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Jee, Hui-Siang Brenda and Lau, Evan and Puah, Chin-Hong and Abu Mansor, Shazali

Universiti Malaysia Sarawak, Universiti Malaysia Sarawak, Universiti Malaysia Sarawak, Universiti Malaysia Sarawak

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DOMESTIC FUEL PRICE AND ECONOMIC SECTORS IN MALAYSIA: A FUTURE OF RENEWABLE ENERGY?

Hui-Siang JEE Brenda, Evan LAU[♣], Chin-Hong PUAH and Shazali ABU MANSOR

Department of Economics, Faculty of Economics and Business,
Universiti Malaysia Sarawak, 94300 Kota Samarahan,
Sarawak, Malaysia.

Abstract: This study empirically examines the relation between the domestic fuel prices with the ten disaggregated economic sectors in Malaysia with the spanning of data from 1990:Q1 to 2007:Q4. We found that only three sectors (agriculture, trade and other services sectors) are cointegrated with the fuel price and fuel price does Granger cause these sectors. Despite the evidence of non-cointegrated in most of the economic sectors, fuel price able to influence these sectors over a longer period. Policy recommendation from this study includes the utilization of the renewable energy (RE) as a strategic plan is the long-term solution due to the high dependency and increasing demand of energy. While energy prices have experienced some correction in response to signs of slower global growth, sufficient government enforcement and support need to be established to facilitate successful renewable energy implementation in Malaysia.

Keyword: Fuel price, Economic sector, Granger causality, Renewable Energy, Growth.
JEL Classification: C32, E31, O53

1. Introduction

Since the discovery of crude oil, it has been plays an important role in the development of the world economy. The transformation of the crude oil to the variety of energy products such as diesel, gasoline, kerosene, butane prove it is a vital source of energy, an irreplaceable transport fuel and an essential raw material in many manufacturing processes (Chang and Wong, 2003). Hamilton (1983) in his seminal work found that that oil prices have strongly correlated with real economic activity in the United States since World War II[1]. As the movement of crude oil prices fluctuates and volatile, it creates uncertainty, leading to

♣ Correspondence Author: Tel: +6082-582430, Fax: +6082-671794, E-mail: lphevan@feb.unimas.my or/and ygwiex@yahoo.com

[1] The episodes of oil price shocks since 1973 give rise to a plethora of studies devoted to this branch of literature (see for example, Hamilton, 1983, 1996; Gisser and Goodwin, 1986; Mork, 1989; Kim and Loungani, 1992; Ferderer, 1996; Papapetrou, 2001; Brown and Yucel, 2002; Cunado and de Gracia, 2003, 2005; Jiménez-Rodriguez and Sánchez, 2005; Raguindin and Reyes, 2005 and Farzanegan and Markwardt, 2009).

economic instability for both oil-exporting and oil-importing countries (Narayan and Narayan, 2007).

The transmission mechanisms through which oil prices have an impact economic activity include (1) supply channel and, (2) demand channel[2]. For the supply side, the increase of oil price is likely to transfer higher cost to the producer. As a result, the producer reduces their energy spending by consuming less energy. With the productivity inefficiency, the production output falls. Additionally, Hamilton (1988) indicates that the relative changes in prices have caused the unemployment rate to increase. When the oil prices increase, the demand for labor in the severely affected sector has reduced due to the contraction in production. With such constrain, the productivity inefficiency in the end has lower down the output growth. Through the demand side channel, the increase of oil prices has redistributed the income from oil-importing country to oil-exporting country (Ferderer, 1996). Accordingly, the disposal income in the oil-importing country decelerates and finally depresses the aggregate demand as the purchasing power has reduced. In this unfavorable environment, the investor is likely to postpone the investment, as the future economic performance is uncertain (Bernanke, 1983) and it slower the investment activity. Therefore, an understanding of the oil price movement[3] is crucial because persistent and long lasting changes can expose producers and industrial consumers to risk, thus affecting investments in

[2] It is worth noting that there are other transmission mechanism discuss in the literature. This includes the real balances, role of monetary policy, the foreign exchange markets and inflation (see for example Ferderer, 1996; Brown and Yucel, 2002; Jiménez-Rodriguez and Sánchez, 2005 and Raguindin and Reyes, 2005) which give rise to indirect on real economic activity.

[3] A look into the chronological movement of oil prices perceived that the previous steep rise in oil prices is due to the supply disruption, but in this past few years it is no longer the main factor of the oil price fluctuations. Rather, the increasing demand from the Asian countries, especially China plus the large consumption from the US have caused oil price to surge. For example, prices increased rapidly in the milenium from a low price of US$19 per barrel in 1999 to US$35 and reaching above $40 by the end of 2004. By mid-2005, the price go beyond US$50 per barrel and rocketing to nearly US$90 per barrel in 2007. On the eve of 2008, a single trade was made at US$100. Oil prices broke through US$110 on March 2008 and by June 2008 stood at US$145. On early July 2008, oil prices rose to a new record of US$147. However, oil prices declined to US$125 a barrel by the end of July. A strong contributor to this price decline is the drop in domestic demand for oil. In August, it droppped below US$115 while by September 10 it went down to US$102 per barrel.

oil inventories and facilities for production and transportation. This matter worsens if oil were the only main source of energy in a country.

