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Assessing the Relationship between Oil Prices, Energy Consumption and Macroeconomic Performance in Malaysia: Co-integration and Vector Error Correction Model (VECM) Approach

HUSSAIN A. BEKHET
Finance and Economics Department
College of Business Management and Accounting
University Tenaga Nasional (UNITEN)
Muadzam Shah Campus, Pahang, Malaysia
Tel: 60-9-455-2020 ext. 2049   E-mail: profhussain@uniten.edu.my / drhussain175@hotmail.com

Nora Yusma Mohamed Yusop
Finance and Economics Department
College of Business Management and Accounting
University Tenaga Nasional (UNITEN)
Muadzam Shah Campus, Pahang, Malaysia
Tel: 60-9-455-2020 ext 3317   E-mail: nora@uniten.edu.my

Abstract

This paper investigates the long run relationship between oil price, energy consumption and macroeconomic performance in Malaysia. The sample period is from (1980-2005) and the time series are subjected to various shortcomings such as autocorrelation, multicollinearity problems and host of other problems; data were first tested for their residuals. The results reveal that there is an evidence for a stable long-run relationship between the oil price, employment, economic growth and growth rate of energy consumption and also substantial short run interactions among them. Also, this paper indicates that the changes of world oil prices also affect the total energy consumption in Malaysia but reverse does not hold in Malaysia context. The linkages and causal effects among the oil price, energy consumption and macroeconomic performance have important policy implications on the benefits of energy conservation and regulation of macroeconomic policy. Given the dominant effects of oil price on energy consumption, better response and right mechanism of energy conservation policies should exist to curb the non renewable energy use and to shift extensively to the inter fuel substitution towards indigenous resources, mainly renewable energy. The most important findings here indicated that the growth of energy used has significant impacts on employment growth and present energy conservation policy especially energy saving policy and energy efficiency initiatives has significant impact on economic growth in Malaysia.

Keywords: Energy Consumption, Employment, World Oil Prices, Economic Growth, Co-integration; Vector Error Correction Model, VECM Granger Causality

1. Introduction:

This paper investigates the long run relationship and causality between energy consumption, oil price, employment growth and economic growth of Malaysia using the co-integration test of Johansen et.al (2004) and VECM causality test of Granger (1987). These tests are useful in assessing the dependence of energy consumption for Malaysian economics. This is important because when a country's economy is heavily dependent on energy consumption, environmental policies for energy conservation could adversely affect economic growth. Therefore the understanding of the direction of causality between energy consumption and economic growth could have important policy implications. Indeed, the relationship between use of energy and economic growth has been a subject of greater inquiry as energy is considered to be one of the important driving forces of economic growth in all economies (Pokharel, 2006). Besides that, this research is also trying to look at the effects of world oil price to energy consumption as well as to the Malaysia economic performances namely the economic growth and employment.

Malaysia's economy has been growing steadily in the last several decades. With an annual average growth projected at 4.8%, the demand for energy consumption will inevitably increase (Ninth Malaysia Plan). Presently, Malaysia is blessed with both conventional and non-conventional energy sources to fuel its economy with more than 80% of its primary energy supply comes from oil and gas (www.epu.gov.my). Malaysia is endowed with conventional energy resources such as oil and gas and other renewable sources and it is currently contributing about 11% of export earning in 2004. Unfortunately, the country's proven oil and natural gas reserves are projected to be depleted in 19 and 33 years respectively if no alternatives measures are found to sustain the reserves (Malaysia Report 2008). Under 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). Under the 9th Malaysia Plan, the development of the energy sector will focus on diversification of fuel sources through greater utilization of renewable energy with emphasis on reducing the dependency on petroleum products (www.epu.gov.my).

Hence, it is no doubt that energy infrastructure growth has been regarded as indispensable to economic development, and is now the driver and stimulus for greater growth and industrialisation in Malaysia. Malaysia's power sector is characterized by strong growth, stable prices and abundance of natural gas resources (Malaysia Report, 2008). The Malaysian economy is expected to grow by 7.5% in the period of 2001-2010, though the GDP actually grew at a steady rate of 4.2% in 2003 (Malaysia Report, 2008). For instance, the electricity sector is undergoing substantial change, from a monopolistic, vertically-integrated industry managed by government utilities, to a sector comprising of government owned utilities as well as private sector players (Malaysia Energy Balance, 1996).

As a developing Asian Nation, Malaysia has a very interesting energy profile, both in the past and for the future. Malaysia is one of the few net exporters of energy in the Asia Pacific region. In the late 1990s, the country exported as much oil and gas as it consumed, and in recent years, oil and gas exports amounted to roughly three-fourths of domestic consumption. Availability of energy resources places Malaysia in a uniquely secure energy position relative to other countries in the region. The government has leveraged these assets to provide stability to domestic electricity markets. The gas sector was developed in tandem with the country's gas generation capacities under a "four fuel" strategy aimed at reducing the country's dependence on oil. Although the four fuel strategy required the development of gas, coal as well as hydro capacity, the clear preference was gas. TNB, which owns 62% of Malaysia's capacity, generates more output with gas (56% of total) than with coal, hydro and fuel oil combined. The country's remaining capacity comprises mainly gas-fired facilities operated by licensed IPPs.

In this context, this paper attempts to explore the possible impacts of energy consumption on employment, and economic growth rate and the effects of oil price changes on energy consumption, employment and economic growth in Malaysia. The aim of the study relates to addressing the puzzle of the increasing levels of energy consumption to induce economic growth in the event of the increasing cost associated with it as well as the apprehensions regarding its sustained supply in future. Therefore, the study undertakes an empirical analysis, towards verifying the relationship between these variables and suggesting policies that could strike a balance between consumption and conservation of energy in sustaining and speeding up the growth momentum of the economy. Even though that correlation may be present, it does not necessarily imply a causal relationship in either direction. Causality tests can provide useful information on whether knowledge of past energy consumption movements improves forecasts of movements in economic growth and vice versa.

In order to accomplish the empirical analysis, it will apply the VECM causality test to examine the short run causal relationship between oil prices, economic growth, employment and energy consumption. Also, we use Johansen & Juselius co-integration test procedures to analyse whether long run relationship between the variables on Malaysia economy exists, by using time series data (1980 – 2005).

The rest of the paper is structured as follows. Section 2 presents the background of the study. Section 3 presents the problem and objectives. Section 4 presents literature review. Section 5 presents data and research methodology. Section 6 describes the results analysis. Section 7 discusses the Policy Implications and finally Section 8 includes some conclusion and further studies recommendations.

2. Background of Study:

Malaysia's energy consumption per unit of Gross Domestic Product (GDP) is high in comparison to most developed and several advanced developing countries. The industry sector contributes about a third of the overall GDP, with a registered growth rate of 13% in 1970 to 27% in 1990. In 1995, the industrial sector accounted for 33.1% of the GDP and it was expected to grow to 37.5% by 2000 (www.epu.gov.my). Industrialization over the last two decades has reduced the share of agriculture in GDP to only 8%, leaving the service and industrial sectors to account for 44% and

48% of GDP respectively. The substantial size of Malaysia's industrial base, plus higher energy intensities of industrial activities has made the industrial sector the traditional engine of growth behind the power sector (Malaysia Report, 2008).

As a developing Asian Nation, Malaysia has a very interesting energy profile, both in the past and for the future. Malaysia is one of the few net exporters of energy in the Asia Pacific region. In the late 1990s, the country exported as much oil and gas as it consumed, and in recent years, oil and gas exports amounted to roughly three-fourths of domestic consumption (Malaysia Report, 2008). Availability of energy resources places Malaysia in a uniquely secure energy position relative to other countries in the region. In 2000, the total primary energy supply was 49.47 mtoe (million tons of oil equivalents). The fuel mix consisted of 71.4% petroleum, 11.6% hydroelectric power, 8.8% natural gas, 7.6% coal and 0.5% biomass (Malaysia Energy Balance, 2005). The greatest fuel mix is petroleum products. Energy is consumed mainly in the transportation and industrial sector, at 41.8% and 37.7% respectively, followed by commercial and residential sectors combined at 13.4% and the agriculture sector, which consumes 0.39% of the energy (Malaysia Energy Balance, 2005).

History has shown that the oil crisis in the 1970s, high oil prices, severely affect economies in both the developed and developing countries. This research attempts to briefly study the impact of spike in oil prices on energy consumption and macroeconomic performance of Malaysia as well as to assess the short run and long run relationship between these variables. However, the impact of high oil prices on Malaysia's economic performance would depend on the exposure of the Malaysian economy to oil, particularly in terms of domestic consumption even on energy consumption and the extent of the spillover effect of the increase in costs on other products and services. At the first glance 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. This is done through pump priming whereby revenue from higher oil prices can be channeled back in to the domestic economy through Government expenditure. Higher energy prices caused by the rapid increase in oil prices would transmit into the economy by reducing the real income of households and prompting them to reduce consumption including the energy consumption. This happens due to the real balance effect that states the inverse relationship between price level and quantity demanded of Real GDP established through the changes in the value of monetary wealth (McConnell & Brue, 2008). As the price level in the economy increases, the purchasing power, and monetary wealth of households and businesses declines, thus resulting in a decline in quantity demanded of goods and services in the economy. Furthermore, high oil prices would then spread throughout the economy, driving up production and distribution costs on a wide variety of goods that will induce firms to reduce output (McConnell & Brue, 2008). in turn will affect to the number of labour employed in the economy. The increase in production and distribution costs would be caused by factors such as the rise in expected price level, workers demanding higher wages (wage push). and increases in non-labour inputs such as raw materials in which will put pressure on the labour market (Frederic, 2007). Holding everything else constant, a decline in Real GDP due to rising oil prices would result in a decline of Malaysia's tax base and if tax rates are held constant, tax revenues will fall. Moreover, should oil prices continue to increase, the amount of government subsidies on fuel and other essential items would also increase. Thus, the Government's expenditure will rise and tax revenues would fall resulting in an increase in the country's fiscal deficit.

It can be seen that the expanding Asian economy contributed greatly to the push towards more energy use. In the 1990's, the oil production and consumption increased tremendously in line with the increase of hydroelectric and coal to produce electricity for the nation (see Chart 1). In fact the trends in energy use of Malaysia resemble the trends found in many developing countries. The total primary energy supply had increased from 5-10 mtoe during the period of 1970-1985. In 1985 the incorporation of natural gas into the fuel mix increased the energy supply to well over 30 mtoe by 1995 (Malaysia Energy Balance, 2005). Successful fuel rebalancing significantly decreased Malaysia's oil consumption while lifting its gas consumption. Oil was reduced from 87% to 43% of the country's total primary energy supply (TPES) between 1980 and 2002, while gas was expanded from 8% to 48% of TPES in the same period (Malaysia Report, 2008). The dramatic shift reduced Malaysia's exposure to oil prices, and provided the foundations for a stable power sector. Although Malaysia has an abundance of natural gas located in reserves throughout its 13 states and secure energy position relative to other countries in the region, the government's current policies have given emphasis to diversify the fuel mix in the country energy profile especially for energy security reasons. Despite not having the need to import oil currently, it seems that the oil reserves of Malaysia are far less abundant and declining (Malaysia Report, 2008). The government has also emphasized renewable energy in recent energy policies, adopting non-hydro renewables as the fifth fuel source in a new "five fuel" energy strategy. Although this indicates a policy commitment to renewables, the medium term focus will likely remain the expansion of coal output in the country's generation mix (Malaysia Report, 2008). Though this indicates a policy commitment to renewable sources, the medium term focus will likely remain the expansion of coal output in the country's generation mix. Industry accounts for (51%) of total electricity sold in Malaysia, with the remainder divided among commercial (29%). residential (19%) and other sectors (Malaysia Energy Balance, 2005).

