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Analyzing the Short Term Effects of Oil Price Changes on Income and Energy Demand Elasticity in Malaysia: Energy Policy Implications

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Abstract. This paper investigates the short term effects of world oil price changes on income and energy demand elasticity in the Malaysian economy by using the bounds testing approach developed by Pesaran & Shin (1995) The results revealed that the growth rate of real GDP, employment and average world oil price have emerged as significant determinants of energy demand in Malaysia. However, the world oil prices would be exogenous variables which affect the total energy consumption in Malaysia, but the reverse does not hold in Malaysian context. There was a bidirectional causality effect between energy demand and GDP, which would have important implications to energy policy, where the energy policy may be implemented without conveying any harmful effects to both energy sector and economy performance. This study would suggest that policy planner should confer prompt response and choose the right mechanism of energy conservation and fiscal policy in order to keep cleans environmental with sound macroeconomic balances.

Keywords: Price and Income Elasticity, Energy Consumption, World Oil Prices, Economic Growth and ARDL

1. Introduction

Malaysia's economy has been growing steadily in the last several decades with an annual average growth projected at 4.8%. Thus, the demand for energy consumption will inevitably increase. During the 8th Malaysia Plan, several strategies were formulated to meet the challenge including the promotion of renewable energy and efficient utilization of resources (Malaysia Report 2008). Meanwhile in the next Malaysian Plan, the development of the energy sector focuses on the diversification of fuel sources through greater utilization of renewable energy with emphasis on reducing the dependency on petroleum products.

Due to the importance of energy sector to the Malaysian economy, the National Depletion Policy has been formulated to preserve the Malaysian economy's energy resources, particularly oil and gas resources. The Four-Fuel Policy was introduced to reduce the economy's over-dependence on oil and later was expanded to incorporate renewable energy as the fifth fuel after oil, gas, coal and hydroelectric (Malaysia Report, 2008). In the year 2008, the government has introduced a broad package of reforms to their energy subsidies. The package included subsidy reductions, cash rebates, windfall taxation on certain sectors and an expansion of the social safety net (IEA, 2009).

Since the early 1980's a number of studies using a vector autoregressive (VAR) model have been made on the macroeconomic effects of oil price changes. In assessing the oil price effects on energy demand and macroeconomic performance, many researchers have concluded that there is a negative correlation between increases in oil prices and the subsequent economic downturns in the United States (Hamilton 1983; Burbidge and Harrison 1984; Gisser and Goodwin 1986; Mork 1989; Hamilton 1996; Bernanke et al. 1997; Hamilton and Herrera 2001; and Hamilton 2003). Mork (1989) found an asymmetry between the responses of the GDP and oil-price increases and decreases, concluding that the decreases were not statistically significant. Thus, his results confirmed that the negative correlation between GDP and increases in oil-price was persistent when data from 1985 onwards were included. Lee and Ronald (1995), on the other hand, reported that the response of the GDP to an oil-price shock depends greatly on the environment of oil-price stability. Due to these reasons, we will use multivariate co-integrations model by adding oil prices (as an

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energy price proxy) as a third variable that allows for additional channel of causality and helps to investigate whether oil prices have a significant impact on energy consumption or even a direct effect on employment and GDP growth.

The rest of the paper is structured as follows. Section 2 presents data and research methodology. Section 3 describes the results analysis. Section 4discusses the Policy Implications and finally Section 5 includes conclusion and further study recommendations.

2. Empirical Framework

2.1 Data and Research Instrument

This study uses annual data to examine both short run and long run relationships between real growth domestic product (LRGDP), energy consumption (LENC), oil prices (LOILP) and employment (LEMP) for Malaysia. Yearly data on real GDP was measured in constant price (2000 as a base year), denominated in US Dollars and energy consumption was measured in kt of oil equivalent. Real GDP and energy consumption were taken from the World Bank database (www.worldbank.com). Meanwhile, employment of millions of people and world oil prices dominated in US Dollars in constant price (2000 as base year), were taken from Economic Planning Unit Malaysia (www.epu.gov.my). All data are being transformed into a log form in order to standardize the different units of measurement and simultaneously to eliminate the problem of heteroscedasticity. In this paper, time series data from 1980 to 2010 for Malaysia will be utilized in order to estimate the value of income elasticity of energy demand and value oil price elasticity of energy demand. To empirically examine the short run and long run relationships among the variables of interest, the model was estimated using the bounds testing (or autoregressive distributed lag, ARDL) co-integration procedure, developed by Pesaran & Shin (1995) and further extended by Pesaran, Shin and Smith (2001). The data analysis will be conducted by using Microfit 5 software.

