RELATIONSHIP BETWEEN DOMESTIC FUEL PRICE AND ECONOMIC SECTORS IN MALAYSIA

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ABSTRACT

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By

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Generally, this study aims to examine the relationship between domestic fuel price and the 10 disaggregated economic sectors in Malaysia. Specifically, we intend to find out the short-run and long-run relationships between these examined variables and to some extent, measure the influence of fuel price on the respective economic sectors. Standard econometric estimating methodologies have been applied in this study. First, the Augmented Dickey-Fuller (ADF) and Dickey-Fuller Generalized Least Square (DFGLS) unit root tests results have shown that all of the examined variables are indeed stationary after first difference. Then, by proceeding to the Johansen-Juselius (JJ) cointegration test only three out of 10 economic sectors, which are the agriculture sector, trade sector and other services sector, seem to have a long-run relationship with fuel price. The results from the vector error correction model (VECM) have further indicated that fuel price does Granger cause these economic sectors in the long term and therefore is a relatively exogenous variable in this study. On the other hand, for the non-cointegrated variables, their short-run relationships have been investigated through standard Granger causality test. However, the short-run unidirectional causality seems to exist in the mining sector with this sector being the leading indicator. Based on these results, the out-of-sample analysis is further

applied to have a clear review on the fuel price-economic sectors' relation. In general, three patterns have been observed for these relations under the generalized variance decomposition analysis (GVDCs).

ABSTRAK

HUBUNGAN DI ANTARA HARGA BAHAN API DOMESTIK DAN SEKTOR EKONOMI DI MALAYSIA

Oleh

Brenda Jee Hui Siang

Secara umumnya, kajian in bertujuan untuk mengkaji hubungan di antara harga bahan api domestik dengan 10 sektor ekonomi di Malaysia. Secara khususnya, kami bertujuan untuk mencari hubungan di antara pembolehubah yang dikaji bagi jangka pendek dan jangka panjang dan selanjutnya mengukur pengaruh harga bahan api ke atas sektor ekonomi yang dipilih. Kaedah analisa ekonometrik yang lazim telah diaplikasikan dalam kajian ini. Pertama, keputusan ujian kepegunan imbuhan *Dickey-Fuller* (ADF) dan kuasa dua terkecil umum *Dickey-Fuller* (DFGLS) telah menunjukkan semua pembolehubah yang dikaji adalah pegun selepas pembezaan pertama. Kemudian, menerusi ujian kopengamiran *Johansen-Juselius* hanya tiga daripada 10 sektor ekonomi, iaitu sektor pertanian, sektor perdagangan dan sektor perkhidmatan lain mempunyai hubungan jangka panjang dengan harga bahan api. Keputusan daripada model vektor pembetulan-ralat juga seterusnya menunjukkan bahawa harga bahan api merupakan penyebab *Granger* kepada sektor ekonomi ini dan sebab itu ia merupakan pembolehubah yang lebih *exogenous* dalam kajian ini. Sebaliknya, bagi pembolehubah yang tidak berkointegrasi, hubungan jangka pendeknya telah dikaji menerusi ujian penyebab *Granger.* Walau bagaimanapun, hubungan penyebab jangka pendek dari satu arah hanya muncul pada sektor

perlombongan dan ia merupakan petunjuk utama. Berdasarkan keputusan ini, analisis di luar sampel terus diaplikasikan untuk memperolehi pandangan yang lebih jelas tentang hubungan bahan api dan sektor ekonomi. Secara umumnya, tiga jenis pola telah diperolehi bagi perhubungan ini dalam ujian penguraian varians umum (GVDCs).

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TABLE OF CONTENTS

Page

LIST OF FIGURES............xii

LIST OF TABLES............xiii

CHAPTER ONE: INTRODUCTION

1.0 Introduction............1

1.1 The Oil Crises and the Malaysian Economy............5

1.2 Problem Statement............8

1.3 Objectives of the Study............12

  1.3.1 General Objective............12

  1.3.2 Specific Objectives............12

1.4 Significance of the Study............13

1.5 Organization of the Study............15

CHAPTER TWO: THE MALAYSIAN ECONOMIC BACKGROUND

2.0 Economics Development in Malaysia............16

2.1 Sectoral Performances in Malaysia............20

2.2 The Oil Industry in Malaysia............21

2.3 Conclusion of Chapter Two............26

CHAPTER THREE: LITERATURE REVIEW

3.0 Introduction..28

3.1 The Review on the Impact of Oil Prices on the Macroeconomic Activities in OECD Countries...28

3.2 The Review on the Impact of Oil Prices on the Macroeconomic Activities in Non-OECD Countries 37

3.3 The Review on the Impact of Oil Prices on the Sectoral Performances..........42

3.4 Review of Other Impacts of Oil Price Fluctuations..47

3.5 Closing Remarks to the Chapter...50

CHAPTER FOUR: METHODOLOGY

4.0 Introduction..53

4.1 Theoretical Framework...54

4.2 The Vector Autoregressive (VAR) Approach...57

4.3 Stationary and Non-Stationary Concepts...58

4.4 The Cointegration Concept...60

4.5 The Causality Concept..61

4.6 Augmented Dickey-Fuller (ADF) (1981) Unit Root Test..........................62

4.7 Dickey-Fuller Generalized Least Square (DFGLS) (1996) Unit Root Test ...64

4.8 Johansen-Juselius (JJ) (1990) Cointegration Approach..............................65

4.9 Vector Error Correction Model (VECM)..68

4.10 Generalized Variance Decomposition Analysis (GVDCs).........................70

4.11 Persistent Profile Technique...72

4.12 Data Description and Model Formulation..73

CHAPTER FIVE: EMPIRICAL RESULTS AND DISCUSSIONS

5.0 Introduction..76

5.1 Unit Root Analysis..77

5.2 Johansen-Juselius (JJ) (1990) Cointegration Test Results........................80

5.3 Temporal Causality Results in Vector Error Correction Model (VECM)......85

5.4 Generalized Variance Decomposition Analysis (GVDCs)........................88

5.5 Persistent Profile Shock for Cointegrating Vector..............................92

5.6 Granger Causality Test Results..94

5.7 Generalized Variance Decomposition Analysis (GVDCs) in Vector Autoregressive (VAR) Model...96

5.8 Conclusion of the Chapter..101

CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

6.0 Introduction..105

6.1 Conclusion..105

6.2 Policy Recommendations..109

6.3 Limitation of the Study...114

REFERENCES

APPENDIXES

LIST OF FIGURES

Page

Figure 1.1: The Fluctuation of World Crude Oil Prices, 1970:Q1-2007:Q4.........3

Figure 1.2: The Real Growth Rate of GDP and Inflation Rate in Malaysia, 1970-2007...7

Figure 2.1: The World Proven Crude Oil Reserves in Malaysia, 1980-2007.......24

Figure 2.2: The Crude Oil Production and Consumption in Malaysia, 1980-2007...26

Figure 2.3: Crude Petroleum Exports and Imports for Malaysia, 2003-2004......26

Figure 4.1: An Oil Shock in the Keynesian Model.....................................56

Figure 5.1: Summary for Temporal Causality Results in Vector Error Correction Model..88

Figure 5.2 (a): Persistent Profile Shock for Cointegrating Vector (lragri)..............93

Figure 5.2 (b): Persistent Profile Shock for Cointegrating Vector (lrtrade).............93

Figure 5.2 (c): Persistent Profile Shock for Cointegrating Vector (lroth)..............93

LIST OF TABLES

Page

Table 1.1: Retail Price of Petrol (RON97) on 31 July 2005 (cent per liter).........5

Table 1.2: Final Commercial Energy Demand by Source, 2000-2010...............9

Table 1.3: Final Commercial Energy Demand by Sector, 2000-2010..............10

Table 1.4 Retail Petrol Fuel Prices in the Asian Countries as at November 2007..10

Table 1.5: Domestic Petrol Fuel Price, 2000-2008....................................11

Table 1.6: Expenditures on Fuel Subsidy and Tax Exemption in Malaysia, 2003-2007 (RM billions)..11

Table 2.1: GDP by Type of Economic Activity, 1975-2007 (Percentage Shares of GDP)..21

Table 2.2: Types of Crude Oil and Its Characteristics..............................23

Table 4.1: List of Variables...74

Table 5.1: Unit Root Test Results...79

Table 5.2: Johansen-Juselius Cointegration Test Results............................81

Table 5.3: Temporal Causality Results in Vector Error Correction Model.........86

Table 5.4: Generalized Variance Decomposition Analysis (GVDCs) Results....90

Table 5.5: Granger Causality Test Results..95

Table 5.6: Generalized Variance Decomposition Analysis (GVDCs) Results.....97

CHAPTER ONE

INTRODUCTION

1.0 Introduction

Since World War II, the world recessions have been preceded by oil crises that have occurred in between 1973 to 1974, 1979 to 1980 and 1990 to 1991. The first oil crisis occurred due to the Yom Kippur War between Syria, Egypt and Israel. In this conflict, crude oil became a political weapon that threatens war supporting countries like the United States (US) and western European countries. Consequently, the embargo on crude oil and the halt in supply caused short term shortages of crude oil in the world market, resulting in price hike from US$3.27 in 1973 to US$11.50 per barrel in 1974 [International Monetary Fund (IMF), various issues].

Moreover, political uncertainty in the Middle East from 1979 to 1980 and 1990 to 1991 also caused escalating oil prices. The second oil crisis occurred during the Iranian Revolution in late 1978 and during the Iran-Iraq War in 1980. The operation of oil fields was interrupted at the same time. This caused oil prices to rise steeply from US$12.78 to US$35.71 per barrel in 1980. Furthermore, learning through experience, the Iraq-Kuwait War of the late 1990 had caused the market to anticipate a crude oil shortage anxiety that drove oil prices up from US$25.66 in the third quarter of 1990 to US$31 per barrel at the end of 1991, resulting in the third oil crisis[1].

Although it is perceived that the previous hikes in oil prices was due to supply disruption, these few years has shown that the supply shocks of crude oil was no longer the main factor that lead to oil price fluctuations. There is an increasing demand from the Asian countries, especially the emergence of China as an economic power house that demanded more crude oil and also the large consumption from the US that caused oil prices to soar [United Nations Economic and Social Commission for Asia and the Pacific (UNESCAP), 2005]. As such, limited supply accompanied with high demand caused crude oil prices to accelerate since the late 1990s and reach its peak in third quarter of 2004, at above US$40 per barrel; in mid-2005, at above US$50 per barrel; exceeding US$70 per barrel in July and August 2006 and rocketing to nearly US$90 per barrel in 2007 (see Figure 1.1). For the first time, world oil prices reached above US$100 per barrel in April 2008. The continual soaring of world oil prices in the most recent months has created the fear that the oil price will reach its highest peak in the near future that will translate into an adverse impact on the world economy.

Many empirical studies have examined the impact of oil shock on economic activity as the increased oil prices have severely affected economic activity. Additionally, the perceived impacts are even greater for oil-importing countries. From the empirical point of view, studies conducted by Hamilton (1983), Gisser and Goodwin (1986), Mork (1989) and others demonstrates that oil prices have an inverse

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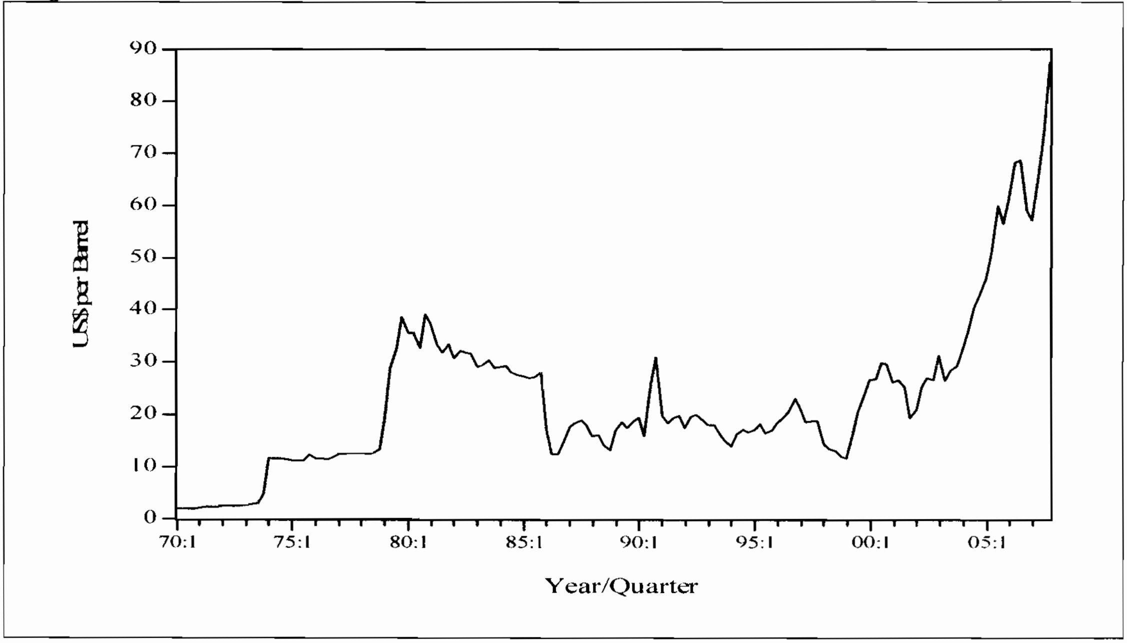
[1] The chronology of oil crises are based on the information adapted from Energy Information Administration (EIA) (2007).

relationship with economic growth and employment, but a positive relationship with inflation. As such, Kim and Loungani (1992) support that the economic interruptions over the past three decades can be attributed to oil price fluctuations.

Figure 1.1: The Fluctuation of World Crude Oil Prices, 1970:Q1-2007:Q4



Note: Shaded areas refer to the oil prices increase periods.
Source: International Monetary Fund (various issues).

On the other hand, from the theoretical point of view, the impact of oil prices on economic activity has been transmitted through several channels. For instance, the increase of oil price is likely to transfer higher cost to the producer on the supply side. In a cost cutting attempt, the producer reduces energy spending by consuming less energy, resulting in inefficient production with excess capacity and declining production output. With this productivity inefficiency, the production output falls. Additionally, as indicated by Hamilton (1988), the relative changes in prices have caused the unemployment rate to increase. When the oil prices increase, the demand for labor in the severely affected sector is reduced due to the contraction in production. However, the possible resources allocation to the efficient sector is difficult as it is costly and time consuming. Consequently, many labors will be left unemployed until the conditions have changed. With such constraints, the productivity inefficiency in the end has lowered the output growth.

Vice versa, through the demand side channel, the increase of oil prices redistributes the income from oil-importing countries to oil-exporting countries. The disposable income in oil-importing countries decelerates and depresses the aggregate demand as purchasing power is reduced. In this unfavorable environment, the investor is likely to postpone irreversible investment as future economic performance is uncertain. As explained by Bernanke (1983), when the future oil price is uncertain, the investor will wait and see the future improvement in order to make any decision. Therefore, the response from oil price increase slows the investment activity[2].

From the transformation mechanism mentioned above, it is noted that the increase of oil prices gives a significant implication to production activity and in the end worsens economic growth, especially for the oil-importing countries. That is why we should question that as a newly emerging industrializing country that consumes large amount of energy products whether Malaysia suffer from the oil price increases or is the Malaysian government able to offset these adverse effects by implementing the fuel tax exemption and fuel subsidy policies for the nation as it is a net oil-exporter. Again, other drawbacks may arise since the rising world oil prices have to be captured by the government in order to maintain its fixed retail fuel price. To have a better understanding of the retail fuel price setting mechanism, an example is shown as below:

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[2] The transformation mechanism discusses earlier is based on the information adapted from Ferderer (1996, pp. 2-3).

Table 1.1 explains that domestic retail prices are related to international market prices as the actual prices are set only after considering existing international prices, operating costs, company margins, petrol station commission, and sales tax. Therefore, it is expected that domestic retail prices directly influence the economic sectors in Malaysia, rather than the indirect influence from international market price, which is transferred through imported product prices. It is important to assess the relation between domestic fuel price and the disaggregated economic sectors in Malaysia as dissimilar results may be discovered across these economic sectors. Ultimately, plausible recommendations can be suggested to further strengthen or minimize the possible effects.

Table 1.1: Retail Price of Petrol (RON97) on 31 July 2005 (cent per liter)

Petrol (RON97)	Peninsular	Sabah	Sarawak
Product cost	164.21	164.21	164.21
+ Operational cost	9.54	8.98	8.13
+ Company margins	4.45	4.45	4.45
+ Petrol station commission	8.00	8.00	8.00
+ Sales tax	58.62	58.62	58.62
= Actual price	244.82	244.26	243.41
- Sales tax (Exemption)	58.62	58.62	58.62
- Subsidy	24.20	25.64	23.79
= Retail price	162.00	160.00	161.00

Source: National Economic Action Council (2005).

1.1 The Oil Crises and the Malaysian Economy

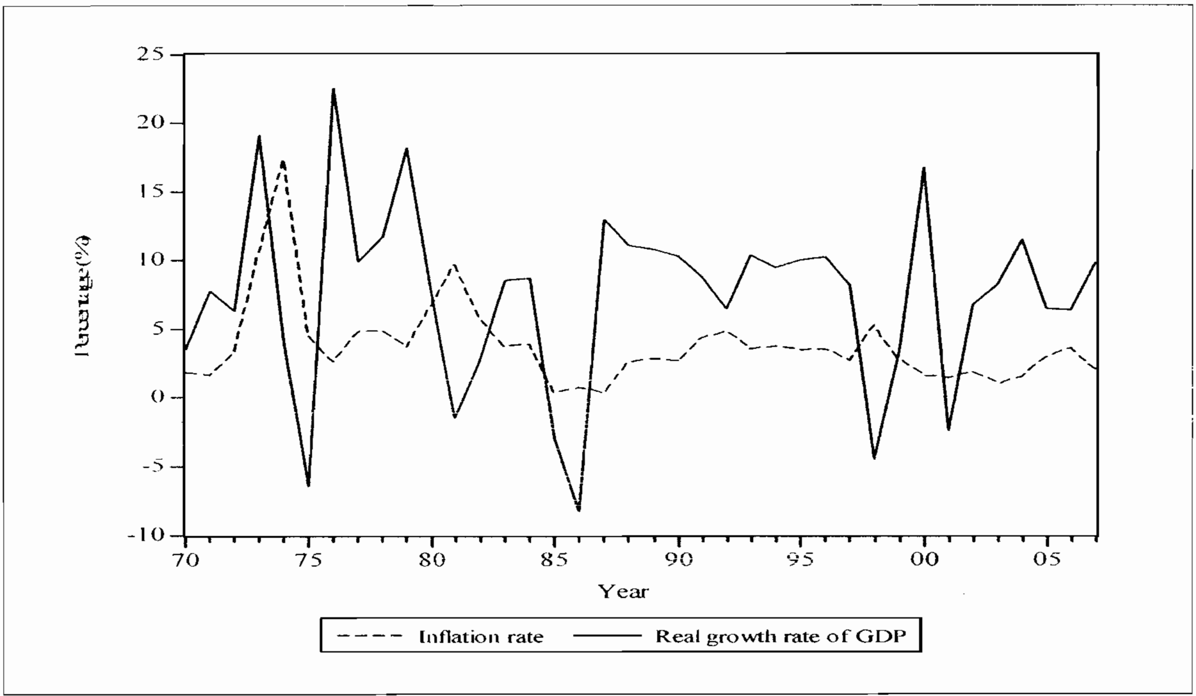
Previously, while experiencing world oil crises, economies in most countries were affected, so was Malaysia's. In Malaysia, the inflation rate responded immediately to the first oil crisis. During this period, the inflation rate recorded a drastic surge from 10.5 percent to 17.3 percent in 1973 and 1974, respectively. Although many researchers supported that oil price has an inverse relation with gross domestic products (GDP) growth, the GDP growth in Malaysia responded to the crisis with some time lags. This is because during that time Malaysia was a net oil-exporter. Therefore, the increase of crude oil prices has contributed to the greater crude oil export earning for Malaysia. As such, Malaysia achieved high real GDP growth of 19.1 percent in 1973 but a slower growth in 1974 at 4.1 percent due to the reduction of export demand from the industrial countries that were affected by the oil crisis. Subsequently, the weaker economic performance in 1974 led to a greater recession in Malaysia in 1975 with negative 6.5 percent growth in real GDP.

Accordingly, the second oil crisis did not produce any greater impact on the Malaysian economy. Although the inflation rate gradually increased from 3.7 percent in 1979 to 6.7 percent in 1980 and 9.7 percent in 1981, the increased were not as great as in the 1970s. The high spending on imported goods from the industrial country that was facing high inflation rates and the increase of diesel and petrol prices in 1980 to 1981, were the major contributors that attributed to the increased inflation rate in Malaysia (Cheng and Tan, 2002). However, the increase of oil prices again has benefited Malaysia's crude oil export earning from RM4,213.5 millions in 1979 to RM6,709.1 millions 1980. Although the real GDP growth slipped from double-digit growth in 1979 to single digit growth in 1980 and dropped to negative in 1981, the growth performances were better than the first oil crisis.

Then, during the third oil crisis, the effects were different from the previous two crises, where it was mildly affected. This time around, the inflation rate rose from 2.6 percent in 1990 to 4.4 percent in 1991 and 4.8 percent in 1992. Meanwhile, the real GDP had documented double-digit growth in 1990 and high real GDP growth in

1991. Such evidence therefore implies that the introduction of a subsidy mechanism in 1983 minimized the effects of international crude oil price hikes on Malaysian economic activity. Such benefits have further been proved by the most recent years economic performances, whereby the inflation rates only fluctuated below 4 percent and the real growth rate of GDP recorded a good track over year 2000 to 2007 (see Figure 1.2). Generally speaking, the subsidization of fuel price is able to contribute to economic activity. Nevertheless, we cannot clearly identify which sector in an economy will be affected by fuel price increases until the disaggregated analysis is implemented.

Figure 1.2: The Real Growth Rate of GDP and Inflation Rate in Malaysia, 1970-2007



Note: The shaded areas refer to the after subsidized periods.
Source: International Monetary Fund (various issues).

1.2 Problem Statement

Crude oil is defined as a mixture of hydrocarbons that exists in natural underground reservoir in liquid phase and remains liquid at atmospheric pressure after undergoing surface separating facilities. It can be refined to produce wider range of petroleum products, such as petrol, diesel, jet fuels, butane and other products used for energy content [Energy Information Administration (2006)][3]. Therefore, petroleum products have been a prime source of economic growth for many developing countries, including Malaysia. It has been used largely as raw materials for derivative products. Therefore, when the crude oil price increased, the impact is felt by many countries.

