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Asymmetric Responses of Energy Consumption in Malaysia: Evidence from Nonlinear ARDL

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ABSTRACT

Many studies have modelled the prices, growth, technology and financial effects on energy consumption in a linear fashion. However, structural changes may trigger asymmetric or nonlinear behaviour in time series analysis. In this paper, we examine the asymmetric influence of economic growth, energy prices, technological innovations and financial development on energy consumption in Malaysia over the period between 1970 and 2018 using a nonlinear ARDL (NARDL) model. The empirical results uncover the existence of asymmetric cointegration relationship between variables. A positive shock in income, energy prices and financial development leads to high energy consumption. Surprisingly, a fall in income does not lower the energy consumption. The results do not provide any evidence of technological effect on energy consumption. In addition, the energy consumption responds more elastically to negative shock than positive shock, which has implications for energy policy. The results also suggest that the short-run and long-run effects are asymmetrical. All variables are found to have asymmetric causal effect on energy consumption in the short-run.

Keywords: Energy Consumption, Asymmetric, NARDL, Malaysia
JEL Classifications: C50, Q31, Q41, Q43

1. INTRODUCTION

Following conventional microeconomics, energy demand is determined by changes in income and price. There has been longstanding interest in calculating price and income elasticity of energy demand across countries, because the elasticity estimates are crucial for climate policies. In a logical sense, the income elasticity of energy demand is less than unity, demonstrating that energy is a necessity. The price elasticity estimates should be negative, reflecting the inverse relationship between price and demand. It is generally accepted that energy demand is rather price-inelastic. As compared to developed countries, energy demand in developing countries has not been very sensitive to changes in energy prices due to the availability of substitutes. The works of Burke and Liao (2015) showed that China's coal demand has become increasingly price elastic. China has been very dependent on coal due to limited energy consumption structure and backward technology. With rapid changes in China's energy sector, there have been more substitutes for coal and thus, price elasticity may increase. In western countries where costs of substitutes are competitive, energy demand is likely to be price elastic as consumers could easily switch to other alternatives as price increases (Bernstein and Griffin, 2006).

Various studies have been done on demand elasticity of energy in developing countries. These include Khan and Ahmed (2009) for Pakistan, Talbi and Nguyen (2014) for Tunisia, Phoumin and Kimura (2014) for East Asia, Solaymani et al. (2015) for Malaysia, Cao et al. (2016) and Dong et al. (2019) for China, Amin and Khan (2020) for Bangladesh, and Liddle et al. (2020) for middle-income economies. Solaymani et al. (2015) estimated the long-run price and income elasticities of −0.1 and 2.90, respectively. On the other hand, Cao et al. (2016) reported the values of 0.6–1.13 for price and income elasticity, respectively. Effects of income was estimated to be smaller than that of price according to Amin and Khan (2020). In addition, the income elasticity reported in Liddle et al. (2020) was in the range of 0.6–0.8, but the price elasticity was always insignificant.

According to standard economic theory, there is no foundation for demand to adjust asymmetrically towards price or income changes. To date, the lion's share of energy demand studies has been based on conditions of symmetry. However, empirical findings suggest the existence of asymmetric responses in energy demand. A common approach to measure asymmetry is to decompose price changes into historical peak, cumulative price cuts, and cumulative price recoveries (Dargay and Gately, 1995; Huntington 2006). Dargay and Gately (1995) demonstrated how and why consumers of non-transport oil respond differently to price rises and cuts. By decomposing price variable, they provided empirical estimates for OECD countries, demonstrating that the effect of price decreases on oil demand in the 1980s was smaller than that of price increases in the 1970s. Through asymmetry analysis, not only the coefficients of price increases appear to be larger than that of price decreases, but the income elasticities also increase. Bachmeier and Griffin (2003) applied partial sum decompositions using Engle-Granger two-step approach. They tested the response of gasoline prices following the changes in prices of crude oil, and found few statistical evidence of price asymmetry. The nonlinear ARDL (NARDL) technique developed by Shin et al. (2014) includes a decomposition of the regressor into its positive and negative changes. The works of Koengkan (2018) concluded that positive shocks in national income has a greater effect on energy demand in Latin American countries than negative shocks. Additionally, energy demand is more sensitive to income changes over a longer time horizon. In Pakistan, Tabasam et al. (2018) found that demand for imported crude oil responds strongly to income falls, thereby contradicting the findings of Koengkan (2018). However, the magnitude of the response is small (0.05), demonstrating inelastic demand.

