Financial development and energy consumption nexus in Malaysia: A multivariate time series analysis

Faridul Islam and Muhammad Shahbaz and Mahmudul Alam

Department of Finance and Economics Woodbury School of Business

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Faridul Islam*
Department of Finance and Economics
Woodbury School of Business
Utah Valley University
Orem, UT 84058-5999
Email: Faridul.Islam@uvu.edu
Phone: 801-863-8858

Muhammad Shahbaz
Department of Management Sciences,
COMSATS Institute of Information Technology
Lahore, Pakistan
Email: shahbazmohd@live.com

Md. Mahmudul Alam
Institute for Environment and Development (LESTARI)
National University of Malaysia (UKM)
43600, Bangi, Selangor, Malaysia
Email: rony000@gmail.com

*Correspondence author

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Abstract

Despite a bourgeoning literature on the existence of a long-run relationship between energy consumption and economic growth, the findings have failed to establish clearly the direction of causation. A growing economy needs more energy, which is exacerbated by growing population. Evidence suggests that financial development can reduce overall energy consumption by achieving energy efficiency. Economic growth and energy consumption in Malaysia have been rising in tandem over the past several years. The three public policy objectives of Malaysia are: economic progress, population growth and financial development. It is of interest to the policymakers to understand the dynamic interrelation among the stated objectives. The paper implements Auto Regressive Distributed Lag (ARDL) approach to cointegration to examine the existence of a long-run relationship among the series: energy consumption, population, aggregate production, and financial development for Malaysia; and tests for Granger causality within the Vector Error Correction Model (VECM). The results suggest that energy consumption is influenced by economic growth and financial development, both in the short and the long-run, but the population-energy relation holds only in the long run. The findings have important policy implications for balancing economic growth vis-à-vis energy consumption for Malaysia, as well as other emerging nations.

Key Word: Financial development; Energy consumption; ARDL; Economic growth
JEL classification: C32; O53; Q20; Q43

Introduction

The nexus between economic growth and energy consumption has been the subject of considerable academic scrutiny over the past few decades. Even so, the available empirical evidence on the relation in general and the direction of the causality in particular, has failed to provide a conclusive answer. As the race for economic prosperity by major emerging nations intensifies, the importance of the topic will grow further.

Energy is the key to the production of goods and services. Many emerging economies are growing at a pace much faster than were projected earlier which has created a spurt in the demand for energy. Although 2009 saw global economic recession, the major energy consuming nations in Asia – China and India – have hardly been affected. The International Energy Agency (IEA) (2009) reports that the global energy use is expected to fall significantly, in 2009, the first time since 1981. However, the demand should be back on the long-term up-trend once economic recovery gathers pace. Barring major policy changes, world primary energy demand by 2030 is projected to rise by 40% from its 2007 level. Collectively, the non-OECD nations will account for over 90% of this increase. Their share of global primary energy demand will rise from 52% to 63%. China and India will account for over 53% of the increase by 2030. Use of fossil fuels will continue to dominate energy scenario, accounting for 77% of the increase. Oil demand is projected to rise from the 85 million barrels per day in 2008 to 105 million in 2030, a 24% rise [IEA Fact Sheet, 2009].

Energy consumption depends on the stage of economic growth. Economic growth is a necessary condition to insure better standards of living. The heightened interest by the major economic powers at gaining a firm foothold on energy rich regions across the globe is a testimony to the fact that energy will remain a major focus for the foreseeable future. The battle for such control will also intensify as more energy will be needed to meet the demand for economic growth. Energy-related greenhouse gases (GHG) make up the bulk of pollutants. Knowledge of the determinants of energy demand can help manage global emissions of GHGs. World Resources Institute reports that developed countries once were the major emitters of most of world's GHG but the emerging nations have now taken that spot. The latter nations have set long-run economic growth as their core mission. The situation may be exacerbated due to higher population growth in many parts of the world.