In Malaysia, it has been largely used as the intermediate inputs in the industrial production activity around 40 percent in 2005 (EPU, 2006). Amongst the types of energy sources, petroleum products are the highly demanded that constitute more than 60 percent of total energy consumption in 2005. This creates an environment of uncertainty as the high dependency on petroleum products kept Malaysia at risk if the international crude oil price remains high.

Although the government practices fuel subsidies and tax exemption mechanism where the price is considered as the lowest amongst the Southeast Asian countries after Brunei (NEAC, 2005), the rise of international crude oil price is likely burdening the government. In order to lighten the burden, the Malaysian government has revised its fuel prices several times in between year 2000 to 2008. For example, the 18.5 percent rises in fuel price in February 2006 (from RM1.62 to RM1.92) has reduced the total expenditure on fuel subsidy and tax exemption, which drop from RM 16 billions in 2005 to RM 14.7 billions in 2006. In early June 2008 the government increase the domestic petrol fuel price to RM2.70 due to the significant increase of the world crude oil. Recently, government in August 23, 2008 reduced the domestic petrol price to RM2.55 per litre after considering the drop in global oil prices over the past month as well as higher inflation in July.

With the motivation in place, this study empirically examined the relation between the domestic petrol price and the disaggregated economic sectors in Malaysia. The present paper extends the existing empirical literature in two directions. First, this paper use Malaysia[4], oil-exporting countries rather than most of the existing literature that focuses on the oil-importing countries[5]. A study by Jiménez-Rodriguez and Sánchez (2005) found that oil price shocks do not bring benefit to UK, one of the oil-exporter countries. Second, we considered the effect of oil prices on ten disaggregated economic sectors in Malaysia[6]. The advantage of using disaggregated data is to see whether fluctuation of the prices will leave any consequences on any particular economic sectors in Malaysia[7]. Although some researchers do suggest that an oil price increase would be beneficial for an oil exporter as a whole, like the reduction of total expenditure in Malaysia, the effects on specific economic sectors remained ambiguous, as the heterogeneity effects may exist across economic sectors. In this sense, manipulation of appropriate policy conclusion on the different economic sector would be able to materialize.

The following is the organization of this paper: Section 2 describes the data and methodology for the study. Section 3 discusses the empirical results and finally, Section 4 presents the concluding remarks.

[4] Malaysia is ranked number 23 in 2006 as a net oil-exporter (see EIA, International Petroleum Monthly, various issues).

[5] Despite being an oil-exporter since 1970s, the increasing domestic oil demand and limited reserve condition, the probing question of sustaining its oil exporting status is rather important (Gan and Li, 2008). Although the issue is beyond the paper, it is of great concern to Malaysia.

[6] According to Department of Statistics (DOS) Malaysia's classification, the Malaysian economic activity can be divided into 10 major sectors, including agriculture, forestry and fishing, mining and quarrying, manufacturing, construction, electricity, water and gas, transport, storage and transportation, wholesale and retail trade, hotels and restaurants, finance, insurance and real estates and business services, government services and other services.

[7] Studies focuses on the impact of oil price shocks to sectoral performances are increasingly available in the literature (see for example, Bauer and Byrne, 1991; Zind, 1999; Schintke, *et al.,* 2000; Valadkhani and Mitchell, 2001; Jiménez-Rodriguez, 2007; Saari, *et al.,* 2008).

2. Data Description and Econometric Strategy

2.1 Data Description

Quarterly data spanning from 1990:Q1 to 2007:Q4 consist of 72 observations were adopted in this study. Table 1 summarized the 11 variables used in this study where domestic fuel price[8] has been obtained from Ministry of Domestic Trade and Consumer Affairs while the 10 economic outputs are compiled from Monthly Statistical Bulletin published by Bank Negara Malaysia. All the variables are all expressed in log terms and converted into real terms (except for fuel prices) by using the consumer price index (CPI) and were expressed in domestic currency prior to estimation.

[Insert Table 1]

2.2 Unit Root and Stationary Testing Procedures

We adopted the Said and Dickey (1984, ADF), Elliott *et al*. (1996, DFGLS) and Kwiatkowski *et al*. (1992, KPSS) testing principles in this study. The ADF and DFGLS share the same null hypothesis of a unit root while KPSS procedure tests for level (η_μ) or trend stationarity (η_τ) against the alternative of a unit root. In this sense, the KPSS principles involve different maintained hypothesis from the ADF and DFGLS unit root tests.