As a net oil-exporter, Malaysia is expected to face either positive or negative effects. For instance, Malaysia was exporting their higher quality crude oil to other countries while importing lower quality crude oil for domestic consumption. Thus, when crude oil prices keep soaring, it will directly contribute to the greater export earnings for Malaysia. However, other imported products from other parts of the world have now become more expensive due to the transformation effects. As such, this phenomenon has created another problem for our country that is the inflation problem. As a matter of fact, the positive effect can only be evaluated if the export earnings are greater than those side effects. However, if crude oil prices decrease, the most obvious impact would be the drop in crude oil exporting value in Malaysia. According to the statistics published by Bank Negara Malaysia (2009), the crude oil

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[3] Fuel is a substance burned for heat or power, such as coal or petrol.

export unit value has dropped from its peak at RM3300 per tonne in July 2008 to below RM1700 per tonne in December 2008.

In Malaysia, amongst the types of energy sources, petroleum products are highly demanded energy sources which constitute more than 60 percent of the total energy consumed (see Table 1.2). As for the demand by sector, it is largely demanded by the transportation and industrial sectors that respectively constitute around 40 percent of total demand (see Table 1.3). As a matter of fact, this high dependence on petroleum products has kept Malaysia at risk if the international crude oil price remains high. For this reason, fuel subsidies and tax exemptions have been given to the nation as a way to take care their national well being. Therefore, in this study, the retail petrol price instead of crude oil price has been used as a proxy for fuel price as the domestic components such as operating costs, company margins, petrol station commission and sales tax have been taking into account in the final petrol price (see Table 1.1)[4].

Table 1.2: Final Commercial Energy Demand by Source, 2000-2010

Source	Petajoules			% of Total		
	2000	2005	2010*	2000	2005	2010*
Petroleum products	820.0	1,023.1	1,372.9	65.9	62.7	61.9
Natural gas	161.8	246.6	350.0	13.0	15.1	15.8
Electricity	220.4	310.0	420.0	17.7	19.0	18.9
Coal and coke	41.5	52.0	75.0	3.4	3.2	3.4
Total	1,243.7	1,631.7	2,217.9	100.0	100.0	100.0

Note: * indicates projected year.
Source: Economic Planning Unit (2006a).

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[4] According to Delsalle (2002), the basic components of fuel price may result in broad range of final fuel price variation across the European countries although the variation in crude oil price is the same.

Table 1.3: Final Commercial Energy Demand by Sector, 2000-2010

Source	Petajoules			% of Total		
	2000	2005	2010*	2000	2005	2010*
Industrial	477.6	630.7	859.9	38.4	38.6	38.8
Transport	505.5	661.3	911.7	40.6	40.5	41.1
Residential and commercial	162.0	213.0	284.9	13.0	13.1	12.8
Non-energy	94.2	118.7	144.7	7.6	7.3	6.5
Agriculture and forestry	4.4	8.0	16.7	0.4	0.5	0.8
Total	1,243.7	1,631.7	2,217.9	100.0	100.0	100.0

Note: * indicates projected year.
Source: Economic Planning Unit (2006a).

With such mechanisms, the fuel price in Malaysia is said to be the lowest amongst the Southeast Asian countries after Brunei (see Table 1.4). Therefore, the rise of international crude oil prices is likely burdening the government, as some budgets have to be allocated to keep the domestic prices low at the expense of other development projects. Subsequently, in order to lighten the burden, the Malaysian government has revised its fuel price several times in between year 2000 to 2008 (see Table 1.5). Consequently, the 18.5 percent rise of fuel price in February 2006 reduced the total expenditure on fuel subsidy and tax exemption, which dropped from RM16 billions in 2005 to RM14.7 billions in 2006 (see Table 1.6).

Table 1.4: Retail Petrol Fuel Price in the Asian Countries as at November 2007

Country	Price (RM per liter)
Brunei	1.22
Malaysia	1.92
Indonesia	2.57
Vietnam	2.77
Thailand	3.19
Laos	3.24
The Philippines	3.45
Cambodia	3.67
India	4.1
Japan	5.01
Singapore	5.07

Source: Economic Planning Unit (2008).

Table 1.5: Domestic Petrol Fuel Price, 2000-2008

Date	Petrol Price (RM per liter)	Changes (%)
Before year 2000	1.10	-
1 Oct 2000	1.20	9.1
20 Oct 2001	1.30	8.3
1 May 2002	1.32	1.5
1 Nov 2002	1.33	0.8
1 March 2003	1.35	1.5
1 May 2004	1.37	1.5
1 Oct 2004	1.42	3.6
5 May 2005	1.52	7.0
13 July 2005	1.62	6.6
28 Feb 2006	1.92	18.5
5 June 2008	2.70	40.6

Source: Ministry of Domestic Trade and Consumer Affairs (2008).

Table 1.6: Expenditure on Fuel Subsidy and Tax Exemption in Malaysia, 2003-2007 (RM billions)

Items	2003	2004	2005	2006	2007
Subsidy	1.8	4.8	8.2	7.3	8.8
Tax Exemption	4.8	7.2	7.8	7.4	7.4
Total	6.6	12.0	16.0	14.7*	16.2

Source: Economic Planning Unit (2008).

Following the adjustments of subsidized fuel price in response to higher international prices, several aspects of this problem have been highlighted. First, it is interesting to measure the consequences of fuel price adjustment on the economic sectors that consume petroleum products as intermediate inputs. This is because some sectors may not rely heavily on petroleum products such as the final services sector. Second, it is important to discern the slight increase in fuel price before 2008, whether such adjustment has greatly accelerated the cost of production or enabled the economic sectors to grab this opportunity by increasing products prices to a larger extent compared to the increase of input price. This is because when the government announced its decision to revise its fuel price, the producer will take for granted to increase the prices of their products immediately. Third, by how much the effects have been felt by energy intensive sector and non-energy intensive sector. Yet, the possible effects remained ambiguous as heterogeneous effects across these sectors may exist, whether they have or have not been affected, have had a relatively beneficial effect or have suffered from the fuel price hikes. To conduct this study, time series data for domestic fuel price and 10 disaggregated economic sectors span from 1990 to 2007 have been collected and applied in the standard estimating procedures such as unit root test, cointegration test and causality test.

1.3 Objectives of the Study

1.3.1 General Objective

The general objective of this study is to find out the relationship between domestic fuel price and the disaggregated economic sectors in Malaysia using the standard econometric method.

1.3.2 Specific Objectives

Particularly, the specific objectives of this study are:

i. To identify the long-run relationship between the fuel price and the 10 disaggregated economic sectors in Malaysia.
ii. To discover the causality pattern between the fuel price and the 10 disaggregated economic sectors in Malaysia.
iii. To discern the influence of fuel price on the 10 disaggregated economic sectors in Malaysia.

1.4 Significance of the Study

Soaring oil prices would leave some consequences on the macroeconomic performance in a country, whether it is positive or negative. Therefore, in order to compete in the world market, it is important to undertake a study to examine the linkage between oil prices and the macroeconomic variables. From the previous empirical researches, most of the studies have been focused on developed countries, such as the US and European countries. Less study is attributed to the developing countries, especially Asian countries. Therefore, we are interested in examining this issue in the Malaysian economy using disaggregate data.

Besides that, most of these studies are focused on the oil-importing country rather than oil-exporting country[5]. Although it is perceived that oil price increases have benefited the oil-exporting country, it may not be entirely true. Jiménez-Rodriguez and Sánchez (2005) found that oil price shocks did not bring any benefits to the UK but did to Norway although both of these countries are net oil-exporters. Hence, this study provides some empirical evidence on the effect of fuel price hike on the Malaysia economy as it is a net oil-exporting country. Specifically, it provides evidence on the economic sectors that benefit or suffer from fuel price fluctuations.

Moreover, most studies are interested in identifying the consequences of oil prices on major macroeconomic indicators such as GDP growth, employment and inflation rate. Only recently, studies have started to realize the importance of the contribution of oil prices on different economic sectors. As such, these studies are

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

intended to examine this issue on oil related sectors such as the mining sector, manufacturing sector and tourism sector. Therefore, in order to differentiate the current study from others, we intend to examine the influence of fuel price on the Malaysian economic activity by disaggregating it into 10 major sectors[6]. By doing so, this study is able to provide a more significant review on the sector that is likely to benefit or suffer from the changes in fuel price.

From the estimated results, this would envisage the possible impact faced by the different sectors, as different sectors will receive different impacts. Thus, different strategies can be recommended to treat different sectors in order to overcome the problems that arise. For instance, if the result indicates that fuel price have adverse impact on manufacturing output growth, a possible way to resolve the problem is to conduct research and development (R&D) on biodiesel that can be used to replace diesel fuel as the raw material, utilize oil more efficiently or reduces dependency on oil. On the contrary, if the fuel price hikes prove to benefit the palm oil and crude oil and petroleum productions, the government can provide more incentives and subsidies to farmers to expand the plantation of oil palm to cope with the rising demand of crude palm oil. In addition, develop or increase investment in exploration and production (E&P) activities to explore more oil reserves in Malaysia or overseas.

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

1.5 Organization of the Study

Chapter 2 of this study discusses the background of the Malaysian economy. Chapter 3 summarizes the literature review on the various impacts of oil prices on the Organization of Economic Co-operation and Development (OECD) and non-OECD countries. Chapter 4 describes the methodology used in this study. Chapter 5 discusses the empirical results and finally the conclusion and recommendations of this study are presented in Chapter 6.

CHAPTER TWO

THE MALAYSIAN ECONOMIC BACKGROUND

2.0 Economics Development in Malaysia[7]

During the colonial period, the economic system in Malaysia was based on a bi-economic system, which was both a traditional and modern economic system. The traditional economic system was implemented in the rural areas by focusing on the agricultural and fishery activities that were enough for self-sufficiency and were given less attention in terms of development by the British government. Concentration was instead given to the development of a modern economic system which focuses on the mining and plantation sectors. The primary commodities produced, especially rubber and tin were then supplied to the western industrialized countries that utilized them as raw materials in their production activities. As such, this boosted the exporting activity in Malaysia with an exchange of imported food and manufactured products. The imbalance of economic development in rural and urban areas therefore widened the poverty gap within the nation.

In spite of this, rubber and tin remained important exporting commodities for Malaysia after its independence in 1957. At the same time, rubber and tin export accounted for 70 percent of Malaysia's total export earnings. However, over a decade, these primary commodities became less significant and their percentage shares of the total export earnings dipped to 53 percent. These commodities had been replaced by

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[7] The discussions for the economic development in Malaysia are based on the information obtained from Economic Panning Unit (EPU) (2006b) and Poon (2005).

the emergence of timber, palm oil, as well as crude oil as the important exporting commodities. Although the economic growth in Malaysia remained resilient until the end of 1960s, the income disparities and poverty problem among the nation was not solved. Several economics policies were introduced to mitigate these problems.

The New Economic Policy (NEP) was introduced in 1970 and it was a 20 year program from 1970 to 1990. The objectives of this policy were to eradicate poverty and restructure the society. To ensure the effectiveness of this policy, the measures taken includes providing sufficient facilities in the agricultural areas, creating employment opportunities through absorption into modern agriculture and other sectors and providing social services like education, health, water, housing and electricity.

In continued efforts to sustain economic growth, development plans in Malaysia were intensively financed by its public funds. As such, the budget was in deficit in Malaysia in the early 1980s. Accompanied with the second oil crisis in 1979 that led to prolonged world economic recession, these slowed down Malaysian economic activity. Therefore, the Malaysian government gradually shifted from an agricultural based economy to a modern industrial economy putting emphasis on hi-tech manufacturing sectors. This move was aimed at expanding export activity in order to maximize economic growth. This adjustment was implemented by pursuing export oriented strategy in 1970s and 1980s as the import substitution industrialization (ISI) strategy implemented in 1960s was not a success.

Under ISI, the government imposed restrictions on imported products with the purpose of promoting domestically manufactured products. However, such policy was not a success due to the small market size and inefficient operation. Then, the government began to realize the importance of opening its markets to foreign countries. Therefore, under the export oriented strategy, the government provided a conducive environment for encouraging private investment in the industrial sector in order to diversify its economy. As a result, the manufacturing sector grew dramatically during these periods and accounted for larger shares of gross domestic products (GDP) than the agricultural sector for the first time in 1987. Additionally, the privatization policy introduced in 1983 also improved the budget deficit problem in Malaysia as the government's burden to bear public expenditure had lessened. Consequently, the Malaysian economy began to recover in 1987 and achieved strong performances at the end of the 1980s and the early 1990s.

In the 1990s, prior to the 1997 Asian financial crisis, the Malaysian economy has documented a robust and high GDP growth of 8.5 percent in between 1991 and 1997. Therefore, this period was referred to as the golden age of Malaysian economic growth. At the same time, the National Development Policy (NDP) was also introduced as the extension of the NEP and the declaration of Vision 2020 was made in 1991. The NDP covered the period from 1991 to 2000 with the main objective of releasing balanced economic growth and equal social development within the nation, while Vision 2020 aimed at making Malaysia a developed country in the upcoming 20 years. Due to the favorable macroeconomic conditions, this has attracted large capital flows into the country that helped to boost industrial sector's growth.

However, due to speculative attacks on the Thai Baht in mid-1997, the crisis brought a contagion effects on other South East Asian countries, including Malaysia. The lost of investors' confidence caused large portfolio outflows from Malaysia. As a result, the equity and property values declined further. In line with this, the rate of Malaysia's real GDP registered negative growth in 1998. As a way to counteract this problem, Malaysia initially adopted a tightening of monetary policy by increasing the interest rates. However, such a remedy not only did not solve the problem but rather worsened the economic conditions. Therefore, Malaysia chose to adopt the policy as opposed to the International Monetary Fund (IMF) by implementing expansionary monetary policy, capital control and pegging the ringgit against the United States (US) dollar at 3.80. Such financial restructuring seemed to restore investors' confidence and Malaysia achieved recovery from the crisis in 1999.

Then in entering the millennium era, Malaysia launched its third long term plan, namely National Vision Policy (NVP) for the period 2001 to 2010. This plan intended to build up a resilient and competitive nation through maintaining its previous long term plan key strategies and putting up new dimensional strategies. The new dimensions including establishing knowledge based economy, strengthening human resource developments, promoting an equitable society and so on. Thus, the establishment of the Multimedia Super Corridor (MSC) in 1996 and the encouragement for using information transportation technology (ICT) provided additional channels to support this policy.

Malaysia during that time was also heavily dependent on manufacturing exports, especially electronic components. The information technology slowdown in the world market in 2001 reduced the world demand for electronic components. As such, it has reduced export earnings that in turn affected Malaysian economic growth. Although the Malaysian economy was again affected by the outbreak of Severe Acute Respiratory Syndrome (SARS) in 2003, it did not hit economic activity in Malaysia hard. Therefore, we can see that in the aftermath of 1997 Asian financial crisis, the Malaysian economy remained stable over the years.

2.1 Sectoral Performances in Malaysia

In Malaysia, economic activity can be classified into 5 major important sectors, namely, agriculture, mining, manufacturing, construction and the service sectors. Since independence, the Malaysian economy has undergone rapid structural transformations from an agricultural based to industrial based economy. Throughout 1960s, the primary commodities' production such as rubber, tin, palm oil and crude oil were important resources that contributed to Malaysian economic growth.

However, when Malaysia ventured into a more diversified economy in the 1970s and 1980s, the agriculture sector's share of GDP reduced. Therefore, in between 1975 and 1985, the agriculture sector's share of GDP reduced from 29 percent to 20 percent. On the other hand, the manufacturing sector's share of GDP surged from 14 percent to 19 percent. At the same time, the mining sector's share of GDP increased from 4 percent to 10 percent compared with the service sector's share of GDP that decreased from 48 percent to 46 percent. Meanwhile, the construction sector's share of GDP remained stable at 5 percent (refer to Table 2.1).

Table 2.1: GDP by Type of Economic Activity, 1975-2007 (Percentage Shares of GDP)

Sector	1975	1985	1990	1995	2000	2007
Agriculture	29	20	15.2	12.9	8.6	10.2
Mining	4	10	11.8	6.2	10.6	14.5
Manufacturing	14	19	24.2	26.4	30.9	28.0
Construction	5	5	3.9	6.2	3.9	2.7
Services	48	46	46.4	50.5	49.3	46.6

Sources: Bank Negara Malaysia (various issues).

Subsequently, in the following years, the agriculture sector was gradually taken over by the manufacturing sector as the single most important sector that played a vital role in the Malaysian economy. As such, the agriculture sector's share of GDP decreased drastically from 15.2 percent in 1990 to 10.2 percent in 2007. On the other hand, the manufacturing sector's share of GDP increased further from 24.2 percent in 1990 to 28.0 percent in 2007. Moreover, the mining sector's share of GDP grew from 11.8 percent to 14.5 percent for the same period. In contrast, the construction sector's share of GDP dropped from 3.9 percent to 2.7 percent. Meanwhile, the services sector's share of GDP remained similar at around 46 percent.

2.2 The Oil Industry in Malaysia[8]

Malaysia, located at the Southeast Asian region, covers a total area of 329,847 square kilometers (km^2). It is rich with abundant natural resources such as natural gas and crude oil. After Indonesia, Malaysia is the second largest oil producer in the Southeast Asian region. With sufficient use of oil and gas as the energy fuel in the industrial production activity, Malaysia is blessed with the acquisition of these assets that have contributed to the economic development. However, these natural resources

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[8] The discussions on oil industry in Malaysia are based on the information adapted from Petronas (2006).

are unrenewable, therefore it is crucial for Malaysia to discover more oil reserves hidden underground to maintain its role as a net oil-exporter.

Crude oil was first found in Baram, Sarawak in 1882 by the British resident. However, the discovery of oil was not commercially utilized, but only a self-sufficient supply to their daily activities such as for medicinal purposes, lighting lamps and waterproofing boats. By 1910, the oil industry in Malaysia had begun to develop. The Anglo-Saxon Petroleum Company in Sarawak carried out onshore exploration activity and oil was found in Miri, Sarawak. Following this, in the 1950s, technological advancement gave a new opportunity for the oil company to explore further into offshore acreage. As a result, two offshore oil production areas were discovered in Sarawak in 1962. On the other hand, in Peninsular Malaysia, the first oil field was discovered in 1971 through the effort of exploration since 1968.

During that time, Malaysia did not have its own national petroleum company. Therefore, the oil company that invested in Malaysia was operating under a concession system, whereby the government had minor control over the operation of the company and received a small royalty and tax payments. Since the first oil shock in 1973, many oil-producing countries have realized that they play an important role in securing their own natural resources. Due to this, Malaysia legislated the Petroleum Development Act in 1974 and the national owned petroleum company was established on 17th August 1974, namely Petroliam Nasional Berhad (Petronas).

Petronas has played a vital role in protecting the interest of oil and gas in Malaysia. In order to develop the oil industry in Malaysia, Petronas cooperated with its wholly owned subsidiary, Petronas Carigali, to be actively involved in the exploration, production, and development of oil and gas resources in Malaysia. To this extent, Petronas also cooperates with other international oil companies by awarding the Product Sharing Contract (PSC) to the international oil players that are interested in operating oil field within Malaysia[9]. Additionally, Petronas also invests abroad in more than 30 countries in order to discover more oil reserves[10]. As such, the overseas revenues have accounted for one third of the total revenue for Petronas.

Within Malaysia, the exploration and production (E&P) activities are conducted in offshore areas of Peninsular Malaysia, Sabah and Sarawak. The oil and gas exploration acreage in Malaysia covers about 565,555 km^2, with about 139,000 km^2 available for deepwater exploration. Under this acreage, 31 out of 66 blocks are under existing exploration with 11 blocks operating in Peninsular Malaysia and remaining 20 blocks in Sabah and Sarawak. Additionally, Malaysia has produced five types of crude oil that have their own characteristics (see Table 2.2). The high American Petroleum Institute (API) gravity at above 40° and low sulphur refers to the "light sweet" crude oil that posses high quality.

Table 2.2: Types of Crude Oil and Its Characteristics

Crude	API Gravity	Pour Point (° C)	Sulphur Content (% by Weight)
Tapis Blend	45.5	15.0	0.08
Labuan Crude	33.0	-7.0	0.07
Miri Light Crude	31.8	-7.0	0.08
Dulang Crude	37.23	36	0.07
Bintulu Crude	33.6	-23.0	0.06

Source: Petronas (2006).

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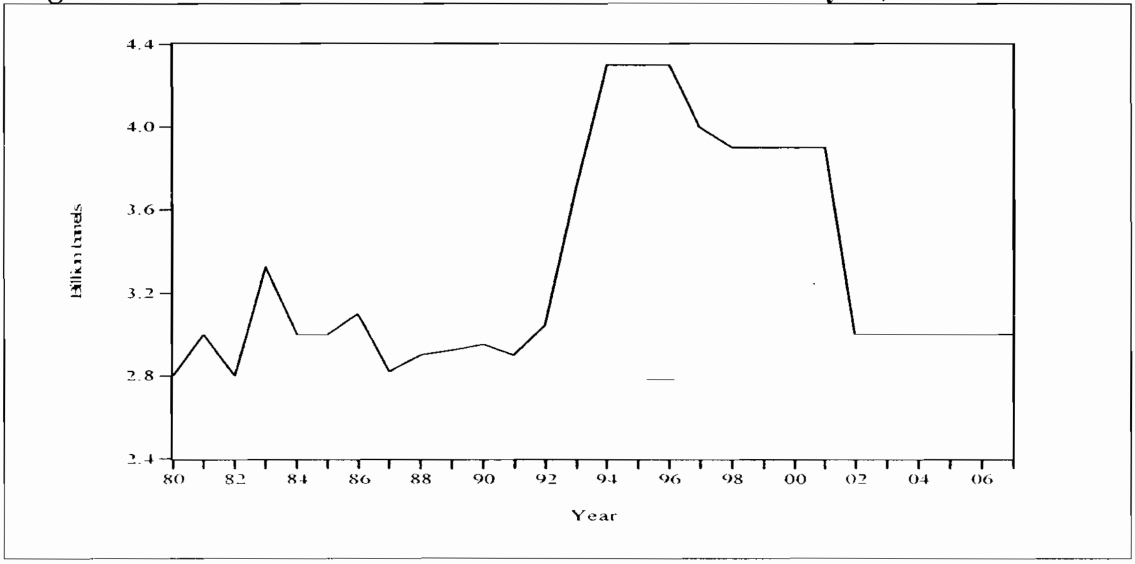
[9] The international oil players that are actively involve in the oil production activity including BP Amoco, Conoco, Enron, Exxon Mobil, Lundin Oil, Murphy Oil, Nippon Mitsubishi Oil, Occidental, Royal Dutch Shell, Texaco and Triton.

[10] Petronas has invested internationally in Algeria, Angola, Benin, Cameroon, Chad, China, Egypt, Equatorial Guinea, Ethiopia, India, Indonesia, Iran, Mauritania, Morocco, Mozambique, Myanmar, Niger, Pakistan, Philippines, Sudan, Turkmenistan, Vietnam, Yemen and so on.