Using US data for 1947–1974, Kraft and Kraft (1978) found uni-directional Granger causality from output to energy consumption. Masih and Masih (1996) found cointegration between energy use and GDP in India, Pakistan, and Indonesia, but no cointegration in the case of Malaysia, Singapore and the Philippines. The same study also found causality flows from energy to GDP in India; and from GDP to energy in Pakistan and Indonesia. Asafu-Adjaye (2000) found causality from energy to income in India and Indonesia, and a bi-directional causality in Thailand and the Philippines. Soytas and Sari (2003) showed bidirectional causality in Argentina; causality from GDP to energy consumption in Italy and Korea; and from energy consumption to GDP in Turkey, France, Germany and Japan. Wietze and Van Montfort (2007) also found energy consumption and GDP co-integrated in Turkey where the causality runs from GDP to energy consumption. Al- Iriani (2006) found unidirectional causality from economic growth to energy consumption in six Gulf Cooperation countries. Using data from more than hundred countries, Chontanawat et al. (2008) found that energy consumption causes economic growth in only 35% of the poorest, 42% of the middle-income and 69% of the high-income nations. Huang et al. (2008) also found no causality between energy consumption and economic growth in low-income groups, but found economic growth in middle- and high-income countries leads to higher the energy use. Lee and Chiang (2008) found long-run causality from energy consumption to economic growth; and a bi-directional causality among energy consumption, capital stock and economic growth for a group of 22 OECD nations. Narayan and Smyth (2008) showed capital formation and energy consumption affect real GDP positively in the long run for the G7 countries.

Studies show that population and economic growth are major driving forces behind increased energy use, and a cause of CO_2 emissions. Baltiwala and Reddy (1993) note that energy demand depends on per capita energy use. Energy needs in several African Asian urban centers are being met from bio fuel. That might change as the more urbanization and industrialization takes place. Dietz and Rosa (1997) and York, Rosa, and Dietz (2003) point out that the elasticity of CO_2 emissions and energy use with respect to population is close to unity. As living standards rises and population continues to grow, so does energy use and CO_2 emissions in city areas (Fong et al. 2007a, b; IGES, 2004).

Recent studies have demonstrated that financial development (FD) can affect demand for energy[1]. FD helps industrial growth, creates demand for new infrastructure; and thus positively impacts energy use. Sadorsky (2010) applied dynamic panel model to 22 emerging nation and found a positive and statistically significant relationship between the series. Tamazian et al., (2009) examined the relationship between environmental degradation and economic growth for 24 transition economies[2] and found support for Environmental Kuznets Curve hypothesis. The authors argue that institutional quality and FD exert favorable impact on environment; and financial liberalization may hurt environmental quality in the absence of institutional framework.

FD can lower energy consumption (EC) by achieving efficiency in its use. At the consumer end, FD makes credit cheap and accessible (Karanfil, 2009) and thus enables consumers buy big tickets items e.g., home appliances, which directly add to energy use. Developed financial market can enhance consumer and business participation in economic activity and thus energy use. Mielnik and Goldemberg (2002) found an inverse relationship between foreign direct investment and energy intensity. The claim that FD can add to efficiency in the use of energy, and at the same time promote economic growth is intuitively appealing. Ang (2008) 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 use 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.

Lorde et.al., (2010) uses capital, labor, technology, and energy as separate inputs to test the existence of long run relation between output growth and electrical energy use; and the direction of causality in Barbados, within the neo-classical aggregate production model. They findings suggest long-run relationship between growth and electricity consumption and bidirectional causality between electrical energy consumption and real GDP in the long run. However the causality is unidirectional from energy to output in the short run. They recommend liberalization of energy sector to encourage efficiency and innovation. Ghosh (2010) argued against efforts to reduce carbon emissions as it could hurt GDP.

The objective of the paper is to examine a long run relationship among consumption of energy, financial development, economic growth, and population for Malaysia by implementing

[1] Stern (2004) argues that most of the earlier studies suffer from methodological shortcomings (e.g., omitted variables, endogeneity, heteroskedasticity etc).
[2] The study employs panel data using standard reduced-form modeling approach and GMM.

autoregressive distributed lag (ARDL) approach to cointegration. The paper extends Ang (2008) study by including financial development as a variable which seems relevant in a globalized world. The choice of ARDL in departure from the Johansen-Juselius procedure, used by Ang (2008), is appropriate given the sample size. The Granger procedure is used to test the direction of causality within the Vector Error Correction Models (VECM). If a set of variables is cointegrated, they must have an error correction representation wherein an error correction term (ECT) must be incorporated in the model (Engle and Granger, 1987). The VECM reintroduces the information lost due to the differencing of series. This step is helpful in examining the long-run equilibrium and the short-run dynamics.

The three major public policy goals of Malaysia are: economic progress (GDP), financial development (FD) and population growth (POP). It is of interest of know how they interact with each other, inter alia. Also, an understanding of the long and short run causality among the series and their direction, if any, is more than a matter of just intellectual curiosity - they can have significant policy implications. Against the backdrops, the need to explore long run relation and causal link among the growth rates in FD, population, GDP and energy use in Malaysia gains particular importance. This paper finds bidirectional causality from FD to EC, EC to GDP and FD to GDP in the long. However, the causality for EC to GDP holds only for the short run. The results found here are intuitively more appealing compared to those reported by Maish and Masih (1996) (they found no cointegration) and by Ang (2008) (he found only unidirectional causality) for Malaysia. Thus the paper can be seen as a modest contribution to the literature.

