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The Relationship between Financial Development and Increased Energy Consumption under the Shadow of Industrialization and Urbanization in Malaysia

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ABSTRACT

This study aims to investigate the relationship among energy consumption and financial development in regard to economic growth, industrialization and urbanization in Malaysia during the time period 1971 to 2008. It has used autoregressive distributed lag bounds testing approach to study this relationship. The findings indicated the long-run relationship among energy consumption, economic growth, financial development, industrialization and urbanization in Malaysia. Obviously a developed financial system can attract investors, then improve the stock market and encourage the efficiency of economic activities in the country. industrialization and urbanization facilitated the process of economic development.

Keywords: Energy consumption, Financial development, Economic growth.

Introduction

The objective of this paper is to assess the relationship among energy consumption, financial development, economic growth, industrialization and urbanization in Malaysia. Being one of the fastest growing economies in the North African region, Malaysia is an interesting case study as it faces energy shortage in fulfilling its growing energy needs. It is also important to investigate the direction of causal relationship between energy consumption and economic growth. If the causality runs from economic growth to energy consumption, energy conservation policies should be encouraged in reducing CO emissions. On the other hand, the energy reduction policies may have inverse impact on economic growth if energy consumption Granger causes economic growth.

The role of financial development in an economy is widely discussed in the economic literature. Both cross-country and country-specific studies discussed the importance of financial development on economic growth. A well established and developed financial system increases the efficiency and effectiveness of financial institutions and boosts the innovations in the financial services delivery system. It also helps the advancement of technology, reduction of information cost and profitability of investment. Improvement in monetary transmission mechanism, as a result of financial liberalization, also encourages savings and investment and enhances economic growth. Literature shows that liberalization of financial markets leads to economic growth. An opposite view is also found in the literature, which states that financial development is a result of economic growth.

A pioneering study by Kraft and Kraft (1978) found that economic growth caused growing energy demand in the United States during 1947–1974. According to Wolde-Rufael (2009) and Apergis and Payne (2009a, 2009b, 2010), rise in energy demand in emerging countries is due to increases of income. To fulfill the growing needs of their people, the emerging countries need more production, which leads to more energy consumption.

Several control variables are used in literature to explain the relationship between energy consumption and economic growth. Population growth, urbanization and industrialization are among the important factors that will boost energy consumption. Rapid growth in population will lead to urbanization, which may further cause more usage of energy. On the other hand, industrialization affects the energy consumption directly and indirectly. Industrialization means enhancement of plants to expand production and hence energy consumption. Industrial growth contributes to economic growth through cross-sectoral growth that further enlarges the demand for energy. Furthermore, industrial growth also increases the demand for labor and thus improves their income. The rise of income boosts the demand for consumer items such as cars, TVs, refrigerators, computers, etc., which increases the energy consumption.

Much of the literature on energy focuses on the nexus of output–energy, which portrays only a partial picture of the problem. According to Boulila and Trabelsi (2004), financial development causes economic growth in Malaysia, which may further cause more energy consumption. To the best knowledge of the authors, this is the only comprehensive study that takes into account financial development, industrialization and urbanization in the energy–growth nexus for Malaysia and uses the longest available data from 1971 to 2008, making the estimation more reliable. The finding may help policy makers to better understand some of the intricate development that confronts Malaysia.

The rest of the paper is organized as follows. Section 2 reviews the literature and Section 3 describes data and methodology. Results are reported in Section 4 and the conclusion is in Section 5.

Literature review

The relationship between financial development and economic growth is complex in both empirical and theoretical literatures (McKinnon, 1973; Bascom, 1994; Dow, 1996; Kaminsky and Schmukler, 2003; Claessens and Laeven, 2004). Without scanning the prevailing economic situation, steps taken for financial development and financial liberalization may be harmful to the economy (Stiglitz, 2000; Rogoff, 2004; Arestis and Stein, 2005). The competition between domestic and foreign banks makes the financial market more flexible and generates more and new opportunities for investment. This flexibility enhances the relationship between economic growth and financial development (Mankiw and Scarth, 2008; Karanfil, 2008; Sadorsky, 2010).