[8] This is another extension of the literature on this branch of studies. Rather than looking into the international prices, we use domestic fuel prices.

2.3 Cointegration Procedure

The system-based cointegration procedure developed by Johansen and Juselius (1990, JJ) to test the absence or presence of long run equilibrium is adopted in this paper[9]. One advantage of this approach is that the estimation procedure does not depend on the choice of normalization and it is much more robust than Engle-Granger test (see Gonzalo, 1994). Phillips (1991) also documented the desirability of this technique in terms of symmetry, unbiasedness and efficiency. Their test utilizes two likelihood ratio (LR) test statistics for the number of cointegrating vectors: namely the trace test and the maximum eigenvalue test. As the JJ procedure is well known in the time series literature and the detail explanation are not presented here.

2.4 Granger Causality Tests

If cointegration is detected, then the Granger causality should be conducted in vector error correction model (VECM) to avoid problems of misspecification (see Granger, 1988). VECM is a special case of VAR that imposes cointegration on its variables where it allows us to distinguish between short run and long run Granger causality. The relevant error correction terms (ECTs) must be included in the VAR to avoid misspecification and omission of the important constraints. The existence of a cointegrated relationship in the long run indicates that the residuals from the cointegration equation can be formulated as follows:

$$\Delta ES_t = \alpha_0 + \sum_{i=1}^{m} \beta_{1,i} \Delta ES_{t-i} + \sum_{i=1}^{n} \beta_{2,i} \Delta FUEL_{t-i} + \mu_1 ECT_{t-1} + \zeta_{1t} \quad (1)$$

$$\Delta FUEL_t = \delta_0 + \sum_{i=1}^{n} \phi_{1,i} \Delta FUEL_{t-i} + \sum_{i=1}^{m} \phi_{2,i} \Delta ES_{t-i} + \mu_2 ECT_{t-1} + \zeta_{2t} \quad (2)$$

[9] Although this is more apparent for multivariate systems or relationships, the Johansen procedure has been used extensively in various bivariate studies (for example, see Masih and Masih, 1994, 1995) indicating more robust findings in contrast to the residual-based counterparts.

where Δ is the lag operator, α_0, δ_0, β's and ϕ's are the estimated coefficients, m and n are the optimal lags of the series ES and FUEL, ζ_{it}'s are the serially uncorrelated random error terms while μ_1 and μ_2 measure a single period response of the ES (FUEL) to a departure from equilibrium. ES refer to the relevant disaggregate economic sectors in Malaysia while FUEL is the domestic fuel price. To test whether FUEL does not Granger cause movement in ES, H_0: $\beta_{2,i} = 0$ for all i and μ_1=0 in Equation (1)[10]. The rejection implies that FUEL causes ES. Similar analogous restrictions and testing procedure can be applied in testing the hypothesis that ES does not Granger cause movement in FUEL where the null hypothesis H_0: $\phi_{2,i} = 0$ for all i and μ_2= 0 in Equation (2). In the case where cointegration is absence, the standard first difference vector autoregressive (VAR) model is adopted. This simpler alternative of causality is feasible through the elimination of ECT from both equations above. In other words, it only contains the short run causality information.

2.5 Generalized Variance Decomposition (GVDCs)

In order to gauge the relative strength of the variables and the transmission mechanism responses, we shock the system and partition the forecast error variance decomposition (FEVD) for each of the variables in the system. However, the results of FEVD based on Choleski's decomposition are generally sensitive to the ordering of the variables and the lag length (see Lutkepohl, 1991). In this paper, the Generalized Variance Decomposition (GVDCs) suggested by Lee *et al*. (1992) is applied here. The innovation of the GVDCs will be represented in percentage form and strength of two variables to their own shocks and each

[10] The F-test or Wald χ^2 of the explanatory variables (in first differences) indicates the short run causal effects ($\beta_{2,i} = 0$ for all i) while the long run causal (μ_1=0) relationship is implied through the significance of the lagged ECT which contains the long run information.

other are measure by the value up to 100 percent. The GVDCs are executed using time horizons of 1 up to 24 quarters.

3. Empirical Results and Discussion

3.1 Unit Root Analysis

Overwhelmingly, the results of ADF and DFGLS tests strongly rejects the *I(0)* null at 95 percent confidence level while the KPSS statistics further strengthened this conclusion by failing to reject the null hypothesis at 95 percent confidence level. Thus, these univariate unit root and stationary tests yield results that are consistent with the notion that all the variables are nonstationary in level but stationary in first difference (i.e., *I(1*). These results are not presented here, but are made available upon request from the authors.

