energy Consumption Nexus in Malaysia: A Multivariate Time Series Analaysis. *MPRA Paper* No. 28403.

Jacobsen, Henrik Klinge. 2007. Energy Intensities and the Impact of High Energy Prices on Producing and Consuming Sector in Malaysia. *Eaviron Dev Sustain*, 11: 137-160.

Johansen, S. 1988. A Statistical Analysis of Co-Integration Vectors? *J. Econ. Dyn. Control,* 12: 231–254.

Jumbe, C. B. L. 2004. Cointegration and Causality Between Electricity Consumption and GDP: Empirical Evidence from Malawi. *Energy Economics,* 26: 61-68.

Kraft, J. and Kraft, A. 1978. Note and Comments: On the Relationship Between Energy and GNP. *The Journal of Energy and Development,* 3: 401-403.

Lee, C. C. 2005. Energy Consumption and GDP in Developing Countries: A Cointegrated Panel Analysis. *Energy Economics,* 27: 415-427.

Lee, C. and C. Chang. 2008. Energy Consumption and Economic Growth in Asian Economies: A More Comprehensive Analysis Using Panel Data. *Resource and Energy Economics,* 30(1): 50–65.

Lee, C., C. Chang, and P. Chen. 2008. Energy-Income Causality in OECD Countries Revisited: The key Role of Capital Stock. *Energy Economics,* 30(5), 2359-2373.

Lee, C. and J. Lee. 2010. A Panel Data Analysis of the Demand for Total Energy and Electricity in OECD Countries. *Energy Journal,* 31(1): 1-23.

Masih, A. M. M., Masih, R. 1996. Energy Consumption, Real Indome, and Temporal Causality: Results from a Multi-Country Based on Cointegration and Error-Correction Modelling Techniques. *Energy Economics,* 18: 165-183.

Masih, A. M. M., Masih, R. 1997. On the Temporal Causal Relationship Between Energy Consumption, Real Income, and Prices: Some new Evidence from Asian-Energy Dependent NICs based on a Multivariate Cointegration/ Vector Error-Correction Approach. *Journal of Policy Modeling,* 19(4): 417-440.

Masih, A. M. M. and R. Masih. 1998. A Multivariate Cointegrated Modeling Approach in Testing Temporal Causality Between Energy Consumption, Real Income and Prices with an Application to Two Asian LDCs. *Applied Economics,* 30(10): 1287-1298.

Narayan, P. K. and R. Smyth. 2008. Energy Consumption and Real GDP in G7 Countries: New evidence from Panel Cointegration with Structural Breaks. *Energy Economics,* 30(5): 2331-2341.

Nielsen, Heino Bohn. 2007. A "Maximum Eigenvalue" Test for the Cointegration Ranks in I (2) Vector Autoregressions. *Economic letters*, 94: 445-451.

Oh, W., and Lee, K. 2004b. Energy Consumption and Economic Growth in Korea: Testing the Causality Relation. *Journal of Policy Modeling,* 26: 973-981.

Shaari, Mohd Shahidan *et al*. 2012. Relationship Between Energy Consumption and Economic Growth: Empirical Evidence for Malaysia. *Business System Review,* 2(1).

Stern, D. 2000. A Multivariate Cointegration Analysis of the Role of Energy in the US Economy. *Energy Economics,* 22: 267-283.

Soile, Ismail O. 2012. Energy-Economy Nexus in Indonesia: A Bivariate Cointegration Analaysis. *Asian Journal of Empirical Research*, 2(6): 205-218.

Solow, Robert M. 1957. Technical Change and the Aggregate Production Function. *Review of Economics and Statistics,* 39: 312-320.

Soytas, U., and Sari, R. 2003. Energy Consumption and GDP: Causality Relationship in G-7 Countries and Emerging Markets. *Energy Economics,* 25: 33-37.

Wolde-Rufael, Y. 2004. Disaggregated Industrial Energy Consumption and GDP: The Case of Shanghai, 1952-1999. *Energy Economics* 26: 69-75.

Yazdan, Gudarzi Farahani *et al*. 2012. Is Cointegration Between Oil Price and Economic Growth? Case Study Iran. *Procedia-Social and behavioral Sciences,* 62: 1215-1219.

Yu, E. S. H., and Jin, J. C. 1992. Cointegration Tests of Energy Consumption, Income, and Employment. *Resources and Energy,* 14: 259-266.