Figure 1 shows the predicted development in relative energy demands by sectors. For example, the demand of the manufacturing and the service/commercial sector was predicted to increase from 31.3% to 39.5% and from 7.8% to 8.3% of final demand in 2020 respectively (Malaysia Energy Balance, 2005) while most of other sectors' share of total final energy demand would decline. This includes the largest single sector, namely transportation share of which was projected to drop from 44.5% in 2003 to 42.1% in 2020. Although transportation is the main energy consumer, its relative share in energy consumptions would decrease. The changes in the sectors' relative shares of final energy demand are mainly caused by the high growth rates for manufacturing sector. Energy intensity improvements are assumed to be very moderate and do not significantly impact the development. In the applied model, the residential demand is mainly determined by the growth in number of households and partly by income growth. This implies moderate demand growth for this sector.

By most estimates, Malaysia is growing 8.1 % annually and will continue at this rate for many years. Particularly, urbanization rates are rising; therefore, total primary energy demand is set to increase by nearly 7% annually (Malaysia Report, 2008). The Malaysian aim is to provide for its citizen's energy demands and for this, 18.5 billion dollars will be required over the period of 10-15 years: 60% allotted to energy generation and the remainder is for transmission and distribution of energy (Malaysia Report, 2008). Such massive economic growth and increasing infrastructure and demand will likely send the total energy use to well over 100 Mtoe in the year 2020. The urban growth rates indicate that industrial sector of the economy would continue to require huge portions of the total amount of energy used in the country (Malaysia Energy Balance, 2005). Also, Malaysia had set goals and standards for the country's future as a whole, to become a completely developed and united country by the year 2020 (Eight Malaysia Plan). Due to an increase in economic development, Malaysia intends on raising the living standard of rural and urban communities' as a well as work towards alleviating poverty, ultimately leading to an adequate and secure energy consumption in the country.

3. The Problem and Objectives:

Recently, literature concerning the relationship between energy consumption and economic growth has gained renewed interest. Energy economics literature has made significant theoretical contributions on the causal effects of energy price fluctuations on economic growth but it lacks linkages between energy consumption and economic growth. At a disaggregated level, electricity consumption is also of special interest. Generally, papers examining the relationship between energy use and economic growth have largely followed a two-step time series procedure (Johansen and Juselius, 2000). Step one is to test the existence of a long-run relationship of the time series, by investigating whether the data series are co-integrated. Step two hinges on the first results. If step one reveals a long-running relationship, then causality (lead–lag). can be tested to examine whether energy use is a leading factor for economic growth, or results from economic growth. If no long-run relationship is revealed, the investigation ends because the two time series are generated independently. When investigating the relationship between energy use and economic growth, the Engle and Granger test (1987). has been a common tool for testing co-integration.

Generally, there are two strands identified in the literature analysing the relationship between energy consumption and economic growth. The first strand includes the proponents of energy consumption as a primary means to achieve economic growth. Energy is expected to play a primary role in achieving economic, social and technological progress and to complement labour and capital in production (Ebohon, 1996). The second strand describes the role of energy as minimal or neutral and is commonly referred to as "neutrality hypothesis" (Yu and Choi, 1985). This hypothesis stems from the fact that energy consumption should not affect economic growth because it represents small proportion of country's gross domestic product. Hence, based on these strands this paper aims to break the silence in the empirical literature pertaining to the relationship between energy consumption, oil price and macroeconomic performance in the Malaysian context. In fact, there have been no individual causality studies on the impact of world oil price changes on energy consumption and macroeconomic performance in Malaysia. There was one study by Ahmad et al (2008). however, it only focused on the impact of oil price shocks on macroeconomic performance especially the impacts to consumer price index (CPI) and producer price index (PPI) and no study was done on the impact on energy consumption. On the other hand, Maamor et al (2005) had focused on the relationship between energy consumption, economic growth and employment, but did not include the oil price as additional channel of causality.

Based on these reasons, this paper attempts to extend the previous research and add world oil prices (as energy price proxy) as the third variables to allow for additional channel of causality and to help investigate whether world oil prices have a significant impact on energy consumption or even a direct effect on employment and GDP growth. In the second model however, we exclude the world oil price variable, as we intend to look at causality relationship between energy consumption, economic growth and employment and whether there is any significance difference or impacts to the whole model after we dropped the oil price variable. We added the employment variables in the both models since in the pretesting of the OLS, the employment variable has improved the number of significant variables in the models. Furthermore, based on the previous studied done in Malaysia, most of the researcher will include the employment variables as one of the channel causality in the study of energy consumption and economic growth. This would imply that there is an indirect effect between energy consumption and economic growth, since it needs other channel to give favorable significant impacts. For instance, Maamor et al. (2005) had included the employment variable in her studied on the relationship between energy consumption and economic growth for Malaysia during the period of 1975-2000. Otherwise, the real GDP growth will not have significant impact on the energy consumption.

The research aim is to study the relationship between energy consumption, employment and economic growth to the Malaysia economy for the period of (1980-2005). Specific objectives of this research are:

(1) To study whether world oil price changes would affect energy consumption, employment and economic growth, in short run and long run.

(2) To find whether there is economic impact of energy consumption on the employment and economic growth in long run.

(3) To explore the possible existence of long run relationship and short run causality effects between energy consumption, economic growth, oil price and employment, in order to determine policy implications, whether the existing energy and macroeconomic policies give impacts to the economic growth.

The related questions that need to be addressed are:

(1) Does the change of world oil prices affect energy consumption, employment and economic growth in long run and short run?

(2) Can the economic impact of energy consumption help to increase the employment and economic growth in long run?

(3) Are there any long run relationship and short run causality effects running between energy consumption, economic growth, oil price and employment and whether the existing energy and macroeconomic policies give impacts to the economic growth?

4. Literature Review:

Nowadays, the importance of crude oil as the main source of energy has waned somewhat, due to the appearance of alternative forms of energy (such as wind, water, biomass and solar power etc). Nonetheless, the importance of oil exceeds economic aspects and affects social life in general. Thus, the prevailing view among economists is that there is a strong relationship between the growth rate of a country and oil-price changes. Precisely, what form this relationship takes, and how it might be modified, and other such questions are issues of outstanding value. As such, the relationship between the macroeconomic variables and the oil-price shocks has been extensively analyzed in the literature. 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). Also, other studies for other countries found that strong correlation or co-integration relationship between world oil prices and macroeconomic variables exist in the long run (see e.g., Boukez 2007; Hamilton 2003; Jones et al 2004; Rodrigues and Sanchez 2004; Davis et al 2005; and Eng & Keong 2004). This relationship seems weaker, however, when data from 1985 onwards is included. Nevertheless, the role of the break-date, 1985-1986, has been considered by only very few researchers, where most of them argued that the instability observed in the relationship may well be due to a misspecification of the functional form employed. The linear specification might as well misrepresent the relationship between GDP growth and oil prices.

This misrepresentation of the linear specification has led to different attempts to redefine the measure of the oil-price changes. These attempts were based on non-linear transformations of the oil prices, in an effort to reestablish the correlation between GDP growth and oil prices. In fact, they were, actually, attempts to restore the Granger-causality between oil prices and GDP, which disappeared when data from 1985 onwards (i.e., periods of oil-price declines) were included. On the other hand, Mork (1989) found 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.

The search for the routes by which oil price shocks work their way through the economy has had some important recent additions (although some studies have been available in preliminary versions for five years or longer). Two of these are primarily theoretical analyses (Rotemberg and Woodford, 1996; Finn, 2000) relying on aggregate models of the economy and connected with data by simulations. The others are empirical, two of which use highly disaggregated data on manufacturing plants (Davis and Haltiwanger, 2001) and individual workers (Keane and Prasad, 1996). These two disaggregated empirical studies shed light on the sectoral shocks transmission mechanism, formulated theoretically by Lilien (1982) and Hamilton (1988) and explored empirically by Loungani (1986). The other empirical studies examine supply-side and demand side routes of impact (Lee and Ni, 2002) interest rate routes (Balke and et al, 2002) and interactions in the markets for refined petroleum products (Huntington, 1998). 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. An oil shock in a price stable environment is more likely to have greater effects on GDP than one in a price volatile environment. These authors thus proposed a measure that takes the volatility of oil prices into account. They found asymmetry in the effects of positive and negative oil-price shocks, but they also managed to re-establish the above-mentioned negative correlation. In the same way, Hamilton (1996) claimed that it seems more appropriate to compare the prevailing price of oil with what it was during the previous year, rather than during the previous quarter. He therefore proposes defining a new measure, the NOPI (Note 1) which also restores the negative correlation between GDP and oil-price increases

In terms of relationship between energy consumption and economic growth there is now well established in the literature, yet the direction of causation of this relationship remains controversial that is, whether economic growth leads to energy consumption or that energy consumption is the engine of economic growth. The direction of causality has significant policy implications. If, for example, there is unidirectional causality running from economic growth or employment to energy consumption, it may imply that energy policies may be implemented with little adverse or no effects on employment and economic growth. On the other hand, if unidirectional causality runs from energy consumption to income or employment, reducing energy consumption could lead to income cut and reduced employment opportunities or vice versa. If there is ‘no causality’ in either direction, the co-called ‘neutrality hypothesis’ would imply that energy policies do not effect economic growth and employment (Asafu-Adjaye, 2000).

Yang (2000) found bidirectional causality between aggregate energy consumption and GDP in Taiwan. However, he observed different directions of causality when energy consumption was disaggregated into different kinds, including coal, oil, natural gas and electricity. His results implied the importance of analyzing the relationship between different sources of energy consumption and GDP. Empirically, the direction of causality between energy consumption and economic activities for the developing as well as for the developed countries had been searched by employing the Granger or Sims techniques. Abosedra and Baghestani (1989) argued that the direct Granger test should be used to determine the direction of this causality. Also, they concluded that for all sample periods tested (1947–1972, 1947–1974, 1947–1979, and 1947–1987); there was a unidirectional causality between GNP and economic growth. The absence of any causality in the United States was also revealed by Erol and Yu (1987) as a part of a larger study including other countries.