Besides income and prices, technology and financial development are widely viewed as fundamental driving forces for achieving economic growth in developing countries; there is a likelihood that technological advancement and financial deepening affect energy use. Studies such as Tang and Tan (2013), Jin and Zhang (2014), and Murad et al. (2018) have found that technological innovation negatively affects energy consumption. Accordingly, an efficient technology is able to make precious energy sources to go a lot further. Nonetheless, another group of studies claimed that technology is associated with high energy consumption (Longo and York, 2015; Jin et al., 2018). It is undeniable that technological improvement provides phenomenal opportunities for energy savings, but it also increases productivity, which in turn increases energy utilization. When gains in energy efficiency result in increased energy consumption, economists called this phenomenon as a rebound effect (Berkhout et al., 2000; Greening et al., 2000). It is essentially the difference between the theoretical efficiency gains and the actual consumption. When something becomes more efficient, it usually becomes cheaper, and consumers can afford to use it more often. Therefore, chasing efficiency alone might have the opposite effect on the total energy consumption.

A number of studies have examined the financial development-energy demand relationship (Sadorsky, 2010; Islam et al., 2013; Yue et al., 2019). According to these studies, financial development affects the use of energy in multiple ways. First, a well-developed financial system allocates credit to those sectors that will create economic growth. Having access to capital is vital for businesses to thrive because it enables the expansion of plants, purchases of equipment, and employment of workers. When businesses grow, so does the economy and this in turn accelerates energy consumption. At the consumer end, an easy credit facilitates spending and creates demand for goods and services that need the use of energy. The studies of Shahbaz and Lean (2012), Coban and Topcu (2013), Komal and Abbas (2015), and Gaies et al. (2019) have found that financial deepening significantly increases the demand for energy. Secondly, financial development might facilitate investments in innovation and technological development to increase energy efficiency. Adom et al. (2019) posited that for a 1% increase in financial development, energy intensity in Ghana would fall by 0.39%–0.54%; they conclude that financial development promotes energy efficiency.

Many studies have modelled the economic, price, technological and financial effect on energy consumption in a linear fashion. However, structural changes may trigger asymmetric or nonlinear behaviour in a time series analysis. Keeping the notion that the impact of economic growth, energy prices, technology and financial development on energy consumption might be asymmetric, we employ NARDL approach to understand such relationship in the case of Malaysia. The rest of the paper is organized as follows: next section discusses the variables, sources of data and the development of NARDL model; the following section discusses the estimated parameters and the evidence of asymmetry; the final section concludes the findings with some recommendations.

2. DATA AND METHODS

This study examined the asymmetric association between energy consumption (*EC*), economic growth (*GDP*), energy prices (*EP*), technological innovation (*P*) and financial development (*DC*) using NARDL (Shin et al., 2014) approach.

$$LEC_t = \alpha_0+\beta_1 LGDP_t+\beta_2 LEP_t+\beta_3 LP_t+\beta_4 LDC_t+\varepsilon_t \quad (1)$$

where, t denotes years, and L represents the natural logarithm. This study covered a period of 49 years, from 1970 to 2018. Annual data on primary energy consumption were drawn from BP Statistical Review of World Energy June 2019, measured in million tons of oil Equivalent. This study used GDP in the year 2010 as constant local currency prices to capture economic growth represented income. Energy prices present difficulties in empirical research since they are not available for most developing countries, including Malaysia (Tang and Tan, 2014) Therefore, as suggested by Sharmin and Khan (2016), the present study used an energy price index which is more accurately reflects the supply and demand in the energy market. The energy price index directed from the World Bank commodity price outlook was used as a logical proxy to represent energy price in Malaysia. We used the filed patent as a proxy for technological innovation, while domestic credit to private sector represents financial development, expressed in percent of GDP. Variables such as real GDP, filed patent and domestic credit were drawn from the World Development Indicators.