3.2 Cointegration Test Results

Before proceed to the cointegration analysis, we identify the number of optimum lags that for the vector autoregression (VAR) system. Such a procedure is important, as the cointegration analysis is sensitive to the lags order (Hall, 1991). For the purpose of the analysis, the Shcwert (1987) approach was adopted and the chosen lags are equal to four.

The results portrays in Table 2 indicate that the null hypothesis have been rejected for both trace test and maximum eigenvalue test in Panels A and F. It implies agriculture sector and wholesale and retail trade, accommodation and restaurants sector (hereafter trade sector) are cointegrated with the fuel price in the long run. Likewise, the other services sector (Panel J) also cointegrated with fuel price although inconsistent results have been drawn from the two tests as Johansen and Juselius (1990) claim that maximum eigenvalue test has high power as compare to the trace test.

[Insert Table 2]

However, we do not find any significant long run relationship between fuel price and the remaining economic sectors, as the null hypothesis has not been rejected. As such, this implies that the mining sector, manufacturing sector, construction sector, electricity and gas and water sector (utilities sector), transport, storage and transportation sector (transportation sector), finance, insurance, real estate and business services sector (finance sector) and government services sector do not cointegrated with the fuel price. Hence, the inferences that we can draw from these results is most of the economic sectors in Malaysia is unlikely to have a long run relationship with the domestic fuel price.

3.3 Temporal Causality Results: VECM

The results presented in Table 3 are the temporal causality estimates in VECM. First, economic sectors (lragri, lrtrade and lroth) are found to be endogenous in the system. This is shown in economic sectors equation where the *ect* is statistically significant suggesting that this three sectors solely bears the brunt of short run adjustment to bring about the long run equilibrium. Second, the *t*-statistics on the lagged residual are statistically significant and negative in all the economic sectors supporting the cointegration results reported in Table 2. Third, we found that the speed of adjustment as measured by the *ect* coefficient to long run equilibrium following a disturbance ranging from 0.047 (lroth) to 0.206 (lragri). The magnitude of these coefficients indicates that the speed of adjustment towards the long-run path varies among these three cases. Specifically, agriculture sector (5 percent), trade sector (13 percent) and other services sector (21 percent) need approximately about twenty, eight and five quarters to adjust to the long run equilibrium due to the short run adjustments. .

[Insert Table 3]

Fourth, the insignificant coefficient of the *ect* in all of the fuel price equations suggesting that the fuel price is relatively exogenous in the system. Fifth, we found that fuel price Granger cause economic sectors in Malaysia in the long run. Further, it is an evident that the null hypothesis of FUEL does not cause (in Granger-sense) ES in the short run is easily rejected at 5 percent significance level except for the lroth sector. Specifically, short run causality is absence in Panel C.

3.4 Generalized Variance Decomposition Analysis (GVDCs)

Table 4 documented the decomposed forecast error variance of the two variables over the different time horizon. The value which measured in percentage in the main diagonal provide a sufficient forecasting information about to which extent the relative variance of one variable is being explained by its own shock or other variable's shocks. If it is mainly explained by its own shock, then the variable is said to be relatively exogenous.

From the reported decomposition results, it shows that the relative variance of most of the variables have been largely attributed by its own shock, especially the relative variance in fuel price. Thus, fuel price is a relatively exogenous variable comparatively to the economic sectors as time expands. For instance, in to Panel A, Table 4 less than half of the lragri variance is being explained by its own innovation as time expand to 24 quarters. This implies that the fuel price has a greater impact on agriculture sector after 24 quarters, which constituted about 83 percent. Similar results are observed in Panel B where the variation in trade sector has been largely indicated by lfuel, which constituted about 64 percent. This support the earlier causality pattern observed in Table 3.

[Insert Table 4]

However, such trend is absence in Panel C, whereby major constitution of relative variance in lroth remains contributed by its own shock even up to 24 quarters. We can imply that the innovation in lroth has remained relatively exogenous but such impact may disappear in a longer time frame as the decreasing trend has been observed. In other words, the fuel price shock is able to affect the other service sector, taking into consideration of a longer time frame, supporting the long run causality existence in Table 3.

3.5 Persistence Profile Shock for Cointegrating Vector

Persistence profile of a system-wide shock is an alternative procedure to positioning the impulse response function (IRFs) introduced by Lee *et al*. (1992) and Lee and Pesaran 1993). It is a unique measure of the effect by the shock in estimating one-step ahead forecast error for the whole system. In other words, it shows the speed of convergence to equilibrium for a cointegrating system[11]. One interesting feature of this kind of experiment is that it gives a feeling for how long it takes the system to adjust back to the long run equilibrium after a real disturbance, or shock occurs.