Ebohon (1996) found a simultaneous causal relationship between energy consumption and economic growth for Tanzania and Nigeria. Kraft and Kraft (1978) supported the unidirectional causality from GNP growth to energy consumption for the United States of America for the period of 1947-1974. Erol and Yu (1987) tested data for six industrialized countries, and found no significant causal relationship between energy consumption and GDP growth and, energy and employment. Yu et al. (1988) found no relationship between energy and GNP. Yu and Chai (1985) also found causality from energy to GDP in the Philippines, but this causality is reversed in the case of the Republic of Korea. A bi-directional causality between growth of energy consumption and GNP growth was observed in Taiwan Province of China (Hwang and Gum, 1991) while Cheng and Lai (1997) found causality from economic growth to energy consumption and from energy consumption to employment without feedback in Taiwan Province of China. The interest of studying the relationship between energy consumption and economic growth arises from the need to understand the complex links between the two variables. Such understanding is basic to regulators and investors in deregulated electricity markets, in order to design a system that ensures reliability and efficiency.

Generally, we can classify these studies to date into four groups. First, a large number of studies found unidirectional causality running from energy consumption to GDP (see e.g., Altinay and Karagol 2005; Lee and Chang 2005; Shiu and Lam 2004; and Soytas and Sari 2003). Second group of studies found unidirectional causality running from economic growth to electricity consumption (see e.g., Ghosh 2002; Fatai et al. 2004; Hatemi and Irandoust 2005). A third group comprises of studies that found bi-directional causality (see e.g., Soytas and Sari 2003; Oh and Lee 2004; and Yoo 2005). The last group comprises of studies that found no causal linkages between energy, or even electricity, consumption and economic growth (see e.g., Yu, et.al 1988; Cheng 1995; and Stern 1993). However, most of these studies had focused primarily on developing economies. The unidirectional causality between energy consumption and economic growth seems to be more consistent for these countries. So, the conclusion is that a reliable increasing energy supply is required to meet growing energy consumption, and as a result to sustain paths of economic growth. Therefore, a further implication is that energy conservation policies may come into conflict with economic growth.

In the relationship between employment and economic growth, several authors have estimated employment elasticities (a measure of the relationship between employment and economic growth) by using incorporated bivariate models for a variety of nations. Boltho and Glyn (1995) found elasticities of employment with respect to output growth in the order of 0.5 to 0.6 for a set of OECD countries. An International Labour Organization Report (1996) concluded that the responsiveness of employment growth to GDP growth has not declined in industrialized countries as a whole. However, a country-by-country analysis revealed mixed results with little relationship found in Germany, Italy and the UK in the 1990s, thus implying a jobless recovery. Padalino and Vivarelli (1997) found significant differences in employment elasticities between different countries, with an elasticity of approximately 0.5 for the United States and Canada while elasticities for Japan, France, Germany, Italy and the UK were close to zero. Pini (1997) estimated that the employment elasticities in Germany and Japan rose between the periods (1979-1995) compared to (1960-1979) while it declined in France and Sweden and showed little change in Italy, UK and US. He also detected negative employment elasticities in Italy and Sweden for the period 1990-1995.

The majority of studies mentioned above incorporated bivariate models which contain energy and economic growth or employment and economic growth for testing the co-integrating relationships and use error correction models to test for granger causality. Other studies also used bivariate models (see e.g., Nachane et al 1988; Glasure and Lee 1988; Cheng and Lai 1997). Aside from the bivariate models there were a few studies that utilized multivariate models that allow for more than two variables in the co-integrating relationships (see e.g., Oh and Lee 2004; Lee 005; Mehrara 2007; Chen et al. 2007; Mahadevan and Asafu-Adjaye 2007). The most common variables used were total primary energy consumption and real GDP, but many studies also looked at specific sectors and energy forms (e.g. industrial, residential and transportation sector or coal, oil, gas and electricity consumption). Only a few studies included energy prices (including oil prices) as a third variable, but most of them used the consumer price index as a proxy (see e.g., Masih and Masih 1996; Asafu-Adjaye 2000; and Asafu-Adjaye 2007).

Due to these reasons, we will use multivariate co-integrations and divide our model into two; for the first model we add oil prices (as 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. In the second model we exclude the oil price variable, as we intend to look at the causality relationship between energy consumption, economic growth and employment.

5. Data and Research Methodology

5.1 Data:

This study uses annual data to examine the causal relationship between oil prices, employment, economic growth and energy consumption for Malaysia. Yearly data on energy consumption from 1980 to 2005 were collected from the Energy Information Administration (EIA) online database (www.eia.doe.com). Total energy consumption was measured in British thermal unit (Btu). The real GDP was measured in constant price (2000 as a base year) denominated in US Dollars and was taken from International Financial Statistics (IFS). Employment of millions of people and average world oil prices dominated in US Dollars in constant price (2000 as base year) were taken from Economic Planning Unit Malaysia (www.epugov.my). Logarithm transformations of energy consumption (LENG), the employment (LEMP), economic growth (LGDP) and average world oil price (LOILP) were all taken before the analysis.

5.2 Methodology:

The time series econometric procedures were used in order to examine the relationship between growth of energy consumed, growth rate of the economy, employment and oil price i.e. whether oil price will affect energy consumption, employment and economic growth and whether energy consumption fuels economic growth or is it the growth rate of income measured by GDP at factor cost which drives the demand for more energy consumption in the economy. There are four steps involved in estimating the relationship between oil price, energy consumption, employment and economic growth. The first step is to test the stationarity of the series or their order of integration, as the series need to be integrated in the same order as shown by the Equation (1). The second step is to examine the presence of a long run relationship among all variables in the equation. However, the long run coefficients are estimated using the associated co-integration model, which is shown in Equations (2) and (3) proposed by the Johansen et al. Once the co-integration is confirmed in the model, the residuals from the equilibrium regression can be used to estimate the error-correction model in the third step. Lastly, several of diagnostic tests – which are tests of normality, autocorrelation, heteroscedasticity in the error term and the stability of model (Figure 2 and 3) have been conducted to examine the validity and reliability of these models. The results of diagnostic tests are summarized in Table 2.

5.2.1 Unit Root Test:

To analyse the long run relationship between a set of variables, Johansen and Julieus (2000) procedure suggested the use of co-integration test which require stationary pre-testing. The precondition for the co-integration of time series is for the series to be integrated in the same order. In other words, if two series are co-integrated in order d (i.e. $I(d)$) then each series has to be differenced d times to restore stationarity. For d=0, each series would be stationary in levels, while for d=1, first differencing is needed to obtain stationarity. A series is said to be non-stationary if it has non-constant mean, variance, and auto-covariance over time (Johansen and Juselius, 2000). It is important to cover non-stationary variables into stationary process. Otherwise, they do not drift toward along term equilibrium. There are two approaches to test the stationarity: Augmented Dickey and Fuller (ADF) test (1979). and the Phillips-Perron (P-P) test (1988). Here, test is referred to as unit-root tests as they test for the presence of unit roots in the series. These tests correct any serial correlation that might exist in the series by including lagged changes of the residual in the regression. This study first ascertains the time series properties, i.e. GDP growth rate by employing the ADF test for stationarity. The equation estimated for the ADF test is as follows:

$$\Delta Y_t = \beta_1 + \beta_2 t + \alpha Y_{t-1} + \delta_3 \Sigma \Delta Y_{t-1} + \varepsilon_t \quad (1)$$

Where ε_t is an error term, β_1 is a drift term and $\beta_2 t$ is the time trend and Δ is the differencing operator. Thus if Y_t follows Equation (1), and ΔY_t follows a random walk, so $\Delta Y_t - \Delta Y_{t-1}$ is stationary. On the other hand, α and δ are coefficient of one period lagged value Y_{t-1} and ΔY_{t-1}, respectively; where $\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2})$. $\Delta Y_{t-2} = (Y_{t-2} - Y_{t-3})$. The number of lagged difference terms to include is often determined empirically, the idea being to include enough terms so that the error term in Equation (1) is serially uncorrelated (Gujarati, 2003). Engle and Yoo (1987) suggested the use of the Schwarz Information Criterion (SIC) in order to select an optimum number of lags. In ADF test, it tests whether $\alpha = 0$, therefore the null and alternative hypothesis of unit root tests can be written as follows:

Ho: $\alpha = 0$ (Y_t is non-stationary or there is a unit root).

H_1: $\alpha < 0$ (Y_t is stationary or there is no unit root).

The null hypothesis can be rejected if the calculated t value (ADF statistics) lies to the left of the relevant critical value. The alternate hypothesis is that α is less than zero ($\alpha < 0$). This means that the variable to be estimated is stationary. Conversely, we cannot reject the null hypothesis if null hypothesis is that $\alpha = 0$, and this means that the variables are non-stationary time series and have unit roots in level. However, normally after taking first differences, the variable will be stationary (Johansen and Juselius, 2000). The underlying critical values were provided in MacKinnon (1991). On the other hand, the specification of P-P test is the same as ADF test, except that the P-P test uses nonparametric statistical method to take care of the serial correlation in the error terms without adding lagged differences (Gujarati, 2003). In this research we will use both of ADF and P-P test to examine the stationary of the target series.

5.2.2 Co-integration Test

The co-integration procedure requires time series system to be non-stationary in their levels. If a non-stationary series has to be differenced *d* times to become stationary, then it is said to be integrated of order *d*: i.e. I (*d*), (Engle and Granger, 1987). When both series are integrated in the same order, we can proceed to examine the presence of co-integration.

For this analysis, empirical studies had been employed such as the Engle and Granger (1987), Johansen (1988) and Johansen and Juselius (1990) method. The Johansen and Juselius test, applies the maximum likehood procedures of the VAR model to determine the number of co-integrating vector. According to this technique, if two variables are co-integrated, the finding of no causality in either direction - one of the possibilities with the standard Granger (1969) and Sims (1972) tests - is ruled out. As long as the two variables have a common trend or co-integrated, causality must exist in at least one direction either unidirectional or bidirectional causality (Granger, 1986 and1988). However, although co-integration indicates the presence or absence of Granger-causality, it does not indicate the direction of causality between variables. This direction of the Granger (or temporal) causality can be detected through the vector error correction model (VECM) derived from the long-run co-integrating vectors. Hence in this study we used two test statistics of co-integration which are the Trace test statistics and Max Eigen value statistics, in order to determine the number *r*, co-integrating vector. Furthermore, we employed the concept of co-integration to investigate the long run equilibrium between the variables in the multivariate Models. The analysis will base on the following equations:

$$\Delta \ \ln Y_t = \alpha_0 + \Sigma \beta_i \Delta \ln Y_t + \Sigma \chi_j \Delta \ln X_t + \varepsilon_t \quad (2)$$

$$\Delta \ \ln X_t = \gamma_0 + \Sigma \sigma_i \Delta \ln X_t + \Sigma \tau_j \Delta \ln Y_t + \varepsilon_t \quad (3)$$

Where (Y_t, X_t) are real income and energy consumption respectively; Δ is a difference operator, ε_t is a random error term with mean zero, α_0 and γ_0 are drift terms, β_i, χ_j, σ_i and τ_j are the coefficient estimates for independent variables. To perform the co-integration test, we have created the null hypothesis as there is no co-integration (r = 0) among variables. If Trace statistics or Max Eigen values exceed the critical value, we will reject the null hypothesis of no co-integration, which means that coefficients values of independent variables are not equal to zero. This would mean that, co-integration exists between two variables (Y_t, X_t). Therefore, the null and alternative hypothesis of unit root tests can be written as follows:

H_0: ($r = 0$, or no co-integration exists between Y_t, and X_t).