The criticism of symmetry of the classical cointegration models has led to the attempts to model asymmetric cointegration relationship between variables. The recent model of NARDL (Shin et al., 2014) is theoretically more appealing than that of conventional approaches to cointegration. For instance, NARDL models the asymmetric relationship between variables, which signifies imbalance in supply and demand. Therefore, the model distinguishes between the effects of positive and negative shock on dependent variable in a single-equation framework. Moreover, the unrestricted specification of NARDL model accounts simultaneously for two types of asymmetry: Short-run asymmetry and long-run asymmetry. As with ARDL model, the NARDL does not require all variables to be integrated into the same order. The model separates the reactions of dependent variable into positive and negative changes in independent variable. Using the partial sum procedure, the rise and fall in the aforementioned macroeconomic variables can be depicted as follows:

$$X_t^+ = \sum_{j=1}^{t} \Delta X_j^+ = \sum_{j=1}^{t} max(\Delta X_j, 0)\, and$$
$$X_t^- = \sum_{j=1}^{t} \Delta X_j^- = \sum_{j=1}^{t} min(\Delta X_j, 0) \tag{2}$$

Hence, NARDL models can be specified as:

$$\Delta LEC_t = \alpha_0 + \rho LEC_{t-1} + \alpha_1 LGDP_{t-1}^+ + \alpha_2 LGDP_{t-1}^- + \alpha_3 LEP_{t-1} + \alpha_4 LP_{t-1} + \alpha_5 LDC_{t-1} + \sum_{j=1}^{p}\gamma_j\, \Delta LEC_{t-j} + \sum_{j=0}^{q1}\delta_j^+\, \Delta LGDP_{t-j}^+ + \sum_{j=0}^{q2}\delta_j^-\, \Delta LGDP_{t-j}^- + \sum_{j=0}^{q3}\zeta_j\, \Delta LEP_{t-j} + \sum_{j=0}^{q4}\pi_j\, \Delta LP_{t-j} + \sum_{j=0}^{q5}\varphi_j\, \Delta LDC_{t-j} + \varepsilon_t \tag{3}$$

$$\Delta LEC_t = \alpha_0 + \rho LEC_{t-1} + \alpha_1 LGDP_{t-1} + \alpha_2 LEP_{t-1}^+ + \alpha_3 LEP_{t-1}^- + \alpha_4 LP_{t-1} + \alpha_5 LDC_{t-1} + \sum_{j=1}^{p}\gamma_j\, \Delta LEC_{t-j} + \sum_{j=0}^{q1}\delta_j\, \Delta LGDP_{t-j} + \sum_{j=0}^{q2}\zeta_j^+\, \Delta LEP_{t-j}^+ + \sum_{j=0}^{q3}\zeta_j^-\, \Delta LEP_{t-j}^- + \sum_{j=0}^{q4}\pi_j\, \Delta LP_{t-j} + \sum_{j=0}^{q5}\varphi_j\, \Delta LDC_{t-j} + \varepsilon_t \tag{4}$$

$$\Delta LEC_t = \alpha_0 + \rho LEC_{t-1} + \alpha_1 LGDP_{t-1} + \alpha_2 LEP_{t-1} + \alpha_3 LP_{t-1}^+ + \alpha_4 LP_{t-1}^- + \alpha_5 LDC_{t-1} + \sum_{j=1}^{p}\gamma_j\, \Delta LEC_{t-j} + \sum_{j=0}^{q1}\delta_j\, \Delta LGDP_{t-j} + \sum_{j=0}^{q2}\zeta_j\, \Delta LEP_{t-j} + \sum_{j=0}^{q3}\pi_j^+\, \Delta LP_{t-j}^+ + \sum_{j=0}^{q4}\pi_j^+\, \Delta LP_{t-j}^- + \sum_{j=0}^{q5}\varphi_j\, \Delta LDC_{t-j} + \varepsilon_t \tag{5}$$

$$\Delta LEC_t = \alpha_0 + \rho LEC_{t-1} + \alpha_1 LGDP_{t-1} + \alpha_2 LEP_{t-1} + \alpha_3 LP_{t-1} + \alpha_4 LDC_{t-1}^+ + \alpha_5 LDC_{t-1}^- + \sum_{j=1}^{p}\gamma_j\, \Delta LEC_{t-j} + \sum_{j=0}^{q1}\delta_j\, \Delta LGDP_{t-j} + \sum_{j=0}^{q2}\zeta_j\, \Delta LEP_{t-j} + \sum_{j=0}^{q5}\pi_j\, \Delta LP_{t-j} + \sum_{j=0}^{q3}\varphi_j^+\, \Delta LDC_{t-j}^+ + \sum_{j=0}^{q4}\varphi_j^-\, \Delta LDC_{t-j}^- + \varepsilon_t \tag{6}$$

To examine the asymmetric impact of changes in independent variable on energy consumption, we developed four models with each deferring by the shocks in independent variables. Model I in Equation (3) incorporates only the decomposition in economic growth; Model II in Equation (4) includes only the decomposition in energy prices; Model III in Equation (5) contains only the decomposition in technological innovation, while Model IV in Equation (6) includes only the decomposition in financial development.