Figure 2.1: The World Proven Crude Oil Reserves in Malaysia, 1980-2007



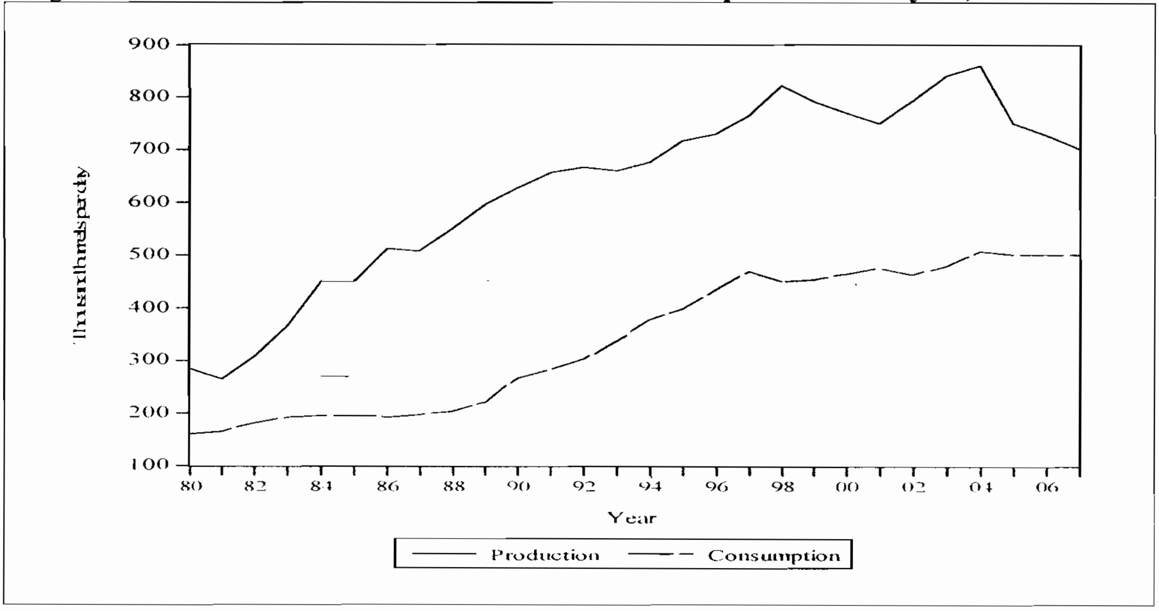
Source: Energy Information Administration (EIA) (various issues).

In terms of proven crude oil reserves, Malaysia has recorded a decrease of crude oil reserves. After reaching the peak of 4.3 billion barrels between 1994 and 1996, the crude oil reserves have gradually fallen to 3.0 billion barrels as at 2007 (see Figure 2.1). However, with the increasing demand for crude oil, Malaysia is expected to become a net oil-importer after 2010. To overcome this problem, Petronas and its subsidiaries have strived to venture into deepwater exploration to discover new oil reserves in Malaysia. As a result, 53 new wells have been drilled. As of March 2006, 60 percent of the additional oil reserves have been attributed by the deepwater discovery.

Furthermore, total oil production (i.e. including lease condensate, natural gas plant liquids and other liquids and refinery processing) has shown an increasing trend from 1980 to 1998. Since 1980 Malaysia has produced 284,000 barrels of crude oil per day and reached a peak in 1998 of 823,130 barrels per day before it dropped back to below 800,000 barrels per day in 1999. However, due to the accomplishments of a few oil-producing fields that need to take some time lags, in 2003, the daily production began to increase. Up until 2004, production progressed to 861,810 barrels per day. However, the data from the EIA has shown that daily production in Malaysia dipped to 702,970 barrels per day in 2007. On the other hand, there was also an increase of petroleum product consumption in Malaysia in between 1980 and 2007, where the demand on petroleum products rose from 160,000 barrels per day to the forecast volume of 501,000 barrels per day (see Figure 2.2).

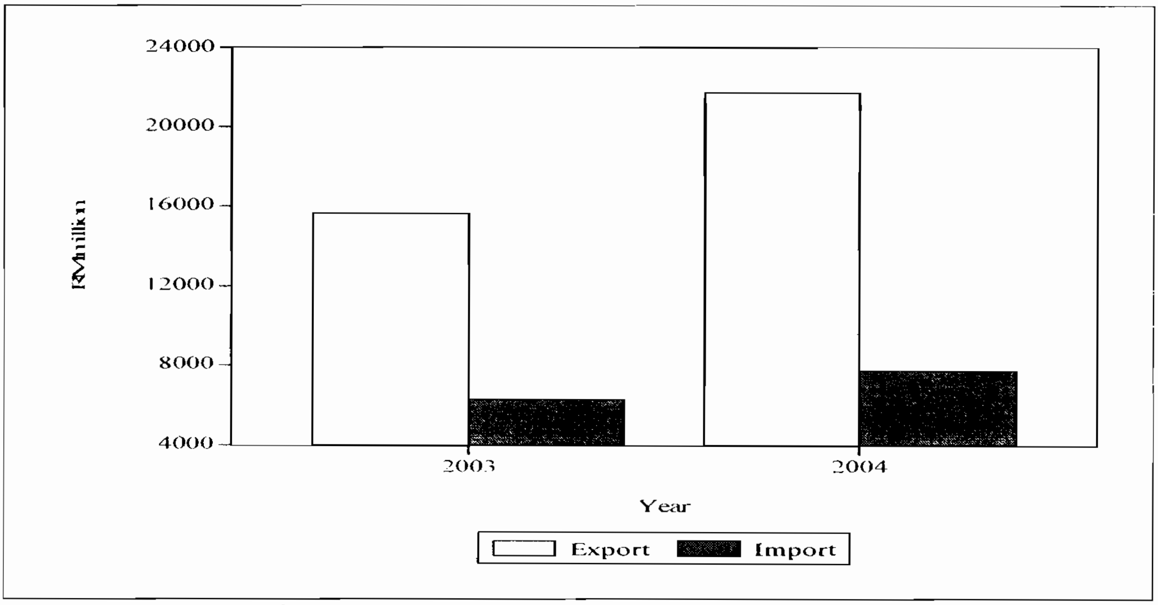
Moreover, in terms of crude petroleum exports and imports, Malaysian crude petroleum exports value has surged from RM15.7 billions in 2003 to RM21.8 billions in 2004 which makes it the second largest export commodity after the export of electrical and electronic goods [Department of Statistics Malaysia (DOS), 2006]. Most of its crude petroleum is exported to Australia that accounted for 23.3 percent, followed by India, 16.5 percent; Thailand, 16.2 percent; Indonesia, 8.3 percent and other countries, 35.7 percent. On the other hand, Malaysia also imported crude petroleum from other countries like Saudi Arabia, 29.8 percent; Oman, 19.4 percent; Vietnam, 13.2 percent; United Arab Emirates, 10.3 percent and other countries, 27.3 percent. The total of imported crude petroleum amounted to RM7.7 billions, which increased from RM6.3 billions compared to the preceding year, 2003 (see Figure 2.3).

Figure 2.2: The Crude Oil Production and Consumption in Malaysia, 1980-2007



Source: Energy Information Administration (EIA) (various issues).

Figure 2.3: Crude Petroleum Exports and Imports for Malaysia, 2003-2004



Source: Department of Statistics Malaysia (2006).

2.3 Conclusion of Chapter Two

The Malaysian economy has undergone rapid structural transformation from an agricultural base to industrial base. Since independence, primary commodities such as rubber and tin were the major sources that had contributed to the economic growth in Malaysia. However, the implementation of import substitution strategy in 1960s and the shift towards export-oriented strategy in 1970s have boosted the industrial sectors in Malaysia, especially the manufacturing sector. Subsequently, the agriculture sector's share of GDP has become relatively small compared to the manufacturing sector. As such, the manufacturing sector begins to take its place as an important economic activity for Malaysia. Throughout these few decades, the manufacturing and services sector remained important in boosting the Malaysian economy. However, recently in 2007, there has also been a significant contribution from the agriculture sector to the Malaysian economy, especially from oil palm and rubber productions.

Furthermore, despite the mining sector being relatively small for its share of GDP, the discovery of oil in the 19th century made a significant contribution to the Malaysian economy. The sufficient use of oil as the raw material in an industrial production activity makes it important to the world economy. In Malaysia, the proven crude oil reserves recorded a gradual decrease to 3.0 billion barrels as at 2007 after reaching its peak at 4.3 billion barrels in between 1994 to 1996. Therefore, it is important for the government owned company, Petronas, to explore new oil reserves to ride on the increasing value of crude oil. Additionally, with higher production of crude oil as compared to crude oil consumption, this has allowed the export of extra crude oil. With the recent high increase of world oil prices in 2007, does this phenomenon have a significant implication to the Malaysian economy with an indirect effect transferred from the high oil price to the other economic activities? Therefore, it is important to study the impact of oil price fluctuations on the economic growth with various perspectives.

CHAPTER THREE

LITERATURE REVIEW

3.0 Introduction

This chapter consists of the review of related literature on the impact of oil price fluctuations on economic growth and will be further divided into four sections to separately review these related literatures. Section 3.1 provides the review on the impact of oil prices on the macroeconomic activities in the Organization of Economic Co-operation and Development (OECD) countries; Section 3.2 discusses the review of the impact of oil prices on the macroeconomic activities in non-OECD countries; Section 3.3 reviews the impact of oil prices on sectoral performance; while Section 3.4 reviews other impacts of oil prices. Section 3.5 contains the closing remarks to the chapter. In addition, these literatures will be summarized into table form in Appendix 3.1, 3.2, 3.3 and 3.4 respectively, and presented at the end of the study.

3.1 The Review on the Impact of Oil Prices on the Macroeconomic Activities in OECD Countries

Post World War II provide much empirical research which was conducted to examine the interrelationship between oil prices and other macroeconomic indicators such as gross domestic products (GDP) growth, industrial production, employment rate, inflation and stock market return. In a pioneer work, Hamilton (1983) for example, found that oil prices have a significant linear relationship with the output and inflation in the United States (US) economy. However, since the collapse of oil prices in the mid-1980s, a problem has been highlighted by most authors on the Hamilton's original equation, whereby when 1980s' data were included in the analysis, the relationship between oil price and other economic variables were insignificant. Therefore, it can be concluded that the earlier data through 1972 or 1980 did not have much power to reveal model misspecification as oil price rarely fell before 1981. In order to solve the oil price specification's problem, several new specifications have been developed, such as oil price increase and decrease specification by Mork (1989), positive and negative scale oil price specification by Lee, *et al.* (1995) and net oil price specification by Hamilton (1996).

Study by Mork (1989) that extend the dataset through 1988:Q2 found that oil prices do not Granger cause output and structural break was across 1986:Q1/Q2. When oil price increase and decrease were entered separately, oil price increases does Granger caused output but oil price decrease did not. However, there were no further theoretical explanations by Mork on these asymmetric effects. Meanwhile, Lee, *et al.* (1995) proposed that in the more stable oil price environment, the impact of oil shock is greater. The GARCH model is estimated to extract the unanticipated component of oil price changes. The scale oil price is then further divided into positive and negative components. From the identified results, the positive part of scale oil price does cause both output and unemployment significantly while negative part does not.

Furthermore, by comparing the results estimated by Hamilton (1996) using net oil price specification with Hooker's (1996) results, the Chow statistic indicates that there was a structural change in 1973:Q4. The Granger causality test is conducted in three separate sub-samples. In the early sub-sample (i.e. 1948:Q1-1973:Q3), the result indicates that oil price does Granger cause GDP. Meanwhile, in the late sub-sample (i.e. 1973:Q4-1994:Q2), the oil price does not Granger cause GDP. This result is consistent with the Hooker's findings. However, in the full sample period, the result is inconsistent, where Hamilton identifies that oil price does Granger cause GDP. To confirm his findings, impulse response function analysis (IRFs) was applied and exhibits that after 1973, oil price has smaller negative effects on GDP. Therefore, he concludes that the significant relationship between oil price and GDP still exists but at a weaker relation after 1973.

Besides using econometric approach to explore this issue, most recent studies have developed various kinds of projection models to quantitatively evaluate the consequences of sustaining higher oil prices on the world economy. Presented by Birol (2004) on the summary of the projection study collaborate conducted by International Monetary Fund's (IMF), International Energy Administration (IEA) and OECD Economic Department, it was mentioned that the impact of higher oil prices on the oil-importing country varied according to their oil intensity. The Euro oil-importing countries were affected the most, followed by Japan and the US. Whereas, the industrial oil-exporting countries only benefited from oil price rise in the first year and fell negative in the second year onwards due to reduced export demand. Meanwhile, the inflation rates in industrial countries have risen by 0.5 percent where the US and Euro areas have been adversely affected. As such, monetary policy responded to the oil price shocks by rising short-term interest rates.

To some extent, Barrell and Pomerantz (2004) also agreed that monetary policy responses have a significant implication in fighting the rise of inflationary pressures. Based on the National Institute's General Equilibrium Model (NiGEM), the study found that a permanent increase of oil price by US$10 caused short-run output to fall more rapidly in the US and the long-run output decrease almost everywhere due to the deterioration of terms of trade between the OECD and Organization of Petroleum Exporting Countries (OPEC) member countries. As such, the immediate response from monetary policy by increasing the real long term rate will rise up the inflation costs. However, if the oil price shock is temporary, the real long term rate does not take part, hence the inflationary pressure is much higher as compared to the permanent shock.

On the way to pursue more evidence on the monetary responses, some studies still disagreed that oil price is a key element that affects the US economy but rather monetary policy that has responded to oil price shocks and in turn affects the aggregate economic activity. However, the question of neutrality arises. Bernanke, *et al.* (1997) argued that monetary neutrality (i.e. constant federal fund rate) does not hold in responding to oil price shocks. On the contrary, Gordon (1998) suggested that the neutrality could be achieved as long as the adjustments in the monetary policy hold nominal GDP constant. Thus, Brown and Yücel (1999) have conducted a study with an objective to examine whether this neutrality issue will affect the monetary response to oil price shocks. The findings from Choleski variance decomposition analysis (VDCs) and IRFs in vector autoregressive (VAR) model shows that the real GDP responds largely to federal fund rate in VDCs. Meanwhile, the result from IRFs is consistent with Gordon's point of view. Federal fund rate has increased in responding to oil price shocks and reduces real GDP. Subsequently, throughout the examined period, the nominal GDP holds constant as the GDP deflator rises in a similar magnitude with real GDP's fall. Moreover, by holding federal fund rate constant under the Sim-Zha (1998) case, the IRFs produced the almost similar trend with the above analysis but at a higher percentage after several months. This result has ruled out the monetary neutrality point of view proposed by Bernanke, *et al.* (1997) and concluded that the monetary neutrality remains as a tool that responds to oil price shocks as long as the nominal GDP holds constant.

Furthermore, in an attempt to shed light on the oil prices' dynamic linkage with other macroeconomic activities in the European countries, several studies have been conducted and showed that oil price changes have an adverse impact on economic growth. According to Papapetrou (2001) and Cunado and de Gracia (2003), they found that oil prices have a negative impact on the industrial production growth in Greece and 15 other European countries. But these studies are conducted in different time periods, covering from 1989:M1 to 1999:M6 and 1960:Q1 to 1999:Q4, respectively. Similarly, these studies have employed Phillips-Perron (PP) (1988) unit root test and generalized IRFs (GIRFs). For extension, Papapetrou (2001) also includes Kwiatkowski, Phillips, Schmidt and Shin (KPSS) (1992) unit root test to examine the non-stationary properties of time-series. The combinations of these methods show that all variables are integrated of order one except stock rate of return, which is integrated of zero order. In the long-run, all the examined variables are not cointegrated based on the results present by Johansen-Juselius (JJ) (1990) cointegration test. Besides that, the generalized VDCs (GVDCs) shows that for all variables, they are more likely explained by its own shock. Nevertheless, based on the result exhibits by GIRFs, it was found that real stock return, employment and industrial production responds negatively to oil shocks, while interest rates responds positively.

On the other hand, Cunado and de Gracia (2003) suspected that there is a structural break between the examined period. Thus, they apply Zivot-Andrews (ZA) (1992) test to detect the possible break period. As long as the structural break is concerned, the Gregory and Hansen (1996) cointegration test with structural break seems more appropriate rather than Phillips and Ouliaris (1990) and Banerjee, *et al.* (1992) cointegration test in finding out the relationship. Nevertheless, all of these approaches fail to find out the long-run relationship between oil price and industrial output growth, but long-run relationship does exist in between oil price and inflation rate. In contrary to many studies, this study also utilizes four different proxies of oil prices (i.e. linear and non-linear model) that are expressed in the US dollar and domestic currency. The Granger causality test shows that non-linear specifications of oil price especially scale and net oil price increases does Granger cause industrial production growth in most of the countries. Thus, this evidence supports the breakdown of the linear relationship between oil prices and economic growth after mid-1980s. However, in either linear or non-linear specifications, oil price does Granger cause inflation rate and the impact is much higher if expressed in the national currency. Thus, it is assumed that the role of exchange rate is taking into account in the macroeconomic variables. Subsequently, by conducting the asymmetries test, such relation seems to exist between the oil price changes and industrial production growth as the oil price decrease does not produce opposite results as in oil price increase.

In addition, the Swiss economy was also found to be mildly affected by oil price shocks (see Atukeren, 2003). Two different methods; time series approach and macroeconometric model, are applied in order to reach the most reliable conclusion. For the subset-transfer-function-based Granger causality test, Atukeren (2003) shows that oil prices have short-run relationship with the 21 variables involved in this model whereby net oil price specification has greater implication than oil price changes specification. But this does not mind map the overall net effect on GDP. Thus, by comparing the Schwarz's Bayesian Information Criterion (BIC) value, the test statistic indicates that oil price shocks cause GDP to decline, together with the decline in employment and inventory investment. However, the author suggests that by reducing the import demand, it is able to minimize the total net loss. On the other hand, KOF's (Konjunkturforschungsstelle) macroeconometric model expects that the negative impact on GDP is worsening as time spans longer. This result was also supported by a study done by Roeger (2005), where the QUEST model forecast that 50 percent surges in oil prices have larger impact on GDP growth in the long term compared to short term. This lower GDP growth is associated with decrease in output, consumption and investment.

For OECD countries, different methods have also been employed to analyze the impact of oil prices on the economic growth, for which Glasure and Lee (2002) have devoted a study on the Korean economy by accessing the impact of oil prices on the real income growth and energy consumption covering the period from 1961 to

1990. The findings from VDCs shows that oil price, followed by money supply, exchange rate, energy consumption and government spending, are the important determinants of real income. Again, oil price is the main factor that explains the variation in energy consumption followed by exchange rate, government spending, money supply and real income. In spite of that, the Johansen (1991) likelihood ratio (LR) test found that there is a single cointegrating vector existing between the examined variables in the long-run. Hence, the vector error correction model (VECM) is applied in order to capture the long-run adjustment information. As a result, oil price contains the future information for both real income and energy consumption. Likewise, real income and energy consumption have been proven to have mutual causation, in which through energy consumption variables (when real income is dependent variable) and error correction term (when energy consumption is dependent variable).

Apart from that, Jiménez-Rodriguez and Sánchez (2005) have applied linear and non-linear specifications of oil price in their multivariate VAR analysis to assess the impact on real economic activity, with the latter specification being able to be used to compare the effects of oil prices' rise and fall. The empirical evidence from the Wald test shows that oil price does Granger cause any variables included in the system, with at least unidirectional causation for all countries and bidirectional causation for most countries. Additionally, the IRFs present a negative relationship between oil prices and economic growth in net oil-importing countries except Japan, which has gone through special economic circumstances. Although oil price surges were perceived beneficial to net oil-exporting countries this relation does not exist in UK but does in Norway. This phenomenon is attributed to the strong appreciation of the pound due to oil price shocks. Such relationships are also more pronounced when presented in non-linear specifications. Thus, based on the accumulated VDCs, it has been indicated that the real GDP for most countries are largely explained by oil price and monetary shocks.

Huang, *et al.* (2005), have considered the varying dependence of oil in different countries. Therefore, they suggested that a multivariate threshold autoregressive (MVTAR) model to be used rather than zero cut off point to assess the impact of oil shocks on the US, Canadian and Japanese economies for the period of 1970:M1 to 2002:M9. Under this model, there is Regime I (threshold variable less than threshold level) and Regime II (threshold variable more than threshold level). The responses in Regime II seemed to provide more detailed information compared to Regime I and this has been proven by the almost similar results observed in the IRFs, where stock returns and industrial output changes react negatively to oil price changes with one period lag for the US, Canada and Japan, respectively. Meanwhile, real interest rate reacts positively to oil price with a two quarter lag within these countries. The same procedure is applied to oil price volatility. However, their results indicated that oil price changes are more powerful in explaining the industrial output changes in these examined countries compared to oil price volatility.

Ultimately, Khademvatani (2006) has conducted an empirical analysis with an aim to investigate the interaction between oil prices and aggregate economic activity in Canada, spanning from 1984:Q1 to 2002:Q4 and utilized conventional unit root tests, Augmented Dickey-Fuller (ADF) (1979) and KPSS (1992) unit root test. But these methods are unable to detect structural break in the series. Therefore, the Perron

(1997) structural break test is included and found that there is an endogenous structural break in all variables except for the commodity price index. Therefore, the study is proceeded with unrestrictive Engle and Granger (1987) cointegration analysis. Contrary to many previous studies, such as Papapetrou (2001), Cunado and de Gracia (2003) and Atukeren (2003), both of the bivariate or multivariate cointegration tests exhibits long-run relationship among the variables. In addition, the empirical study also found moderate symmetry effect of oil prices on Canadian economic activity. Appendix 3.1 summarizes the reviews done on the impact of oil prices on the macroeconomic activities in OECD countries.

3.2 The Review on the Impact of Oil Prices on the Macroeconomic Activities in Non-OECD Countries

In the East Asian region, most of the countries are net oil-importers, except for Malaysia and Indonesia. Hence, does the surge in oil prices threaten those countries' economy; regardless whether they are net oil-importer or net oil-exporter? In Singapore, there have been some studies conducted to examine oil price changes on economic growth, such as Abeysinge and Wilson (2000) and Chang and Wong (2003). For Abeysinge and Wilson (2000), they separately investigated the direct and indirect impact faced by Singapore using Econometric Studies Unit (ESU) multi-country model. The findings show that a 10 percent increase in oil price has greater effects on inflation as time expands, due to the increasing cost of production and reduce in consumer expenditure. The overall Singaporean economy is experiencing a negative growth although in a short period they recorded positive growth, where the effect indirectly transferred through their trade link with other trading partners, especially Malaysia and Indonesia. Hence, this phenomenon can be explained by the perception that longer periods of oil price surges have worsened the economic condition in Malaysia and Indonesia, therefore affecting their export demand from Singapore.