According to Karanfil (2009), the causality between economic growth and energy consumption is not justified just by a simple bivariate model. He suggested adding one of the financial variables such as domestic credit to private sector, stock market capitalization or liquid liabilities into the model. He also argued that interest rate and exchange rate can affect the energy consumption through energy prices. In this regard, Stern (2000) indicated the omission of relevant variables from the model. Furthermore, positive and significant relationships between energy consumption and economic growth are found by Lee and Chang (2008) by including capital stock in the model for some Asian countries. Bartleet and Gounder (2010) studied the casual relationship between energy consumption and economic growth using both bivariate and multivariate models. They found that economic growth, employment and energy consumption have cointegration relationship. The causality results show that economic growth causes energy consumption and economic activity determines the increase of energy demand. Using the neo-classical production function, they found that capital stock plays an important role in determining the direction of casual relationship between energy consumption and economic growth, and real GDP and employment also significantly affect the energy consumption.Sadorsky (2010) used different indicators of financial development in twenty-two emerging economies during the period 1990–2006. They found that the impact of financial development on energy demand is positive and significant but small. Shahbaz et al. (2010) suggested a significant and positive effect of financial development on energy consumption in Pakistan. The causality analysis indicated bidirectional casual relation between financial development and energy consumption. In Malaysia, Islam et al. (2011) revealed that financial development and economic growth have positive impact on energy consumption. Different from Pakistan, a unidirectional causality was found running from financial development to energy consumption in Malaysia.On the energy–growth relation, Chontanawata et al. (2008) showed that energy consumption Granger causes economic growth in the OECD countries but the reverse happened in the non-OECD countries. They also commented that energy conservation policies may have inverse effect on economic growth. Ozturk et al. (2010) indicated that economic growth Granger causes energy consumption in the low income countries while feedback hypothesis is found in the middle income countries. Similarly, Ozturk and Acaravci (2010) revealed the bidirectional causal relation between energy consumption and economic growth in Hungary. Altunbas and Kapusuzoglu (2011) found no long-run causality between energy consumption and economic growth but short run unidirectional causality runs from economic growth to energy consumption in the United Kingdom.Belloumi (2009) confirmed cointegration and bidirectional causal relationship between energy consumption and economic growth in Malaysia. However, by applying the bivariate Johansen cointegration and Granger causality approaches, their findings may be biased. Lutkepohl¨ (1982) argued that omissions of important variables provide biased and inappropriate results on the relationship. Bartleet and Gounder (2010) also recommended incorporating other pertinent variables that also play an important role to elucidate the energy–growth nexus. Thus, we try to fill this research gap by investigating the relationship with a multivariate model.

Data and methodology

The sample used is annual data covering the period 1971– 2008 taken from the World Development Indicators (WDI-CD, 2009). Energy consumption is measured by total energy consumption per capita (kg of oil equivalent). Domestic credit to private sector as share of GDP is the proxy for financial development. Real GDP per capita measures the economic growth, industrial value added as share of GDP is the proxy for industrialization and urban population as share of total population is the proxy for urbanization.Log–linear specification produces a better result compared to the linear functional form of model. Thus, all data are transformed to natural logarithmic. Modified from Sadorsky (2010), the basic framework for energy demand is