As an important economic player in East Asia, the focus on Malaysia is justified for good reasons. Since independence in 1959 the resource rich Malaysia, the only democratic nation in the Muslim world, has successfully prosecuted a policy of enviable economic growth. The strategy has paid off. Malaysia boasts of being among the emerging nations with the highest rates of economic growth. However, notable spurt in energy consumption followed by a concomitant rise in pollutant emissions in recent times have made the choice of this country for study not only timely but also of much significance. According to the United Nations Development Report, CO2 emission in Malaysia has increased by 221% during 1990 to 2004 period which list the nation at 26th among the top 30 greenhouse gas emitters (The Associated Press 2007). If the current rate of emissions persists, Malaysia may move up the ladder. The fact that Malaysia is a signatory to Kyoto Protocol did little to alter the pattern in the rapid growth in emissions

(Liebman, 2007). However, the several initiatives taken by the government to harness renewable energy and to cut CO2 emissions are reassuring. The paper finds FD helps energy consumption and economic growth which will help policymakers choose appropriate strategy for sustainable economic growth.

The paper is organized as follows. Section 2 describes data and empirical strategy and section 3 presents the results. Section 4 reports the results while section 4 draws conclusion.

2 Data, Variables and Methodology

Data used in the paper are from the World Development Indicator (WDI 2009-CD-ROM). The study period covers 1971 to 2008. Energy consumption (EC) is measured in kg of oil equivalent per capita. Economic growth is proxied by the growth in real GDP, and POP refers to total population. Domestic credit to the private sector as share of GDP is used to measure financial development (FD). Domestic credit, obtained from the banking sector, includes gross credit to various sectors; with the exception of credit to the central government, which is net. Banking sector includes monetary authorities and deposit money with banks, and other banking institutions for which data are available. Also included are institutions that do not accept transferable deposits but incurs liabilities such as, time and savings deposits. Although imperfect, this provides a reasonably good measure for the development of financial sector[3].

The following empirical model is postulated to describe the relationship among the variables for purpose of estimation, in log-linear form.

$$EC = f(FD, GDP, POP) \tag{1}$$

$$LEC = \delta_{\circ} + \delta_{GDP} LGDP + \delta_{POP} LPOP + \delta_{FD} LFD + \mu_t \tag{2}$$

To establish long run relation among the variables we implement ARDL bounds testing approach to co-integration (Pesaran et al. 2001). This procedure has several advantages. Apart from the desirable small sample properties, ARDL can be applied irrespective of the order of integration, i.e., *I(0),* or *I(1).* A dynamic error correction model (ECM) can be derived from a simple linear transformation of a modified ARDL model which integrates the short-run dynamics

[3]McKinnon (1973) and King et al. (1993) used share of liquid liabilities (LLY) to GDP to proxy for financial development (FD). Increase in LLY shows the volume of financial sector, but is not a measure FD; and may not show savings mobilization. The later may misrepresent nation having high indicator even with an poor financial market. Standard proxies for FD are domestic credit issued to private sector as share of GDP; and the ratio between commercial bank assets to the sum of commercial bank assets and central bank assets (Yucel, 2009; Shahbaz, 2009, Shahbaz, 2010).

with the long-run equilibrium without loss of any long-run information. This approach involves estimating the following conditional error correction version of the ARDL model.

$$\Delta y = \lambda_1 + \lambda_2 y_{t-1} + \lambda_3 z_{t-1} + \lambda_4 x_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta y_{t-1} + \sum_{j=0}^{p} \alpha_i \Delta x_{t-j} + \sum_{s=0}^{p} w_s \Delta z_{t-s} + \mu_i \quad (3)$$

Where $\lambda 1$ is a drift component and μ_t represents a white noise error processes. The ARDL approach estimates $(p+1)^k$ number of regressions in order to obtain optimal lag length for each variable, where *p* refers to the maximum number of lags used; and *k* to the number of variables in Equation-3. The optimal lag structure for the regression is selected by the Schwarz-Bayesian criteria (SBC) to eliminate serial correlation[4]. Following Pesaran et al. (2001), two separate statistics are employed to test for the existence of long-run relationship and *F-test* for the joint significance of the coefficients of lagged levels in Equation-3. Two asymptotic critical bounds are used to test for co-integration when the independent variables are *I(d)*. The lower value is used if the regressors are *I(0)*, and the upper value for *I(1)* regressors.