H_1: ($r \neq 0$, or co-integration exists between Y_t, and X_t).

The result of the co-integration test will be sensitive to the lag chosen. For this co-integration test, we used the Johansen and Juselius (2000) co-integration test and determined the proper lag profile on the basis of the SIC procedure. If the variables are co-integrated, then it implies that causality among the variables must exist, at least in one direction.

5.2.3 Vector Error-Correction Modeling (VECM)

If the series are co-integrated, Granger representation theorem states that an error correction model (ECM) describes the dynamic relationship. The VECM is a restricted VAR designed for use with non-stationary series that are known to be co-integrated. The VECM has co-integration relations built into the specification so that it restricts the long-run behavior of the endogenous variables to converge to their co-integrating relationships while allowing for short-run adjustment dynamics. The co-integration term is known as the error correction term since the deviation from long-run equilibrium is corrected gradually through a series of partial short-run adjustments. The advantage of ECM framework lies in its strength of capturing both the short run dynamics and long run equilibrium relation between two series. Durr (1993) observed that the error correction model are appropriate when the dependent variable is known to exhibit short run changes in response to changes in the independent variables.

Engle and Granger (1987) demonstrated that once a number of variables (say, X_t and Y_t) are found to be co-integrated, there always exists a corresponding error-correction representation which implies that changes in the dependent variable are a function of the level of disequilibrium in the co-integrating relationship (captured by the error-correction term) as well as changes in other explanatory variable(s). The short-term variation can be predicted by using ECM. Masih and Masih (1996), for instance, proposed the ECM, which can be explained by the following equation:

$$\Delta Y_t = \alpha_0 + \Sigma\beta_i\Delta X_{t-1} + \Sigma \chi_j \Delta Y_{t-1} + \gamma_i ECT_{t-1} + \varepsilon_t \tag{4}$$

$$\Delta X_t = \alpha_0 + \Sigma\beta_i \Delta Y_{t-1} + \Sigma \chi_j \Delta X_{t-1} + \gamma_i ECT_{t-1} + \varepsilon_t \tag{5}$$

$$ECT = Y_t - \delta X_t \tag{6}$$

where (Y_t, X_t) are real income and energy consumption respectively, Δ is a difference operator, ε_t is a random error term with mean of zero, α_0, β_i and χ_j are the coefficient estimates for independent variables, which need to be derived through a VAR regression, δ is the co-integrating factor, which can be derived through OLS in a first stage and γ_i is the coefficient estimates for error correction term (ECT_{t-1}). ECT stands for error correction term, which can also be interpreted as the speed of adjustment (Soytas and Sari, 2003; and Masih and Masih, 1996). It is then possible to verify the causality between the studied variables. In our case, for instance, Equation (4) will be used to test causation from energy consumption (X_t) to real income (Y_t), and Equation (5) will be used to test causality from income (Y_t) to energy consumption (X_t). The causality test is examined by conducting a *Wald* Test that is by calculating the joint *F* statistics of the dynamic terms based on the null hypothesis where asset of coefficients on the lagged values of independent variables is equal to zero. Therefore, the null hypothesis and alternative hypothesis in the VECM causality test can be written as follow:

H_0: Coefficient of β_i and χ_j is equal to 0.

H_1: At least one of the coefficients of β_i and χ_j , is not equal to 0.

We will conclude that the independent variables do not cause dependent variables if the null hypothesis cannot be rejected. A consequence of relationships described by Equation (4) to (5) is that either ΔX_t, ΔY_t or a combination of both must be caused by ECT_{t-1} which is itself a function of X_{t-1}, Y_{t-1}. Intuitively, if (X_t, Y_t) share a common trend, then the current change in X_t (say, the dependent variable) is partly the result of X_t moving into alignment with the trend value of Y_t (say, the independent variable). The Granger-causality (or endogeneity of the dependent variable) can be exposed either through the statistical significance of:

(i) the lagged ECTs by a t-test;

(ii) a joint test applied to the significance of the sum of the lags of each explanatory variables in turn, by a joint F or Wald Chi Square test;

(iii) a joint test of all the set of terms just described in (i) and (ii) by a joint F or Wald Chi-Square test, i.e. taking each of the parenthesized terms separately.

Thus, the non-significance of both the t and F or Wald Chi-Square tests in the VECM indicates econometric exogeneity of the dependent variables (Engle and Granger, 1987). In addition to indicating the direction of causality among variables, the VECM approach allows us to distinguish between 'short-run' and 'long-run' Granger causality. When the variables are co-integrated, in the short-term, deviations from this long-run equilibrium will feed back on the changes in the dependent variable in order to force the movement towards the long-run equilibrium. If the dependent variable (say, the change in the energy consumption) is driven directly by this long-run equilibrium error, then it is responding to this feedback. Otherwise, it is responding only to short-term shocks to the stochastic environment. The F-tests of the 'differenced' explanatory variables give us an indication of the 'short-term' causal effects, whereas the 'long-run' causal relationship is implied through the significance. Otherwise, the 't' test(s) of the lagged error-correction term(s) (ECT) is derived from the long-run co-integrating relationship(s).

According to the empirical literatures analyzing causality between energy consumption and economic growth, when causality flows from energy to income (unidirectional). the economy is dependent on energy and economic growth can be adversely affected by the energy saving policies which means a reduction in energy consumption. Boehm (2007) found that in 8 out of 23 of the European Countries the causalities are running from energy consumption to economic growth which means that energy saving policies could harm the economic growth to this related countries. However, when causality flows from income to energy, the economy is relatively less dependent on energy and environmental policies would have little or no impact on economic growth. In other words, energy conservation policies might be initiated without any negative effect on economic growth (Boehm, 2007). Bidirectional causality, on the other hand, suggests that energy and economic growth complement each other (Lee, 2005) and jointly determined and affected at the same time, but efficiency policies have no negative impact in the short run (Boehm 2007).

These theoretical contentions have been generally based on positive causality. However, when causality is negative, the energy dependence interpretation becomes less intuitive and opens to other alternative interpretations (Lee, 2005). In fact, when causality flows negatively from energy to income, increasing energy consumption would lead to lower economic growth. Conversely, when causality flows negatively from income to energy, increased economic growth results reduced energy consumption. The interpretation of such causality is not as clear as several factors may be the culprits in the adverse impact on energy. In fact, oil price factors also may put upward pressure on energy consumption (Squalli, 2007). Thus, to analyse the causality between the studied variables, this research has developed several models, associated by VECM framework which shown in the following models:

Model 1: VECM for Oil Price, Consumption, Real GDP, Employment and Total Energy include the following equations:.

1- Enegy Consumption Equation (ENG)

$$\Delta \ln Eng_t = \sigma_{10} + \Sigma\sigma_{11}\Delta \ln Eng_{t-1} + \Sigma\sigma_{12}\Delta \ln Oilp_{t-1} + \Sigma\sigma_{13}\Delta \ln Emp_{t-1} + \Sigma\sigma_{14}\Delta \ln Gdp_{t-1} + \gamma_{it}ECT_{t-1} + \varepsilon_t$$

Where; $*ECT_{t-1} = \ln Eng_{t-1} - \Phi_0 - \Phi_1 \ln Oilp_{t-1} - \Phi_2 \ln Gdp_{t-1} - \Phi_3 \ln Emp_{t-1}$

2- Economic Growth Equation (GDP)

$$\Delta \ln Gdp_t = \sigma_{20} + \Sigma\sigma_{21}\Delta \ln Gdp_{t-1} + \Sigma\sigma_{22}\Delta \ln Oilp_{t-1} + \Sigma\sigma_{23}\Delta \ln Emp_{t-1} + \Sigma\sigma_{24}\Delta \ln Eng_{t-1} + \gamma_{it}ECT_{t-1} + \varepsilon_t$$

Where; $*ECT_{t-1} = \ln Gdp_{t-1} - \Phi_0 - \Phi_1 \ln Oilp_{t-1} - \Phi_2 \ln Emp_{t-1} - \Phi_3 \ln Eng_{t-1}$

3- Employment Level Equation (EMP)

$$\Delta \ln Emp_t = \sigma_{30} + \Sigma\sigma_{31}\Delta \ln Emp_{t-1} + \Sigma\sigma_{32}\Delta \ln Oilp_{t-1} + \Sigma\sigma_{33}\Delta \ln Gdp_{t-1} + \Sigma\sigma_{34}\Delta \ln Eng_{t-1} + \gamma_{it}ECT_{t-1} + \varepsilon_t$$

Where; $*ECT_{t-1} = \ln Emp_{t-1} - \Phi_0 - \Phi_1 \ln Oilp_{t-1} - \Phi_2 \ln Gdp_{t-1} - \Phi_3 \ln Eng_{t-1}$

4- World Oil Price Equation (WOILP)

$$\Delta \ln Oilp_t = \sigma_{40} + \Sigma\sigma_{41}\Delta \ln Oilp_{t-1} + \Sigma\sigma_{42}\Delta \ln Emp_{t-1} + \Sigma\sigma_{43}\Delta \ln Gdp_{t-1} + \Sigma\sigma_{44}\Delta \ln Eng_{t-1} + \gamma_{it}ECT_{t-1} + \varepsilon_t$$

Where; $*ECT_{t-1} = \ln Oilp_{t-1} - \Phi_0 - \Phi_1 \ln Emp_{t-1} - \Phi_2 \ln Gdp_{t-1} - \Phi_3 \ln Eng_{t-1}$

Model 2: VECM for Total Energy Consumption, real GDP and Employment include the following equations:

1- Enegy Consumption Equation (ENG)

$$\Delta \ln Eng_t = \sigma_{10} + \Sigma\sigma_{11}\Delta \ln Eng_{t-1} + \Sigma\sigma_{12}\Delta \ln Empt_{-1} + \Sigma\sigma_{13}\Delta \ln Gdp_{t-1} + \gamma_{it}ECT_{t-1} + \varepsilon_t$$

Where; $*ECT_{t-1} = \ln Eng_{t-1} - \Phi_0 - \Phi_1 \ln Gdp_{t-1} - \Phi_2 \ln Empt_{-1}$

2- Economic Growth Equation (GDP)

$$\Delta \ln Gdp_t = \sigma_{20} + \Sigma\sigma_{21}\Delta \ln Gdp_{t-1} + \Sigma\sigma_{22}\Delta \ln Emp_{t-1} + \Sigma\sigma_{23}\Delta \ln Eng_{t-1} + \gamma_{it}ECT_{t-1} + \varepsilon_t$$

Where; $*ECT_{t-1} = \ln Gdp_{t-1} - \Phi_0 - \Phi_1 \ln Emp_{t-1} - \Phi_2 \ln Eng_{t-1}$

3- Employment Level Equation (EMP)

$$\Delta \ln Emp_t = \sigma_{30} + \Sigma\sigma_{31}\Delta \ln Emp_{t-1} + \Sigma\sigma_{32}\Delta \ln Gdp_{t-1} + \Sigma\sigma_{33}\Delta \ln Eng_{t-1} + \gamma_{it}ECT_{t-1} + \varepsilon_t$$

Where; $*ECT_{t-1} = \ln Emp_{t-1} - \Phi_0 - \Phi_{11} \ln Gdp_{t-1} - \Phi_2 \ln Eng_{t-1}$

Where σ_{1t}, σ_{2t}, σ_{3t}, and σ_{4t} are parameters to be estimated in the equations, which need to be derived through a VAR regression, Φ is the co-integrating factor, which can be derived through OLS in the first stage and γ_{it} is the coefficient estimates for error correction term (ECT_{t-1}). Δ is a difference operator; ε_t is a random error term with mean of zero. Therefore, the null hypothesis and alternative hypothesis in the above VECM models test can be written as follow:

H_0: σ_{1t}, σ_{2t}, σ_{3t}, and σ_{4t} are equal to 0 (There is no causality).