$$ENC_t = f\ (FD_t, GDPC_t, IND_t, URB_t) \qquad (1)$$

where ENC is logarithmic total energy consumption per capita, FD is logarithmic domestic credit to private sector as share of GDP, GDPC is logarithmic real GDP per capita, IND is logarithmic industrial value added as share of GDP and URB is logarithmic urban population as share of total population.Financial development indicates the actual amount of money to be used in investment projects. A high value of financial development implies developed financial market, which means bank and equity markets and fund are available for investment (Minier, 2009; Sadorsky, 2010). There are two main mechanisms to explain the enhancement in financial markets, which are linked with investment activities and hence the economic growth. The first mechanism is level effect, which reveals that developed financial markets channel financial resources to the high return projects. Regulations set a better accounting and reporting system, which enhances investor's confidence and attracts foreign direct investment (Sadorsky, 2010). The second mechanism is efficiency effect, which means financial development increases liquidity and asset diversification and raises funds for appropriate ventures. Thus, the impact of financial development on economic growth and thus the energy consumption should be positive.Economic growth leads industrialization, which is the backbone of the economic activities, and increases the demand for energy through sectoral growth. Similarly, energy literature such as Aqeel and Butt (2001) for Pakistan, Ghosh (2002) for India, Morimoto and Hope (2004) for Sri Lanka, Altinay and Karagol (2005) for Turkey, Ang (2008) for Malaysia, Bowden and Payne(2009) for USA, Halicioglu (2007) for Turkey, Odhiambo (2009) for Tanzania posited that economic growth has positive impact on energy consumption. The increase of share of industrial sector's value to GDP means more energy is required in order to keep the pace of economic growth consistent. A nation's ability in upgrading machineries to develop their industrial sectors varies will explain the intensity of energy consumption. Jiang and Gao (2007) reported that a rise in industrial growth is linked with high demand for energy consumption in China.Urbanization is a major feature of economic development that involves many structural changes throughout the economy and has important implication to the energy consumption. Urbanization deliberates population and hence economic activities. The rise in economic activities due to urbanization increases the demand for energy consumption. Mishra et al. (2009) indicated that energy consumption is caused by urbanization in the short run for the Pacific Island countries. In the long span of time, energy consumption and urbanization cause gross domestic product.We employ the autoregressive distributed lag (ARDL) bounds testing approach to cointegration developed by Pesaran et al. (2001) to explore the existence of long-run equilibrium among the series. The bounds testing approach has several advantages. The approach is applied irrespective of whether the variables are I(0) or I(1), unlike other widely used cointegration techniques. Moreover, a dynamic unrestricted error correction model (UECM) can be derived from the ARDL bounds testing through a simple linear transformation. The UECM integrates the short-run dynamics with the long-run equilibrium without losing any long-run information. The UECM is expressed as follows:

$$\Delta ENC_t = \alpha_1 + \alpha_t T + \alpha_{ENC} ENC_{t-1} + \alpha_{CDPC} CDPC_{t-1} + \alpha_{FD} FD_{t-1} + \alpha_{IND} IND_{t-1} + \alpha_{URB} URB_{t-1} + \sum_{i=1}^{p} \alpha_i \Delta ENC_{t-i} + \sum_{j=0}^{q} \alpha_j \Delta GDPC_{t-j} + \sum_{k=0}^{r} \alpha_k \Delta FD_{t-k} + \sum_{l=0}^{s} \alpha_1 \Delta IND_{t-1} + \sum_{m=0}^{t} \alpha_m \Delta URB_{t-m} + \mu_t \quad (2)$$

$$\Delta FD_t = \beta_1 + \beta_T T + \beta_{ENC} ENC_{t-1} + \beta_{GDPC} GDPC_{t-1} + \beta_{FD} FD_{t-1} + \beta_{IND} IND_{t-1} + \beta_{URB} URB_{t-1} + \sum_{i=1}^{p} \beta_i \Delta FD_{t-i} + \sum_{j=0}^{q} \beta_i \Delta GDPC_{t-j} + \sum_{k=0}^{r} \beta_k \Delta ENC_{t-k} + \sum_{l=0}^{s} \beta_i \Delta IND_{t-i} + \sum_{m=0}^{t} \beta_m \Delta URB_{t-m} + \mu_t \quad (3)$$

$$\Delta GDPC_t = \theta_1 + \theta_T T + \theta_{ENC} ENC_{t-1} + \theta_{GDPC} GDPC_{t-1} + \theta_{FD} FD_{t-1} + \theta_{IND} IND_{t-1} + \theta_{URB} URB_{t-1} + \sum_{i=1}^{p} \theta_i \Delta GDPC_{t-i} + \sum_{j=0}^{q} \theta_i \Delta FD_{t-j} + \sum_{k=0}^{r} \theta_k \Delta ENC_{t-k} + \sum_{l=0}^{s} \theta_l \Delta IND_{t-l} + \sum_{m=0}^{t} \theta_m \Delta URB_{t-m} + \mu_t \quad (4)$$

$$\Delta IND_t = \rho_1 + \rho_T T + \rho_{ENC} ENC_{t-1} + \rho_{GDPC} GDPC_{t-1} + \rho_{FD} FD_{t-1} \qquad (5)$$

$$+\rho_{IND} IND_{t-1} + \rho_{URB} URB_{t-1} + \sum_{i=1}^{P} \rho_i \Delta IND_{t-i}$$

$$+\sum_{j=0}^{q} \rho_i \Delta \mathrm{FD}_{t-j} + \sum_{k=0}^{r} \rho_k \Delta \mathrm{ENC}_{t-k} + \sum_{l=0}^{s} \rho_i \Delta \mathrm{GDPC}_{t-i}$$