For Figure 1a, it shows a declining trend of the cointegrating vector in moving towards the long-run equilibrium point. In other words, their response to a system-wide shock is quite marginal as their response is lower than one unit throughout the horizon. On the other hand, for Figures 1b and c, the overshooting effects have been observed in the first few quarters, whereby the cointegrating vector response higher than one unit due to the one unit shock in the system. Nevertheless, these effects tend to be eliminated after few quarters (i.e. starting

[11] This long run information obtained mimics the error correction term (ECTs) through the vector error correction model (VECM) framework applied earlier in the presence of cointegration. In addition, impulse response function (IRFs) and half-life measurement also quantify on how fast a shock occurred and when the whole process would in principle, take to complete.

from quarter seventh to quarter ninth) before reach to zero point. The three figures tend to be reverted back to its long run equilibrium point but at a slower pace of more than 20 quarters. With such evidence, we can confirm that these variables are indeed poses a long-run cointegrating relationship as suggested in cointegration analysis. Additionally, the slow restoration is likely to mirroring some time lags in response to the governmental policy adjustment.

[Insert Figures 1a, 1b and 1c]

3.6 Granger Causality Test Results

Since no long run equilibrium is evident for seven other economic sectors in Table 2, hence the pairwise Granger (1969) causality test in first difference seems to be an appropriate tool. We used the lag structures from one up to four and the results are summarized in Table 5. By referring to Panel B, C, D, E and F, it shows that the *F*-statistics are insignificant, therefore, hinders us from rejecting the null hypothesis. As such, this implies that the fuel price does not Granger cause the manufacturing sector, construction sector, transportation sector and financial sector in Malaysia and vice versa in short-run. Results in Panel G indicated the existence of bidirectional causality between the fuel price and government services sector only in lag one. Therefore, we rather justify that there are no causality relationship between these variables as their relation only exist in a very short period of time.

Only in Panel A, there is a short run causality relationship running from mining sector to the fuel price. This pattern exist due to the fact that the oil companies will strive to look for more oil reserves or extract more crude oil from the previously uneconomically oil drilling fields in the case of high rise international oil prices. Accordingly, that particular sector output will increase and contribute to the greater export earnings for the country. This in turn we used to finance the domestic fuel subsidies in which the causality perceived. Therefore, in the shorter period, the Malaysian government is able to maintain its domestic fuel price and reduce the nation's burden.

[Insert Table 5]

3.7 Further Evidence

Following the suggestion by Engle and Granger (1987), we further execute GVDCs experiment with the purpose to forecast the effects of fuel price shock on the respective economic sectors in Malaysia beyond the sample period. The estimated results for the GVDCs derived from the VAR model is further exhibited in Table 6. From the reported results, is has been shown that over these 24 quarters, the relative variance in lfuel is generally explained by its own shock, evidence of exogeneity.

The effects of disturbances in fuel price in some sectors have arisen after several quarters. The identified sectors include manufacturing sector, utility sector, transportation sector and government services sector. For the manufacturing sector, the contribution of the disturbances in fuel price has increased from 4.898 percent in first quarter to 16.013 percent in 24 quarters (see Panel B). Since the refined petroleum products are not the main manufactured products in Malaysia, the influences from fuel price are therefore would not immediately transfer to the manufacturing sector reflecting the slow transformation effects. Such result is similar to those reported by Jiménez-Rodriguez (2007) who claims that the greater shock is received by the manufacturing industrial sector in the United Kingdom and the United States after second year.

Similar findings were pronounced in the utilities sector (see, Panel D). As indicated by Villar and Joutz (2006), when crude oil price temporarily increased by 20 percent, the natural gas price will increase by 5 percent. This is likely to reflect the Malaysian case, where the rise of the fuel will project a positive increase to the natural gas price as well as electricity price. This would eventually transfer higher cost to the electricity sector and utility sector as a whole. For the transportation sector, the influence of fuel price hike is likely to increase the transportation cost embedded in the operating activities. For the remaining sectors, the impacts are quite marginal in the 24 quarters period. For instance, the impact of fuel price on the government services sector is marginal, as fuel is not considered as an intermediate input.

4. Concluding Remarks

This paper set up to examine the relationship between domestic petrol price and the 10 major economic sectors. The paper, which is exclusively empirical in nature, leads us to several important conclusions. First, out of 10 economic sectors, only the agriculture sector, trade sector and other services sectors have a comovement with fuel prices. Second, the significant coefficient for *ect* in the sectoral equations imply that that fuel price is the leading variable for these three economic sectors in the long run. Third, through the standard Granger causality test, unidirectional causality running from mining sector to fuel price is discovered. Fourth, since most of the economic sectors in Malaysia are not cointegrated with petrol price, we further adopt GVDCs experiment on the non-cointegrated sectors. The GVDCs allow one to put the perspectives of relationship between oil prices and the economic sectors. Overall, the results show that the fuel price is the relative exogenous variables in this study suggesting that the fuel price is able to influence some of these sectors over a longer period.