On the other hand, Chang and Wong (2003) explored this issue by focusing the impact on the GDP growth, inflation and employment rate using conventional methods. From the estimated results, there is long-run relationship between the variables. For extension, the IRFs exhibits that inflation in Singapore has continued to increase as time expands and reached its peak in the third year. This finding is consistent with the previous study done by Abeysinge and Wilson (2000). Meanwhile, the adverse impact on GDP growth and employment rate in Singapore only appears in the fifth quarter. Besides that, the VDCs also show that the consequences of oil price on macroeconomic activities are marginal, as some energy saving efforts have been implemented since late 1980s. Therefore, the study concludes that although the oil price impact on the Singaporean economy is marginal, but the adverse impact still remains and cannot be ignored.

Apart from that, some studies are interested to explore this issue on the Russian economy as Russia is an oil-exporting country. Rautava (2004) has utilized a cointegration approach to investigate the long-run and short-run dynamic relationship between the examine variables. The results from the Johansen (1988) cointegration analysis indicated that two cointegrating vectors existed in the long-run. The increase of oil price by 10 percent causes GDP to grow by 2.2 percent, while the appreciation of real exchange rate leads GDP to decrease by 2.7 percent. On the other hand, the government fiscal revenue increased by 4.6 percent and 25.3 percent, respectively, when oil price and GDP grew by 10 percent. This mirroring of oil price tends to have greater impact on fiscal revenue than GDP, while fiscal revenue have high dependence on GDP growth. For extension, the application of ECM for short-run analysis has shown that oil price and real exchange rate, respectively, have positive and negative influences on GDP and fiscal revenue. However, real exchange rate is not affected by oil price fluctuations. Indirectly, the real exchange rate may have a balancing power on the GDP growth, which offset the gain from oil price changes.

Moreover, some notable studies have also contributed their study on the developing Asian countries. Park (2004) and the Asian Development Bank (ADB) (2004) have explored this study using Oxford Economic Forecasting (OEF) model to quantify the impact of oil prices on Asian economies. Park (2004) found that a US$10 per barrel increase in oil prices will deteriorate trade balances, GDP and inflation in the Asian region. The countries that are affected the most are the net oil-importer like Singapore, Thailand and the Philippines. Although Malaysia is a net oil-exporter, its trade balance and GDP is only slightly affected due to its stronger export demand from trading partners that have offset the total gains.

Furthermore, the analysis also finds that if the oil price surge is temporary, it will at the end improve the trade balances condition, as there is revenue recycled from net oil-exporter to net oil-importer. But still, the GDP and inflation has deteriorated and becomes greater when oil price surges are sustained for longer period. Indeed, the impact on trade balances is also infected. Thus, the study by Park (2004) confirmed the finding from ADB (2004) that identified the duration of oil price surges are more pronounced in affecting the trade balances than the price surges in Asian economies. For instance, a comparison between the sustainability of oil price increase by US$10 and the temporary increase of oil prices by US$20 have worsen the trade balance prospect for Asia, as the long period of oil price surges have dampened the export activities in Asia.

For extension, Cunado and de Gracia (2005) have conducted another study that focuses this issue on the six Asian countries. The observed sample size covered from 1975:Q1 to 2002:Q2. Differing from other studies, this study has included that both oil price expresses in the US dollar and local currency, which is specified in linear and non-linear models, to deeply investigate whether the impact is reflected by world oil price fluctuations or other factors. The method applied in this study is almost similar to their previous study that has been conducted on European countries in 2003. The estimated statistics identified that there is no long-run relationship among the variables although the structural break cointegration method is applied. Hence, short-run relationship is examined. The Granger causality test observes that non-linear specifications of oil price does Granger cause economic activity in Japan, South Korea and Thailand, either it is expressed in the US dollar or local currency. Vice versa, when linear specification is applied, these variables do not Granger causes each other in all countries. Additionally, non-linear specification of oil prices have significant relation with inflation in all countries when expressed in local currencies but this relationship only exists in Japan, South Korea and Thailand when oil prices are expressed in the US dollar. Therefore, the study suggests that the short-run relationship between oil prices and economic growth and inflation are more significant when expressed in local currency and in non-linear specifications.

Moreover, Raguindin and Reyes (2005) also apply the linear and non-linear specification of oil price (i.e. oil price increase and oil price decrease) in the IRFs and VDCs in forecasting the effects of oil price shocks on the Philippine economy that covers wide range of economic indicators like real GDP, CPI, real effective exchange rate, real wages and money supply. They found that real GDP responds negatively to the oil price shocks and the negative effects tend to die out after quarter nine or ten. Meanwhile, inflation responds positively to the oil price shock with less enduring effects. From this point of view, their study has reinforced that the asymmetric oil price-macroeconomic relationship does exist in the Philippine economy as the decrease of oil price also dampens the economic activity and inflation pressure. For the remaining indicators, the effects received from the oil price shock are marginal. As a matter of fact, the VDCs exhibit that shocks in oil price have significantly contributed to the variation in real GDP and inflation while the variation in real effective exchange rate, real wages and money supply are marginal. Nevertheless, non-linear specification of oil price seems to play a more significant role than the linear specification in explaining such variations. Yet, the oil price decrease is more prominent than the oil price increase, except for the real effective exchange rate case.

Furthermore, for Olomola and Adejumo (2006), their finding is inconsistent with the major empirical analysis conducted. From the JJ (1990) cointegration test, they found that there are at least two cointegrating vectors that exist within the examined variables. In addition, the measurement from the VDCs shows that oil price is unnecessarily contributing to the changes of output and inflation in Nigeria, although Nigeria is an oil-exporting country. Instead, the real exchange rate fluctuations are in fact influenced by oil price shocks as increases in income earning causes exchange rate to appreciate. As such, trade activities are affected and it is said that "Dutch-Disease" exists in Nigeria. Also, the findings point out that in a longer period, money supply tends to be affected by oil price shocks and real exchange rates. Therefore, monetary policy seems to respond to oil price shocks in Nigeria. Appendix 3.2 provides the summary for the review on the impact of oil prices on the macroeconomic activities in non-OECD countries.

3.3 The Review on the Impact of Oil Prices on Sectoral Performances

In previous literatures, more studies emphasized the relationship between oil prices and macroeconomic indicators. As yet, less attention is attributed to oil prices and sectoral performance. Based on a few studies conducted by Bauer and Byrne (1991), Zind (1999) and Schintke, *et al.* (2000), they found that different sectors experience different impacts from oil price shocks.

According to Bauer and Byrne (1991), the economic slowdown and the increase of price level in the US have been attributed to the oil price increases. However, the adverse impact is not as great as in the 1970s. Their study focused on the sectoral and regional performances due to the oil price increases. From their observation, different sectors and regions have received different effects. On the consumption side, transportation sector's expenditure on oil is accounted for a large share of total costs. Therefore, its impact from oil price surges is greater than other sectors. Moreover, the South region that has a high usage of oil in manufacturing sectors is likely to suffer from the shocks. Vice versa, in the production side, the oil producing states such as Alaska, Texas, Louisiana and California are benefiting from oil price surges in short term. But in the long-run, it will be offset by the total lost, while other substitute sectors like coal producers may benefit from it.

For Zind (1999), he has examined the variability of oil prices on the economy in Gulf Cooperation Council (GCC) member countries. He further disaggregated the economic activity into five major sectors and the time series data are divided into two phases, covering the period from 1972 to 1980 (i.e. oil price increasing phase/ phase I) and 1981 to 1996 (i.e. oil price decreasing and weakly recovering phase/ phase II). From the Analysis of Variance (ANOVA), the results reported that the sectoral output increase considerably in phase II compared to phase I. However, the results recorded a significant slow growth in phase II when measured in year-on-year growth rates. As such, the author suggests that the shock in second phase has led to the overall increase in GCC economy, but at a lower growth rate. Across the five major sectors, the mining sector has the lowest growth rate preceded by all other goods sectors, all other services sectors, manufacturing sectors and government sectors in the second phase.

Also, Schintke, *et al.* (2000) have carried out an input-output analysis on the potential price effect faced by 58 selected individual industrial sectors in Germany due to higher imported energy price changes. The findings identified that there are only 10 sectors (i.e. in between 1995 to 1999) and 16 sectors (i.e. in between 1999 to 2000) that have the total effects of more than 1 percent, respectively. The variation of effects across different production sectors depended on their oil intensities, whether the costs effects have directly or indirectly transformed into the sectors. For example the cost burden for coke, refined petroleum products and nuclear fuel is 58 percent, air transport is 10 percent and water transport is 4 percent. Therefore, the authors considered it was important to distinguish different types of energy source in the import price increases calculation model as the cost structure for various production sectors were varies.

Moreover, Jiménez-Rodriguez (2007) also measures the impact of oil price shocks on eight individual manufacturing industries in the six OECD countries with the purpose to identify the response of output in different industries towards the shocks in oil price as well as the evidence of cross-industry and cross-country heterogeneity. By using the monthly data span from 1975:M1-1998:M12 (for Germany, Italy, the UK and US) and 1980:M1-1998:M12 (for France and Spain) to conduct the IRFs, several implications have been drawn. On the aggregate manufacturing output response, the reaction differs across the European Monetary Union (EMU) (i.e. Germany, Italy, France and Spain) countries but is similar across the Anglo-Saxon (i.e. the UK and US). Meanwhile, on the disaggregated manufacturing output response, the significant differential pattern was observed across the examined countries except the Anglo-Saxon countries as most of the industries react similarly. Hence, main conclusion of the study is, cross-country and cross-industry heterogeneous responses exists in the EMU countries while homogenous responses exists in the Anglo-Saxon countries. Such identification is likely related to the manufacturing industrial structure rather than the oil consumption as oil consumptions have fallen in all countries. Furthermore, the results seem to be robust when the changes in the number of lags, identification assumptions and real oil price definition have drawn similar output responses.

Yet, this issue can also be focused on the disaggregated agriculture and agro-based sectors as what have been done by Saari, *et al.* (2008) for the Malaysian case. By using the input-output analysis, they found that domestic materials constitute a larger portion of total production cost for these sectors. Hence, the simulation analysis based on the assumption of lifting the government intervention by increasing the domestic petroleum prices (i.e. up to 90 percent) revealed that such move is severely affecting the cost of production for fishing, forestry and logging and oil palm industries as petroleum products are important intermediate inputs for these industries. As such, it has been suggested that the fuel subsidy should remain in order to safeguard socio-economic welfare. However, in order to be sectoral cost competitive, it is also being suggested that the domestic petroleum prices shall be determined based on the international prices.

Contrary to the analyses that focused on the sub-sectors of the specific sector, a study by Valadkhani and Mitchell (2001) focused on the impact of petroleum price changes on the 35 sectors involved in the Australian economy using the modified version of the Leontief input-output (IO) price model. Based on the results obtained, there are three main findings drawn from the analysis. First, they concluded that the Australian industries in mid-1990s, as compare to in late 1970s, are less vulnerable to the petroleum price increase, except for few sectors. Then, the increase of cost of production is mostly borne by the motorists, farmers and livestock breeders. Meanwhile, the effects felt by the manufacturing industries are indirect as petroleum is not significantly used in these industries. Second, by assessing the petroleum price changes on the overall economy, again the results indicated that the Australian economy is now less reactive towards petroleum price changes as the consumer price index, gross output and GDP deflator has dropped by 0.7 percentage points, 0.5 percentage points and 0.6 percentage points, respectively. Nevertheless, they stressed that we cannot expect the current impact is insignificant based on this findings. Finally, to measure the price rise induced by petroleum price on household expenditure represented through different income groups, it is however hard to get the clearer understanding as the effects are felt by both households and producers. Hence, they tentatively conclude that the impacts from price hikes are regressive.

In this technologically advanced era, Doroodian and Boyd (2003) have included this element in the impact of oil price shock towards the economic growth in the US. By utilizing dynamic Computable General Equilibrium (CGE) model, the model predicts that over the next 20 years since 1994, an oil shock with low/regular economic growth and no technological changes has driven up the producer price for production sectors that are more related to crude oil and petroleum products. The divergence of production price index (PPI) and consumer price index (CPI) from the benchmark seems to converge in short period. When this model allows for some extent of technological changes in manufacturing and refining sectors, the finding is similar but PPI and CPI tend to converge faster. Beyond 2008, all prices are predicted to fall below the benchmark due to the technology efficiency, except gasoline, housing and utility prices. Although the model extends to assume that there will be low economic growth and substantial technological changes, but the PPI and CPI are expected to converge more quickly compared to previous scenarios. Therefore, the conclusion from this study draws that technological efficiency is able to minimize the adverse impact of oil shocks.

Since transport and oil are the key drivers of tourism industry, Yeoman, *et al.* (2007) investigated the long term impact of oil prices on Scottish tourism[11]. This study employs a triangulation method that consists of energy inflation scenario (scenario 1) and paying for climate change scenario (scenario 2)[12]. The results expect that the further the traveling destination, the larger the percentage changes be created, as the shift to alternative sources is insufficient. In comparison between the increase of value added tax (VAT) and carbon taxation in second scenario, carbon taxation tends to have a greater impact on the employment in tourism sector rather than government revenue. Meanwhile, the subsidy provided to rail transport is a benefit to this industry as tourists tend to shift from car to rail transportation. Therefore, it is useful to apply this method in decision making by policy makers. The summary for the review on the impact of oil prices on the sectoral performances is shown in Appendix 3.3.

3.4 Review of Other Impacts of Oil Price Fluctuations

In the most recent studies, some of the researchers have started to show concern on the indirect impact brought about by oil price fluctuations. Therefore, Hoag and Wheeler (1996) investigated on the effect of oil price shocks toward the employment in coal mining in Ohio. The ADF (1979) unit root test, Engle and Yoo (1987) cointegration test and Choleski VDCs were conducted in their study. The

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[11] The study was focused on the long term consequences because of previous research has shown that rising oil prices do not have noticeable impact on international tourism in short term.

[12] Under the triangulation method, both qualitative and quantitative data can be used for analysis and construction of scenarios. These advantages have overcome the existing problem in scenario planning whereby policy makers and business strategies have dismissed quantitative data while social scientists have dismissed qualitative data.

empirical findings indicated that all variables are significant at first difference form. Moreover, they are not moving together in the long-run. Beyond that, the VDCs imply that in comparison between oil price and coal price shocks toward employment in Ohio coalmines, the oil price has larger impact on total employment, surface employment and underground employment in Ohio. Although coal price and wages have smaller impact on employment variables, but in long term, it has effectively affected the surface employment. This can be explained by the fixed and variable costs constitution in the coal mining industry. For the surface mining industry, it constitutes by more variable costs than fixed cost. Thus, when the coal price shocks and wages increase, it would be necessary to increase the variable costs and lead to the shut down of some uncompetitive surface coal mines.

Besides exploring the dynamic linkage between oil prices and employment, some studies also explored that the significant relation between oil prices and the stock market. Sadorsky (1999) conducted an analysis on the US stock market that covered the period from 1950:M1-1996:M4. The empirical results indicate that both oil price shocks and oil price volatility plays a significant role in affecting the real stock return, as captured by VDCs. In addition, the IRFs also show that oil price shocks have an immediate negative impact on the real stock return and the effect is stabilized after three months, while real stock return have a positive relationship with interest rates and industrial production. This implies that oil price shocks would indirectly affect other macroeconomic indicators. However, by separating this examined period into two sub-periods, the results show that oil price explains a larger portion on real stock return than interest rate after 1986 due to the dynamic changes of oil price in between 1986 and 1990. Furthermore, the asymmetry test identified that oil price volatility has an asymmetric relationship with economic activity.

In contrast to the study by Sadorsky (1999), Maghyereh (2004) extends the empirical examination on the 22 emerging stock markets finding that oil price have less impact on emerging stock markets. As implied by GVDCs, the results exhibited that oil price shocks explain less than 2 percent of the stock markets and gradually reduced to less than 1 percent for 16 emerging countries. But still, some of the countries continue to be faced with greater impact from oil price shocks due to their higher dependency on oil. The outcome from IRFs also justify that the stock markets respond slowly to oil price shocks. The stock markets inefficiently respond to oil price on the second day after shocks and stabilize on the fourth day and seventh day for Argentina, Brazil, China, Czech Republic, Egypt and Greece.

Apart from that, Huang and Guo (2007) have contributed their studies on the various types of shocks in the market that affect China's real exchange rate, Renminbi (RMB). Contrary to all reviews in this chapter, they have employed Im, *et al.* (2003) panel unit root test in their study. The JJ (1990) cointegration test also found that all of the variables are not moving together in long-run. As captured by IRFs, the figures depict that oil price shocks cause RMB to depreciate, but in a shorter period. After three months, the RMB will appreciate 0.3 percent above the baseline. This indicates that China does not depend on imported oil as heavily as its other trading partners included in the RMB basket peg regime. Nevertheless, the VDCs show that oil price shocks explain large portions of real exchange rate in the long-run. This means that the strict energy regulations imposed by the Chinese government have caused the oil price shocks in the Chinese market to not move in line with the shock in world market. Hence, the real exchange rate responds to the world market with some time lags. Appendix 3.4 presents the summary for review on the other impacts of oil price fluctuations.

3.5 Closing Remarks to the Chapter

From the related literature discussed above, we can conclude that this issue has been in the spotlight in many countries around the world. A pioneer work on the relationship between oil prices and economic activity was been conducted by Hamilton (1983). However, following the oil prices fall in 1980s, his work has been criticized by some authors on the oil price misspecification, as the analysis is extended to 1980s dataset and the relationship is insignificant. Therefore, several new oil price specifications have been developed by other authors to overcome the previous model's inefficiency, such as oil price increase and decrease specification by Mork (1989), scale oil price specification by Lee, *et al.* (1995) and net oil price increase specification by Hamilton (1996). However, not much of the literatures are applying all these specification in their study except Cunado and de Gracia (2003, 2005) that was interested to compare the different oil price specifications on the economic activity.

Besides that, some of these literatures are also concerned about the inclusion of structural stability test in their study when the sample period is suspected to include some major events. This is to avoid from obtaining the erroneous conclusions, when the false null hypothesis is not rejected. Therefore, besides adopting the standard estimating procedures, such as ADF, PP, KPSS unit root tests and JJ cointegration test, the ZA unit root test and Gregory-Hansen cointegration test is included in their study when the sample's structural stability is put into consideration. However, based on the analysis conducted by Cunado and de Gracia (2003), the result is almost similar with the result without structural break. Therefore, reaffirm the relationship identified in their study.

In addition to the standard estimating procedure, which is usually known as in-the-sample analysis, the out-of-sample analysis is also gaining popularity. Therefore, many literatures in this study have applied out-of-sample analysis such as IRFs and VDCs. These methods have the advantages in terms of make forecasting beyond the sample period. Therefore, a good review for the researchers is provided on what is expected to happen in future and measure the effect of one variable towards the other variables. Hence, the appropriate strategy can be recommended to circumvent the identified problem.

Although there are many literatures applying standard estimating procedures in studying the relationship between oil price and economic activity, but in investigating the relationship between oil price and disaggregate economic sector, most of the literatures are using qualitative method or input-output analysis, except Jiménez-Rodriguez (2007) that using IRFs to gauge the response of disaggregate manufacturing sector on the oil price shock. Thus, the lack of literatures in this area has created a gap for our study that examines the relationship between fuel price and disaggregated economic sectors using standard estimating procedures.

Additionally, another gap between our study and previous literatures is the used of international oil prices as the proxy of oil price, whereby our study is utilizing domestic fuel price as the proxy. The reason behind this dissimilarity is oil price in Malaysia has been given subsidy; therefore it is suitable to apply final retail prices in the study as it has taken other related costs into account. Although there are some gaps exist between our study and previous literatures, yet it could be a guideline for us to venture into different scopes of study.

CHAPTER FOUR

METHODOLOGY

4.0 Introduction

This chapter discusses the methodology used in analyzing the relation between the fuel price and the disaggregated economic sectors in Malaysia. The discussion on the theoretical framework is initially introduced, to be followed by a brief discussion on the vector autoregressive (VAR) approach. Then, the stationary and non-stationary concepts, as well as the cointegration and causality techniques will be described. For the description of methodologies applied, it begins with the Augmented Dickey-Fuller (ADF) (1981) and Dickey-Fuller Generalized Least Square (DFGLS) (1996) unit root tests that investigate the stationary properties of the time-series data, followed by the Johansen-Juselius (JJ) (1990) cointegration test that analyze the long-run relationship between the examined variables. Furthermore, the vector error correction model (VECM) and standard Granger (1969) causality test will be used to indicate the direction of causality. In spite of that, the out-of-sample test like generalized variance decomposition analysis (GVDCs) will be applied in this study to make a forecasting on the variation in one variable due to a shock in a system. Eventually, the persistent profile technique is adopted to measure the effects of system-wide shock on the cointegrating vector.

4.1 Theoretical Framework[13]

A shock in oil price is often related to recession in economic activity. From past experiences, the world economic recessions are preceded with major oil crises. Because of this, there have been many empirical studies that have been conducted to investigate the inverse relationship between oil price and economic activity. Empirical findings by many researchers like Rasche and Tatom (1977), Darby (1982), Hamilton (1983) confirms this relationship. From this point of view, several channels have been pointed out to uncover the nexus between oil price and economic activities. For instance, the supply side shock channel, demand side channel, income transfer channel, real balance channel and so on. However, since the focal point of this study is on the disaggregated output, therefore, the discussions on the theoretical framework in this study will be based on the supply side shock channel. To some extent, the indication by Brown and Yücel (2001) also suggested that the classic supply side shock best presents the inverse relationship between the oil price shock and GDP growth that also take inflationary pressure into account.

Generally, crude oil is an important source that is used to produce energy products like petrol, diesel and kerosene. As such, it is considered the vital input in production activity. Therefore, by referring to the production function indicated in Equation (4.1), the production output is related to the input (i.e. capital and labor) as well as the overall effectiveness of the inputs that may refer as productivity. Accordingly, any changes in productivity, input, or both will cause the output to change. Otherwise, the output will remain constant. In order to account for the output

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[13] The discussions for the theoretical framework are based on the information adapted from Abel and Bernanke (2001, pp. 206-209 and 419-422).

growth (i.e. percentage changes in output), the production function then can be rewritten in the growth form, as shown in Equation (4.2), namely growth accounting equation.

$$Y=Af(K,N) \tag{4.1}$$

$$\frac{\Delta Y}{Y}=\frac{\Delta A}{A}+a_K\frac{\Delta K}{K}+a_N\frac{\Delta N}{N} \tag{4.2}$$

Where f is a function relating output Y to capital K and labor N, Y or $\frac{\Delta Y}{Y}$ is the total output or rate of output growth, A or $\frac{\Delta A}{A}$ refers to the total factor productivity (also known as productivity) or rate of productivity growth[14], K or $\frac{\Delta K}{K}$ denotes the capital or rate of capital growth, N or $\frac{\Delta N}{N}$ is the labor or rate of labor growth, and a_K and a_N respectively are the elasticities of output with respect to capital and labor.

Based on the growth accounting equation, it is known that the productivity and input are sources of growth in output, as the growth in output can be resulted from the growth in productivity, capital inputs and labor inputs, respectively. By applying this theory in our study, it can give us the general understanding on the impact from changes in input (i.e. due to oil shock) as well as productivity that can affect the output growth. Such translation effect can also be further explained by the supply shock in the Keynesian model that shows how the effect of oil shock is transferred to the level of output in an economy.