$$+\sum_{m=0}^{t} \rho_m \Delta URB_{t-m} + \mu_t$$

$$\Delta URB_t = \sigma_1 + \sigma_T T + \sigma_{ENC} ENC_{t-1} + \sigma_{GDPC} GDPC_{t-1} + \sigma_{FD} FD_{t-1}$$

$$+\sigma_{IND} IND_{t-1} + \sigma_{URB} URB_{t-1} + \sum_{i=1}^{p} \sigma_i \Delta UR\sigma_{t-i}$$

$$+\sum_{j=0}^{q} \sigma_i \Delta FD_{t-j} + \sum_{k=0}^{r} \sigma_k \Delta ENC_{t-k} + \sum_{l=0}^{s} \sigma_l \Delta IND_{t-l}$$

$$+\sum_{m=0}^{t} \sigma_m \Delta IND_{t-m} + \mu_t \qquad (6)$$

where D is the first difference operator and m_t are error terms. The optimal lag structure of the first difference regression is selected by the Akaike Information criteria (AIC). Lags are induced by the noise property in the error term. Pesaran et al. (2001) suggested F-test for joint significance of the coefficients of the lagged level of the variables. For example, the null hypothesis of no long-run relationship between the variables in Eq. (2) is H_0 : a_{ENC} ¼a_{GDPC} ¼a_{FD} ¼a_{IND} ¼ a_{URB} ¼ 0 against the alternative hypothesis of cointegration H_1 :

aENC ∂aGDPC ∂aFD ∂aIND ∂aURB ∂o

Two asymptotic critical bounds are used to test for cointegration, lower bound is applied if the regressors are I(0) and the upper bound is used for I(1). If the F-statistic exceeds the upper critical value, we conclude the favor of a long-run relationship. If the F-statistic falls below the lower critical values, we cannot reject the null hypothesis of no cointegration. However, if the F-statistic lies between the two bounds, inference would be inconclusive. When the order of integration for all the series is known to be I(1), the decision is made based on the upper bound. Similarly, if all the series are I(0), then the decision is made based on the lower bound. The robustness of the ARDL model has been checked through some diagnostic tests. The diagnostics tests check serial correlation, functional form, normality of error term and heteroskedasticity.

After investigating the long-run relationship between the variables, we employ the Granger causality test to determine the causality between the variables. If there is cointegration, an error correction model can be developed as follows:

$$
\left(1-L\right)\begin{bmatrix} ENC_t \\ FD_t \\ GDPC_t \\ IND_t \\ URB_t \end{bmatrix} = \begin{bmatrix} \phi_1 \\ \phi_2 \\ \phi_3 \\ \phi_4 \\ \phi_5 \end{bmatrix} + \sum_{i=1}^{p}(1-L)\begin{bmatrix} a_{11i}\, a_{12i}\, a_{13i}\, a_{14i}\, a_{15i} \\ a_{21i}\, a_{22i}\, a_{23i}\, a_{24i}\, a_{25i} \\ a_{31i}\, a_{32i}\, a_{33i}\, a_{34i}\, a_{35i} \\ a_{41i}\, a_{42i}\, a_{43i}\, a_{44i}\, a_{45i} \\ a_{51i}\, a_{52i}\, a_{53i}\, a_{54i}\, a_{55i} \end{bmatrix}\begin{bmatrix} ENC_{t-i} \\ FD_{t-i} \\ GDPC_{t-i} \\ IND_{t-i} \\ URB_{t-i} \end{bmatrix} \tag{7}
$$

$$
+\begin{bmatrix} \xi_1 \\ \xi_2 \\ \xi_3 \\ \xi_4 \\ \xi_5 \end{bmatrix}\left[ECT_{t-1}\right] + \begin{bmatrix} \mu_{1t} \\ \mu_{2t} \\ \mu_{3t} \\ \mu_{4t} \\ \mu_{5t} \end{bmatrix}
$$

where (1L) is the difference operator; ECT_{t1} is the lagged error correction term, which is derived from the long-run cointegrating relationship. The long-run causation is shown by significance t-statistic of the lagged error correction term. The existence of a significant relationship in first differences of the variables provides evidence on the direction of the short-run causality. The joint w^2 statistic for the first difference lagged independent variables is used to test the direction of short-run causality between the variables. For instance, $a_{12,i}$ a0 8_i indicates that Granger causality runs from financial development to energy consumption.