If the F-statistic exceeds the upper limit of the critical value, a long run relationship exists regardless of the order of integration, *I(0)* or *I(1)*. If the *F*-statistic falls below the lower critical values, the null hypothesis of no cointegration is sustained. However, if the statistic falls between these two bounds, inference would be inconclusive. When the order of integration among the variables is known, and if all of them are *I(1)*, then the decision is made based on the upper bound. Similarly, if all the variables are *I(0)*, then the decision is made based on the lower bound. If variables are cointegrated, the conditional long run model can be obtained from the reduced from solution of Equation-3 and the variables in their first difference are jointly equal to zero, i.e. $\Delta x = \Delta y = \Delta z = 0$. Thus**,**

$$y_t = \partial_\circ + \partial_2 x_t + \partial_3 z_t + \nu_t \quad (4)$$

where, $\partial_\circ = -\lambda_1/\lambda_2$; $\partial_2 = -\lambda_3/\lambda_2$; $\partial_3 = -\lambda_4/\lambda_2$, and ν_t is the random error. The long run coefficients in Equation-3 are estimated by OLS. If cointegration exists among the variables, then the error correction model can be represented by the following reduced form equations.

[4]SBC selects the smallest lag length to specify a parsimonious model. The mean prediction error of AIC based model is 0.0005 while that of SBC based model is 0.0063 (Shrestha and Chowdhury, 2007).

$$\Delta y_t = \sum_{i=1}^{p} \lambda_i \Delta y_{t-1} + \sum_{j=1}^{m} \beta_i \Delta x_{t-j} + \sum_{k=1}^{n} \beta_k \Delta z_{t-k} + \eta ECM_{t-1} + \omega_t \quad (5)$$

$$\Delta LEC = \partial_{\circ} + \partial_{GDP} \Delta LGDP + \partial_{POP} \Delta LPOP + \partial_{FD} \Delta LFD + \eta ECM_{t-1} + \omega_t \quad (6)$$

Goodness of fit of the ARDL model, diagnostic and stability test are conducted to assess serial correlation, functional form, normality and heteroscedisticity associated with the model. The stability test is conducted using the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMsq). In addition, the Chow Forecast Test[5] is used to examine the reliability of ARDL model.

3. Findings and Discussion

3.1 Time series properties and cointegration

Prior to employing the ARDL cointegration approach, it may useful to test the order of integration of each series by applying the Ng-Perron (2001) procedure. The results in Table 1 suggest non-stationarity in the level (unit root); but difference stationary (no unit root, I(1)).

Table 1: Statistical Output for Unit Root Test (Ng-Perron) [ABOUT HERE]

To test the existence of cointegration, ARDL bounds tests approach is applied. The appropriate lag length for the series and to compute the F-statistics for cointegration, we consider lag 2, based on the minimum values of FPE, AIC, SBC and HQ criterion (Table 2).

Table 2: Lag Length Selection Criteria for Cointegration [ABOUT HERE]

Table-3 presents the F-statistics for cointegration. The computed F-statistics is 6.479 when energy consumption, economic growth and population are forcing variables at lag order 2. The test statistics exceeds the upper critical bounds at the 5 percent. This confirms cointegration among energy consumption, economic growth, financial development and population at the 5 percent level for the Malaysia for the period of study.

Table 3: Statistical Output for Cointegration Test (Bounds Test) **[ABOUT HERE]**

[5] The procedure examines the prediction error of the model using Chow test noted here.

Fig 1: Trends in the series used here to explore long run relation [ABOUT HERE]

The results are consistent with the findings of Aqeel and Butt, (2000) for Pakistan; Ghosh, (2002), and Paul and Bhattacharya, (2004) for India; Morimoto and Hope, (2004) for Sri Lanka; Ghali and El-Sakka, (2004) for Canada; Oh and Lee, (2004) for Korea; Altinay and Karagol, (2005) for Turkey; Ang, (2008) for Malaysia, Bowden and Payne, (2009) for USA; Halicioglu, (2009) for Turkey; Odhiambo, (2009) for Tanzania; and Belloumi (2009) for Tunisia. The coefficient of financial development is 0.07 and significant at the 5 percent level. The result confirms that for Malaysia, financial development helps cheaper credits which promotes business activities and adds to demand for energy. The ease of credit facilitates consumers purchase of automobiles, home and appliances. These directly add to energy use. Studies show that a 1 percent increase in credit to private sector (financial development) raises energy consumption directly and indirectly [Karafil, 2009; Sadorsky, 2010]. A 1 percent increase in population raises energy consumption by 0.4 percent on average all else same which is consistent with the findings by Baltiwala and Reddy (1993).