From the empirical investigation, we acknowledge the function of domestic fuel price in affecting the economic sectors in Malaysia. This rather implies that it is important to consider not just whether oil prices increases (internationally or domestically) or decline (and by how much) but also the environment in which the movement takes place. With the fluctuation of international oil prices, the challenge ahead for Malaysia in order to attain sustainable economic growth is crucial. In the sense, proactive agenda should be formulates to ensure efficient coordination in the future scenario of the oil prices. This includes the innovation in energy efficient technologies and upgrading existing equipment in order to reduce dependency on crude oil.

Malaysian government actively pursues the development of renewable energy (RE) since 1999 with the adoption of the Fifth Fuel Diversification Policy in the eighth Malaysian plan (EPU, 2001). According to Gan and Li (2008, pg. 897) after the recognition of RE as the fifth fuel in Malaysia, a numbers of project were implemented. This includes the projects like Small Renewable Energy Power Program (SREP), BioGen and National Biofuel Policy[12]. Renewable energy such as biofuel from the blend of 5 percent processed palm oil and 95 percent diesel would be an alternative especially for the industrial sectors. The revenue from palm oil industry would be another option for government to reduce the subsidy burden and a stable foreign exchange rate regime. Besides, the applications of biofuel, the utilization of the hydropower, solar power and wave power would be another alterative sources. This would made beneficial for Malaysia especially in the view of decreasing fossil fuel production and increasing energy demand coupled with the increasing awareness of environmental issues, concern for increasing green house gas emissions and uncertain oil prices. Sufficient

[12] The introduction of Sarawak Corridor of Renewable Energy (SCORE), under the 9th Malaysian Plan also another initiative by the government for the RE strategic plan. Although it is one of the five regional development corridors, the focus is on exploration of the new and renewable natural energy resouces especially for the industrial development plan.

government enforcement and support in the form of regulatory framework, incentives and targets need to be established to facilitate successful RE implementation. With the energy crisis faced by the world of depleting energy sources and high-energy consumption, cooperation for the energy conservation policies among the Asian countries would be another imperative move.

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Table 1: List of Variables

Variable	Description
lfuel	Natural logarithm of fuel prices
lragri	Natural logarithm of real agriculture, forestry and fishing output
lrmin	Natural logarithm of real mining and quarrying output
lrmfc	Natural logarithm of real manufacturing output
lrcons	Natural logarithm of real construction output
lrutilities	Natural logarithm of real electricity, gas and water output
lrtrade	Natural logarithm of real wholesale and retail trade, accommodations and restaurants output
lrtransport	Natural logarithm of real transport, storage and transportation output
lrfin	Natural logarithm of real finance, insurance, real estates and business services output
lrgov	Natural logarithm of real government services output
lroth	Natural logarithm of real other services output

Table 2: Cointegration Test Results

H_0	H_1	Trace Statistc	95% Critical Value	Maximum-Eigenvalue Statistc	95% Critical Value
Panel A: lragri (k = 4, r = 1)					
r = 0	r = 1	17.075*	15.41	16.679*	14.07
r < = 1	r = 2	0.396	3.76	0.396	3.76
Panel B: lrmin (k = 4, r = 0)					
r = 0	r = 1	13.250	15.41	11.847	14.07
r < = 1	r = 2	1.402	3.76	1.402	3.76
Panel C: lrmfc (k = 4, r = 0)					
r = 0	r = 1	5.080	15.41	5.061	14.07
r < = 1	r = 2	0.019	3.76	0.019	3.76
Panel D: lrcons (k = 4, r = 0)					
r = 0	r = 1	10.296	15.41	10.190	14.07
r < = 1	r = 2	0.106	3.76	0.106	3.76
Panel E: lrutilities (k = 4, r = 0)					
r = 0	r = 1	6.940	15.41	6.533	14.07
r < = 1	r = 2	0.407	3.76	0.407	3.76
Panel F: lrtrade (k = 4, r = 1)					
r = 0	r = 1	29.991*	15.41	29.312*	14.07
r < = 1	r = 2	0.679	3.76	0.679	3.76
Panel G: lrtransport (k = 4, r = 0)					
r = 0	r = 1	5.935	15.41	5.880	14.07
r < = 1	r = 2	0.055	3.76	0.055	3.76
Panel H: lrfin (k = 4, r = 0)					
r = 0	r = 1	7.299	15.41	7.290	14.07
r < = 1	r = 2	0.008	3.76	0.008	3.76
Panel I: lrgov (k = 4, r = 0)					
r = 0	r = 1	9.184	15.41	5.832	14.07
r < = 1	r = 2	3.352	3.76	3.352	3.76
Panel J: lroth (k = 4, r = 1)					
r = 0	r = 1	15.049	15.41	15.045*	14.07
r < = 1	r = 2	0.005	3.76	0.005	3.76

Notes: Asterisk (*) indicates statistically significant at 5 percent level, while the k is the lag length and r represents the number of cointegrating vector.