2.2 Model Specification

We explore the short run relationship between real gross domestic product (LRGDP), energy consumption (LENC), oil prices (LOILP) and employment (LEMP). The error correction model representation of the ARDL model can be written as follows:

$$\Delta \ln RGDP_t = \beta_0 + \sum_{j=1}^{k} \beta_{11} \Delta \ln RGDP_{t-j} + \sum_{j=0}^{k} \beta_{12} \Delta \ln ENC_{t-j} + \sum_{j=0}^{k} \beta_{13} \Delta \ln OILP_{t-j} +$$

$$\sum_{j=0}^{K} \beta_{14} \Delta \ln EMP_{t-j} + n_{11} \ln RGDP_{t-1} + n_{12} \ln ENC_{t-1} + n_{13} \ln OILP_{t-1} + n_{14} \ln EMP + \xi_t \text{......(1)}$$

$$\Delta \ln ENC_t = \beta_0 + \sum_{j=1}^{k} \beta_{11} \Delta \ln ENC_{t-j} + \sum_{j=0}^{k} \beta_{12} \Delta \ln RGDP_{t-j} + \sum_{j=0}^{k} \beta_{13} \Delta \ln OILP_{t-j} +$$

$$\sum_{j=0}^{K} \beta_{14} \Delta \ln EMP_{t-j} + n_{11} \ln ENC_{t-1} + n_{12} \ln RGDP_{t-1} + n_{13} \ln OILP_{t-1} + n_{14} \ln EMP + \xi_t \text{.........(2)}$$

The terms with the summation signs in the above equations represent the error correction dynamics while the second part (terms with ηijs) correspond to the long run relationship; Δ denotes a first difference operator; ln represents natural logarithmic; β0 is an intercept and ξt is a white noise. Once the co-integration is confirmed, the further two step procedure in ARDL is taken to estimate the models.

3. Empirical results

3.1 Unit-Root Tests

The unit root tests are used to assess the order of integration of the variables. According to Pesaran & Pesaran, 1997, the ARDL bounds testing procedure can be applied irrespective of whether the variables are I(0) or I(1). Therefore, to confirm that the data are stable, we have conducted the Augmented Dickey-Fuller (ADF) unit root test to test the null of unit root against the alternative of stationary. This test was performed on both levels and first differences of all variables. The results in level and first differences are reported in Table 1.

Table 1: Results of ADF Tests for Unit Roots

Variables	Level	1st Diff
LRGDP	-2.385441	-5.064396***
LENC	-2.958903	-6.677150***
LOILP	0.735199	-4.120358***
LEMP	-2.577672	-5.880473***

Note: *,**,*** denotes significance level of 10%, 5%, 1%, respectively

The results show that we could not reject the null hypothesis of unit roots for all variables in level forms. However, the null hypothesis was rejected when the ADF test was applied to the first differences of each variable. The first differences of LRGDP, LENC, LOILP and LEMP are stationary, indicating that these variables are in fact stationary of order one, I(1). Since all variables are stationary after first differencing, it is appropriate to test whether the variables are co-integrated or not.

3.2 Co-integration test

The second step is to test for the presence of the long run relationship through the bounds testing approach. The results of the ARDL bounds test with regard to Malaysia are reported in Table 2. In the LRGDP and LENC model as dependent variables, we note that the computed F-statistics for Malaysia is above the upper bound critical values provided by Narayan (2005). Hence, we have strong evidence to reject the null hypothesis of no co-integration at 1%, 5% and 10% significance level, respectively. It shows that there was a long run relationship between LRGDP, LENC, LOILP and LEMP for LRGDP, LENC, LOILP and LEMP Model.

Table 2: Bounds Test Results

F-statistics	LRGDP Model	LENC Model
	4.4608**	9.2718***
1% I(0)	4.614	4.614
I(1)	5.966	5.966
5% I(0)	3.272	3.272
I(1)	4.306	4.306
10% I(0)	2.676	2.676
I(1)	3.586	3.586

Notes: *,** and *** indicate 10%, 5% and 1% level of significance, respectively. The test statistics of the bound tests are compared against the critical values reported in Pesaran et al. (2001).