NARDL maintains similar characteristics as typical ARDL model as it estimates the error correction model using OLS technique. To verify the asymmetric cointegration relationship between variables, bounds testing procedure tests the null hypothesis, H_0: $\rho = \alpha_1 = \alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = 0$ against alternative hypothesis, H_A: $\neq \alpha_1 \neq \alpha_2 \neq \alpha_3 \neq \alpha_4 \neq \alpha_5 \neq 0$. If the test rejects the null hypothesis, we may conclude that the variables are cointegrated in the presence of asymmetry. Further, the asymmetric long-run parameter are estimated as $\theta^+ = \alpha_1/–\rho$ and $\theta = \alpha_2/–\rho$ in Model I; $\theta^+ = \alpha_2/–\rho$ and $\theta = \alpha_3/–\rho$ in Model II; $\theta^+ = \alpha_3/–\rho$ and $\theta = \alpha_4/–\rho$ in Model III; $\theta^+ = \alpha_4/–\rho$ and $\theta = \alpha_5/–\rho$ in Model IV. The rejection of the null hypothesis $\theta^+ = \theta$ using Wald test implies a long-run asymmetry. It means that the magnitude of the responds in dependent variable when X increases is not identical to when X decreases. Similarly, short-run asymmetric effect can be tested through the null hypothesis of $\delta^+ = \delta^-$; $\zeta^+ = \zeta^-$; $\pi^+ = \pi^-$ and $\varphi+ = \varphi$.

Furthermore, asymmetric short-run causal effects are examined using the Wald test. This approach was implemented based on the following equations:

$$\Delta LEC_t = \alpha_0 + \sum_{j=1}^{p}\gamma_j \Delta LEC_{t-j} + \sum_{j=0}^{q1}\delta_j^+ \Delta LGDP_{t-j}^+ + \sum_{j=0}^{q2}\delta_j^- \Delta LGDP_{t-j}^- + \sum_{j=0}^{q3}\zeta_j \Delta LEP_{t-j} + \sum_{j=0}^{q4}\pi_j \Delta LP_{t-j} + \sum_{j=0}^{q5}\varphi_j \Delta LDC_{t-j} + \varepsilon_t \tag{7}$$

$$\Delta LEC_t = \alpha_0 + \sum_{j=1}^{p}\gamma_j \Delta LEC_{t-j} + \sum_{j=0}^{q1}\delta_j \Delta LGDP_{t-j} + \sum_{j=0}^{q2}\zeta_j^+ \Delta LEP_{t-j}^+ + \sum_{j=0}^{q3}\zeta_j^- \Delta LEP_{t-j}^- + \sum_{j=0}^{q4}\pi_j \Delta LP_{t-j} + \sum_{j=0}^{q5}\varphi_j \Delta LDC_{t-j} + \varepsilon_t \tag{8}$$

$$\Delta LEC_t = \alpha_0 + \sum_{j=1}^{p}\gamma_j\,\Delta LEC_{t-j} + \sum_{j=0}^{q1}\delta_j\,\Delta LGDP_{t-j} + \sum_{j=0}^{q2}\zeta_j\,\Delta LEP_{t-j} + \sum_{j=0}^{q3}\pi_j^{+}\,\Delta LP_{t-j}^{+} + \sum_{j=0}^{q4}\pi_j^{+}\,\Delta LP_{t-j}^{-} + \sum_{j=0}^{q5}\varphi_j\,\Delta LDC_{t-j} + \varepsilon_t \quad (9)$$

$$\Delta LEC_t = \alpha_0 + \sum_{j=1}^{p}\gamma_j \Delta LEC_{t-j} + \sum_{j=0}^{q1}\delta_j \Delta LGDP_{t-j} + \sum_{j=0}^{q2}\zeta_j \Delta LEP_{t-j} + \sum_{j=0}^{q3}\pi_j \Delta LP_{t-j} + \sum_{j=0}^{q4}\varphi_j^{+} \Delta LDC_{t-j}^{+} + \sum_{j=0}^{q5}\varphi_j^{-} \Delta LDC_{t-j}^{-} + \varepsilon_t \quad (10)$$

Positive and negative change in economic growth cause energy consumption if the null hypothesis, H_0: $\delta^+ = \delta^- = 0$ is rejected. Changes in energy prices cause energy consumption if H_0: $\zeta^+ = \zeta^- = 0$ is rejected. For the third model, H_0: $\pi^+ = \pi^- = 0$ must be rejected if technological change causes energy consumption. Lastly, the rejection of H_0: $\varphi^+ = \varphi^- = 0$ implies that changes in credit to private sector cause energy use.