Table 3: Temporal Causality Results

	k = 4		
Dependent variable	Chi-square statistics		coefficients
Panel A	Δlragri	Δlfuel	*ect*
Δlragri	-	9.542 (0.023)*	-0.206 [-4.047]*
Δlfuel	1.672 (0.643)	-	-0.003 [-0.178]
Panel B	Δlrtrade	Δlfuel	*ect*
Δlrtrade	-	9.329 (0.025)*	-0.128 [-5.331]*
Δlfuel	3.444 (0.328)	-	0.024 [1.459]
Panel C	Δlroth	Δlfuel	*ect*
Δlroth	-	2.066 (0.559)	-0.047 [-3.704]*
Δlfuel	0.046 (0.997)	-	0.021 [0.989]

Notes: Asterisk (*) indicates statistically significant at 5 percent level. The values presented in square bracket [ ] and in parentheses ( ) are the t-statistics and p-values, respectively.

Table 4: Generalized Variance Decomposition Analysis (GVDCs) Results

Percentage of variations in	Horizon (quarters)	Due to innovation in:	
Panel A:		Δlragri	Δlfuel
Quarters relative variance in: Δlragri			
	1	*94.213*	5.787
	4	*93.340*	6.660
	8	*87.281*	12.719
	24	*17.321*	82.679
Quarters relative variance in: Δlfuel			
	1	1.349	*98.651*
	4	2.215	*97.785*
	8	2.247	*97.753*
	24	2.087	*97.913*
Panel B:		Δlrtrade	Δlfuel
Quarters relative variance in: Δlrtrade			
	1	*98.818*	1.182
	4	*96.848*	3.152
	8	*90.011*	9.989
	24	*36.061*	63.939
Quarters relative variance in: Δlfuel			
	1	2.101	*97.899*
	4	3.229	*96.771*
	8	3.892	*96.108*
	24	5.720	*94.280*
Panel C:		Δlroth	Δlfuel
Quarters relative variance in: Δlroth			
	1	*99.795*	0.205
	4	*98.749*	1.251
	8	*98.953*	1.047
	24	*77.596*	22.404
Quarters relative variance in: Δlfuel			
	1	0.121	*99.879*
	4	0.129	*99.871*
	8	0.251	*99.749*
	24	1.192	*98.808*

Notes: The columns in italic represent the impact of their own shock or innovation.

Table 5: Short Run Granger Causality Results

Null Hypothesis	Lag 1	Lag 2	Lag 3	Lag 4
	F-Statistics			
Panel A:				
lfuel does not Granger cause lrmin	0.480	0.798	0.353	0.347
lrmin does not Granger cause lfuel	11.675*	7.089*	4.179*	3.271*
Panel B:				
lfuel does not Granger cause lrmfc	0.693	1.171	0.488	0.459
lrmfc does not Granger cause lfuel	3.593	1.840	1.351	1.172
Panel C:				
lfuel does not Granger cause lrcons	0.002	0.471	0.373	0.329
lrcons does not Granger cause lfuel	0.038	0.302	0.200	0.232
Panel D:				
lfuel does not Granger cause lrutilities	0.024	0.152	0.056	0.036
lrutilities does not Granger cause lfuel	2.181	1.749	1.194	0.927
Panel E:				
lfuel does not Granger cause lrtransport	0.245	0.759	0.480	0.329
lrtransport does not Granger cause lfuel	3.403	1.772	1.181	0.933
Panel F:				
lfuel does not Granger cause lrfin	1.262	1.233	0.820	0.693
lrfin does not Granger cause lfuel	1.404	0.784	0.570	0.562
Panel G:				
lfuel does not Granger cause lrgov	7.848*	2.021	0.779	0.291
lrgov does not Granger cause lfuel	4.332*	2.381	1.544	1.232

Notes: Asterisk (*) indicates statistically significant at 5 percent level.

Table 6: Further Evidence

Percentage of variations in	Horizon (quarters)	Due to innovation in:	
Panel A:		Δlrmin	Δlfuel
Quarters relative variance in: Δlrmin			
	1	*99.681*	0.319
	4	*98.620*	1.380
	8	*98.709*	1.291
	24	*99.046*	0.954
Quarters relative variance in: Δlfuel			
	1	0.001	*99.999*
	4	1.639	*98.361*
	8	2.864	*97.136*
	24	3.690	*96.310*
Panel B:		Δlrmfc	Δlfuel
Quarters relative variance in: Δlrmfc			
	1	*95.102*	4.898
	4	*90.738*	9.262
	8	*86.710*	13.290
	24	*83.987*	16.013
Quarters relative variance in: Δlfuel			
	1	2.463	*97.537*
	4	2.438	*97.562*
	8	2.452	*97.548*
	24	2.453	*97.547*
Panel C:		Δlrcons	Δlfuel
Quarters relative variance in: Δlrcons			
	1	*95.888*	4.112
	4	*95.722*	4.278
	8	*95.186*	4.814
	24	*94.987*	5.013
Quarters relative variance in: Δlfuel			
	1	4.487	*95.513*
	4	3.918	*96.082*
	8	3.749	*96.251*
	24	3.576	*96.424*
Panel D:		Δlrutilities	Δlfuel
Quarters relative variance in: Δlrutilities			
	1	*94.934*	5.066
	4	*91.559*	8.441
	8	*86.522*	13.478
	24	*81.384*	18.616
Quarters relative variance in: Δlfuel			
	1	9.584	*90.416*
	4	13.303	*86.697*
	8	14.243	*85.757*
	24	14.422	*85.578*