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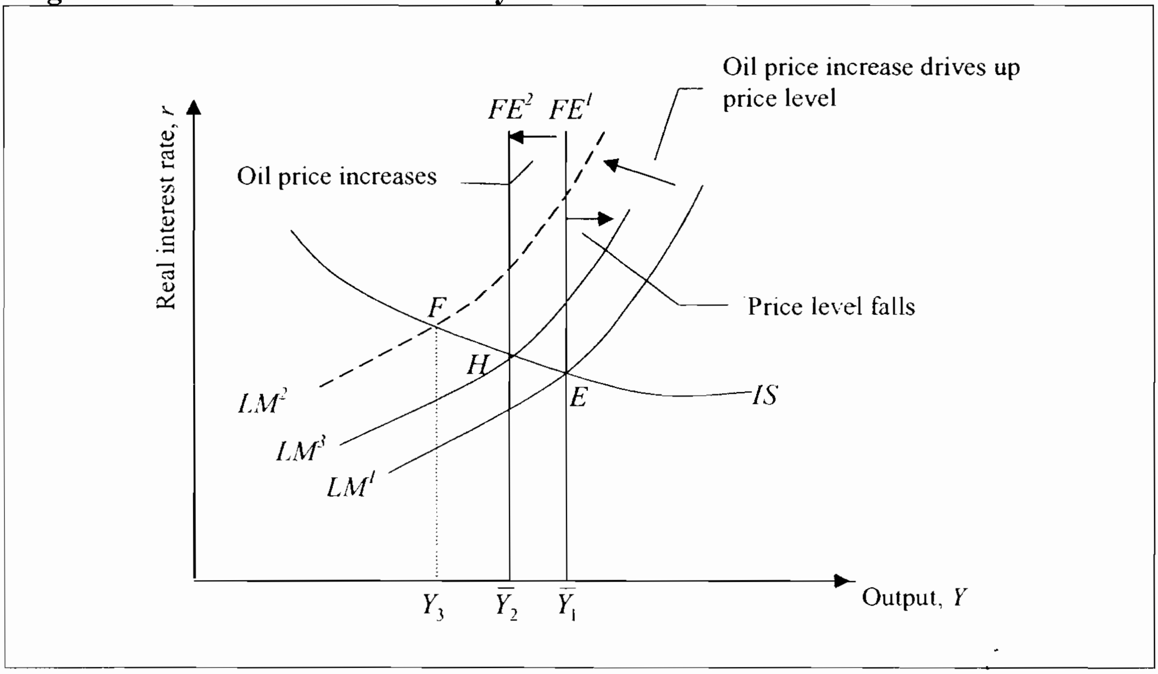
[14] The growth in productivity may due to the improvement in technologies, management practices and so on that helps to increase the efficient utilization of capital and labor in production activity.

Figure 4.1: An Oil Shock in the Keynesian Model



Source: Adapted from Abel and Bernanke (2001, p. 421).

As explained in the Keynesian model, when there is a temporary shock in oil price, the relative input price will become more expensive since oil is an important input in the production activity. Due to this, the producer will tend to reduce their energy spending by consuming less energy. With such constraints, the firm's productivity decreases and hence the amount of full-employment level of output ($\bar{Y}$) that can be produced has fallen from $\bar{Y}_1$ to $\bar{Y}_2$, as the full-employment (*FE*) line has shifted from FE^1 to FE^2 in long-run, associated with the adjustment in wages and price level.

Meanwhile, in the short-run, there are two components that can lead to the drop in output. Firstly, through the effect of oil shock on the general price level that may depend on the menu cost of each firm, whereby if the predetermined price is slightly differing from the "right" price, the firm will maintain its predetermined price. Vice versa, if the difference between the predetermined price and the right price is large, the firm will adjust the price level in order to secure the firm's profit margin. Thus, the oil-dependent firms tend to react quickly to an increase in the output price vis-à-vis the less oil-dependent firm. Yet, the average price level does increase in the short-run although the price stickiness does exist in the sense that not all firms adjust their price level towards the equilibrium value.

Secondly, the increase of price level in the short-run has reduced the real money supply, leading the *LM* curve shifts to the left from LM^1 to LM^2. Again, at the new equilibrium point, *F*, the output has further declined to Y_3, lower than $\bar{Y}_2$ and the real interest rate has increased. Accordingly, the economy undergoes stagflation, which is a drop in output and rising inflationary pressure. With such unfavorable conditions, the purchasing power of consumers reduces and in the end depresses the aggregate demand. To this extent, the fall in price level has restored the *LM* curve back to LM^3 in long-run. Though, any expansionary policies suggested in this model to boost output do not give the perfect solution as the output increased at expend of rising inflation pressure.

4.2 The Vector Autoregressive (VAR) Approach

Previously, in simultaneous equation or structural modeling, it was vital to determine the exogenous and endogenous variables in the model. This has been a subjective question and therefore been criticized as being too restrictive. Due to this, the VAR approach has been proposed by Sims (1980) to overcome this weakness. According to Sims (1980), if a set of variables are interrelated, they should be treated symmetrically, without distinguishing between exogenous and endogenous variables. Therefore, each of the variables in the system is an endogenous variable, which is a function of its own lagged value and lagged value of other variables. Hence, this approach is known as VAR because of the appearance of a lagged dependant variable as the independent variable that is termed as autoregressive, while we are dealing with two or more variables in a vector it is termed as vector. Subsequently, this approach is useful in testing the multivariate cointegration analysis, VECM, Granger causality, generalized impulse response analysis (GIRFs) and GVDCs in forecasting the interrelationship between the examine variables. Below is the VAR model:

$$Y_t = c + \Pi_1 Y_{t-1} + \Pi_2 Y_{t-2} \ldots \Pi_p Y_{t-p} + \varepsilon_t , t = 1, \ldots T \qquad (4.3)$$

4.3 Stationary and Non-Stationary Concepts[15]

In time-series analysis, the data acquired can be generated from the stochastic (random) process, where the values obtained are the realization from such process. Obviously, the observed values tend to follow a random walk model (RWM). This means that the time series data is either exhibiting increasing or decreasing trends. Under such circumstances, the data is said to be non-stationary. Due to this, it will hinder us from studying its behavior for entire periods of time under consideration. Therefore, in econometric analysis, it is important to determine stationary and non-stationary properties of the data.

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[15] The discussions for stationary and non-stationary concepts are adapted from Gujarati (2003, pp. 797-802).

Stationary refers to time series data which possesses constant mean and variance over time. Additionally, the covariance between the two time period depends on the lag between the two time periods. Such criteria can be expressed as:

$$\text{Mean:} \qquad E(Y_t) = \mu \tag{4.4}$$

$$\text{Variance:} \qquad \text{var}(Y_t) = E(Y_t - \mu)^2 = \sigma^2 \tag{4.5}$$

$$\text{Covariance:} \qquad \gamma_k = E[(Y_t - \mu)(Y_{t+k} - \mu)] \tag{4.6}$$

where Y_t is the stochastic time series and k is the lag. Therefore, when the data series is said to be stationary, this implies that the values will always fluctuate around the mean and return to its mean as time displace.

Meanwhile, the data series is said to be non-stationary when it does not contain the criteria exposed to stationary. For instance, consider the following RWM:

$$Y_t = Y_{t-1} + u_t \tag{4.7}$$

where u_t is the white noise error term. If Y_{t-1} is equal to 1, then we can conclude that the unit root problem exists. In order to solve this problem, one of the remedies is to first differentiate the time series data to obtain stationary data[16].

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[16] According to Dickey, *et al.* (1991), many macroeconomic series tend to represent adequately in first difference form rather than in levels form.

4.4 The Cointegration Concept

The concept of cointegration was first introduced by Granger (1981) and further extended by Engle and Granger (1987). Cointegration means that there exists one or more linear combinations between the examined variables that are stationary although individually they contained unit root properties (Dickey, *et al.*, 1991). Therefore, this concept suggests that these variables tend to move together in long-run. In other words, divergence of the cointegrated series in short-run will converge to achieve a certain equilibrium point over time. Hence, the existence of cointegrated properties reveals that there is a long-run effect from one variable to other variables (Zou and Chau, 2006). Due to the existence of cointegration, it will rule out the possibility of spurious regression results.

Obviously, it is important to ensure that all of the included variables are in the same integrated properties in order to determine whether they are cointegrated or not. Suppose that there is a pair of series (i.e. variable X_t and Y_t), if both of the series are in the non-stationary conditions, with same order of integration, let say integrated of order d (i.e. $X_t \sim I(\mathrm{d})$ and $Y_t \sim I(\mathrm{d})$), then Engle and Granger (1987) has suggested that it is vital to identify whether the residual, μ_t, in the regression model of Y_t on X_t, is stationary, $I(0)$.

$$Y_t = \alpha + \beta X_t + \mu_t \qquad (4.8)$$

If the residual is found to be stationary, it implies that the linear combination between these variables has canceled out their stochastic trend. As such, X_t and Y_t are cointegrated. Is spite of this, the regression model shown in Equation (4.8) can be known as cointegrating regression and the slope parameter is the cointegrating parameter.

Since a pair of these variables is cointegrated, Granger (1988) claimed that causality relationship between these variables must exist in at least one direction. However, the direction of causality was not indicated in this cointegrating model. Therefore, it will be captured by the error term, which is called error correction mechanism (ECM). This mechanism can be used to capture short-run dynamic behavior while restricting the long-run behavior of the variables from diverging from their cointegrating relationship.

4.5 The Causality Concept

The concept of causality has been proposed by Granger (1969) in order to predict the causality pattern existing between the examine variables. According to Granger (1969), the X is said to "Granger cause" Y if the past value of X contains the information that helps to better predict the current and future values of Y rather than using the past value of Y itself and vice versa. Hence, if variable X is found to be Granger caused variable Y and vice versa, it means that there is a short-run relationship between the examined variables, either the causality pattern is unidirectional or bidirectional. On the contrary, if both of the variables are found to non-Granger cause each other, then it means they do not have the ability to influence each other, and therefore, do not poses short-run causality relationship. Since the development of this concept, it has been widely applied in economic research.

4.6 Augmented Dickey-Fuller (ADF) (1981) Unit Root Test[17]

In estimating the non-stationary properties of time-series data, a unit root test initially was developed by Dickey and Fuller, namely Dickey-Fuller (DF) (1979) unit root test. In this underlying test, they were concerned over the three possible circumstances that might appear in the RWM, such as without drift, with drift and drift with stochastic and deterministic trends. Hence, three different forms of models and hypotheses have been made under this unit root test, as shown in below:

$$\Delta Y_t = \delta Y_{t-1} + u_t \tag{4.9}$$

$$\Delta Y_t = \beta_1 + \delta Y_{t-1} + u_t \tag{4.10}$$

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + u_t \tag{4.11}$$

Equations (4.9), (4.10) and (4.11) represent the RWM without drift, with drift and drift with stochastic and deterministic trends, respectively. The null hypothesis, H$_0$: $\delta = 0$ is tested against the alternative hypothesis, H$_1$: $\delta < 0$. If the null hypothesis is not rejected, it means the time series contains a unit root. Otherwise, the time series is said to be stationary with zero mean, nonzero mean or in deterministic trend, respectively.

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[17] The discussions for ADF (1981) test are adapted from Gujarati (2003, pp. 814-818).

However, this unit root test assumes that the error term, u_t is uncorrelated. Therefore, this method is inapplicable in the case that the error term is correlated. Hence, the ADF (1981) unit root test is developed to accommodate this shortcoming by augmenting the lagged values of the dependent variable, ΔY_t. To take the Equation (4.11) as an example, the ADF test regression model is written as:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t \tag{4.12}$$

where ΔY_{t-1} is the lagged first difference, ε_t denotes white noise error term and m represents the number of lags. It is important to determine the number of lags before proceeding further into the unit root test, as appropriate lag length helps to determine the size and power of unit root test[18]. Usually, it has been suggested to select the lag length using the Schwert (1989) formula (see Harris, 1992).

Subsequently, the hypothesis testing is conducted. Similar to DF test, the estimated t-statistic in ADF test is compared with the critical value developed by MacKinnon (1991 and 1996). If the calculated t-statistic is smaller than the critical value at any level of significance, for instance 1 percent, 5 percent and 10 percent, the null hypothesis will not be rejected and vice versa. Therefore, non-rejection of null hypothesis implies that the time series is non-stationary. As such, the same procedure is repeated by differencing the time series. This time around, if the time series is found to be stationary, then the result concludes that the time series is integrated of order one, $I(1)$. Subsequently, the cointegration test can be carried out.

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[18] According to Harris and Sollis (2003), too few lags may result in over-rejecting the null when it is true, while too many lags may reduce the power of the test.

4.7 Dickey-Fuller Generalized Least Square (DFGLS) (1996) Unit Root Test

Besides the ADF test discussed earlier, there is another efficient unit root test that has begun to draw attention from recent research, which is the DFGLS unit root test. This test is known to have higher power than the ADF test to differentiate the stationary and non-stationary properties of time-series (Elliot, *et al.*, 1996). This test has been proposed by Elliot, *et al.* (1996) using local-to-unity generalized least square (GLS) detrending to transform the data series.

To begin, the y_t[19] is detrended via generalized least square (GLS) estimation. The detrended y_t is then denoted as y_t^d, that is:

$$y_t^d = y_t - \hat{\beta}' z_t \tag{4.13}$$

where $\hat{\beta}_0, \hat{\beta}_1$ are obtained by regressed y_t on z_t, for which $y_t = [y_1, (1-\bar{\alpha}L)y_2, ..., (1-\bar{\alpha}L)y_T]$, $z_t = [z_1, (1-\bar{\alpha}L)z_2, ..., (1-\bar{\alpha}L)z_T]$ and $\bar{\alpha} = 1 + \bar{c}/T$. When the deterministic trend z_t contains the intercept term only, then $z_t = (1)'$, while $\bar{c} = -7.0$. On the other hand, if trend and intercept term are included in the regression, $z_t = (1,t)'$ and $\bar{c} = -13.5$. Ultimately, the detrended y_t is replaced in the ADF regression model as shown below:

$$\Delta y_t^d = \alpha + \gamma t + \rho y_{t-1}^d + \sum_{i=1}^{m} \delta_i \Delta y_{t-i}^d + \varepsilon_t \tag{4.14}$$

where m is the maximum lag length.

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[19] The original y_t that being used to derive detrended y_t is obtained directly from the original ADF regression model [see Equation (4.12)]

In order to make a stationary decision, it is also based on the comparison with the critical value that has been developed. For DFGLS test, the critical value simulated by Elliot, *et al.* (1996) is similar to the DF critical value when there is trend and intercepts terms applied in the regression model. When the calculated *t*-statistic is greater than the critical value, then we will reject the null hypothesis of the data series containing a unit root.

4.8 Johansen-Juselius (JJ) (1990) Cointegration Approach

JJ (1990) cointegration test is one of the most popular method that have been widely utilized to investigate the long-run relationship between the economic variables. Although the cointegration approach has been first developed by Granger (1981) and extended by Engle and Granger (1987), this method poses some drawbacks over the cointegration method proposed by Johansen (1988, 1991) and Johansen and Juselius (1990).

In this study, the unrestricted VAR model has been used to examine the cointegration between the economic variables. It begins with the following equation:

$$Y_t = \alpha + \sum_{k=1}^{p} \Pi_k Y_{t-k} + \varepsilon_t \qquad (4.15)$$

where Y_t is an (n x 1) vector of non-stationary variables with t = 1,...,T, α is an (n x 1) constants vector and ε_t is a Gaussian error that is identically and independently distributed (i.i.d.), $(0, \Sigma)$.

Since the variables are assumed to be non-stationary, it must be cointegrated at first order by differencing the variable, such as $\Delta Y_t = Y_t - Y_{t-1}$. Therefore, Equation (4.15) should be restructuring as in error correction form:

$$\Delta Y_t = \sum_{k=1}^{p-1} \Gamma_k \Delta Y_{t-k} + \Pi Y_{t-1} + \varepsilon_t \qquad (4.16)$$

where Δ is the first differences operator, I is an (n x n) identity matrix, $\Gamma_k = \sum_{k=1}^{p-1} \Pi_k - I = -(I - \Pi_1 - ... - \Pi_k)$ and $\Pi = \sum_{k=1}^{p} \Pi_k - I = -(I - \Pi_1 - ... - \Pi_p)$, with k = 1,2,..., p-1.

Moreover, in order to derive maximum likelihood estimates for cointegrating vector, the (n x n) matrix, Π, is produced by the form of $\Pi = \beta\theta'$, where β is an adjustment parameters and θ is an r cointegrating relations among variables. Then, the rank, r, in Π matrix is used to indicate the number of combination Y_t that is stationary. If r = 0, this means the combination of Y_t is non-stationary. Then the Equation (4.16) will be applied to transform the model into first difference form. The reformulate equation is shown in Equation (4.17). Consequently, ? Y_t are stationary with integrated of order one when $0 < r < n$.

$$\Delta Y_t = \alpha + \sum_{k=1}^{p-1} \Gamma_k \Delta Y_{t-k} + (\beta\theta')Y_{t-1} + \varepsilon_t \qquad (4.17)$$

Furthermore, to determine rank, *r*, it can be identified through two approaches. First is the Trace test (λ_{trace}) and second is the Maximum Eigenvalue test (?$_{max}$). For the Trace test, the formula is as below:

$$\lambda_{trace} = -T \sum_{i=q+1}^{p} \log(1-\hat{\lambda}_i) \qquad (4.18)$$

where $\hat{\lambda}_i$ is estimated eigenvalues and T is number of observations. The null hypothesis for Trace test is there are at most *r* cointegrating vector against the alternative hypothesis of there are *r* or more cointegrating vector, where r = 0,1,2,...,etc.

To this extent, the Maximum Eigenvalue test (?$_{max}$) is formulated as below:

$$\lambda_{max} = -T \log(1-\hat{\lambda}_r) \qquad (4.19)$$

It is tested by the null hypothesis that there are *r* cointegrating vectors against $r + 1$ cointegrating vectors for alternative hypothesis. Identically, both of these tests have non-standard distributions, thus it is compared with the critical value tabulated by Johansen and Juselius (1990). If the test statistic is greater than the tabular value, the null hypothesis will be rejected.

4.9 Vector Error Correction Model (VECM)

In the presence of cointegrating relationship between the examine variables, it has been suggested that the finding of no causality is ruled out (Masih and Masih, 1996). Therefore, as indicated by Granger (1986, 1988), as long as the two variables share the common trend and are moving together in long-run, there must exist a causality pattern between them, either unidirectional or bidirectional. Therefore, Engle and Granger (1987) state that the existence of corresponding error correction representation derive from the cointegrating vector being used to indicate the changes in dependant variables due to the level disequilibrium in long-run and fluctuations in short-run elasticity.

Therefore, the error correction model (ECM) framework provides an additional channel for testing the Granger causality. Then, the ECM can be expressed in the following form:

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{m} \beta_{1,i} \Delta Y_{t-i} + \sum_{i=1}^{n} \beta_{2,i} \Delta X_{t-i} + \mu_1 ECT_{t-1} + \zeta_{1t} \qquad (4.20)$$

$$\Delta X_t = \delta_0 + \sum_{i=1}^{n} \phi_{1,i} \Delta X_{t-i} + \sum_{i=1}^{m} \phi_{2,i} \Delta Y_{t-i} + \mu_2 ECT_{t-1} + \zeta_{2t} \qquad (4.21)$$

where Δ is the lag operator, α_0, δ_0, β's and ϕ's are the estimated coefficients, m and n are the optimal lags of the series Y and X, ζ_{it}'s are the serially uncorrelated random error terms while μ_1 and μ_2 measure a single period response of Y or X to a departure from equilibrium. Thus, the interchange role between series Y and X in Equation (4.20) to derive Equation (4.21) is called VECM.

Since this ECM is applied to investigate Granger causality among the variables, it can be detected through conventional *t*-test and joint *F*-test on the lagged *ECT* and the lag of all independent variables, respectively. However, if there is an indication of non-significance of both *t*-test and *F*-test, this will imply the econometric exogeneity of the dependent variable (Masih and Masih, 1996).

Thus, when both of these tests are significant, it will indicate the short term and long term causal effect between these variables. For instance, if the *F*-test on all lagged independent variables is significant, as the null hypothesis of H_0: $ß_1 = ß_2 \ldots ß_k = 0$ is rejected, then it will show that there is a short term causal effect, where the short-run elasticity reflects the changes of dependent variable due to the changes in independent variable. Moreover, if the *t*-test on the lagged *ECT* is significant, it will indicate the long term causal effect as the lagged *ECT* contains the long term information. Additionally, the speed of adjustment will be captured by the coefficient of lagged *ECT*. This is where the long term disequilibrium will be eliminated by short term adjustment. Therefore, when the examined variables are cointegrated, any deviation from the long-run equilibrium point will be eliminated by the short term adjustment. Due to this, it is important to have a significant lagged *ECT*, otherwise this will indicate the violation of the theory.

However, if the examined variables are not cointegrated with each other, then they only enter into the standard Granger (1969) causality test. The model for this test is similar to Equation (4.20) and (4.21) with the exclusion of *ECT* in the model. This is because since *ECT* is representing the long-run information contain in the model, therefore when there is no long-run relationship, the *ECT* is unnecessary to be included in the model. In other words, it is sufficient to study the short-run causality between the examine variables when the long-run relationship does not exist.

4.10 Generalized Variance Decomposition Analysis (GVDCs)[20]

The causality test discussed in the previous section is known as an in-the-sample causality test. According to Masih and Masih (1997), the ECM *F*- and *t*-tests have been conducted within the sample size. Therefore, beyond the sample period, these approaches are unable to show the dynamic properties of the system and to measure of the relative strength among the examine variables. So, the out-of-sample causality test like variance decomposition analysis (VDCs) has been defined to have a good picture on the relative strength of these variables. For the VDCs, it has been used to explain the distribution of forecast error variance of one variable into proportion due to the innovations in other variables, including its own.

In the past, the traditional decomposition analysis is computed after the shocks in the systems have been orthogonolized using the cholesky decomposition (see Sims, 1980). Therefore, it is important to determine the ordering of the variable before entering into the analysis. In addition, the result is variant when the variables are reordered in the VAR model. Due to this, the orthogonolized approach is said to be sensitive to the ordering of the variables and the lag length selections (see Lütkepohl, 1991). To take note on these drawbacks, Pesaran and Shin (1998) have proposed

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[20] The discussions for GVDCs are adapted from Pesaran and Shin (1998, pp. 17-29).

another approach, namely GVDCs to overcome this problem. From the infinite moving average representation, the GVDCs model can be established.