Empirical findings and discussion

Table 1 reports the descriptive statistics and correlation matrix of the variables. The correlation results show significant and positive association between financial development and energy consumption. There is also positive link between economic growth, industrial value added, urbanization and energy consumption. The association of economic growth, industrial value added and urbanization with financial development is positive and significant. The correlation between industrial value added and economic growth is positive but it is insignificant while urbanization is positively and significantly correlated with economic growth.

The results of Ng and Perron (2001) unit root tests are reported in Table 2. Ng–Perron test is preferred as the results are more reliable and consistent compared to the traditional ADF and P–P tests. DeJong et al. (1992) and Harris and Sollis (2003) argued that due to their poor size and power properties, these tests are not reliable for small sample size. These tests will over-reject the null hypotheses when it is true and accept H_0 when it is false.

Table 1: Descriptive statistics and correlation matrix.

Variables	ENC	FD	GDPC	IND	URB
Mean	6.3659	4.0319	7.2380	3.3474	4.0306
Std. dev.	0.2818	0.2096	0.2814	0.1156	0.1246
Skewness	0.3952	1.0237	0.2263	1.5606	0.3455
Kurtosis	2.2822	2.9722	2.3332	5.5438	1.8006
FD	0.8833				
GDPC	0.9737	0.7964			
IND	0.5899	0.7002	0.4871		
URB	0.9785	0.8712	0.9518	0.5091	

Table 2: Results of the Ng–Perron unit root test.

Variables	MZa	MZt	MSB	MPT
Level				
ENC	3.3273	1.1513	0.3460	24.6911
FD	8.2178	1.9570	0.2381	11.2944
GDPC	1.8814	0.8360	0.4443	39.6181
IND	6.0343	1.7368	0.2878	15.1009
URB	9.8729	2.0209	0.2047	10.0736
1st Difference				
ENC	27.4132^{n}	3.7003	0.1349	3.3353
FD	33.2143^{n}	4.0718	0.1225	2.7623
GDPC	19.6562^{nn}	3.1235	0.1589	4.7049
IND	16.8163^{n}	2.8182	0.1675	5.9001
URB	20.0058^{nn}	3.1531	0.1576	4.6129

Note: ^{n} and ^{nn} indicate the significance .

Table 3: Results of ARDL cointegration test.

Variable	ENC	FD	GDPC	IND	URB
F-statistics	7.737^{nnn}	6.754^{nnn}	6.031	8.430^{nn}	0.7215
Critical values^{a}	1% level	5% level	10% level		
Lower bounds	10.150	7.135	5.950^{a}		
Upper bounds	11.130	7.980	6.680		
Diagnostic tests					
R2	0.8957	0.8974	0.8465	0.7917	0.9439
AdjR^{2}	0.8133	0.7774	0.6104	0.4273	0.8554
F-statistics	10.878^{n}	7.295^{n}	3.5854^{n}	2.1726^{nnn}	10.7668^{n}

Note: ^{n}, ^{nn} and ^{nnn} show the significance at 1%, 5% and 10% level, respectively.
Critical values bounds are from Narayan (2005) with unrestricted intercept and unrestricted trend.

Table 4: Results of the Johansen cointegration test.

Hypothesis	Trace statistic	Maximum eigenvalue
R¼0	92.8829^{n}	36.5734^{nn}
Rr1	56.3094^{n}	29.1072^{nn}
Rr2	27.2022	14.0898
Rr3	13.1123	12.3818
Rr4	0.7305	0.7305

Note: ^{n} and^{nn} show significance at 1% and 5% level, respectively.