(Table 6 Continued)

Panel E:		Δlrtransport	Δlfuel
Quarters relative variance in: Δlrtransport			
	1	*94.608*	5.392
	4	*90.243*	9.757
	8	*85.610*	14.390
	24	*81.334*	18.666
Quarters relative variance in: Δlfuel			
	1	1.149	*98.851*
	4	1.227	*98.773*
	8	1.292	*98.708*
	24	1.285	*98.715*
Panel F:		**Δlrfin**	**Δlfuel**
Quarters relative variance in: Δlrfin			
	1	*99.617*	0.383
	4	*99.565*	0.435
	8	*99.591*	0.409
	24	*99.704*	0.296
Quarters relative variance in: Δlfuel			
	1	1.773	*98.227*
	4	2.680	*97.320*
	8	2.726	*97.274*
	24	2.641	*97.359*
Panel G:		**Δlrgov**	**Δlfuel**
Quarters relative variance in: Δlrgov			
	1	*99.897*	0.103
	4	*99.803*	0.197
	8	*99.312*	0.688
	24	*96.799*	3.201
Quarters relative variance in: Δlfuel			
	1	0.056	*99.944*
	4	0.026	*99.974*
	8	0.012	*99.988*
	24	0.008	*99.992*

Notes: The columns in italic represent the impact of their own shock or innovation.

Figure 1a: Persistence Profile Shock for Cointegrating Vector (lragri)

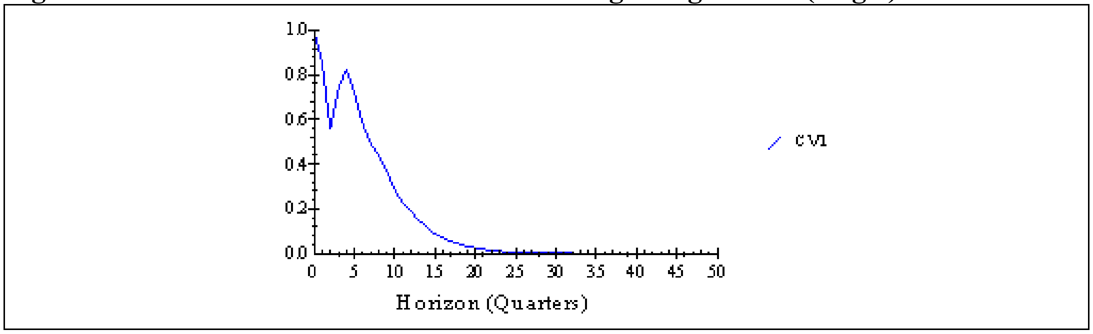

Figure 1b: Persistence Profile Shock for Cointegrating Vector (lrtrade)

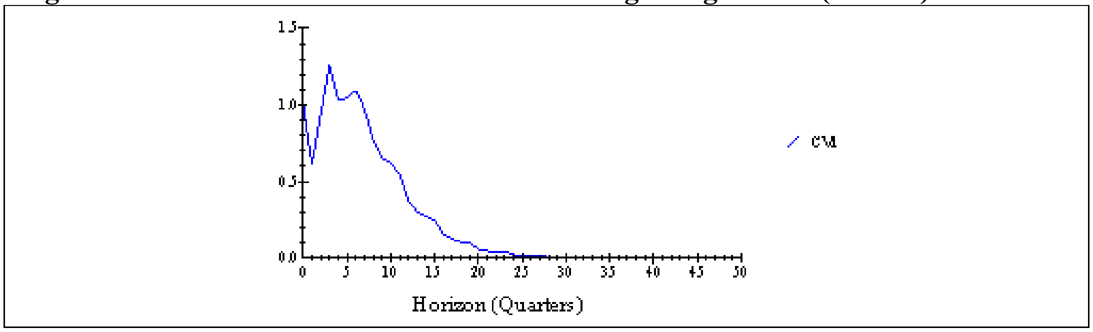

Figure 1c: Persistence Profile Shock for Cointegrating Vector (lroth)