H_1: At least one of coefficient of σ_{it} is not equal to 0 (There is causality).

If the computed F-statistics is above the critical value, we reject the null hypothesis. This means that the independent variables do not cause dependent variables. Then, it concludes that there is at least one direction or unidirectional of causality effect among the variables. On the other hand, if the calculated F-statistics is lower than critical value, we cannot reject the null hypothesis of no causality among the variables in the short run. In other words, there is no causality found in the model. Meanwhile the value of the residual estimated error correction term (ECT_{t-1}), are estimated in the deviation from long run equilibrium in period (t-1).

Statistically, the equilibrium of ECT is zero, suggesting that (in this case $\Delta LGDP_t$ and $\Delta LENG_t$) $\Delta LGDP_t$ adjusts to changes in $\Delta LENG_t$ in the period (t-1). If the computed value of ECT is nonzero then the model is out of equilibrium. If $\Delta LENG_t$ is zero and ECT_{t-1} is positive, this means that $\Delta LGDP_t$ is too high to be in equilibrium, that is, $\Delta LGDP_t$ is above its equilibrium value. Since the $\gamma_{it}ECT_{t-1}$ (coefficients estimate of ECT_{t-1}) is expected to be negative, as shown by all equations in Model 1 and 2, ΔLGD_t will be negative to restore the equilibrium. That is, if ΔLGD_t is above its equilibrium, it will start falling in the next period to correct the equilibrium error.

Conversely, if the ECT is negative and the $\Delta LGDP_t$ is below its equilibrium value, $\gamma_{it}ECT_{t-1}$ will be positive, which will cause ΔLGP_t to be positive, leading $\Delta LGDP_t$ to rise in period t. Thus, the absolute value of γ_{it} decides how quickly the equilibrium is restored. The coefficient of the lagged error-correction term (ECT_{t-1}), however, is a short-term adjustment coefficient and represents the proportion by which the long-run disequilibrium (or imbalance) in the dependent variable is being corrected in each short period. Non-significance or elimination of any of the 'lagged error-correction terms' affects the implied long-run relationship and may be a violation of theory. The non-significance of any of the 'differenced' variables which reflects only short-run relationship, however, does not involve such violations because theory typically has little to say about short-term relationships (Thomas, 1993).

6. Empirical Results:

We have estimated the relationship between energy consumption, real GDP, employment and world oil prices for Model 1 and Model 2. These estimations are presented step by step as follows:

Unit-Root Tests

This section analyses the time series properties of data during the period of 1980-2005 which were used in the ADF and P-P unit root tests. These unit-root tests were performed on both levels and first differences of ADF and P-P tests for all variables, as can be seen in Table 3.

Table 3 shows that all variables have a unit root in their level for ADF and P-P test, since the *p*-value for all series are not significant. Based on these estimated results, we failed to reject the null hypothesis of unit roots at all level. However, when we performed the unit root test at first difference, I(1), the results of ADF and P-P indicated that all variables are stationary at first difference or I(1) the *P*-value is significant at 1% and 5%. This means that after we have taken the first difference of all variables, we discovered that there is no evidence of the existence of unit roots in ADF and the P-P tests. Interestingly, however, first differencing of all the variables shows stationarity under this test.

6.1 Co-integration Test

The result of the co-integration test for multivariate via the Johansen and Juselius procedure for Model 1 and 2 are provided in Table 4. This table presents the Johansen co-integration test at selected lag levels from the minimum of SIC. We have chosen minimum SIC which is at lag 2 for this multivariate model. The null hypotheses of non co-integration were rejected, suggesting that at least one co-integrating vector existed. Also, the results of maximal eigenvalue for both models are reported in Table 4.

Table 4 shows that the null hypothesis (there is no co-integration, r = 0), is clearly rejected since the trace statistics and maxi eigenvalue exceeds the critical values at 1% and 5% level. Therefore, it can be concluded that there is only one co-integrating relation among the variables in Model 1. This implies that all variables, namely LENG, LGDP, LEPM and LOILP, are co-integrated and follow a common long run path. On the other hand, the results for Model 2 of co-integration implied that the null hypothesis of $r = 0$, $r \leq 1$ and $r \leq 2$ have been rejected since the computed value (*F*-value) of Trace test is more than critical value at 1% and 5% level. Meanwhile for max eigenvalue, it indicates that the null hypothesis of $r = 0$ and $r \leq 2$ have been rejected at 5% level. However, at 1% level, all maxi eigenvalue are not significant. These results of co-integration for Model 2 indicate that there are 3 co-integrating equations of Trace statistics and max eigenvalue indicates 1 co-integrating equations, at 5% level. The results of co-integration in Model 2 indicate that all variables are co-integrated and present a long run relationship. The presence of co-integration among these variables also had been found by other researchers (see e.g., Ghosh 2002; Fatai et al 2004; and Hatemi and Irandoust 2005). Maamor et al. (2005) found that there is presence a co-integration relationship between economic growth, energy consumption and employment in the long run for Malaysia during the period of 1975-2000. Pedroni (2004) also, indicated at least one co-integrating relation for the panel of 19 European countries, which confirmed the presence of long run relationship between the energy consumption, economic growth and energy price. The results for Malaysia indicated that there is existence long run co-integrating relationships among the variables. Based on the Johansen and Juselius Co-integration test, its show that in the Model 1 there is only one co-integrating relationship among the variables and while in Model 2 there are 3 co-integrating relationship. The results for model 1 and 2 are presented below:

First: Long Run Co-integration Consumption Equation:

Model 1

$$LENG_t = 21.4 - 1.18LGDP_{t-1} + 4.92LEMP_{t-1} - 0.0062LOILP_{t-1}$$

SE:	(0.328)	(0.695)	(0.04)
t :	(-3.590)	(7.069)	(-.1522)

Model 2;

$$LENG_t = 21.4 - 0.877LGDP_{t-1} + 4.111LEMP_{t-1}$$

SE:	(0.557)	(1.17)
t :	(-1.57)	(3.494)

Model 1 (Equation 1) shows that the real GDP and level of employment have emerged as significant determinant of energy consumption function, with *t*-value (3.590 and 7.069), but the average world oil price was not significant. However, when we excluded the oil price variables in the second Model we found that the real GDP is no longer give significant impact to the energy consumption. This indicated that oil price variables have improved the number of significant variables in the Model 1. The results would imply that real GDP growth has significant impacts to energy consumption through an oil price channels. However in Model 2, only employment variable was significant (t-value, 3.494). The value of income elasticity of demand for energy is greater than unity (1.18), for model 1. This result is in line with the Goldstein-Khan values [1.0, 2.0] for typical income elasticity (Goldstein and Khan, 1985). The estimated results of coefficients in the model 1 inferred that, there was strong negative relationship between Real GDP and Energy Consumption, with negative sign. Also, other studies support our finding, for instance Selamah et al (2005) found strong long run relationship between Real GDP and energy consumption in Malaysia (see also e.g., Gupta-Kapoor and Ramakrishanan 1999; Stern 2000; Ghosh 2002; Fatai et al 2004; and Hatemi and Irandoust 2005).

Second: Long Run Co-integration GDP Equation:

Model 2;

$$LGDP_t = 18.1 - 1.139LENG_{t-1} + 4.686LEMP_{t-1}$$

SE:	(0.245)	(0.602)
t:	(-4.65)	(7.77)

Model 2 shows that there is positive relationship between employment and economic growth. This result seem support our expected findings which suggested that when employment growth increase there will be increased in economic growth.

Third: Long Run Co-integration EMP Equation:

Model 2

$$LEMP_t = 4.34 +0.243LENG_{t-1} +0.213LGDP_{t-1}$$

SE:	(0.0243)	(0.05)
t:	(5.61)	(4.23)

The employment equation in 2 above shows that there is a significant relationship between EMP, ENG and GDP respectively. These results indicate that there is positive relationship between energy consumption and employment, in the long run. This means that the increased level of energy used could lead to increase of employment growth.

6.2 Vector Error-Correction Models (VECM)

VECM Granger Causality Wald Test Result Interpretation

As mentioned earlier, the F-tests of the 'differenced' explanatory variables gave us an indication of the 'short-term' causal effects, whereas the 'long-run' causal relationship is implied through the significance of the 't' test(s) for the lagged error-correction term(s) (ECT) which contains the long-term information since it is derived from the long-run co-integrating relationship(s). In order to determine the lag length of the VAR model, information theoretic model selection criteria attributed to Schwarz (1978) (Schwarz information criteria) were considered. Based on this procedure, a VAR [12] specification is selected for this analysis.

After experimenting with the general form of the ECM for each equation in both models, we found that at least one of the coefficients estimates was not equal to one. Hence the null hypothesis has been rejected. The estimated Error Correction Models for Short Run Analysis are presented and discussed in the following:

First: Short Run VECM for ENG Equations:

Model 1;

$$\Delta lnEng_t = -0.031 + 1.77\Delta lnGdp_{t-1} - 2.09\Delta lnEmp_{t-1} - 0.061\Delta lnOilp_{t-2} - 0.652ECT_{t-1} + \varepsilon_t$$

SE :	(0.036)	(0.423)	(0.67)	(0.03)	(0.151)
F :	(-0.859)	(4.18)	(-3.123)	(-1.87)	(-4.29)
P-value =	0.27	0.000	0.0002	0.06	0.000

R^2= 0.723 , F-Statistics= 3.77, SSE = 0.016 , ECT_{t-1} = -0.652

Model 2;

$$\Delta lnEng_t = 0.021 + 1.48\Delta lnGdp_{t-1} - 1.98\Delta lnEmp_{t-1} - 0.54ECT_{t-1} + \varepsilon_t$$

SE :	(0.026)	(0.32)	(0.558)	(0.10)
F:	(0.823)	(4.622)	(-3.546)	(-5.247)
P-value =	0.25	0.000	0.0002	0.000

R^2= 0.76, F-Statistics= 6.7, SSE = 0.03, ECT_{t-1}=-0.54

Model 1 shows that the real GDP, level of employment and average world oil price have emerged as significant determinant of energy consumption function. While Model 2 shows that all determinants were also found to be significant, at 1% level. The aggregate energy consumption is found to be oil price and was inelastic demand ($\alpha < 1$).This coefficient estimate is (-0.061) while the value of income elasticity of demand energy is greater than unity (1.77 and 1.48)و for Model 1 and 2, respectively. 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).