Ng–Perron test can solve the problem of over-rejection of null hypothesis and can be applied on small sample size. Table 2 shows that all variables are I(1).The Akaike information criterion is used to select the lag length for ARDL bounds testing approach to cointegration. Results of ARDL bounds testing are reported in Table 3. We find three cointegration vectors when energy consumption, financial development and industrialization are used as the dependent variables. This result confirms the existence of long-run relationship between energy consumption, economic growth, financial development, industrialization and urbanization in Malaysia. For robustness check, we also perform the Johansen multivariate cointegration test. Results in Table 4 show two cointegrating vectors. This implies that the long-run relationship between the variables is valid and robust.Since there are cointegration vectors among the variables, we derive the long-run elasticities as the estimated coefficient of one lagged level independent variable divided by the estimated coefficient of one lagged level dependent variable and multiply with a negative sign. Table 5 shows that financial development is positively related to energy consumption and significant at the 5% level. A 10% increase in domestic credit to private sector is expected to raise energy demand by 1.4%, ceteris paribus. Financial development promotes investment, which raises energy demand due to economic growth. The easy access of credit enables consumers to purchase big ticket durable consumer items, and the usage of consumer items directly increases the energy demand. Naceur and Samir (2007) documented that banks and equity markets promote economic growth in Middle East and North African countries, including Malaysia. Our finding is consistent with Karanfil (2009) and Sadorsky (2010).The coefficient of economic growth indicates that economic growth has significant and positive effect on energy consumption. A 1% increase in economic growth enhances demand for energy consumption by 0.5%, ceteris paribus. This finding supports the view of Aqeel and Butt (2001) in Malaysia. The impact of rising industrial value added also has significant positive impact on energy consumption. The rise in industrial activities requires more energy to contribute in the gross domestic product. A 10% rise in industrial value added increases energy consumption by 2%. Meanwhile the impact of urbanization on energy consumption is positive and highly significant. The result reveals 0.9% of energy consumption increase due to 1% rise in urban population. This empirical evidence supports the findings by Lui (2009) and Mishra et al. (2009) on the relationship between urbanization and energy consumption.The short-run elasticities are computed as the estimated coefficients of the first differenced variables. The short-run results are reported in Table 5. Financial development exerts positive impact on energy consumption marginally. In short-run, energy consumption will increase by 0.1% due to a 1% increase in domestic credit to private sector. The impact of economic growth on energy consumption is positive and highly significant. A 1% rise in economic growth will increase energy consumption by 0.7%. The economic activities in industrial sector are positively associated with energy consumption. It is found that 1% increase in industrial value added will cause 0.2% energy consumption rise. However, the impact of urbanization on energy consumption is insignificant.

The significance of error correction term implies that change in the response variable is a function of disequilibrium in the cointegrating relationship and the changes in other explanatory variables. The coefficient of ECT_{t1} shows speed of adjustment from short-run to long-run and it is statistically significant with negative sign. Bannerjee et al. (1998) noted that significant lagged

Table 5: Long-run and short-run analysis.

Dependent variable¼ENC		
Long-run results		
Variable	Coefficient	t-statistic
Constant	1.9161^{n}	6.6508
FD	0.1352^{nn}	2.0699
GDPC	0.4840^{n}	7.8169
IND	0.2130^{nn}	3.2317
URB	0.8733^{n}	4.9217
Short-run results		
Variable	Coefficient	t-statistic
Constant	0.0016	0.0787
FD	0.0800	1.5116
GDPC	0.6547^{n}	4.6351
IND	0.2352^{nn}	2.3841
URB	0.2266	0.1445
ECT$_{t}$1	0.6457^{nn}	3.0367
Diagnostic tests		
Test	F-statistic	Prob. value
w^2normal	0.8323	0.6595
w^2serial	1.9906	0.1548
w^2arch	0.0150	0.9030
w^2white	0.7055	0.7110
w^2remsay	2.3963	0.1321

Note: ^{n} and ^{nn} denote the significance at 1% and 5% level, respectively.

Table 6: Results of the VECM Granger causality test.

Variables	ENC	GDPC	FD	IND	URB	ECT$_{t}$1
ENC	–	7.4987^{n} [0.0028]	1.1753 [0.3252]	2.8752^{nnn} [0.0752]	1.1884 [0.3213]	0.5009^{nnn} [1.8965]
GDPC	7.4239^{n} [0.0029]	–	1.8783 [0.1738]	3.5267^{nn} [0.0448]	8.8627^{n} [0.0012]	0.0630 [0.6636]
FD	3.7378^{nn} [0.0380]	6.5878^{n} [0.0050]	–	0.8249 [0.4499]	0.4369 [0.6508]	0.7420^{n} [4.1282]
IND	0.7228 [0.4952]	0.7107 [0.5006]	1.0233 [0.3739]	–	0.7511 [0.4822]	0.5217^{n} [2.9060]
URB	2.9234^{n} [0.0723]	3.8143^{nn} [0.0358]	0.09525 [0.9095]	0.8342 [0.4459]	–	0.0175 [1.6602]

Note: ^{n}, ^{nn} and ^{nnn} show significance at 1%, 5% and 10% levels, respectively. Figure in the parentheses is the p-value for variables and t-statistic for ECT.Error term with negative sign is a way to prove that the established long-run relationship is stable. The deviation of energy consumption from short-run to the long-run is corrected by 64.6% each year. In addition, the model passes all diagnostic tests for non-normality of error term, serial correlation, autoregressive conditional heteroskedasticity, white heteroskedasticity and model specification.