Table 4: Statistical Output for Long Run Log Linear Regression Model (Eq.3) [ABOUT HERE]

The short run elasticity of energy consumption with respect to economic growth (0.7) is significant and close to its long-run value. The same elasticity with respect to financial development is 0.12 and significant, but larger than the long-run estimate. Perhaps, the short run consumer and business response captures the enthusiasm for improved living conditions and opportunity to profit, respectively. This has been possible by the solid economic growth in Malaysia. Once the consumers get used to the basic amenities, and business expansion gets costlier, the short run euphoria should evaporate. The elasticity of energy consumption with respect to population is positive; but not significant. A reason may be that the dynamics in the interaction of population with other macroeconomic series takes much longer time.

Table 5: Statistical Output for Short Run Log Linear Regression Model (Eq. 6) [ABOUT HERE]

The coefficient of the error-correction term (ecm_{t-1}) shows the speed of adjustment from the short to the long-run. This is statistically significant and negative, as expected. Bannerjee et.al., (1998) argue that such value confirms the integrity of long run relationship among the variables found earlier. The value of ecm_{t-1} (-0.8761) implies that the energy consumption is corrected by (87.61) percent each year due to adjustment from the short towards long-run. The lag length for short run model is selected using the SBC.

Table 6: Statistical Output for Sensitivity Test (Eq. 3 and 6) [ABOUT HERE]

Model No.	Serial Correlation	ARCH Test	Normality Test	Heteroscedisticity Test	Ramsey Reset Test
Long Run (Eq. 3)	1.26 (0.30)	0.06 (0.81)	1.28 (0.53)	1.82 (0.13)	1.44 (0.25)
Short Run (Eq. 6)	1.2 (0.32)	0.27 (0.61)	0.73 (0.69)	0.57 (0.79)	0.75 (0.39)

Note: The P-values are given in the parenthesis

Both the long run and the short run regression specification tests pass well with respect to the serial correlation and autoregressive conditional heteroscedisticity. The results suggest that the error terms are normal and homoscedistic. The Ramsey Reset Test (Table-6) suggests that the model is well specified. The short run stability of model, investigated by CUSUM and CUSUMsq test on the recursive residuals reported in Figure 2 and 3, shows that the statistics fall outside the critical bands of the 5% confidence interval. This suggests instability of the parameters under both the tests. This happened around the year 1982-1984.

Figure 2: Plot of Cumulative Sum of Recursive Residuals [ABOUT HERE]

Figure 3: Plot of Cumulative Sum of Squares of Recursive Residuals [ABOUT HERE]

Chow test is used to examine significant structural break in the data over the period 1983-2008. The F-statistics does not indicate any structural break (Table 7). Chow forecast test is more reliable and preferable than graphs of Cumulative sum and Cumulative of Squares tests. Graphs can produce misleading results (Leow, 2004).

Table 7: Statistical Output for Stability Test (Chow Forecast Test) [ABOUT HERE]

3.2 Direction of Causality within VECM

Causal link among the series is examined by applying the Granger procedure within the VECM. Existence of cointegration implies the existence of causal link in at least one direction. Engle-Granger (1987) cautioned against using the Granger causality test in first difference through vector auto regression (VAR) method due to the possibility of misleading results in the presence of co-integration. The inclusion of an error-correction term helps to capture the long run relationship. The Granger causality test is augmented by an error-correction term which is formulated as a bi-variate p^{th} order vector error-correction model (VECM) as follows:

$$\begin{bmatrix} \Delta LEC_t \\ \Delta LFD_t \\ \Delta LGDP_t \\ \Delta LPOP_t \end{bmatrix} = \begin{bmatrix} k_1 \\ k_2 \\ k_3 \\ k_4 \end{bmatrix} + \sum_{i=1}^{p} \begin{bmatrix} d_{11}(L) & d_{12}(L) & d_{13}(L) & d_{14}(L) \\ d_{21}(L) & d_{22}(L) & d_{23}(L) & d_{24}(L) \\ d_{31}(L) & d_{32}(L) & d_{33}(L) & d_{34}(L) \\ d_{41}(L) & d_{42}(L) & d_{43}(L) & d_{44}(L) \end{bmatrix} \begin{bmatrix} \Delta LEC_{t-1} \\ \Delta LFD_{t-1} \\ \Delta LGDP_{t-1} \\ \Delta LPOP_{t-1} \end{bmatrix} + \begin{bmatrix} \delta_1 ECM_{t-1} \\ \delta_2 ECM_{t-1} \\ \delta_3 ECM_{t-1} \\ \delta_4 ECM_{t-1} \end{bmatrix} + \begin{bmatrix} C_1 \\ C_2 \\ C_3 \\ C_4 \end{bmatrix} + \begin{bmatrix} \eta_1 \\ \eta_2 \\ \eta_3 \\ \eta_4 \end{bmatrix} \quad (7)$$

Where, Δ is a difference operator, ECM represents the error-correction term derived from long run cointegrating relationship via ARDL model; C_i (i = 1….4) are constants; and η_i (i =1…4) are serially uncorrelated random error terms with zero mean. The VECM provides directions for Granger causality. Long-run causality is captured by a significant lagged *ECM* terms, using t test, while F-statistic or Wald test captures short run causality.