Before inferences were drawn, various diagnostic tests were used to assess the adequacy of the dynamic specification, specifically the Breusch-Godfrey LM test for serial correlation, ARCH LM test for heteroskedasticity, and Jarque-Bera statistic for normality.

3. EMPIRICAL RESULTS AND DISCUSSION

We first subjected each series to ADF and breakpoint unit root tests to ensure that no *I* (2) variables were involved. The null hypothesis of these tests is defined as the presence of a unit root. Unlike ADF test, Breakpoint unit root test allows for levels and trends that differ across a single break date. It selects a breakpoint where the dickey-fuller -statistic is minimized. The results of the unit root tests are presented in Table 1. Most of the time series are free from the unit root problem after first differencing. The results from the Breakpoint unit root test are in conformity with those of ADF test, suggesting that no *I* (2) variables are involved in this study.

Since the tests indicate a mixed order of integration, we can check the long-run relationship between variables using bounds test. The bounds *F* -statistics are reported in Table 2. For all models, clear evidence of an asymmetric long-run association emerges. Accordingly, economic growth, energy price, technological innovation and financial development can determine the variations in energy consumption. A range of diagnostic tests was carried out to check whether the NARDL models is valid in its specification, as shown in Panel E of Table 2. Results depict that all models are free from non-normality, serial correlation and heteroskedasticity.

Table 1: Unit root test results

Variable	Augmented Dickey-Fuller		Breakpoint test	
	Level	FD	Level	FD
LEC	−3.25**	−5.21***	−4.31* (1977)	−6.56*** (1978)
LGDP	−2.37	−5.73***	−3.54 (1987)	−7.57*** (1998)
LEP	−2.50	−6.59***	−3.65 (1998)	−8.04*** (1974)
LP	−1.50	−10.46***	−27.72*** (1984)	−12.20*** (1974)
LDC	−2.81*	−2.51	−3.52 (1979)	−7.34*** (1992)

FD denotes first difference. ***, ** and * represents significance at 1%, 5% and 10%, respectively. The associated break dates are in square parentheses

In Model I, the long-run coefficients for GDP^+ indicate the effects of income increases on energy consumption, with a value of 0.75, while the coefficient of *GDP* is 5.34. The results demonstrate that not only economic expansion increases energy consumption, but economic contraction also causes energy consumption to increase. This finding is consistent with that of Shahbaz et al. (2018) in the context of Brazil and Russia. Malaysia as a newly industrialized nation needs energy for economic development. High income accelerates growth in economic activities and in response, higher demand for energy. However, when income falls, urbanization and population may continue to rise, driving energy demand for housing, utilities and transportation. Energy consumption responds more elastically to a fall than to a rise in income. This is in accord with the works of Sheldon (2017) who found that electricity and non-electricity (primary energy) consumption are more responsive to decreases in GDP.

Both price increases and price decreases in Model II also show a promoting effect on energy utilization. This result indicates that Malaysian economy depends largely on primary energy even when the energy prices increase. During heavy industrial development, coupled with urbanization and motorization, industrial energy demand experiences a high-speed growth. At this stage, demand for services primarily in production of energy-intensive goods such as houses, vehicles, machines and infrastructures begin to expand, creating more demand for energy (Chong et al., 2015). This result is not surprising considering the vision to turn Malaysia into a fully developed nation, which creates a situation where energy becomes an inelastic product. The country needs more energy to prosper but at the same time price keeps on increasing, resulting in energy consumption becomes insensitive to price changes. Furthermore, we found that energy consumption responds strongly to decreases in price than to increases in price.

The results obtained from Model III imply no significant reaction observed in energy consumption due to technological change. Nonetheless, we found that an increasing credit availability increases energy consumption as shown in Model IV, and this verifies the role of financial development as one of the key drivers in energy consumption. It enhances financial efficiency and reduces borrowing constraints, thereby intensifies the use of energy by increasing consumption (Mukhtarov et al., 2018).