By considering the VAR model used in the GVDCs, we begin with the following equation:

$$X_t = \sum_{i=1}^{p} \Phi_i X_{t-i} + \Psi w_t + \varepsilon_t,\ t = 1, 2, ..., T, \qquad (4.22)$$

where the m x 1 vector of jointly determined dependent variables is $X_t = (x_{1t}, x_{2t}, ..., x_{mt})'$, while the deterministic and/or exogenous variables is represented by w_t, q x 1 vector. For the m x m and m x q coefficient matrices, they are denoted by $\{\Phi_i, i = 1,2,..., p\}$ and Ψ. To this extent, it is assumed that VAR model is not perfectly collinear and X_t is covariance stationary. Hence, the Equation (4.22) can be restructured as the infinite moving average representation shown below:

$$X_t = \sum_{i=0}^{\infty} A_i \varepsilon_{t-i} + \sum_{i=0}^{\infty} G_i w_{t-i}, t = 1, 2, ..., T, \qquad (4.23)$$

where the coefficient matrices A_i is obtained from the following equation:

$$A_i = \Phi_1 A_{i-1} + \Phi_2 A_{i-2} + ... + \Phi_p A_{i-p}, i = 1,2,..., \qquad (4.24)$$

with $A_0 = I_m$ and $A_i = 0$ for $i < 0$, and $G_i = A_i \Psi$.

Since the VDCs is the method that forecast the effect of shocks, there are three important information should be contained in the model. For instance, the size of shocks occurs at time *t*, the steady-state economic conditions at time *t*-1 and the expected shocks hitting the economy at time *t*+1. Then, the GVDCs model is shown in below:

$$\theta_{ij}^{g}(n) = \frac{\sigma_{ii}^{-1} \sum_{l=0}^{n} (e_i' A_l \sum e_j)^2}{\sum_{l=0}^{n} e_i' A_l' e_i}, i, j = 1, \ldots, m \qquad (4.25)$$

whereby $\sum_{j=1}^{m} \theta_{ij}^{g}(n) \neq 1$, as the original shocks is a non-zero covariance.

4.11 Persistent Profile Technique[21]

Persistent profile technique was developed by Pesaran and Shin (1996) as a tool to measure the speed of adjustment of the cointegrating relation (i.e. $Z_t = \beta' X_t$) towards the long-run equilibrium point following system-wide shock. Through the draw from a multivariate distribution of the vector $\varepsilon_t = [\varepsilon_{1t}, \varepsilon_{2t}, \ldots, \varepsilon_{pt}]$, the shock is analyzed. This approach is an extension from the traditional IRFs. However, it poses an advantage over the traditional IRFs as it is invariant to the ordering of shocks that have been orthogonalized in the underlying VAR model. At time *t*, the variance-covariance matrix of the shock ε_t is Σ. Based on the information available at time *t*-1, the propagation is reviewed through time *t*+1 to *t*+*n* of the variance of shock. In

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[21] The discussions for persistent profile technique is adapted from Yang, *et al.* (2005, pp. 7-8).

addition, the variance of disequilibrium error in this technique is increasing from time $t+1$ to $t+n$. Following this, the unscaled persistent profile is shown as below:

$$H_z(n) = Var(Z_{t+n} \mid I_{t-1}) - Var(Z_{t+n-1} \mid I_{t-1}) \quad (n = 0,1,2,\ldots) \qquad (4.26)$$

where $Var(Z_{t+n} \mid I_{t-1})$ is the variance of Z_{t+n} conditional on the information set, I_{t-1}, while n denotes the time horizon. Thus, in a stationary equilibrium, the shock will finally be eliminated. In other words, as time goes by, the incremental variance will become smaller and smaller and reach zero. Thereby, the speed of convergence after shock is indicated by $H_z(n)$.

4.12 Data Description and Model Formulation

In order to conduct the analysis, there are 11 variables that have been used in this study. These include the Malaysian premium petrol price (also known as RON97 starting 1 December 1991), indicated as fuel price and GDP by kind of economic activity that covers the value added for 10 major sectors in Malaysia (see Table 4.1). For the fuel price variable, we use the domestic fuel price instead of world crude oil price like many previous empirical analyses due to several reasons. First, the fuel price in Malaysia had been subsidized by the government. Therefore, any changes in the world oil price will not instantly reflect the domestic fuel price. As such, it is rather the domestic fuel price than the world oil price that directly influences economic activity in Malaysia. Second, although there are many empirical studies that employed the world oil price variables, their analyses are focused on the macroeconomic activity rather than disaggregating sectoral output, therefore, we follow the study by Saari, *et al.* (2008) that utilized the domestic petroleum price in assessing the impact on the selected sectoral outputs in Malaysia.

Table 4.1: List of Variables

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

This study employs quarterly data that spans from 1990:Q1 to 2007:Q4 which consists of 72 observations. The study period is chosen based on the availability of the data and these periods cover a range of fuel price adjustments made over these few years that may better reflect fuel price increase. Accordingly, all of the examine variables have been transformed into natural logarithm before entering the examination with the purpose of compressing the variables' scale (Gujarati, 2003). Apart from that, the real prices for the economic sector have been obtained through dividing the nominal prices with the domestic consumer price index (CPI). Then, in terms of data sources, the fuel price data has been obtained from the Ministry of Domestic Trade and Consumer Affairs that is measured in Malaysia Ringgit (MYR) per liter, while the 10 disaggregating outputs data are compiled from Monthly Statistical Bulletin (various issues), published by Bank Negara Malaysia that are measured in MYR millions.

In this context, all of the identified variables will be tested based on the bivariate basis, with the fuel price being the independent variable, while each of the economic sectors is presented as dependent variable. Thus, the model formulation for this study is shown as follows based on the basic linear regression model:

$$Y = \beta + \beta_1 X_1 + \varepsilon \tag{4.27}$$

where Y = the dependent variable,

β = intercept,

β_1 = regression coefficient,

X_1 = the independent variable and

ε = error term

CHAPTER FIVE

EMPIRICAL RESULTS AND DISCUSSIONS

5.0 Introduction

This chapter focuses on the empirical results of this study and their interpretation. Initially, we will discuss the Augmented Dickey-Fuller (ADF) and Dickey-Fuller Generalized Least Square (DFGLS) unit root tests results in order to determine the variables' stationary properties before proceeding to the next step. Next, the Johansen-Juselius (JJ) cointegration test results will be discussed to identify long-run relationship between the variables. Consequently, the vector error correction model (VECM) will give us a significant review on the "long-term" and "short-term" Granger causality in the cointegrating relationship. Furthermore, by tracing out the dynamic path of the persistent profile shock on the cointegrating vector, it helps to figure out the convergence of the cointegrated vector towards the long-run equilibrium point.

However, since the VECM does not gauge the out-of-sample causality and explain the degree of variables' exogeneity, thus the generalized variance decomposition analysis (GVDCs) is presented to assess the variation in one variable due to the innovation in other variables including its own. Meanwhile, for the non-cointegrated variables, the interaction amongst the variables can be expressed through the standard Granger causality test results that show the short-run causality pattern between the examined variables. Again, these non-cointegrated variables were analyzed through the GVDCs derived from the vector autoregressive (VAR) model with the purpose as explained before.

5.1 Unit Root Analysis

In an empirical study, the initial analysis that needs to be conducted is to test the presence of stationary properties of the time-series data. In most of the time-series data, it tends to be trend stationary. As such, the evidence of co-movement between the variables is spurious due to the time trend correlations amongst the time-series. By regressed the variables on time or including a deterministic time trend, the valid inferences can be drawn from the stationary series (Harris and Sollis, 2003). In addition, it is also important to verify the order of integration of time-series data. As according to Granger (1986), it is necessary for the cointegrated variables to be integrated at the same order or to contain a deterministic trend.

In this study, we have employed the conventional ADF unit root test and modified ADF test, namely DFGLS unit root test to check for the stationary properties of all series. The variables under consideration include lfuel, lragri, lrmin, lrmfc, lrcons, lrutilities, lrtrade, lrtransport, lrfin, lrgov and lroth[22]. According to Hamilton (1994), if a series contains both deterministic or stochastic trend, the intercept and trend terms should be included in the test model. Meanwhile, if the series does not display any trend and fluctuates around nonzero mean, then the test model should include intercept term only. However, to make our results more robust, both terms

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[22] Please refer to Table 4.1 for the description of these variables.

have been implemented in level and first differences forms. Table 5.1 presents the results summary from the ADF and DFGLS unit root tests.

Panel A reports the test statistics obtained from the ADF test. Since the ADF test results are sensitive to the lag length selection, therefore the lag length in ADF test is selected automatically based on Schwartz Information Criterion (SIC). Accordingly, the critical values developed by Mackinnon (1996) have been used to compare with the ADF test statistics. Since in level form all the series' test statistics are less than the developed critical values, we fail to reject the null hypothesis. The non-rejection of the null hypothesis indicates that the time-series data contains a unit root. As such, first differencing of all series needs to be implemented in order to acquire stationary series. This time around, all the test statistics are greater than the critical values, we can then reject the null hypothesis at 5 percent level of significant.

To confirm our findings, again, the application of DFGLS unit root test, which is said to be more efficient than the ADF test, also shows similar results for all series (see Panel B), whereby the DFGLS test statistics are less than the critical values, leading to the non-rejection of the null hypothesis against the alternative hypothesis at level form but rejects the null hypothesis at first difference form at 5 percent level of significance. Since all the series are stationary at the first difference, therefore no further test, such as second difference need to be conducted.

Consequently, the consistent results drawn from these tests enable us to conclude that all variables are non-stationary at level form but stationary at first difference form. Such findings supported the indication by Dickey, *et al.* (1991) who claims that many macroeconomic series tend to represent adequately by first differencing rather than their levels. As such, the first order integration of the series are said to be integrated of order one, *I*(1). Since the stationary properties of the data series is established with the same order of integration, the JJ cointegration analysis is proceeded to identify the long-run relationship between the examine variables.

Table 5.1 Unit Root Test Results

Variable	Test Statistics								Conclusion
	Level				First Difference				
Panel A:	t_μ		t_τ		t_μ		t_τ		
lfuel	1.603	[1]	-0.508	[1]	-4.641*	[1]	-5.157*	[1]	*I*(1)
lragri	-0.260	[4]	-1.467	[4]	-3.093*	[3]	-9.752*	[1]	*I*(1)
lrmin	0.215	[1]	-2.634	[1]	-6.080*	[1]	-6.394*	[1]	*I*(1)
lrmfc	-1.538	[2]	-3.034	[4]	-10.681*	[1]	-10.784*	[1]	*I*(1)
lrcons	-2.702	[4]	-2.999	[5]	-5.744*	[1]	-6.195*	[1]	*I*(1)
lrutilities	-2.638	[3]	-1.113	[6]	-3.140*	[3]	-5.345*	[5]	*I*(1)
lrtrade	-0.473	[4]	-1.880	[4]	-3.029*	[3]	-10.661*	[1]	*I*(1)
lrtransport	-1.724	[7]	-2.860	[4]	-4.720*	[6]	-4.999*	[6]	*I*(1)
lrfin	-1.882	[1]	-2.037	[1]	-6.374*	[1]	-6.579*	[1]	*I*(1)
lrgov	1.347	[4]	-1.045	[4]	-4.525*	[4]	-4.838*	[4]	*I*(1)
lroth	-2.183	[4]	-2.147	[2]	-3.233*	[3]	-7.794*	[1]	*I*(1)
Panel B:	τ_μ		τ_τ		τ_μ		τ_τ		
lfuel	1.856	[1]	-0.469	[1]	-4.489*	[1]	-5.155*	[1]	*I*(1)
lragri	0.519	[4]	-1.857	[4]	-2.856*	[3]	-3.150*	[3]	*I*(1)
lrmin	0.448	[1]	-1.785	[1]	-5.968*	[1]	-6.261*	[1]	*I*(1)
lrmfc	0.883	[4]	-1.631	[5]	-10.422*	[1]	-10.931*	[1]	*I*(1)
lrcons	-0.514	[5]	-1.561	[5]	-4.645*	[1]	-6.173*	[1]	*I*(1)
lrutilities	-0.286	[8]	-1.612	[8]	-2.056*	[3]	-5.053*	[2]	*I*(1)
lrtrade	1.449	[4]	-1.352	[4]	-9.154*	[1]	-10.391*	[1]	*I*(1)
lrtransport	1.121	[5]	-1.551	[5]	-4.768*	[6]	-5.079*	[6]	*I*(1)
lrfin	1.215	[1]	-1.435	[1]	-6.421*	[1]	-6.625*	[1]	*I*(1)
lrgov	1.078	[9]	-0.955	[8]	-2.719*	[7]	-4.953*	[6]	*I*(1)
lroth	1.025	[4]	-0.772	[4]	-2.567*	[3]	-7.890*	[1]	*I*(1)

Notes: The t and τ statistics are for ADF (Panel A) and DFGLS (Panel B) unit root tests, respectively. The subscript μ allows an intercept term while τ in the model allows for intercept and deterministic trend term. Asterisk (*) indicates statistically significant at 5 percent level. The values in square bracket [ ] are the optimum lags determined by Schwartz Information Criterion (SIC).

5.2 Johansen-Juselius (JJ) (1990) Cointegration Test Results

In an attempt to find out the long-run relationship between fuel price and the disaggregated output in Malaysia, we have performed the JJ cointegration analysis in order to shed light on the co-movement between these variables. After testing the univariate properties of each variable, the next step is to identify the number of optimum lags that enter the VAR model. Such procedure is important as the cointegration analysis is sensitive to the lags order (Hall, 1991). With the appropriate lag length selection, it is likely to help avoid the serially correlated problem existing in the error terms. As such, in this study, we have employed the Shcwert (1987) approach to determine the number of lags and the selected optimum lags is equal to four ($k = 4$) that is being applied in the VAR system.

Accordingly, the estimated results presented in Trace test and Maximum Eigenvalue test will indicate the number of cointegrating vectors that exists in this study. The presence of the significant long-run relationship is built when the test statistics are greater than the critical values established by Mackinnon (1991). As referred in Table 5.2, the estimated results shown in Panel B, C, D, E, G, H and I indicate that we fail to reject the null hypothesis against the general hypothesis for both Trace test and Maximum Eigenvalue test. As such, this implies that the mining sector, manufacturing sector, construction sector, electricity and gas and water sector (hereafter utilities sector), transport, storage and transportation sector (hereafter transportation sector), finance, insurance, real estate and business services sector (hereafter finance sector) and government services sector do not cointegrate with the fuel price. As such, the inferences that we can draw from these results are that most of the economic sectors in Malaysia are unlikely to have a long-run relationship with the domestic fuel price.

Table 5.2: Johansen-Juselius Cointegration Test Results

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

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

On the other hand, the opposite results have been found in Panel A and F, as both of the Johansen's LR tests consistently show that the first null hypothesis have been rejected at 5 percent level, as the test statistics are greater than the tabulated critical values. In this context, it implies that the agriculture sector, and wholesale and retail trade, accommodation and restaurants sector (hereafter trade sector) are cointegrated with the fuel price in long-run. For the remaining sector (i.e. other services sector as shown in Panel J), it is interesting to note that inconsistent results have been obtained from the two LR tests, where the Trace test indicates the absence of cointegrating relationship, while the Maximum Eigenvalue test has identified a unique cointegrating relationship between the examine variables. Under such circumstances, we will rely on the Maximum Eigenvalue test as Johansen and Juselius (1990) claims that this test has high power as compare to the Trace test. As such, the other services sector is considered to be cointegrated with the fuel price.

With the evidence of co-movement between the fuel price and the agriculture sector, trade sector and other services sector with single cointegrating vector, it is therefore suggested that these sectors tend to move together with fuel price and bind together in one equilibrium point in long-run. Then, by normalizing each of the cointegrating vectors with respect to fuel price, the estimated long-run regression model is established. Since the normalized equations are expressed in the double logarithm functional form, the estimated coefficients are therefore known as elasticity coefficient. The normalized equations with respect to fuel price are given as follows:

$$\text{lragri} = 4.016 + \underset{[5.776]^{*}}{1.953}\ \text{lfuel} \tag{5.1}$$

$$\text{ltrade} = 4.350 + \underset{[6.628]^{*}}{1.609}\ \text{lfuel} \tag{5.2}$$

$$\text{lroth} = 3.774 + \underset{[1.791]^{**}}{0.537}\ \text{lfuel} \tag{5.3}$$

For the first regression model [see Equation (5.1)], the positive elasticity coefficient for lfuel has verified that fuel price is positively related to the agriculture sector in Malaysia. Additionally, the evidence from statistically significant *t*-statistics at 5 percent level has strengthened this long-run relationship. As such, we can expect that when fuel price increases by 1 percent, the agriculture sector output will increase by 1.953 percent. Although the simulation study conducted by Saari, *et al.* (2008) has found that the increase of domestic petroleum price will transfer higher cost to the agriculture sector as this sector consumes large amounts of petroleum related products as the intermediate inputs, but the identified positive relationship in this study can be explained through which the output value has increased due to the contribution from certain primary commodities, especially oil palm production as it is more or less related to the international oil prices. For instance, as crude oil price keeps on soaring in the international market, some countries might shift to biofuel consumption. As a result, the by-products of biofuel such as oil palm and soy bean will be raised in its demand. As one of the major exporters of crude palm oil, Malaysia is likely to benefit from the increase of oil palm demand. Therefore, the increase of output value is expected to encounter the overall rise in the cost of production in the agricultural sector.

Apart from that, positive long-run relationships between fuel price and the final services sector that covers the trade sector and other services sector have also been observed. The positive sign of lfuel has indicated that when fuel price increase by 1 percent, the trade sector and other services sector will increase by 1.609 percent and 0.537 percent, respectively. The validity of these long-run relationships is affirmed when both of the represented *t*-statistics are statistically significant at 5 percent and 10 percent levels, respectively. The reason behind these positive associations may be due to the acceleration of the products price in the market that eventually leads to higher output value. Such transformation again has a linkage with fuel price, whereby when fuel price increase in the market, the service provider will increase their products' price in order to gain higher profits. As an example for the trade sector, when domestic fuel price increases as well as the world oil price hikes, it will indirectly raise up the energy related products price and food price in the market. As a way to circumvent this problem, the retailer and restaurants will rush to make an adjustment in their products' price by charging higher. Towards this end, the service providers are likely to benefit from the fuel price increase as they grabbed this opportunity by increasing their product prices higher than the input price increase in order to gain higher profit. Eventually, the value added for this sector will be accelerated.

Since most of the intermediate input and final output prices have increased in the market, people will expect that goods and services in the market become more expensive. Thus, other non-oil related industries like private health, private education, entertainment activities, laundry services and other services will also raise up their service price as their operating costs have increased. As such, the output value will increase in the long-run. However, since such service industries are very important in our daily lives, people tend to accept this price level. Though, we have to take note that the drastic increase of output price in the market is likely to fire up the inflation pressure in Malaysia.

However, in the most recent drop in domestic fuel price associated with the fall in international crude oil price due to worldwide economic slowdown, the impact might be felt by Malaysian economy. According to Richardson (2009), as the oil and food exporting countries like Malaysia, Vietnam and Thailand, they were helped by the surge in prices in the first half of 2008 but also the losers when the price collapses. From a short term point of view, the reduced in fuel price generally will help minimize the inflation problem in the country and improve the standard of living. However, in long term, this will lead to the contraction in investment activity for some industries such as palm oil plantation, and oil exploration and production activity[23]. Thus, in future the problem of short of supply may still arise and raise up the fuel price.

5.3 Temporal Causality Results in Vector Error Correction Model (VECM)

In an attempt to find out the long-run relationship between the examined variables using the JJ cointegration test, this approach, however, does not provide the information about the direction of causality between the variables. To this extent, VECM approach is built to provide an additional channel for the determination of the long-run and short-run causality pattern amongst the cointegrated variables. The error correction term (*ECT*), derived from the cointegrating relationship, is used to detect the long-run relationship and the speed of adjustment. Therefore, the significant *ECT* will imply the adjustment in the dependent variable towards the long-run equilibrium. Meanwhile, the joint significance of the explanatory variables will indicate the short-run interaction with the dependent variable.

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[23] The cheaper fuel price will discourage biofuel utilization and hence slower down the biofuel industry's development. This in the end will affect the palm oil demand. Similarly, when the fuel price is low, the oil producer may not favorable to invest in oil exploration and production activity or continue operating the uneconomic oil field.

Table 5.3: Temporal Causality Results in Vector Error Correction Model

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

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

The results presented in Table 5.3 are the temporal causality estimates in VECM. Since a single cointegrating vector exists in the two dimensional VAR model, there is only one unique *ECT* in each of the equations under study. By referring to Panels A, B and C in Tables 5.3, the economic sector equations are presented first followed by the fuel price equation. By discerning each of the respective coefficients of the *ECT*, the estimated results indicate that only the coefficients of the ECT in the economic sector's equation are statistically significant. Therefore, we can suggest that fuel price in the long-run has an influential impact on the economic sectors in Malaysia. As a result, each of the respective economic sectors will bear the brunt of short-run adjustment towards its long-run equilibrium point. In other words, any short-run deviation from the long-run equilibrium point will be corrected by the adjustment in the economic sector. As highlighted in the coefficient of *ECT*, the speed of adjustment for the agriculture sector and trade sector is quite fast, whereby both of these sectors will move together with fuel price and achieve one equilibrium point after one and two years, respectively. However, it takes a longer time for the other services sector to make an adjustment that is after five years. On the other hand, the identified insignificant coefficients of the ECT in all of the fuel price equations have been observed. Such phenomena have therefore indicated that the economic sectors do not play a significant role in affecting the domestic fuel price[24]. Thus, we can say that the fuel price variable is relatively exogenous in this study as it cannot be influenced by other variables. Additionally, the appearance of the single significant coefficient of the *ECT* in each panel also reinforces that there is only one cointegrating relationship in the respective cointegrated variables as stated earlier in the JJ cointegration analysis.