The estimated error correction models are presented and discussed in the following:

Table 3: The error correction representation for the selected ARDL model

LRGDP Model (1);

$\Delta lnRGDP_t = 6.495^{***} + 0.361\Delta lnENC_t^{***} + 0.0724\Delta lnOILP_t^{**} + 0.625\Delta lnEMP_t - 0.445ECT_{t-1}^{***} + \xi_t$

$\bar{R}^2 = 0.5252$, F-stat. = 9.2427, SSE = 0.028, $EC_{t-1} = -0.4446$, DW=1.9803

$\chi^2_{sc} = 0.558$; $\chi^2_{ff} = 2.109$; $\chi^2_{nor} = 0.5434$; $\chi^2_{het} = 0.0209$

LENC Model (2);

$\Delta lnENC_t = -39.63^{***} + 1.187\Delta lnRGDP_t^{***} + 0.513\Delta lnRGDP_{t-1} - 0.614\Delta lnRGDP_{t-2} - 0.183\Delta lnOILP_t - 0.1065\Delta lnOILP_{t-1} - 0.054\Delta lnOILP_{t-2} + 0.057\Delta lnOILP_{t-3} - 0.057\Delta lnOILP_{t-3} - 1.387\Delta lnEMP_t - 2.495\Delta lnEMP_{t-1}^{**} - 1.998\Delta lnEMP_{t-2}^{**} - 2.572ECT_{t-1}^{***} + \xi_t$

$\bar{R}^2 = 0.7571$, F-stat. = 7.944, SSE = 0.033, $EC_{t-1} = -2.572$, DW = 2.187

$\chi^2_{sc} = 1.676$; $\chi^2_{ff} = 0.033$; $\chi^2_{nor} = 2.426$; $\chi^2_{het} = 1.906$

The error correction terms (ECt-1) for both models are significant. So it can be concluded that in the short-term, for any deviations from long-run equilibrium, the energy consumption and real GDP models will give feedback on the changes in the independent variables, in order to force the movement towards the long-run equilibrium. If energy consumption is driven directly by this long-run equilibrium error, then it is responding to this feedback. Also, both models show the negative sign of ECT which is indicating a move back towards equilibrium. On the other hand, if it has a positive sign of an error correction term, it indicates that the systems in the model are moving away from equilibrium (Granger, 1978).

4. Energy Policy Implications: Short Term Analysis

The ECM estimated study results inferred that in the short run, there is a positive bidirectional causality running between economic growth and total energy consumption. The bidirectional causality always could be found in the developed countries rather than developing countries (See e.g., Boehm 2007; Yang 2000; Soytas and Sari 2003; Oh and Lee 2004; and Yoo 2005). Bidirectional causality, on the other hand, suggests that energy consumption and economic growth complement each other but efficiency policies or other policy would not have an adverse impact to each other in the short run. The bidirectional causality result also had been supported by the Granger causality of VECM analysis suggesting that there could be two-way causality between energy consumption growth and economic growth in the future. There could be a similar unidirectional influence from economic growth in disaggregated energy consumption and from disaggregated energy consumption growth to economic growth (Granger, 1988).

The most important finding here indicated that the changes in world oil price would have a positive impact on Malaysia's real GDP in the short term. As an oil exporting country, high oil prices would benefit the Malaysian economy as the positive gains from higher oil prices would offset any negative impact on the economy especially fuel subsidy. The findings are also being supported by Villafuerte et al. (2009) which focused on the 31 OPCs oil producing countries (OPCs). The study found that oil revenue is a critical source of fiscal revenue where fiscal oil revenue accounted for more than 25 percent of total fiscal revenue over the 2005-2008 period. Figure 1 shows that the revenue growth rate is at an average of 9.5 percent of the 2000-2010 period while the average expenditure growth rate for the 2000-2010 period was slightly below then revenue (9.1 percent).

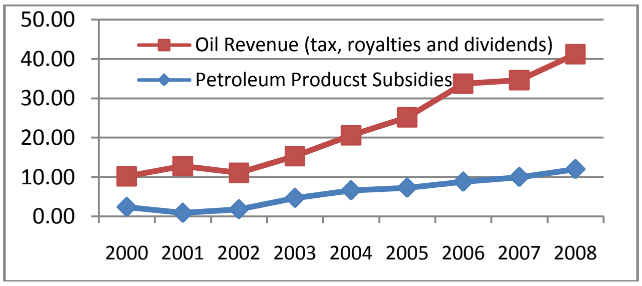

Figure 1: Malaysia Oil Revenue and Petroleum Product Subsidies (RM Billion)
Source: Data taken from www.epu.gov.my

The significant result in the short term also could be explained by the implementation of several policies i.e. monetary policy that relates to price mechanism to attain an appropriate balance between maintaining price stability due to higher oil price and achieving the maximum sustainable level of economic growth. Regarding the negative unidirectional causality effects running from oil prices to energy consumption, it shows that in the short term the world oil price changes would have an adverse effect on energy consumption. This result seems to support our expected finding that there could be a negative relationship between oil price and energy consumption in the short term.