W_{LR} and W_{SR} represent Wald statistics for the null hypothesis of long-and short-run symmetry, respectively. The results in Panel C indicate a long-run asymmetric influence of income on energy consumption, but the effect is rather symmetrical in the short-run. The asymmetric responds could be partly explained by the irreversibility of the income effect (Gately and Huntington, 2002). This means that demand-increasing effect of an income

Table 2: NARDL model estimation results

Variable/Test	Model I	Model II	Model III	Model IV
Panel A: Bounds Test				
F-Statistic	8.79***	6.44***	4.76**	6.67***
Panel B: Long-Run Estimates				
LX^{+}	0.75***	0.23**	0.01	0.51***
LX	5.34**	0.33***	0.07	0.44
Panel C: Asymmetric Test				
W^{LR}	3.998 (0.056)	9.276 (0.006)	6.011 (0.022)	2.597 (0.118)
W^{SR}	1.274 (0.269)	9.262 (0.006)	4.166 (0.052)	0.081 (0.778)
Panel D: Asymmetric Causality				
$\Delta LX+\neq>\Delta LEC$	16.008 (0.000)	9.768 (0.005)	5.423 (0.011)	5.968 (0.007)
$\Delta LX- \neq>\Delta LEC$	8.042 (0.002)	2.805 (0.042)	18.712 (0.000)	4.880 (0.036)
Panel E: Diagnostic Checking				
Jarque-Bera	1.193 (0.551)	1.750 (0.417)	0.339 (0.844)	1.876 (0.391)
Serial correlation	1.334 (0.248)	1.164 (0.281)	1.045 (0.307)	0.169 (0.681)
Heteroskedasticity	0.786 (0.375)	1.418 (0.234)	0.013 (0.911)	0.069 (0.793)

***, ** and * represents significance at 1%, 5% and 10%, respectively. W_{LR} and W_{SR} represent Wald statistics for long-run and short-run symmetry. While $X^{+}$and X are positive and negative changes in explanatory variables. Probability values are in square parentheses

increase is not necessarily reversed by an equal fall in income, nor does decrease in income produce similar impact to when income increases. Different economic sectors respond differently to adversity and prosperity. Some of the sectors may react more elastically than the others during economic upturn or downturn. The symmetric behaviour, on the other hand, might due to view that changing consumption patterns in the short-run involve high costs. Thus, respond in demand to income increases is equally big and persistent as income decreases.

As far as asymmetry is concerned, we also found evidence of asymmetric price and technological effect on energy consumption. Price-induced technological change improves energy efficiency and thus reduces energy use per unit of output. The resultant energy saving will not tail off until the end of the technology life cycle. Contrarily, Wald test confirmed the symmetric effect of financial development both in short-run and long-run. This finding is unexpected, and the possible explanation is that Malaysia has not yet reached a point that would trigger an asymmetric association between financial development and energy consumption. The results in Panel D show that the null hypothesis of non-causality can be rejected for all cases suggesting that changes in economic growth, energy prices, technological innovation and financial development significantly cause changes in energy consumption. This highlights the fact that Malaysia has not yet managed to divest from fossil fuels-dependent activities.

4. CONCLUSION

Modelling energy demand is important for the design and formation of energy and environmental policy. However, most of the empirical studies assumed a symmetric association between energy consumption and macroeconomic variables. For theoretical background, economic events such as crisis and structural change could vitiate any linear relationship between these variables. Keeping this aspect in context, in this study, we employed nonlinear ARDL estimation procedure to determine the asymmetric influence of economic growth (represented income), energy prices, technological innovation and financial development on energy consumption using annual data from 1970 to 2018.

Our key findings point to the existence of asymmetric cointegration between variables. Thus, ignoring such asymmetries will likely cause biases in elasticity estimates, which are the critical input parameters for evaluating energy policies. Turning to the long-run estimation, empirical findings reveal that the attempt to increase energy prices in order to reduce energy consumption in the long-run is unlikely an effective strategy. Fuel is highly subsidized in Malaysia, particularly natural gas and petroleum. These subsidies are partly the reason why a price increase shows a plus effect on energy consumption. In addition to energy subsidies, the increasing needs for energy add to the point, as the country moves toward a high-income status. The results further suggest that the increasing credit would not improve the efficiency in energy use. The scarcity of commercial lending for energy efficiency is one of the key barriers to adoption of energy efficiency equipment in Malaysia (APERC, 2018). The reason is that the banks lack the guidance and expertise in evaluating energy efficiency projects (Ministry of Energy, Green Technology and Water, 2015). Moreover, the funding for energy efficiency investments is normally provided to companies but not individual consumers. For the latter, lack of awareness on energy conservation creates barriers in increasing financial flows to energy efficiency projects.

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