Besides the observation on the long-run interaction, the short-run dynamic interaction also can be assessed through the significant *Chi*-square statistics. Interestingly, the presented results have shown that two of the null hypothesis, that are fuel price does not Granger cause agriculture sector and fuel price does not Granger cause trade sector have been rejected at 5 percent level, leaving the remaining null hypotheses non-rejected. Such results therefore have identified a unidirectional causality relationship between fuel price and the agriculture and trade sectors in Malaysia, with fuel price being the leading variable in this relationship. Thus, in the short-run, any changes in domestic fuel price could be rapidly anticipated by the changes in agriculture sector and trade sector, such as the drastic increase of palm oil demand and the surge of retail products prices in the market in response to the fuel price increase as well as world oil price hikes[25]. Meanwhile, for the non-rejected null hypotheses, these have implied that all of the related lagged explanatory variables do not contain the predictive information on the respective dependent variables. That is, the economic sectors in Malaysia do not have the ability to influence the domestic

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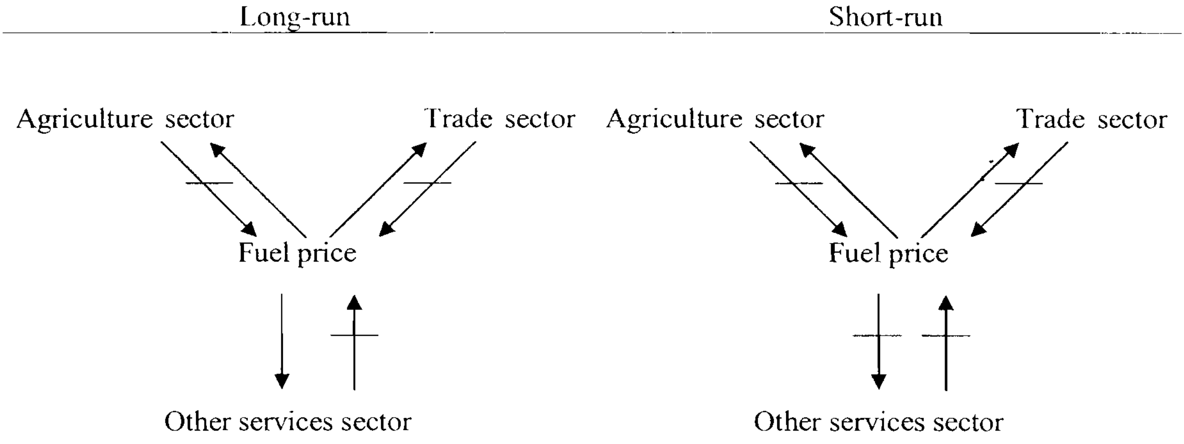
[24] Such results reaffirm the role plays by the government in controlling the domestic fuel price and therefore the economic sectors may not have a significant influence on fuel price.

[25] When oil price began to increase in year 2004, the production of crude palm in Malaysia has increased from 13,976,000 tonnes in 2004 to 17,734,000 tonnes in 2008. Meanwhile, at the same periods, the CPI in Malaysia has increased from 105.9 points to 111.4 points.

fuel price. However, for the non-causality from the fuel price to other services sector, this may be due to the lagged response from the other services sectors towards the changes in fuel price, meaning that the other services sector only responded to the fuel price changes in the long-run but not in the short-run. The results for the temporal causality in VECM are summarized in Figure 5.1.

Figure 5.1: Summary for Temporal Causality Results in Vector Error Correction Model



Note: ⟶ indicates Granger cause while ⟶|⟶ indicates non-Granger cause.

5.4 Generalized Variance Decomposition Analysis (GVDCs)

Besides the examination on the variables' causality relation within the sample period, the GVDCs are another tool that helps to measure the out-of-sample dynamic interaction between the variables. Documented in Table 5.4 are the decomposed forecast error variance of the variables due to the innovation in other variables and its own over the different time horizon. Thus, the values (i.e. in percentage) in the main diagonal provide sufficient forecasting information about to which extent the relative variance of one variable is being explained by its own shock or other variable's shocks. If it is mainly explained by its own shock, the variable is said to be relatively exogenous.

From the reported decomposition results, it shows that the relative variance of most of the variables have been largely attributed by its own shock, especially the relative variance in fuel price. As shown in Panel A, the relative variance of lragri and lfuel are explained by their own shock in the first quarter, which are 94.213 percent and 98.651 percent, respectively. However, the relative exogenous of lragri has become relatively endogenous when the contribution by its own shock has decreased drastically as time horizon expands to 24 quarters, whereby less than half of the lragri variance is being explained by its own innovation. Therefore, this implies that the fuel price has a greater impact on the agriculture sector after 24 quarters, which constitutes about 82.679 percent. Meanwhile, the lfuel still remains its relative exogeneity on the relative variance in lfuel on the 24 quarters that is 97.913 percent.

Similar results are also reported in Panel B, whereby in the first few quarters the variables' relative variance have been explained by its own shock. For instance, in the first quarter, 98.818 percent of the variation in lrtrade has been attributed by its own shock. But when the time horizon reaches 24 quarters, the variation in this sector has been largely indicated by lfuel, which constituted 63.939 percent. Nevertheless, such phenomena does not exist in the variation in lfuel as we notice that even from the beginning until the 24 quarters, approximately more than 90 percent of the relative variance in lfuel has been mainly explained by its own innovation (i.e. 97.899 percent in the first quarter and 94.280 percent in the 24 quarters). As such, we can draw an implication that fuel price tends to be strongly affected the trade sector only after several quarters. On the other hand, the shock in fuel price has retained as an important movement that affect the variation in lfuel.

Table 5.4: Generalized Variance Decomposition Analysis (GVDCs) Results

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

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

Although a similar trend is likely to appear in the previously discussed results, it is however interesting to observe that such a trend does not exist in the results presented in Panel C that decomposes the relative variance in other services sector. In particular, in the first quarter, about 99.795 percent of the relative variance in lroth has been attributed by its own shock. Up until 24 quarters, it remains relatively explained by its own shock but at a decreasing rate that is 77.596 percent. Thus, we can conclude that the innovation in lroth has retained its relative exogeneity in affecting its own variation. But such impact may disappear in a longer time frame as the decreasing trends have been observed, which means it is rather fuel price shock than other services sector shock in affecting the variation in lroth in future. In other words, the fuel price shock is able to affect the other service sector, but at a slower pace. Again, the presented results have firmly justified that the shock in fuel price is relatively exogenous in explaining its own variance, which is 99.879 percent and 98.808 percent in the first quarter and 24 quarters, respectively.

Overall, the decomposition results for the relative variance in lfuel have indicated that fuel price is the relative exogenous variable in this study as its forecast variance cannot be largely explained by other variables under study. As such, it is known to be the most exogenous variable in the system. In addition, such verification has also been supported by the other implications, such as in a longer time horizon, the shock in fuel price has emerged as a mover that helped to explain the relative variance in economic sectors, especially in the agriculture and trade sectors. Thus, from the acquired empirical results, we can expect that in long-run, the movement in fuel price is able to affect the changes in economic sectors. Likewise, these results support the findings from VECM presented earlier that indicate that fuel price is the exogenous variable whilst it can affect the economic sectors in the long-run.

5.5 Persistence Profile Shock for Cointegrating Vector

Having identified a single cointegrating relationship between the fuel price and the agriculture sector, trade sector and other services sector in the JJ cointegration analysis, we have further adopted the persistent profile technique to examine the effect of system-wide shock on the cointegrating vector. This approach is quite similar to the impulse response function analysis (IRFs) but it investigates the variables' response towards a one standard deviation shock in a whole system. Therefore, the invariant result obtained is regardless to the ordering of the variables in the VAR system. By plotting the persistent profile shock for cointegrating vector, it provides us the information about the speed of adjustment or convergence to the long-run equilibrium due to the shock.

Figures 5.2 (a), (b) and (c) show the persistent profile shocks for cointegrating vector. For Figure 5.2 (a), it shows a declining trend of the cointegrating vector in moving towards the long-run equilibrium point. In other words, their response to a system-wide shock is quite marginal as their response is lower than one unit throughout the horizon. For Figures 5.2 (b) and (c), the overshooting effects have been observed in the first few quarters, whereby the cointegrating vector response higher than one unit due to the one unit shock in the system. Nevertheless, these effects tend to be eliminated after a few quarters (i.e. starting from quarter seven to quarter nine) before reaching zero point. Thus, the forecasting effects of shock on the cointegrating vector are rather temporary.

5.6 Granger Causality Test Results

In this study, there are several sectors that are found to be non-cointegrated with fuel price in the long-run. With such findings, we wish to present the Granger causality test results for further understanding of the short-run relationship or the direction of causality between these non-cointegrated variables. Though the variables under consideration are non-stationary in their level, the standard first difference VAR model is applied. As reported in Table 5.5, is the *F*-statistics for the Granger causality test spanning from lag one to lag four. The null hypothesis of no Granger causality from lfuel to each of the sectoral outputs (i.e. variables that are not cointegrated) and vice versa is tested against the alternative hypothesis. The insignificant *F*-statistics will indicate non-causality between these variables.

Panels B, C, D, E and F in Table 5.5 show that the *F*-statistics are insignificant. Therefore, this hinders us from rejecting the null hypothesis. As such, this implies that the fuel price does not Granger cause the manufacturing sector, construction sector, transportation sector and financial sector in Malaysia and vice versa in the short-run. Apart from that, although the results showed in Panel G have indicated that there is bidirectional causality between the fuel price and government services sector in lag one since both of the null hypothesis have been rejected, but these relation do not exist after that (i.e. from lag two to lag four). Therefore, we rather justify that there is no causality relationship between these variables as their relation only exists in a very short period of time.

Table 5.5: Granger Causality Test Results

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

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

However, the results presented in Panel A have verified that there is a short-run relationship between the mining sector and fuel price, at a unidirectional causality. The rejection of the null hypothesis of lrmin does not Granger cause lfuel throughout lag one to lag four has strongly supported that the mining sector in Malaysia is the leading variable that causes the domestic fuel price. Such causality pattern can be explained through which if the world oil price increases, the oil companies will strive to look for more oil reserves or extract more crude oil from previously uneconomical oil drilling fields. Accordingly, the mining sector's output will increase and contribute to the greater export earnings for Malaysia. As such, the revenues receive, in terms of tax, dividend and royalty can be used to finance the domestic fuel subsidies. Therefore, in the shorter period, the Malaysian government is able to maintain its domestic fuel price and reduce the nation's burden.

5.7 Generalized Variance Decomposition Analysis (GVDCs) in Vector Autoregressive (VAR) Model

Based on the standard Granger causality test performed in the previous section, the inference drawn from this test is that most of the non-cointegrated variables are found to be non-Granger cause each others in short-run. The ambiguous results therefore have prevented us from having a clear understanding of the interaction between fuel price and the economic sector. Therefore, we follow the suggestion by Engle and Granger (1987) that uses the VAR model in first difference form to further simulate the GVDCs model with the purpose to forecast the effects of fuel price shock on the respective economic sectors in Malaysia when they are not cointegrated. The estimated results for the GVDCs derived from the VAR model are further exhibited in Table 5.6.

From the reported results, it has been shown that over these 24 quarters, the relative variance in lfuel is generally explained by its own shock. Specifically, from Panel A to Panel G, we can see that the innovations in lfuel have accounted for more than 95 percent of the variation in lfuel, except for Panel D. For instance, 99.999 percent in first quarter and 96.310 percent in 24 quarters for Panel A, 97.537 percent in first quarter and 97.547 percent in 24 quarters for Panel B, 95.513 percent in first quarter and 96.424 percent in 24 quarters for Panel C, 90.416 percent in first quarter and 85.578 percent in 24 quarters for Panel D, 98.851 percent in first quarter and 98.715 percent in 24 quarters for Panel E, 98.227 percent in first quarter and 97.359 percent in 24 quarters for Panel F and 99.944 percent in first quarter and 99.992 percent in 24 quarters for Panel G. As such, the weak influences of sectoral outputs on fuel price have therefore strengthened our previous finding that indicated that the fuel price variable is relatively exogenous in this study[26].

Table 5.6: Generalized Variance Decomposition Analysis (GVDCs) Results

Percentage of variations in	Horizon (quarters)	Due to innovation in:	
Panel A:		$\Delta lrmin$	$\Delta lfuel$
Quarters relative variance in: $\Delta lrmin$			
	1	*99.681*	0.319
	4	*98.620*	1.380
	8	*98.709*	1.291
	24	*99.046*	0.954
Quarters relative variance in: $\Delta lfuel$			
	1	0.001	*99.999*
	4	1.639	*98.361*
	8	2.864	*97.136*
	24	3.690	*96.310*
Panel B:		$\Delta lrmfc$	$\Delta lfuel$
Quarters relative variance in: $\Delta lrmfc$			
	1	*95.102*	4.898
	4	*90.738*	9.262
	8	*86.710*	13.290
	24	*83.987*	16.013
Quarters relative variance in: $\Delta lfuel$			
	1	2.463	*97.537*
	4	2.438	*97.562*
	8	2.452	*97.548*
	24	2.453	*97.547*
Panel C:		$\Delta lrcons$	$\Delta lfuel$
Quarters relative variance in: $\Delta lrcons$			
	1	*95.888*	4.112
	4	*95.722*	4.278
	8	*95.186*	4.814
	24	*94.987*	5.013
Quarters relative variance in: $\Delta lfuel$			
	1	4.487	*95.513*
	4	3.918	*96.082*
	8	3.749	*96.251*
	24	3.576	*96.424*

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[26] See discussions in Section 5.6.

Table 5.6: Generalized Variance Decomposition Analysis (GVDCs) Results (continued)

Percentage of variations in	Horizon (quarters)	Due to innovation in:	
Panel D:		Δlrutilities	Δlfuel
Quarters relative variance in: Δlrutilities			
	1	*94.934*	5.066
	4	*91.559*	8.441
	8	*86.522*	13.478
	24	*81.384*	18.616
Quarters relative variance in: Δlfuel			
	1	9.584	*90.416*
	4	13.303	*86.697*
	8	14.243	*85.757*
	24	14.422	*85.578*
Panel E:		Δlrtransport	Δlfuel
Quarters relative variance in: Δlrtransport			
	1	*94.608*	5.392
	4	*90.243*	9.757
	8	*85.610*	14.390
	24	*81.334*	18.666
Quarters relative variance in: Δlfuel			
	1	1.149	*98.851*
	4	1.227	*98.773*
	8	1.292	*98.708*
	24	1.285	*98.715*
Panel F:		Δlrfin	Δlfuel
Quarters relative variance in: Δlrfin			
	1	*99.617*	0.383
	4	*99.565*	0.435
	8	*99.591*	0.409
	24	*99.704*	0.296
Quarters relative variance in: Δlfuel			
	1	1.773	*98.227*
	4	2.680	*97.320*
	8	2.726	*97.274*
	24	2.641	*97.359*
Panel G:		Δlrgov	Δlfuel
Quarters relative variance in: Δlrgov			
	1	*99.897*	0.103
	4	*99.803*	0.197
	8	*99.312*	0.688
	24	*96.799*	3.201
Quarters relative variance in: Δlfuel			
	1	0.056	*99.944*
	4	0.026	*99.974*
	8	0.012	*99.988*
	24	0.008	*99.992*

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

Furthermore, for the examination on the relative variance in respective sectors, the relative exogenous characteristic also has been found within these sectors. Nevertheless, the effects of disturbances in fuel price on some sectors have arisen after several quarters. The identified sectors include manufacturing sector, utility sector, transportation sector and government services sector. For the manufacturing sector, the contribution of the disturbances in fuel price has increased from 4.898 percent in first quarter to 16.013 percent in 24 quarters. The slow transformation effects however, may reflect the different effects received by the sub-sectors including in the manufacturing sector. For instance, since refined petroleum products are not the main manufactured products in Malaysia, but electrical and electronic products, the influences from fuel price increases therefore will not immediately transfer to the manufacturing sector. As such, the time consumed by the manufacturing producer to make an adjustment therefore leads to the slow transformation effects. Such results are quite comparable to the findings by Jiménez-Rodriguez (2007) who claim that greater shock effect is received by the manufacturing industrial sector in Anglo-Saxon countries [i.e. the United Kingdom (UK) and the United States (US)] after the second year.

Moreover, for the utilities sector, its relative variance attributed by the fuel price has also been shown of accelerating from 5.066 percent in first quarter to 18.616 percent in quarter 24. This time around, the influence of fuel price on the utilities sector is quite related to the electricity and gas sub-sector. As indicated by Villar and Joutz (2006), when crude oil price temporarily increased by 20 percent, the natural gas price will increase by 5 percent. This is likely to be reflected in the Malaysian case, whereby when the government decides to rise up the fuel price, the natural gas price as well as electricity price will follow to increase. As such, the increase of petrol price that lead to the surge in natural gas price in the end will transfer higher cost to the electricity sector, as gas has been utilized as a heating fuel for the power generating purposes. Nevertheless, the extent to which the utilities sector has been affected also depend on the export earnings gain from the selling of natural gas as it will contribute to the electricity sub-sector through subsidy, as Malaysia is one of the important natural gas producers cum exporters.

Similarly, for the transportation sector, the explanatory power of fuel price in accounting for variations in the transportation sector has expanded after 24 quarters, that is from 5.392 percent in first quarter to 18.666 percent in quarter 24. The influence of fuel price on the transportation sector can be explained by the increase of fuel price that is likely to increase the transportation costs embedded in the operating activities as the retail fuel price does increase in the domestic market although it is largely borne by the government. Yet, the effect is more burdensome for the logistic companies that depend highly on the fuel consumption.

Subsequently, for the government services sector, its forecast error variance is 0.103 percent attributed by the fuel price in first quarter and 3.201 percent in the 24 quarters. From the estimated statistics, it seems that the impact of fuel price on the government services sector is quite marginal and this may be due to the indirect linkage between these variables. In particular, when the fuel price increases, it will not be directly transferred to the government services sectors like education, health, defense and so on, as these sectors are not directly utilizing the fuel as an intermediate input. Instead, the effect is likely to be transferred through other products in the market that are in the end directed to the government services sector and raise up its consumption expenditure. As such, it allows the effects reach to the government services sector at a slower pace.

For the remaining sectors like mining, construction and financial sectors, their relative variances are relatively static as explained by the innovations in fuel price. For instance, the shock in fuel price only explained about 0.319 percent of the variation in the mining sector in first quarter and remained at about 0.954 percent in quarter 24. Additionally, the influence of fuel price on the construction sector only accounted for 4.112 percent in first quarter and 5.013 percent the 24 quarters. Meanwhile, the relative variance in financial sector contributed by the innovation in fuel price only recorded at 0.383 percent in first quarter and 0.296 percent in 24 quarters. From this point of view (i.e. the stable influence from fuel price), we may expect that the fuel price does not really affecting these sectors over the time horizons.

5.8 Conclusion of the Chapter

From the presented empirical results, there are several inferences that we can draw from these estimating procedures. For the determination of the stationary properties of time-series data, the ADF unit root test and DFGLS unit root test results have been reported. Based on the results obtained, we can conclude that all of the variables are integrated of order one since the empirical evidence has shown that in level form, all of these variables are non-stationary as the null hypothesis has not been rejected. However, by first differencing the time-series data, the null hypothesis has been rejected at the conventional levels of significance. Therefore, indicating that the univariate properties of the time-series data are now stationary.

With the stationary properties after first differencing, this allows us proceed to the JJ cointegration analysis that assists in examining the long-run relationship between the examine variables. In particular, the results presented by Trace test and Maximum Eigenvalue test showed the agriculture sector, trading sector and other services sector are found to be cointegrated with the fuel price, leaving the other sectors non-cointegrated. This implies that in the long-run, there will be a co-movement between these variables and reach to one equilibrium point since there is only single cointegrating vector exist in this relationship. Then, by normalizing the cointegrating relationship with respect to fuel price, the results justified that there is a positive association between the respective economic sectors and fuel price.

Nevertheless, the JJ cointegration analysis does not give us the indication on the direction of causality. To that reason, the VECM approach has been used to discern the causality pattern of the cointegrated variables. The significant coefficient of *ECT* in agriculture sector, trade sector and other services sector equations, but insignificant coefficient of *ECT* in fuel price equation therefore indicate that the fuel price does Granger caused the respective economic sectors in the long-run, while the feedback causation does not hold. In other words, the economic sectors will bear the brunt of short-run adjustment towards the long-run equilibrium point. Meanwhile, the fuel price variable remains relatively exogenous since it is not Granger caused by the economic sectors. Such findings therefore strengthen Granger's (1986, 1988) idea that there is at least one direction of causality if both variables are cointegrated. To some extent, the short-run causality of fuel price on the economic sectors has only been observed in the agriculture and trade sectors.

Furthermore, in order to measure the speed of adjustment towards the long-run equilibrium point, the persistent profile shock on the cointegrating vector has been adopted. By tracing the dynamic path of the system-wide shock, it exhibits that all of the cointegrating relationships tend to revert back to its equilibrium point but at a slower pace (i.e. more than 20 quarters), whereby the overshooting effects seems to have occurred in the trade sector and other services sectors in the first few quarters but diminishes around quarter seven. With such evidence, we can confirm that these variables are indeed possessing a long-run relationship with each other as defined earlier in the JJ cointegration analysis.

Conversely, for the non-cointegrated variables, the interactions have been examined through the standard Granger causality test. From the estimated results, it shows that there is a unidirectional causality running from the mining sector to fuel price throughout the examined lag periods, whilst bidirectional causality has been discovered between the government services sector and the fuel price in lag one and leads us to conclude that they non-Granger cause each other in the short-run. Furthermore, for the remaining sectors like the manufacturing, construction, utilities, transportation and financial sectors, they are also found to non-Granger cause the fuel price in short-run and vice versa.

In spite of that, the GVDCs have been used to further investigate the dynamic interaction between these variables beyond the sample periods, although the simulation method for GVDCs may differ for cointegrated to non-cointegrated variables. For cointegrated variables, the GVDCs model has been derived from the VECM. Meanwhile, for non-cointegrated variables, the GVDCs model is derived from the first difference VAR model. Consistently, the estimated results for relative variance in fuel price have been largely explained by its own shock, leading us to conclude that fuel price is the relative exogenous variable in this study. Therefore, any changes in the economic sectors are not able to influence the fuel price. For the relative variance in sector, some sectors are found to be largely affected by fuel price as time expands but some are not. For instance, more than 50 percent of the relative variance in the agriculture sector and trade sector has been largely explained by fuel price as time expands to 24 quarters. On the other hand, the increasing influence from fuel price as time expands but at a marginal magnitude have been observed in the other services sector, manufacturing sector, utilities sector, transportation sector and government services sector. From this point of view, it is presumed that the subsidy given by the government has lessened the total effects directed to the economic sectors. Additionally, the slight increase of fuel price raise up the production cost marginally. Therefore, the received effect is not great. Finally, for the remaining sectors like mining sector, construction sector and financial sector, since the reported results indicated that the receiving effect from fuel price shock is quite stable, therefore we conclude that the fuel price does not really affect these sectors throughout these horizons.

CHAPTER SIX

CONCLUSION AND RECOMMENDATIONS

6.0 Introduction

From the introduction of this study until the empirical analysis, finally, the conclusion of this study can be made. Overall, in the perspective to find out the relation between the fuel price and the disaggregated economic sectors in Malaysia, we can sum up that although the influences of fuel price varies across sectors, in majority the effects are marginal due to the slight increase of fuel price and large amount of subsidy given by the government. Based on these findings, several recommendations have been suggested in order to counteract the problem (i.e. raise in fuel price) although some sectors are found to be positively associated with the fuel price hikes. Such an idea is developed with an aim to gradually reduce the dependence on petroleum products in future. Ultimately, in order to have improvement for future study, the limitations of this study and possible solutions have been suggested.

6.1 Conclusion

This study is conducted to examine the relationship between fuel price and the disaggregated economic sectors in Malaysia that is usually classified into 10 major sectors. In particular, this study investigates the long-run and short-run relationship between the variables and to some extent measure the influence of fuel price on the economic sectors. In contrary to most of the empirical analysis, this study has adopted Malaysia (i.e. newly emerging country whilst net oil-exporting country) as the examined country by focusing the interaction between the fuel price and the specific economic sectors rather than choosing the developed country as the examined country and focus this issue on the general economic performance. With such findings, it enables us to identify which sectors are more affected by the fuel price hikes. Then, the appropriate strategy or policy recommendation can be developed to minimize the possible effects.