The significant value of real income in the energy consumption function would indicate that in the short run there is positive unidirectional causality running from real income to energy consumption. This result was consistent for both models, captured by Wald test where P-value was 0.00 and significant at 1% level. These results inferred that the growth rate of national income would lead to more demand for energy consumption. The income elasticity of energy consumption (Model 1 and 2) values was found to be elastic ($\alpha > 1$), since the coefficient estimates were 1.77 and 1.48 respectively**.** The coefficient estimates of Model 1 (1.77) indicates that, in the short run when national income increases by 100% then the energy consumption would increase by 177%. The positive unidirectional causality running from economic growth to energy consumption seems to be more consistent for developing countries (see, e.g., Ghosh 2002; Fatai et al. 2004; Hatemi and Irandoust 2005; and Jay Squalli 2006).

Moreover, the coefficients of employment for model 1 and 2 were -2.09 and -1.98 respectively, and were the most effective coefficient among all the variables. This means that, if holding other independent variables constant and employment increases by 1%, the energy demand will decrease nearly by 2%. Then, it can be concluded that the energy demand is very sensitive to the level of employment. Also, this means that there is significant negative unidirectional causality running from employment to energy consumption at 1% and 5% level. In other words, the increase of the employment level would lead to the decrease of energy consumption, and vice versa. However, the results indicated that 76% of the energy demands variation was explained by the independent variables. The negative relationship between employment and energy consumption could be explained by the energy saving policy.

The estimated models also indicated that the null hypothesis which is world oil price does not cause to energy consumption, can be rejected with the significance at 10% level. This means that in short run the changes in world oil price would effect the energy consumption. Also, there is a negative unidirectional causality between oil price and energy consumption. However, if the world oil prices increase, the energy consumption will decrease.

The estimated coefficient of the error correction term (ECT_{t-1}) for Model 1 and Model 2 are highly significant at 1% and 5% level. This suggests the validity of a long run equilibrium relationship among the variables. In other words, the energy consumption systems had corrected its previous period's disequilibrium for the long term. However, if the changes of energy consumption were driven directly by this long-run equilibrium error, then it was responding to this feedback by 65.2 % of speed adjustment. In other words, when the variables were found to be co-integrated in this equation, in the short-term, deviations from this long-run equilibrium would feed back on the changes in the dependent variable in order to force the movement towards the long-run equilibrium.

If we compare between the two models above, we would see that in Model 1, which included oil price as the channel of causalities, the speed of adjustment is 65.2% which is higher than the speed adjustment of Model 2 (54%). These results indicated that the system that included oil price variable had corrected its previous disequilibrium by responding to this feedback faster than the second Model. The reasons could be that when there is oil price shocks or crisis in the economy the government will respond and give feedback to this shocks through its various policies, such as price mechanism control, fiscal stabilizing policies, monetary policies and fuel subsidies policies in order to control the drastic effects to the economy, which in turn could help return the economy to the right track.

Second: Short Run VECM for GDP Equation:

Model 1;

$$\Delta lnRealGDP_t = 0.0766_{-1} - 0.126\Delta lnEng_{t-1} - 0.245lnEmp_{t-1} - 0.013\Delta lnOilp_{t-2} - 0.111ECT_{t-1} + \varepsilon_t$$

SE:	0.026)	(0.136)	(0.486)	(0.023)	(0.11)
F :	(2.88)	(-0.93)	(-0.503)	(-0.579)	(1.00)
P-value =	0.001	0.3103	0.3276	0.5902	(0.375)

$R^2 = 0.519$, F-Statistics= 1.56 , SSE = 0.008 , $ECT_{t-1} = -0.111$

Model 2;

$$\Delta lnRealGDP_t = 0.078 – 0.133\Delta lnEng_{t-1} - 0.42\Delta lnEmp_{t-1} - 0.07ECT_{t-1} + \varepsilon_t$$

SE :	(0.022)	(0.137)	(0.473)	(0.008)
F:	(3.53)	(-0.966)	(-0.894)	(-0.817)
P-value =	0.000	0.293	0.274	0.223

$R^2 =$ 0.426 , F-Statistics= 1.59 , SSE = 0.026 , $ECT_{t-1}= -0.07$

The above estimated models show that the relationship between GDP, ENG, EMP, OILP**,** and error correction terms is insignificant, even at 10% significance level. The non-significance of the t, F and Wald Chi-Square tests indicates econometric exogeneity of the dependent variables (Granger, 1986).

Third: Short Run VECM for EMP Equation:

Model 1;

$$\Delta lnEmp_t = 0.045 + 0.349\Delta lnGdp_{t-1} - 0.17\Delta lnEng_{t-1} - 0.004\Delta lnOilp_{t-1} + 0.053ECT_{t-1} + \varepsilon_t$$

SE:	(0.014)	(0.168)	(0.074)	(0.012)	(0.06)
F:	(3.12)	(2.08)	(-2.34)	(-0.34)	(0.879)
P-value =	0.17	0.09	0.058	0.8429	0.206

$R^2= 0.678$, F-Statistics= 0.014 , SSE = 0.0026 , $EC_{t-1} = 0.053$

Model 2;

$$\Delta lnEmp_t = 0.647 + 0.396\Delta lnGdp_{t-1} - 0.175\Delta lnEng_{t-1} - 0.003ECT_{t-1} + \varepsilon_t$$

SE:	(0.297)	(0.142)	(0.07)	(0.04)
F :	(-1.78)	(2.77)	(-2.411)	(-0.08)
P-value =	0.17	0.007	0.05	0.206

$R^2= 0.65$, F-Statistics= 3.93 , SSE = 0.002 , $EC_{t-1} = 0.003$

The EMP equation (model 1 and 2 above) shows that real GDP and energy consumption have emerged as significant determinant of employment function models. There is short run dynamics causality effect between energy consumption and employment level and between real income and employment with statistic significance at 10% and 5%, respectively. However, no adjustment has been made in the long run, since the error correction term was insignificant (P-value = 0.206). The estimated coefficient also indicated that there was negative unidirectional causality running from energy consumption to employment and positive unidirectional causality running from real income to employment, and they were consistent in both models. This means that in short run there is adverse effects between employment and energy consumption, and direct effects between employment and real income. Also, the increase of real income would lead to increase in employment level.

Fourth: Short Run VECM for OILP Equation, Model 1:

$$\Delta lnOilp_t = 0.530 + 1.64\Delta lnGdp_{t-1} - 6.99\Delta lnEmp_{t-1} - 1.14\Delta lnEng_{t-1} - 0.066ECT_{t-1} + \varepsilon_t$$

SE :	(0.297)	(3.42)	(5.44)	(1.52)	(1.231)
F:	(-1.78)	(0.48)	(-1.28)	(0.753)	(0.54)
P-value =	0.17	0.7628	0.4374	0.206	0.345

R^2= 0.419, F-Statistics= 1.04, SSE = 1.07 , ECT_{t-1} = 0.066

The oil price model indicated that in the short run world oil price become an exogenous variable, since all independent variables were not significant, even at 10% significance level. The error correction term (ECT) was also not significant, as showed by P-value (0.345). The non-significance of t, F and Wald Chi-Square tests indicated the presence of econometric exogeneity of the dependent variables (Granger, 1986). These results were quite similar to Glasure's (2002) findings. Thus, the overall VECM causality results can be summarized in Figure 4.

Insert Figure 4 Here

Figure 4 shows that there is short run causality running from ENG to EMP, EMP to ENG, GDP to EMP, GDP to ENG and WOILP to ENG. In other words, the VECM causality test indicated that in the short run there is positive unidirectional causality effects running from real income to energy consumption and real income to employment, however opposite does not hold good in Malaysian context. Beside that, there is negative bidirectional causality effect between energy consumption and employment, and vice versa, which means that the changes of energy consumption and employment would affect each other. In the case of Malaysia, the world oil price becomes an exogenous variable since all independent variables in oil price model are not significant (see Table 6-b).

The error correction term (EC_{t-1}) is only significant in the energy consumption model. So, it can be concluded that in the short-term, for any deviations from long-run equilibrium, the energy consumption will feed back 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. The coefficient estimate of error correction term of -0.652 for the Model 1 (Equation 1) means that when there is an exogenous shock on the model, the system corrects it disequilibrium by 65.2% speed of adjustment per year in order to return to the equilibrium. Also, both models show that the energy consumption has shown negative sign of ECT which is indicating a move back towards equilibrium. On the other hand, if it has a positive sign of error correction term, it indicates that the systems in the model are moving away from equilibrium (Granger, 1978).

7. Policy Implications:

The linkages and causal effects among the oil price, energy consumption and macroeconomic performance have important policy implications on the benefits of energy conservation and regulation of macroeconomic policy. According to the empirical literatures that analyze causality between energy consumption and economic growth, when causality flows from energy to income (unidirectional), the economy is dependent on energy and economic growth can be adversely affected by the energy saving policies which means a reduction in energy consumption (Boehm, 2007). However, when causality flows from income to energy, then the economy is relatively less dependent on energy and environmental policies would have little or no impact on economic growth. In other words, energy conservation policies might be initiated without any negative effect on economic growth (Boehm, 2007). Bidirectional causality, on the other hand, suggests that energy consumption and economic growth complement each other (Lee, 2005) and jointly determined and affected at the same time, but efficiency policies have no negative impact in the short run (Boehm, 2007). These theoretical contentions have generally been based on positive causality. However, when causality is negative, the energy dependence interpretation becomes less intuitive and is open to other alternative interpretations (Lee, 2005). In fact, when causality flows negatively from energy to income, the increase of energy consumption would lead to lower economic growth. Conversely, when causality flows negatively from income to energy, the increase of economic growth would result in reduced energy consumption. The interpretation of such causality is not as clear as several factors may be the culprits in the adverse impact on energy. In fact, oil price factors also may put upward pressure on energy consumption (Squalli, 2007).

The VECM estimated study results inferred that in short run there is positive causality running from economic growth to total energy consumption. This would imply that when national income rises, it directly leads to more consumption demand for energies in Malaysia, which may imply that energy saving policies may be implemented with little adverse or no harm effects on economic growth in the short run. However, in the long run there is negative effect from economic growth to total energy consumption which may imply that energy policy especially would have significant impacts on economic growth in the long run. The findings of this study which is a unidirectional running from GDP to energy consumption have also been supported by the previous research (see Kraft and Kraft, 1978). They found the unidirectional causality from GNP growth to energy consumption for the USA for the period of 1947-1974. However, the Granger causality of VECM analysis suggested 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 to disaggregated energy consumption and from disaggregated energy consumption growth to economic growth (Granger, 1978). Importantly, the estimated results would infer that the presence energy policy has significant impact on economic growth in Malaysia in the long run but not in the short run. This could be explained by the implementation of energy conservation policy that relates to energy saving and efficiency policies which had been introduced since 1999 under a "four fuel" strategy aimed at reducing the country's dependence on oil revenue (Malaysia Report, 2008).