However, the aggregate energy consumption is found to be oil price inelastic demand ($\alpha < 1$) while the value of income elasticity of energy demand is greater than unity (1.77). The income and price elasticity estimates were in line with the Goldstein-Khan results [-0.50, -1.0] for typical price elasticity and [1.0, 2.0] for typical income elasticity (Goldstein and Khan, 1985). This would imply that in the short term, increase in world oil price would have only minimal impact to the aggregate energy demand in Malaysia. On other hand, in the short term, the energy demand aggregate is very elastic or more sensitive to the changes in growth of real output rather than the oil price. The negative unidirectional causality effects running from oil prices to energy consumption in the short term also could be explained by the spillover effects that trigger the economy's response. Increasing the price of energy in the short term will directly increase in the consumer price index (CPI) and causes the indirect effect to the Producer Price Index (PPI) (Ahmat et.al, 2008).

5. Conclusions and Future Studies

Given the non-adverse effects between energy consumption and economic growth, government and energy planner should confer prompt response and choose the right mechanism of energy conservation. The study could suggest that for achieving higher economic growth, reducing oil, gas and coal especially in the consumption sectors of the economy and shifting towards indigenous resources mainly, hydropower and biomass would have a positive impact on the current account balance as well as keeping the environment clean. Therefore, there should be extensive efforts by all parties in the country to exploit the renewable sources of energy for consumption and production purposes especially in transportation and industrial sector.

6. References

[1] Ahmad N.M., and Jusoh, M., (2008), “Impact of Oil Price on Output and Price level in Malaysia, Paper presented in National University Malaysia Conference, Port Dickson, 12-13 October, Malaysia.

[2] Böhm, D.C., (2007), “The Causal Relationship between Energy Prices, Energy Consumption and Economic Growth: A Panel Co-integration Analysis”, European Economics and Finance Society: www.eefs.eu.

[3] Burbidge, J.; and Harrison, A., (1984), “Testing for the Effects of Oil-Price Rises Using Vector Autoregressions,” *International Economic Review*, Vol. 25, pp: 459-484.12

[4] Gisser, M., and Thomas H. G., (1986), “Crude Oil and the Macroeconomy: Tests of Some Popular Notions,” *Journal of Money, Credit, and Banking*, Vol.18, pp. 95-103.

[5] Goldstein, M.; and Khan, M, (1985), “Income and Price Effects in Foreign Trade”, In *Handbook of International Economics,* In Jones, R. and Kenen, P. (Ed.), Amsterdam and New York, North-Holland, Elsevier, Vol. 2, pp: 1041-1105.

[6] Granger, C.W.J. (1988), “Some Recent Developments in the Concept of Causality,” *Journal of Econometrics,* 39, 199-211.

[7] Hamilton J. D., (1983), “Oil and the Macroeconomy since World War II”, *Journal of Political Economy,* Vol. 91, pp: 228—248.

[8] Hamilton J. D. and Herrera A. M. (2001), Oil Shocks and Aggregate Macroeconomic Behaviour: The Role of Monetary Policy, Discussion Paper 2001-10, University of California, San Diego.

[9] Lee, K., and Ronald A. R., (1995), “Oil Shocks and the Macroeconomy: The Role of Price Variability,” *Energy Journal*, Vol.16, pp. 39-56.

[10] Mork, Knut A., (1989), “Oil and the Macroeconomy When Prices Go Up and Down: An Extension of Hamilton’s Results,” *Journal of Political Economy*, Vol. 91, pp: 740-744.

[11] Oh, W., and Lee, K., (2004), Causal relationship between energy consumption and GDP revisited: the case of Korea 1979-1999. *Energy Economics,* Vol. pp: 26, 51-59.

[12] Pesaran, M. H., Yongcheol, S.; and Smith, R.J., (2001), Bounds testing approaches to the analysis of level relationships, *Journal of Applied Econometrics,* Vol. 16, pp: 289-326.

[13] Soytas, U., and Sari, r., (2003), Energy Consumption and GDP: Causality relationship in G7 countries and emerging markets. *Energy Economics,* Vol. *25,* pp: 33-37.

[14] Yang, H. Y., (2000), A Note on the Causal Relationship between Energy and GDP in Taiwan, *Energy Economics*, Vol. 22, pp.309-317.