Results reported in Table-8 for the Granger causality test show bidirectional link between financial development and energy consumption in the long run; but short run causality from financial development to energy consumption. Causality is bidirectional for economic growth and energy consumption in the long and the short run at the 1% and 5% levels, respectively. In the long run, economic growth causes population at the 1% level, while population causes economic growth at the 5% level. There is no significant causal link between economic growth and population in the short run. In the long run, bivariate causal relationship is found between financial development and population at the 1% level, but the causality runs only from population to financial development in the short run, and is significant at the 5% level.

Table 8: The Results of Granger Causality (VECM) [ABOUT HERE]

We find long run bidirectional causality among all the series. The short run results are of interest - the flows from EC to GDP is bidirectional suggesting energy dependence. FD causes EC but not the other way around. This is important because higher energy consumption means higher production cost and thus loss of competitive advantage in a global world. Financial institutions support economic agents and thereby provide the help. The long run economic growth of Malaysia was has been aided by FD which necessitated more workers. This gap has been filled through immigrant worker leading to higher POP. The absence of causality flowing from: FD to GDP and GDP to FD; GDP to POP and POP to GDP; EC to POP and POP to EC; EC to FD; and FD to POP in the short run is not unexpected as these forces are known to take longer time to make perceptible impact.

All the long run causality tests survive a 1% level significance except EC to POP, FD to POP and GDP to POP, which are significant at the 5% level. In the short run, the causality test is significant for FD to EC at the 8% level; GDP to EC at the 5% level; EC to GDP and POP to FD at the 2% level.

Table 9: Summary of the Results from VECM [ABOUT HERE]

4 Conclusions and implications for policy

The paper examines the long run relation among the series of financial development, population, economic growth on energy consumption for Malaysia. The topic merits special importance due to the possible interrelations among the series with implications for CO_2 emissions. To support a growing economy and the needs of its population, more goods and services must be provided. The latter requires higher energy consumption. Financial development can influence the development of an energy infrastructure and thus help gain overall energy efficiency, inter alia. A priori, developed financial infrastructure should favor efficient use of energy, but the results so far have been mixed. The concern is that Malaysia, a major emerging economy in the East Asian region, is experiencing relatively high rate of economic growth and a rise in CO_2 emission.

The present study implements autoregressive distributive lag model (ARDL) to cointegration to investigate the existence of a long run relation among the above noted series; and the Granger causality within VECM to test the direction of causality and the behavior of

forcing variables on energy consumption. The results based on time series data from 1971 to 2008 confirm cointegration among these series. The effect of population growth on energy use is positive, only in the long run. Finally, financial development promotes efficient energy use. This should help formulate appropriate public policies. Finally, financial development promotes efficiency in energy use which can be very helpful in formulating policies.

In some sense, the paper can be seen as an examination of the Malaysia's policy to support economic growth by encouraging population growth, and financial development as enunciated in the "Vision 2020". Since GDP and energy consumption cause each other in the short and the long run, their high interdependence will lead to higher energy consumption in coming days. Moreover, population causes energy consumption in the long run. So, in the absence of a clearly articulated and implemented sustainable development policy, the strategy to achieve the goals of vision 2020 might produce adverse impact on environment in the long run. The finding that financial development leads to energy consumption only in the long run, but energy consumption causes the financial development both in the long and the short run offers some hope. This implies that financial loans used by both the consumers and the investors will add to energy demand. In the short run Malaysia could benefit from two pronged policy: promote financial development; and continue the present policy to address the labor shortage issue.

Emphasis should be placed on investing in renewable energy sources and adopt other energy savings methods including energy mix and mitigation options in the long run. Failure to address the short run needs may not bring happy ending to the stated goals of the vision 2020. The concern is that the economy might become completely energy dependent and suffer the consequences of high CO_2 emission. As a long run goal, financial development strategy should be adopted for creating a sound energy infrastructure and thus achieve efficiency in the overall energy use. As the facts point to, the results so far have been mixed.