Moreover, the results show that there is negative relationship between energy consumption and employment, in short run but positive relationship in the long run. In other words, the increase of energy used could lead to the increase of employment growth, in long run. Establishing positive relationship between energy used and employment has important policy implications, which can be explained by the improvement in economic activities in country especially in industrial and manufacturing sector, since to increase the scale of production there is a need to increase the level of energy used and numbers of labours employed to support the production, which in turn will translate into a hike on employment growth. The estimated results also indicated that employment growth has positive impacts to economic growth, since the people standard living have improved this would lead to expanding the economic activities and hereby stimulate the growth of economic in the Malaysian economy. Concisely, based on the research finding it inferred that economic impacts of energy consumption help to increase the employment and economic growth in long run, which answered the second research question.

This study found that the changes in world oil price do not have any significant impact to Malaysia's real GDP either in the short run or long run, which we highlighted in the first research objectives. These results seem do not support our expected findings as there should be negative relationship between oil price and economic growth. Furthermore, should oil prices continue to increase, the amount of government subsidies on fuel and other essential items would also increase. Thus, the Government's expenditure will rise and tax revenues would fall resulting in an increase in the country's fiscal deficit. However, this could be explained by the successful fuel rebalancing which significantly decreased Malaysia's oil consumption between 1980 and 2002. The dramatic shift reduced Malaysia's exposure to oil prices, and provided the foundations for a stable power sector; in turn avoid the severe impact to nation's real GDP growth.

Regarding the negative unidirectional causality effects running from oil prices to energy consumption, it shows that in the short run the world oil price changes would have adverse affect to energy consumption. However, in the long run, there is non significant relationship between oil price and energy consumption in Malaysia, which have policy implications. Increasing the price of energy in short run, especially oil will have two effects: direct and indirect effects on the price level. The increase of oil price directly increases in the consumer price index (CPI) and causes indirect effect to Producer Price Index (PPI) (Ahmat et.al, 2008). The industry producers will transfer the increase in the energy prices in their operating cost to the goods and services price. This will trigger macroeconomic effects in the form of the increases in prices of goods and services. In addition, in the short run the uncertainty of the oil prices may also affect the consumer expectation as if they expect the higher oil price. This will cause inflation and would produce long term effects. As a result they will reduce the energy used, especially oil and shift to the inter fuel substitution mainly bio fuel or gas. Hence, in the short run, the higher oil price will cause a decrease in the non renewable energy consumption.

Moreover, the results show that there is positive causality running from economic growth to employment either in the short run or long run. The positive relationship also been supported by the previous findings by

Selamah et al. (2005), which studied the relationship between employment and economic growth in Malaysia from 1975 to 1995 (see also e.g., Pini 1997; Pianta, et al 1996). The government policy affects human capital development i.e. labour skills through educational policies, worker training or relocation programs and health programs in order to boost productivity growth which in turn will affect the economic growth (Nine Malaysia Plan). When the productivity of labour increased, the number of new workers to be employed would be affected. Positive relationships in the long run would mean that restructuring of major economic sectors has increased relationship between employment and economic growth.

Importantly, the estimated research finding indicates that there is a long run relationship between energy consumption, economic growth, oil price and employment and also short run causality effects between the studied variables in the models, which shows that there is a unidirectional causality running from real GDP to employment, a unidirectional causality from real GDP to energy consumption, a unidirectional causality from oil price to energy consumption and only one bidirectional causality running between employment growth and energy consumption, or vise versa. Interestingly, our estimated results infer that the presence energy policy has significant impact on the economic growth in Malaysia in the long run but not in the short run. Based on the research findings, it has proved that in the long run the existing energy and macroeconomic policies in Malaysia has significantly impacts to the economic growth as well as employment growth, which already answered the third research question.

8. Conclusions and Further Studies:

The main result of this paper is that long-run relationship between the oil prices, economic growths, and employment and growth rate of energy consumption does exist in Malaysia. The implication of the co-integration among the variables studied would imply that all series in the model move together in the long run. This co-integration relationship provides information about the long run relationship.

Again these results support the previous findings from other researches and the theory behind the relationship studied. Establishing negative relationship between real economic growth and energy consumption and positive relationship between energy consumption and employment growth in the long run have important policy implications. It shows that the present energy conservation policy especially energy saving policy and energy efficiency initiatives have able to give significant impact on both employment growth and economic growth in Malaysia. 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 positive impact on the current account balance. The consumption of these non-renewable energies would increase the deficit in Malaysia's balance of payment position of the economy in the future. Hence, there should be wide-ranging efforts to exploit the renewable sources of energy for consumption and production purposes especially in industrial sector. This sector consumed 35.7 percent of total commercial energy in Malaysia. Furthermore, the extensive uses of combustion fuel in the industries have contributed massively to the emission of CO_2, a greenhouse gas, into the atmosphere. These gases can exacerbate global warming and lead to environmental destruction and health hazards.

Another interesting question from the above empirical analysis is that, why the energy consumption doesn't contribute to the economic growth in the short run? In other words, had there been an increase in supply of energy from other sources, there would have been much better economic growth? Then given the supply constraint, what should be the energy policy for Malaysia in particular? Is there a possibility of converting the abundant availability of gas into other qualitative energies? These are the relevant issues for future research which need to be addressed for a rational national energy policy. It has been suggested that in order to retard the fuel import growth, inter fuel substitution towards indigenous resources, mainly hydropower would be required. The expansion of hydropower would replace diesel-based electricity generation. Electricity can be treated as a potential fuel to replace petroleum products mainly in household and transportation sector. One can also undertake a study on the energy use in different sectors and their contribution to the growth of the sector as each sector has different energy use intensity for different forms of energy use.

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Notes

Note 1. Net Oil Price Index.

Table 1. Historic and projected average household size by region.

Avg. hh size	1970	1980	1991	2000	2010	2020
MY	5.5	5.2	4.9	4.5	4.2	3.9
PM	5.5	5.2	4.9	4.4	4.1	3.8
SB	5.3	5.4	5.2	5.1	5.1	5.0
SW	6.0	5.5	5.0	4.7	4.3	3.9

Sources: Malaysia Energy Balance

MY (Malaysia). PM (Peninsular Malaysia). SB (Sabah) and SW (Sarawak)

Table 2. Diagnostic Test of VECM Model.

Diagnostic	Parameter estimates		F- Value	
	Model 1	Model 2	Model 1	Model 2
LM (2)	4.192	16.29	0.8983	0.4326
Hetero (2)	171.014	74.54	0.6724	0.7602
Jarque-Bera	18.114	10.922	0.0204**	0.0908
CUSUM test	ok	ok		

Table 3. ADF and P-P unit root tests for stationarity.

Variables	**ADF**				**P-P**			
	Level		1st Differences		Level		1st Differences	
	t-statistic	p-value*	t-statistic	p-value*	t-statistic	p-value*	t-statistic	p-value*
LENG	-1.539	0.4977	-3.44	0.0194**	-1.99	0.2877	-3.288	0.0269**
LGDP	-0.61	0.8511	-3.41	0.0204**	-0.573	0.8596	-3.465	0.0183**
LEMP	-0.855	0.7852	-5.299	0.0003***	-1.66	0.4376	-6.21	0.000***
WOILP	-1.283	0.6208	-4.964	0.0006***	-1.283	0.6208	-4.978	0.0006***

Notes: *indicate the one-sided p-values for testing the null hypothesis that the variables have a unit root or non stationary.

***, **, * indicate the significance level of 1%, 5% and 10%, respectively.

The optimum lags lengths for ADF determined by the Schwarz Info Criterion (SIC).

Table 4. Johansen's Test for Multivariate Co-integrating Vector.

MODEL 1: LENG, LGDP, LEMP and LOILP.							
Hypothesized No. of CE(s)	**Trace Statistic**	**Critical Value 0.05**	**Critical Value 0.01**	**Maxi Eigenvalue**	**Critical Value 0.05**	**Critical Value 0.01**	**Results**
None* (r = 0)	(60.97***)**	47.856	54.681	(36.177***)**	27.584	32.715	Trace Test and max-eigenvalue indicates1co-integration equation at 1% and 5% level
At most 1 (r ≤ 1)	24.793	29.797	35.458	14.926	21.131	25.861	
At most 2 (r ≤ 2)	9.866	15.494	19.93	7.699	14.264	18.52	
At most 3 (r ≤ 3)	2.167	3.841	6.634	2.167	3.841	6.634	
MODEL 2: LENG LGDP LEMP							
None*	(40.516***)**	29.797	35.458	24.575**	21.132	25.861	Trace test indicates 3 and max-eigenvalue indicates 1co-integration
At most 1* (r≤1)	15.941**	15.494	19.937	9.924	14.264	18.52	
At most 2*(r≤2)	6.017**	3.841	6.634	6.017*	3.841	6.634	

Note: ***, ** and * denote statistically significant at 1%, 5% and 10%, respectively.

Table 5. Government Expenditure and Oil Revenues, 2005-2007 (RM billion).

Sources	2005	2006	2007
Oil Revenues (Oil tax, royalty and dividend, and export duty).	31.0	45.5	51.1
Petrol/ Gas Subsidies.	8.2	7.3	8.8
Ratio Subsidies/Oil Revenues (%).	26.45	16	17

Source: www.epu.gov.my

Table 6(a). Vector Error-Correction (VEC) Model- Estimation Results for logarithmic series.