VECM Granger causality analysis

The Granger causality test is performed to find the direction of causality between energy consumption and other variables. As there is long-run relationship, we apply the VECM framework to detect the causality between the variables for both short and long runs. The results of Granger causality test are reported in Table 6.

Our empirical results suggest that ECT$_{t1}$ has negative sign and statistical significance in the energy-equation, finance-equation and industrialization-equation. This implies that there is bidirectional causality between financial development and energy consumption, financial development and industrialization, and industrialization and energy consumption in the long-run. Offering affordable credit to individuals will increase the purchase of electrical home appliances and more usage of these electrical products will increase the energy consumption. On the other hand, increase of energy consumption will lead to more economic and investment activities. This raises the demand for financial services and leads to financial development.

Bidirectional causality between financial development and industrialization reveals that financial development and industrialization are complementary. On one hand, financial development causes industrialization by providing easy access of financial resources to firms. On the other hand, increase in industrialization demands more financial services and leads to financial development. At the same time, industrial growth demands more energy and energy as an important input of production may improve the productivity and output.

In the short-run, we find bidirectional causal relationship between energy consumption and economic growth. This implies that energy conservation polices may not adversely affect the economic growth. This finding is consistent with Belloumi (2009), who reported feedback effect in Malaysia. On the other hand, industrialization Granger causes energy consumption and economic growth. We also find that energy consumption Granger causes urbanization while economic growth and urbanization have feedback effect. The demand-side hypothesis is confirmed as economic growth Granger causes financial development. Unidirectional causality is also found from energy consumption to financial development.

Conclusion

The literature on financial development–economic growth nexus enlightens us on the importance of finance in economic activities while the energy literature relates the role of energy in enhancing economic growth. In a free market system, entrepreneurs translate their ideas to actions with the assistant of finance. A financially developed system provides an appropriate way to reallocate financial resources in high return investment projects. Hence, investment stimulates economic growth, which in turn raises the demand for energy. This paper attempts to verify the reasoning that is intuitively appealing in the case of Malaysia.Our empirical evidences confirm that cointegration exists among the variables. We also find that financial development, economic growth, industrialization and urbanization increase energy consumption in Malaysia, especially in the long-run. Granger causality test reveals long-run bidirectional causal relationship between financial development and energy consumption, financial development and industrialization, and industrialization and energy consumption. Hence, sound and developed financial system that can attract investors, boost the stock market and improve the efficiency of economic activities should be encouraged in the country. Nevertheless, promoting industrialization and urbanization can never be left out from the process of development.

Moreover, the long-run unidirectional causality from economic growth to energy consumption supports the energy conservation policy. The environment friendly policies such as electricity conservation, including efficiency improvement measures and demand-side management policies, which aim to reduce the wastage of electricity would not adversely affect the economic activities in the long span of time. However, the shortrun bidirectional causality between energy consumption and economic growth implies that energy conservation policies will restrict economic growth in Malaysia. Therefore, energy conservation policies should be used in the long-run only. In the short-run, the government could encourage investment activities on research and development to formulate new energy savings technology and involve financial sector to meet the rising demand for energy due to the industrialization and urbanization.

While modernization of financial system does not help in economic growth and energy consumption, short-run economic policies may focus on enhancing the productivity and improving the overall economy in the country. The unidirectional causality from energy consumption to financial development implies that government should implement loose monetary policy, which will stimulate investment activities and enhance economic growth and hence the energy consumption. In turn, sustainable economic growth will generate more demand for financial services, which will then push the development of financial sector. The government can also direct the financial institutions to invest in energy sector for meeting the rising demand for energy.Industry sector is the second contributor after the agriculture sector in Malaysia, so Malaysian government should encourage investment activities not only in the small industry such as cottage industry but also in the heavy industry. This wave of industrialization will promote economic growth and increase the energy consumption. Besides, the government should pay attention to explore new sources of energy to meet the rising demand for energy. Last but not the least, the government should also provide energy facilities in the rural areas to control the rapid urbanization and its environmental consequences.

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