The economic growth literature emphasizes the importance of financial development on economic prosperity. Among others, an aim of the energy literature is to examine the relationship between financial development and energy consumption. The empirical models used here fit the data reasonably well and pass most diagnostic tests. The results show that financial development measured by domestic credit to the private sector as share of GDP increases the demand for energy in emerging economies. These findings deserve close scrutiny for a number of reasons. Emerging economies that continue to develop financial markets should see energy demand rise

above and beyond those caused by rising income. Any energy demand projections in emerging economies at the exclusion of financial development as an explanatory variable might provide inaccurate estimate actual energy demand and unduly interfere with the conservation policies. Malaysia should take extra caution in providing the necessary environment and infrastructure that must precede financial development policy. Containing greenhouse gas emissions may be harder if these targets are set without taking into account the impact of financial development on the energy demand.

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Table 1: Statistical Output for Unit Root Test (Ng-Perron)

	Variables	MZa	MZt	MSB	MPT
Data Set - Level	LEC	-9.67	-2.15	0.22	9.61
	LGDPC	-10.90	-2.29	0.21	8.53
	LPOP	2.36	2.03	0.85	197.86
	LFD	-4.20	-1.18	0.28	19.21
Data Set – 1st Difference	ΔLEC	-20.47**	-3.19	0.15	4.45
	ΔLGDP	-23.90*	-3.45	0.14	3.81
	ΔLPOP	-21.48**	-3.20	0.14	4.66
	ΔLFD	-40.07*	-4.47	0.11	2.27

The *, ** denotes rejection of the null at the 1% and 5% levels, respectively

Table 2: Lag Length Selection Criteria for Cointegration

Lag	Log Likelihood	LR statistic**	Final prediction error (FPE)	Akaike information criterion (AIC)	Schwarz information criterion (SC)	Hannan-Quinn information criterion (HQ)
0	97.57	NA	6.49e-08	-5.19	-5.02	-5.13
1	330.22	400.68	3.87e-13	-17.23	-16.35	-16.92
2	384.67	81.66	4.75e-14*	-19.37*	-17.78*	-18.81*

* indicates lag order selected by the criterion.
** LR test (each test at 5% level)

Table 3: Statistical Output for Cointegration Test (Bounds Test)

Model for Estimation	Lag Length	F-Statistics	Lower - Upper Bound at 1%	Lower - Upper Bound at 5%	Lower - Upper Bound at 10%
F_{EC}(EC/GDP, FD, POP)	2	1.95	7.76 - 8.92	5.26 – 6.19	4.21 – 5.04
F_{GDP}(GDP/EC, FD, POP)	2	3.09	7.76 - 8.92	5.26 – 6.19	4.21 – 5.04
F_{POP}(POP/EC, GDP, FD)	2	3.87	7.76 - 8.92	5.26 – 6.19	4.21 – 5.04
F_{FD}(FD/EC, GDP, POP)	2	6.48**	7.76 - 8.92	5.26 – 6.19	4.21 – 5.04

*, **, *** denotes rejection of the null at 1% and 5% significance level, respectively
Note: Critical values bounds are computed by surface response procedure developed by Turner (2006).

Table 4: Statistical Output for Long Run Log Linear Regression Model (Eq. 3)

Variables	Coefficient	Std. Error	t-Statistic	p-value	DW Test	R^2
Constant	-7.81*	2.34	-3.33	0.002	1.69	0.937
LGDP	0.86*	0.14	6.24	0.000		
LPOP	0.39***	0.21	1.86	0.072		
LFD	0.07**	0.03	2.41	0.023		

*, **, *** denotes significant at the 1%, 5%, 10% levels, respectively

Table 5: Statistical Output for Short Run Log Linear Regression Model (Eq. 6)

Variables	Coefficient	Std. Error	t-Statistic	p-value	DW Test	R^2
Constant	0.002	0.05	0.05	0.96		
LGDP	0.70*	0.19	3.55	0.001		
LPOP	0.56	1.94	0.29	0.78	1.94	0.52
LFD	0.12*	0.04	2.77	0.01		
ECM_{t-1}	-0.88*	0.21	-4.19	0.0002		

*, **, *** denotes significant 1%, 5%, 10% level, respectively

Table 6: Statistical Output for Sensitivity Test (Eq. 3 and 6)

Model No.	Serial Correlation	ARCH Test	Normality Test	Heteroscedisticity Test	Ramsey Reset Test
Long Run (Eq. 3)	1.26 (0.30)	0.06 (0.81)	1.28 (0.53)	1.82 (0.13)	1.44 (0.25)
Short Run (Eq. 6)	1.2 (0.32)	0.27 (0.61)	0.73 (0.69)	0.57 (0.79)	0.75 (0.39)