		Independent Variable (F-statistics)								ECT	
Dependent Variables		$\Delta LENG_{t-1}$		$\Delta LGDP_{t-k}$		$\Delta LEMP_{t-j}$		$\Delta LWOILP_{t-l}$		ΔEC_{t-1}	
Equation		Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
1	$\Delta LENG_t$	0.29(+)	0.185(+)	1.767(+)	1.48(+)	-2.09(-)	-1.98(-)	-0.06(-)	n/a	*-0.652*(-)	-0.533(-)
	SE	0.187	0.1628	0.423	0.32	0.647	0.558	0.032	n/a	0.151	0.1
	F	[1.58]	[1.134]	[4.179***]	[4.622***]	[-3.123**]	[-3.546***]	[-1.87*]	n/a	[-4.29***]	[-5.247***]
2	$\Delta LGDP_t$	-0.126(-)	-0.133(-)	0.33(+)	0.389(+)	-0.245(-)	-0.423(-)	-0.013(-)	n/a	0.11(+)	0.07(+)
	SE	0.135	0.138	0.306	0.272	0.486	0.473	0.023	n/a	0.11	0.086
	F	[-0.93]	[-0.966]	[1.08]	[1.433]	[-0.5]	[-0.894]	[-0.579]	n/a	[1.00]	[0.817]
3	$\Delta LEMP_t$	-0.174(-)	-0.175(-)	0.349(+)	0.396(+)	-0.43(-)	-0.547(-)	-0.004(-)	n/a	0.053 (-)	-0.003(-)
	SE	0.074	0.07	0.168	0.142	0.267	0.249	0.012	n/a	0.06	0.045
	F	[-2.34**]	[-2.411**]	[2.077**]	[2.77**]	[-1.62]	[-2.20**]	[-0.338]	n/a	[0.879]	[-0.083]
4	$\Delta LWOILP_t$	1.145(+)	n/a	1.649(+)	n/a	-6.99(-)	n/a	-0.03(-)	n/a	0.667(+)	n/a
	Se	1.52	n/a	3.42	n/a	5.44	n/a	0.25	n/a	1.23	n/a
	F	[0.753]	n/a	[0.48]	n/a	[-1.28]	n/a	[-0.135]	n/a	[0.54]	n/a

Note : (Note : ( ) Standard errors and [ ] *F*-statistics
*** ***, ** and * denote statistically significant at 1%, 5% and 10%, respectively.
*value for ECM_{t-1} is the t-value and (+) and (-) signs indicate the short run effects.

Table 6(b). VECM Granger Causality/Wald Test

Dependent Variable	Joint short/ long term test (chi-square)							
	LENG and ECT		LGDP and ECT		LEMP and ECT		LOILP and ECT	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
D $LENG_t$	n/a	n/a	23.47	27.96	16.68	22.35	5.4	n/a
	n/a	n/a	(0.00***)	(0.00***)	(0.0002***)	(0.00***)	(0.067*)	n/a
D $LGDP_t$	2.34	2.213	n/a	n/a	2.232	3.57	1.05	n/a
	(0.3103)	(0.3306)	n/a	n/a	(0.327)	(0.168)	(0.59)	n/a
D $LEMP_t$	5.688	5.814	4.748	9.71	n/a	n/a	0.342	n/a
	(0.058*)	(0.055*)	(0.093*)	(0.0078***)	n/a	n/a	(0.8429)	n/a
D $OILP_t$	3.157	n/a	0.54	n/a	1.65	n/a	n/a	n/a
	(0.2063)	n/a	(0.7628)	n/a	(0.4374)	n/a	n/a	n/a

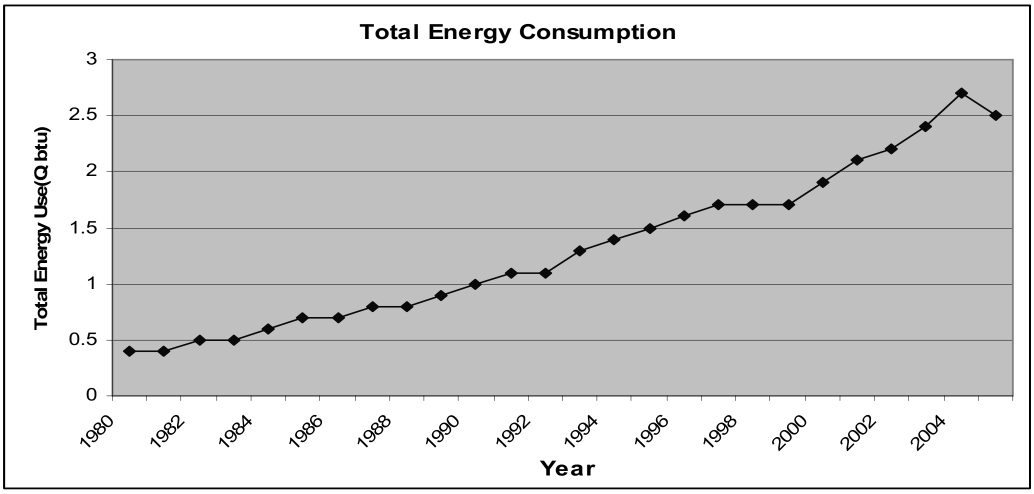
Note: ***,** and * denote statistically significant at 1%, 5% and 10% , respectively.

The table reports the chi-sq value and probability value is in parentheses at 2 degree of freedom (df).

Table 7. Fuel and Diesel Price (in Liters) Comparison among Selected Countries 2004 and 2006.

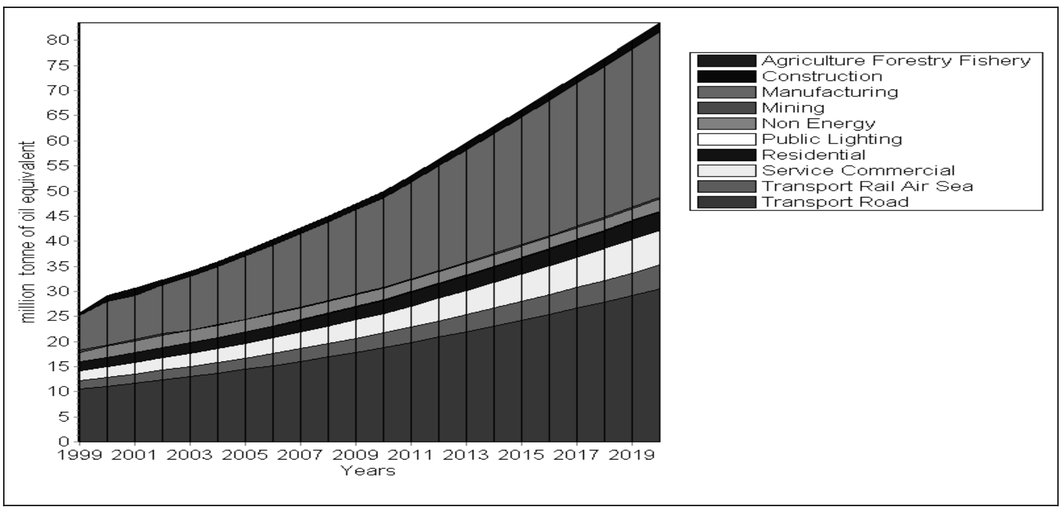
Country	2004		2006	
	Petrol	Diesel	Petrol	Diesel
Malaysia	1.41	0.84	1.96	1.48
Thailand	2.05	1.41	2.59	2.41
Indonesia	1.03	0.68	2.11	1.63
Singapore	3.38	2.09	3.40	2.33
Vietnam	1.82	1.22	2.48	1.96
Myanmar	0.46	0.38	2.44	2.78
Taiwan	2.70	2.09	3.07	2.63
Hong Kong	5.85	3.80	6.25	3.92
China	1.82	1.63	2.55	2.26

Sources: www.epu.gov.my



Source: Own Computation based on EIA database

Chart 1. Energy Consumption Growth in Malaysia



Source: Malaysia Energy Balance.

Figure 1. Final Energy Demand 2000 - 2020 by Sectors - Future Scenario.

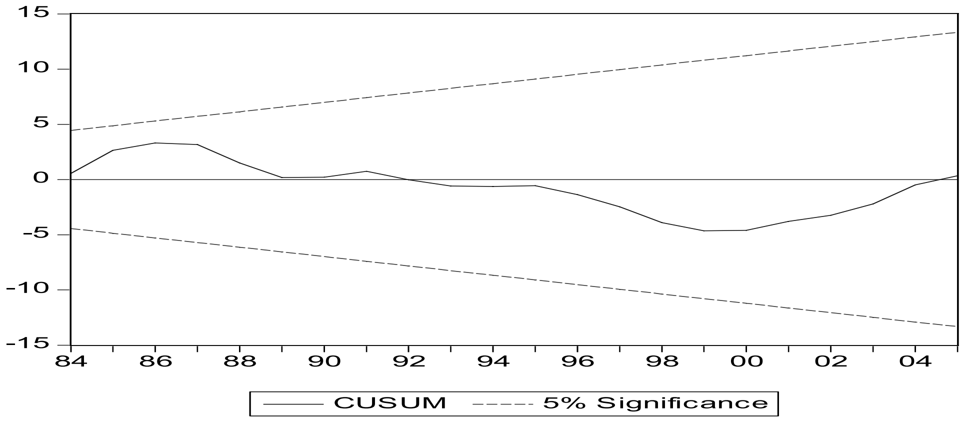


Figure 2. Stability Test of Energy Consumption Function Model 1.

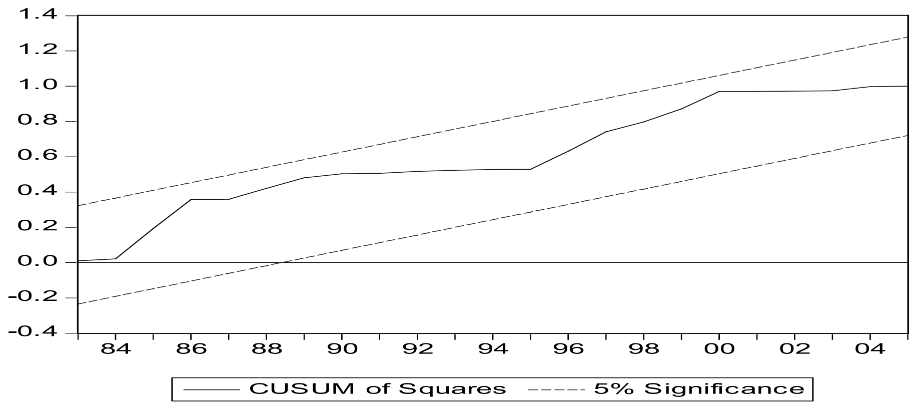


Figure 3. Stability Test of Energy Consumption Function Model 2.

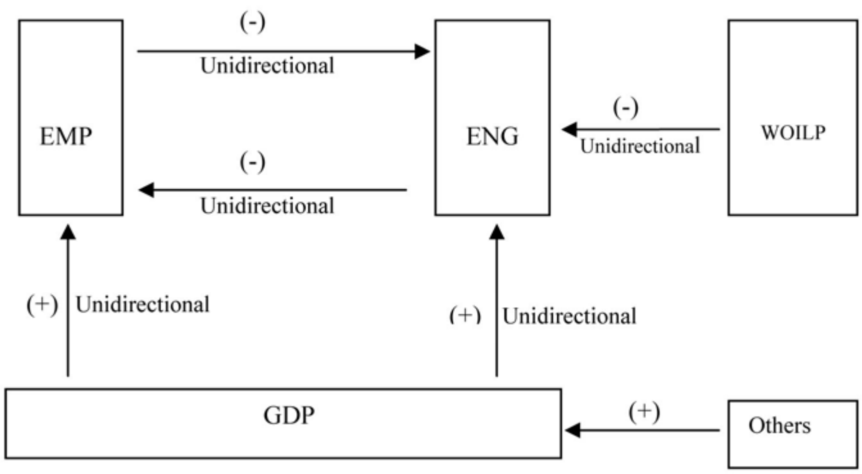


Figure 4. VECM Short Run Causality Test for LENG, LGDP, LWOILP and LEMP.