Note: The P-values are given in the parenthesis

Table 7: Statistical Output for Stability Test (Chow Forecast Test)

Forecast Period	F-statistics	Probability of F-statistics	Log likelihood ratio	Probability of Log likelihood ratio
1983- 2008	0.143	0.99	34.64	0.12

Table 8: The Results of Granger Causality (VECM)

Dependent Variable	F-statistics				
	$\sum \Delta \ln EC_t$	$\sum \Delta \ln FD_t$	$\sum \Delta \ln GDP_t$	$\sum \Delta \ln POP_t$	ECT_{t-1}
$\Delta \ln EC_t$	-	2.2452 (0.0815)	3.3572 (0.0518)	0.0169 (0.9832)	-0.1043 (0.0006)
$\Delta \ln FD_t$	1.3887 (0.2687)	-	1.0221 (0.3750)	4.1625 (0.0281)	-0.5240 (0.0074)
$\Delta \ln GDP_t$	4.4360 (0.0229)	0.3244 (0.7260)	-	0.3831 (0.6858)	-0.5850 (0.0049)
$\Delta \ln POP_t$	0.1518 (0.8599)	0.5192 (0.6015)	0.2236 (0.8012)	-	-0.0097 (0.0492)

Note: The Probability-values are reported in the parenthesis

Table 9: Summary of the Results from VECM

Direction of Causality	Short Run (F-statistics)	Long Run (ECT_{t-1})
FD causes EC	At 8% significance level	At 1% significance level
GDP causes EC	At 5% significance level	At 1% significance level
POP causes EC	No	At 1% significance level
EC causes FD	No	At 1% significance level
GDP causes FD	No	At 1% significance level
POP causes FD	At 2% significance level	At 1% significance level
EC causes GDP	At 2% significance level	At 1% significance level
FD causes GDP	No	At 1% significance level
POP causes GDP	No	At 1% significance level
EC causes POP	No	At 5% significance level
FD causes POP	No	At 5% significance level
GDP causes POP	No	At 5% significance level

Fig 1: Trends in the series used here to explore long run relation

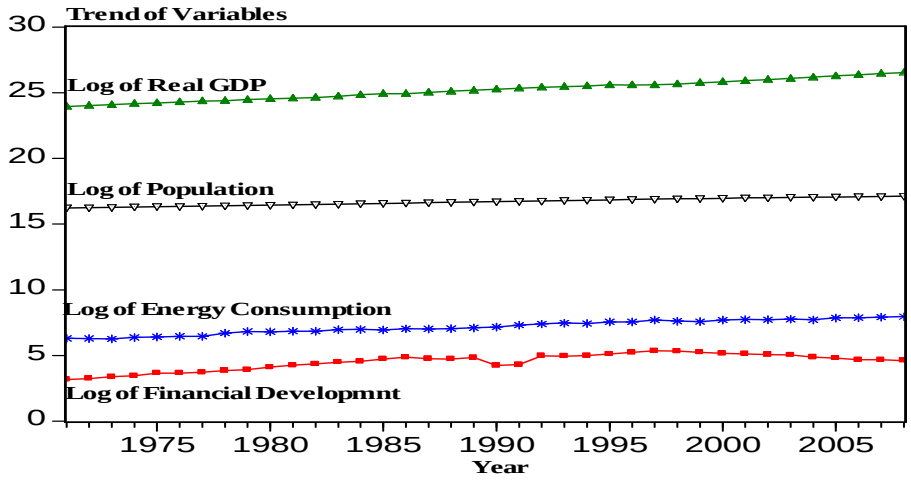

Figure 2: Plot of Cumulative Sum of Recursive Residuals

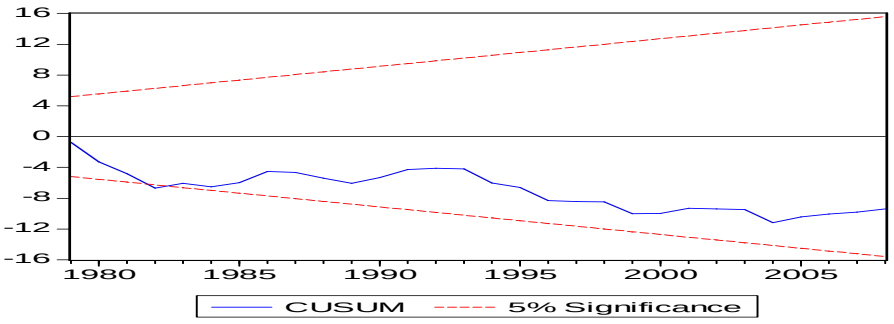

Figure 3: Plot of Cumulative Sum of Squares of Recursive Residuals