In order to conduct this analysis, we utilized the data span from 1990:Q1 to 2007:Q4. As the preliminary to the research, we employed the conventional Augmented Dickey-Fuller (ADF) unit root test and modified ADF test, namely Dickey-Fuller Generalized Least Square (DFGLS) unit root test to find out the stationary properties of the examine variables. The results of these tests show that all the variables are non-stationary in level form but stationary in the first difference form. Therefore, the variables are said to be integrated of order one, $I(1)$. Since all of these variables have achieved the same order of integration, then the Johansen-Juselius (JJ) cointegration test are conducted to identify the long-run relationship. The results indicate that only the agriculture sector, trade sector and other services sector have long-run co-movements with fuel price at a single cointegrating vector. In other words, they will reach one equilibrium point in the future.

By normalizing the cointegrating relationship with respect to fuel price, all of these equations justify that there are positive association between these variables, whereby the increase of fuel price will increase the output for the agriculture, trade and other services sectors. This is because as fuel price increase, it will create an opportunity for these sectors. For instance, if the fuel price keeps increasing in the market, in the long-run, people will tend to shift to the utilization of biofuel. As such, the world demand for palm oil will increase and finally raise up the oil palm production output that can contribute to greater export earnings[27]. Furthermore, as a final services sector (i.e. trade sector and other services sector), the increase of fuel price transferred as higher costs to other intermediate inputs, subsequently, the service providers can grab this opportunity to increase their service price more than the increase of input prices in order to gain more profit margin. Although this will more or less affect the product's demand by the consumer, in a longer period, the consumer will finally accept the prices. Consequently, such reaction may raise up the output growth in the final services sectors.

Although the JJ cointegration test indicates the co-movement of the examined variables, this method does not show the direction of causality. For this reason, the vector error correction model (VECM) and standard Granger causality test have been applied in those variables that are cointegrated and non-cointegrated. The evidence from the significant error correction term (*ECT*) in the sectoral equations but not in the fuel equations implies that fuel price is the leading variable for the economic sectors in the long-run. Additionally, the significance of *Chi*-square statistics also denote that the fuel price does Granger cause the agriculture sector and trade sector in short-run. In order to further confirm these cointegrating relationships, the

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[27] In between year 2004 and 2008, the crude oil exports volume in Malaysia has increased gradually from 12,223,000 tonnes to 15,699,000 tonnes (i.e. increment of 28 percent). However, in terms of crude oil exports values, it has recorded as much as 120 percent increment from RM 20,842 millions to RM 45,955 millions at the same periods.

implementation of the persistent profile shock on cointegrating vector also reaffirm that all of the variables tend to adjust back to its equilibrium point in long-run.

On the other hand, the results from the standard Granger causality test documented that there is a unidirectional causality between the mining sector and fuel price in the short-run, with the mining sector being the leading variable. Moreover, bidirectional causality has been observed between the government services sector and fuel price in a very short period. Therefore, we conclude that these variables are rather non-Granger caused to each others. For the remaining sectors, like manufacturing sector, construction sector, utilities sector, transportation sector and financial sector, they are also found to be non-Granger caused fuel price and vice versa in short-run.

Ultimately, in order to make a forecast on the influence of fuel price on the economic sectors beyond the sample period, the generalized variance decomposition (GVDCs) analysis has been conducted. From the analysis, it shows that fuel price is the relative exogenous variable in this study as it is not influenced by the economic sectors as time expands. However, for some of the economic sectors, they are relatively exogenous at the beginning but become relatively endogenous as time expands. Thus, it is expected that fuel price is able to influence some of these sectors over a longer period, but the effects are somehow marginal for most of the economic sectors. Such outcomes have been discovered in all these examine economic sectors excluding the mining sector, construction sector and financial sector. From this point of view, it is presumed that the government's role in providing the fuel subsidy therefore has minimized the total effects received by the economic sectors. Although the government has revised its fuel price, it only slightly increases for the sample period under study, thus will not create a major impact for the economic sectors.

6.2 Policy Recommendations

Empirical results show that fuel price has either long-run or short-run relationship with several economic sectors examined in this study. Although it has been found that the influence of fuel price on economic sectors is marginal, it is however important for Malaysia to find the appropriate strategy to cope with the opportunities and threats posed by fuel price hikes, as the continual increase of crude oil price in the world market will eventually increase the government's burden in bearing the fuel subsidy. Thus, a plausible recommendation will be suggested to gradually curb this problem.

For the agriculture sector in Malaysia, it is beneficial from the fuel price hikes. This can be related to the increase of palm oil demand due to the high oil prices. For this reason, the long term energy transmission mechanism should be recommended under this study, such as shift from petrol fuel to biofuel. This can be proved by the inclusion of renewable energy in Five-Fuel Diversification Policy in Malaysia (see Mohamed and Lee, 2006). In the past few decades, biofuel has been widely introduced in part of the world. By using animal fat and vegetable oil as feedstock, it can be used to produce alternative fuel products such as vegetable oil, biodiesel, biobutanol and so on to replace petroleum gas like petrol and diesel. Such biofuel related products become important when the crude oil price keeps on soaring in the world market. As such, the biofuel industries began to expand in the Americas, Europe and Asia and biofuel is commonly used in automotive transport. Due to this, the demand for palm oil (which is one of the by-products for biofuel) from western countries has increased. Therefore, as a major palm oil exporter, this can create a direct and indirect opportunity for social benefits (Sumathi, *et al.*, 2006). Thus, the Malaysian government should encourage more development in estate areas for the purpose of commercial planting of palm oil. Additionally, the government should conduct research and development (R&D) on oil palm for the purpose to improve the yielding quality.

However, since palm oil is an edible food, it will sometimes face the problem of short of supply due to the strong demand competition from food and non-food producers. As indicated by Gan and Li (2008), the debate for biofuel and food use does exist and it is one of the challenges that will be faced. Accordingly, the new discovery of other plantation like Jathropha Curcas originating from Central Africa that has been widely planted in Asia and Africa also give the local farmer a new source of income earning, as this plant is suitable to be grown in Malaysia with an uncomplicated cultivation. Also, it poses an advantage over palm oil as it is a non-edible plant. Therefore, the food producer will not compete with the non-food producer to acquire this production that in the end rises up its market price instantly. However, this plant is still not popular in Malaysia as it just been introduced recently in 2007. Therefore, the related agency plays an important role in spreading the information about the important of Jathropha oil in producing biodiesel. Besides that, incentive can be given to encourage farmers to take part in Jathropha plantations in order to increase production to meet future demand. As such, this can contribute to greater export earning for Malaysia. Moreover, it is also important to ensure the Jathropha seed quality as the oil extraction depends on its quality. Therefore, funding should be allocated to the related body to conduct R&D on seed quality.

Furthermore, it is also recommended that the government should provide favorable investment conditions to attract investment and cooperation in biofuel industries, spanning from refinery processes to marketing levels. Although Malaysia has successfully produced biodiesel in the past few years, continual improvement effort is still needed to reach a desirable production level. In addition, Malaysia is not limited to produce one biofuel product but can expand to other biofuel productions such as biobutanol, biogas, bioethanol and so on. Therefore, investment and cooperation with other experts is important to ensure development in this field and enable Malaysia to become a potential major biofuel exporter in future. But the environmental issues that arise must be tackled in line with the development in palm oil plantation activity.

Besides the applications of biofuel in future daily activity, the utilization of other alternative energy like hydro power, solar power, wave power and so on also are alternatives to solve the high oil price problem. As such, the Malaysian government should take other countries as an example to move towards commercialization of renewable energy. Therefore, government support is one of the ways that can help to achieve the objective, this includes allocation of government funds to develop renewable industries, providing incentives to encourage the utilization of renewable energy, R&D in this field and so on. To ensure the above recommendations can be successfully implemented, human resource development is also another important issue that should be taken note of, as with educated or skilled labor, they can deliver more creative and innovative ideas for development purposes.

Meanwhile, for the trade and other services sectors, although fuel price has positive stimulation on these sectors, it is however important to take note that another problem may arise when the products' prices keep on increasing, that is inflation problem. Hence, it has been suggested that the government should enforce retail price transparency, whereby the government is not only controlling certain daily products such as flour, rice, cooking oil and so on, but extend to cover wider range of products. For example noodles, canned food, fruits and so on. With such enforcement, this can prevent the individual reseller from charging higher to the consumer. Indirectly, the drastic surge of consumer price index can be avoided.

Furthermore, although the manufacturing, utilities and transportation sectors are less affected by fuel price hikes due to the fuel subsidy, it is also important to efficiently utilize the petrol fuel and reduce the dependency on it. For the long term strategy, the innovation in energy efficient technologies and upgrading existing equipment are gradual moves towards reducing dependency and efficiently utilizing of petrol fuel. Like many western countries, they have began to use blend diesel (i.e. mixture of biodiesel and petroleum diesel) to run motor vehicles and invent the machine that can run using biofuel. Therefore, R&D can be conducted by our motor vehicle producers to design modern diesel engines that can utilize blend diesel. As such, in future, the demand for crude oil will be reduced.

However, as a backup for the above recommendation, Nassos (2005) has suggested that oil tax can be imposed on the nation as the effects can be spread through a broader scale. Therefore, this suggestion might be applicable for the Malaysia case as the Malaysian government does not impose oil tax to their nation. With such a move, it is not only the oil price effects that can be borne together by the nation, but it can also contribute to greater tax revenue for the government. Although such action may cause further hardships to the consumer, but in the end the nation will use the oil related products more efficiently in order to reduce the dependency on it. At the same time, the tax revenue paid can be allocated to other national development purposes.

Furthermore, for the mining sector in this study, it seems that the sector itself is rather dominant in affecting the fuel price in short-run. As a net oil-exporter, Malaysia should allocate large capital investment on the exploration and production (E&P) activities to discover more unexplored crude oil reserves embedded in Malaysia[28]. In other parts of the world, many oil companies have begun to explore deepwater acreage, so was Malaysia. There are some deepwater acreage yet to be explored and remain untested although the deepwater E&P activity that began to be implemented in Malaysia (i.e. in Kikeh field, Gumusut-Kakap field and Malikai field) are ready to come on stream in the next few years. Well, the main challenges to venture into deepwater acreage are the advance technical assistance and high operating costs. Therefore, it is important for Petronas to discover more crude oil reserves (either within Malaysia or overseas) by cooperating with foreign oil companies through awarding production sharing contracts (PSC). Thus, if crude oil

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[28] However, this activity is subjected to the other prioritized project such as the current stimulation package that helps to fuel the weakening economy and to encourage spending.

reserve is increased, the future earnings for oil companies are ensured. Then, from the royalty, dividend and taxation pay by the oil companies, the government's revenue will accelerate and this sufficient amount of revenue can be allocated to finance fuel subsidy. Ultimately, for the least affected sectors like financial and construction sectors, further study need to be conducted to identify the main factor that affect these sectors for the Malaysian case.

6.3 Limitation of the Study

In this study, we intend to investigate the relationship between the domestic fuel price and the 10 disaggregated economic sectors in Malaysia. However, there are several limitations that have been uncovered in this study. The first limitation is the availability of the time-series data spanning from the 1970s to 1980s. With regards to many previous empirical analysis, like the study by Hamilton (1983), Papapetrou (2001) and Cunado and de Gracia (2003), they have utilized data that covers the previous oil shocks period in order to have a closer understanding towards the impact of oil shocks on the macroeconomic variables. Nevertheless, the unavailability of the longer time span disaggregating outputs data has prevented us from including these time-series data in our study. Therefore, our analysis only covers a short span of time by using the quarterly data. Such application was in contrary to Campbell and Perron's (1991) opinion that in the VAR framework, there is no gain to switch from low frequency data to high frequency data as the span of the data is more important than the number of observations.

Additionally, the second limitation is the variables used in this study. For instance, the fuel price variable used in this study is the retail fuel price that has been subsidized by the Malaysian government. As a result, the effects on disaggregated economic sectors may be distorted by the use of the subsidized fuel price data. Therefore, the estimated results based on the retail fuel price may not accurately reflect the real circumstances that should be happening in Malaysia. Also, this weakness has limited us to explore further on cross border countries as most of the countries do not practice this policy in their countries. As such, this has hindered us making a comparison amongst the regional countries on this issue. Therefore, it has been suggested that we should include the unsubsidized fuel price in future studies. Certainly, in the most recent restructuring of fuel price in June 2008, this has given the future study useful information to evaluate whether the unsubsidized fuel price will create a major negative impact for the Malaysian economy or to make the economic sectors to become more competitive in this challenging environment.

Initially, besides including the 10 major disaggregated economic sectors in our study, we also planned to examine this issue on the more specific sectors by including the sub-sectors in Malaysia that according to the classification from the Department of Statistics Malaysia (DOS). With such inclusion, it is not only giving us the general review, but also the specific indication on the different effects received by the respective sub-sectors. However, the reclassification of the sub-sector from 39 sectors to 41 sectors in 2007, especially for the manufacturing sector that shows the main changes does not allows us to further investigate this issue on the sub-sectors. Moreover, we also need to take note that some of the sectors like the fishery sector and partial transportation sector that have been given subsidies by the government. To that reason, the actual effects are hard to determine given that we do not have enough information.

Finally, despite using the econometrics model in conducting the analysis, one can also use the macronometric model or simulation analysis in examining this study. Like the studies by Birol (2004), Roeger (2005) and Saari, *et al.* (2008), they have respectively utilized the Multimode model, QUEST model and price simulation analysis to find out the effects of oil price or fuel price on the macroeconomic variables. With such models, it will not only give the indication on the effects receive by each sector, but also the clarification on the affected amount (i.e. in percentage). Therefore, the combination of this econometrics model and the macronometric model or simulation analysis will further strengthen our analysis.

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APPENDIXES

Appendix 3.1: Summary for the Review on the Impact of Oil Prices on the Macroeconomic Activities in OECD Countries

Author	Country / Year	Variables	Methodology	Findings
Hamilton (1996)	The US/ 1948:Q1-1994:Q2	GDP growth, net oil price increases, treasury bill rates, inflation and import price changes	▪ Chow stability test ▪ Granger causality test ▪ IRFs	▪ In the early sub-sample, the oil price does Granger cause GDP. ▪ In the late sub-sample, the oil price does not Granger cause GDP. ▪ In the full sample period, the oil price does Granger cause GDP. ▪ The significant relationship between oil price and GDP still exists but at a weaker relation after 1973.
Birol (2004)	OECD countries/ 2004-2008*	Oil price, GDP, CPI and trade balance	▪ OECD's interlink model ▪ IMF's multimode model ▪ IEA's world energy model	▪ The average GDP growth rate has fallen by 0.3 percent, while the average inflation rate has increased by 0.5 percent from the baseline. ▪ The impact is varied according to their oil intensity. ▪ Oil-exporting countries only benefit from oil price rises in the first year.
Barrel and Pomerantz (2004)	OECD countries/ 2005-2008*	GDP, CPI and monetary response	▪ NiGEM	▪ Permanent increase of oil prices has caused short-run output fall more rapidly in the US and the long-run output decrease almost everywhere else. ▪ The immediate responses from monetary policy by increasing the real long term rate will rise up the inflation cost. ▪ Real long term rate does not take part in temporary oil price shocks, hence the inflationary pressure is much higher.

Appendix 3.1: Summary for the Review on the Impact of Oil Prices on the Macroeconomic Activities in OECD Countries (continued)

Author	Country / Year	Variables	Methodology	Findings
Brown and Yücel (1999)	The US/ 1956:M1-1997:M12	Real GDP, GDP deflator, commodity price index, real oil prices, the federal fund rate, short and long term interest rates	▪ VAR model ▪ Choleski VDCs ▪ IRFs	▪ Constant federal funds rate remains as a tool responses to oil price shocks as long as the nominal GDP hold constant.
Papapetrou (2001)	Greece/ 1989:M1-1999:M6	Real oil price, interest rates, IPI, employment and real stock return	▪ Multivariate VAR model ▪ PP (1988) and KPSS (1992) test ▪ JJ (1990) cointegration test ▪ GIRFs and GVDCs	▪ Oil prices have negative impact on industrial production growth and employment. ▪ Oil price does not have cointegration relation with the examined variables.
Cunado and de Gracia (2003)	15 European countries/ 1960:Q1-1999:Q4	Oil price (four proxies), CPI and IPI	▪ PP (1988) and ZA (1992) test ▪ Phillip and Ouliaris (1990), Banerjee, *et al.* (1992) and Gregory and Hansen (1996) cointegration test ▪ Error correction model (ECM) ▪ IRFs	▪ Oil prices have negative impact on industrial production growth. ▪ Oil prices do not have long-run relationship with industrial production growth, but have relationship with inflation rate. ▪ Non-linear specification of oil price is found to be Granger caused industrial production growth. ▪ Oil price does Granger cause inflation rate and the impact is much higher if expressed in the national currency. ▪ Asymmetric relationships exist between the oil price changes and industrial production growth.
Atukeren (2003)	Switzerland/ 1980:Q1-2002:Q4 and 2003-2004*	Real oil price, net oil price and 48 macroeconomic variables	▪ ADF (1979) and PP (1988) unit root tests ▪ Subset-transfer-function-based Granger causality tests ▪ KOF's macroeconometric model	▪ 21 out of 48 macroeconomic variables are Granger caused with oil prices. ▪ But overall, the decrease of real GDP in Switzerland is rather small. ▪ The simulation results identified that oil price shocks will approximately reduce the GDP by 0.1 percent and 0.3 percent for the first and second year after shocks. ▪ Oil price shocks are in fact affecting the domestic demand, investment and trading activity.

Appendix 3.1: Summary for the Review on the Impact of Oil Prices on the Macroeconomic Activities in OECD Countries (continued)

Author	Country / Year	Variables	Methodology	Findings
Roeger (2005)	EU area/ 2004:Q1-2013:Q4* —	GDP, consumption, investment, import, export, oil consumption, oil price, employment, real wages, prices, nominal and real interest rate	▪ QUEST model	▪ The GDP falls by 0.5 percent and 1 percent after the first and second year of oil shocks, respectively. ▪ The lower GDP is associated with decreases in output, consumption and investment.
Glasure and Lee (2002)	Korea/ 1961-1990	Real government spending, real money supply, real GDP, real oil price (in Korean Won), energy consumption, oil price shocks combined and error correction term	▪ Perron (1997) structural unit root test ▪ Johansen (1991) LR test ▪ VDCs ▪ VECM	▪ Oil prices have major influence on real income growth, followed by money supply, exchange rates, energy consumption and government spending. ▪ Oil prices also have major influence on energy consumption, followed by exchange rates, government spending, money supply and real income. ▪ Oil prices contain the future information for both real income and energy consumption. ▪ Real income and energy consumption have bidirectional causation.
Jiménez-Rodríguez and Sanchez (2005)	OECD countries/ 1972:Q2-2001:Q4	Real GDP, real effective exchange rate, real oil price, real wage, inflation, and short and long term interest rate	▪ Multivariate VAR model ▪ DFGLS and P_T (1996), $DFGLS_U$ and Q_T (1999) and ADF (1979) tests ▪ Wald test ▪ LR test ▪ Block exogeneity tests ▪ Orthogonalise IRFs and VDCs	▪ Oil price does Granger cause any variables included in the system, with at least unidirectional causation for all countries and bidirectional causation for most countries. ▪ Oil prices have negative interaction with economic growth in net oil-importing countries except Japan. ▪ Oil price surges are perceived benefits to the net oil-exporting country, but this relation does not exist in UK but Norway due to the strong appreciation of pound. ▪ Real GDP for most countries are largely explained by oil price and monetary shocks.

Appendix 3.1: Summary for the Review on the Impact of Oil Prices on the Macroeconomic Activities in OECD Countries (continued)

Author	Country / Year	Variables	Methodology	Findings
Huang, *et al.* (2005)	The US, Canada and Japan 1970:M1-2002:M9	Real oil price, IPI, interest rate and real stock return	▪ MVTAR ▪ PP (1988) and KPSS (1992) unit root tests ▪ ZA (1992) and HEGY (1990) structural break unit root tests ▪ Johansen (1988) cointegration test ▪ VDCs and IRFs	▪ The responses in Regime II seem to provide more detailed information compared to Regime I. ▪ Stock returns and industrial output changes react negatively to oil price changes. Meanwhile, real interest rates react positively. ▪ Oil price changes are more powerful in explaining the industrial output changes compared to oil price volatility.
Khademvatani (2006)	Canada/ 1984:Q1-2002:Q4	Nominal GDP, nominal cost of imported crude oil, short-run interest rate, aggregate implicit price deflator and the commodity price index	▪ VECM model ▪ ADF (1979) and KPSS (1992) unit root tests ▪ Perron (1997) structural break test ▪ Unrestricted Engle and Ganger (1987) cointegration test	▪ There is endogenous structural break in all variables except for the commodity price index. ▪ There is an evidence of long-run relationship among the variables. ▪ There is moderate symmetry effect of oil prices on Canadian economic activity.

Note: * denotes projection period.

Appendix 3.2: Summary for the Review on the Impact of Oil Prices on the Macroeconomic Activities in Non-OECD Countries

Author	Country / Year	Variables	Methodology	Findings
Abeysinge and Wilson (2000)	Singapore / 2000 and 2001*	Oil price, GDP and CPI	▪ ESU multi-country model	▪ Singapore experiences negative direct impact, positive indirect impact from oil shocks in the shorter period. ▪ As time expands, the net impact on growth is negative.
Chang and Wong (2003)	Singapore/ 1978:Q1-2000:Q3	Real oil price, real GDP, CPI and unemployment rate	▪ ADF (1979, 1981), PP (1988) tests ▪ Johansen (1988), JJ (1990) cointegration tests ▪ VECM ▪ IRFs and VDCs	▪ The consequences of oil price on GDP growth, inflation and employment rate in Singapore are marginal. ▪ Inflation responses immediately, while GDP and employment rate takes some time lagged to response to oil shocks.
Park (2004)	10 Asian economies/ 2004 and 2005*	Oil price, GDP, trade balance and CPI	▪ OEF model	▪ US$10 per barrel increases in oil price has deteriorated the trade balances, GDP and inflation of Asia. ▪ If the oil price surge is temporary, it will at the end improve the trade balances condition. ▪ But still, the GDP and inflation will be deteriorated and become greater when oil price surge is sustained for longer period.
Rautava (2004)	Russia/ 1995:Q1-2002:Q4	GDP, international oil price, government revenue and real exchange rate	▪ VAR model ▪ Johansen (1988) coitegration approach ▪ ECM	▪ There are two cointegrating vectors exist in long-run. ▪ The increase of oil price by 10 percent causes GDP to grow by 2.2 percent, while the appreciation of real exchange rate leads GDP to decrease by 2.7 percent. ▪ The government fiscal revenue has increased by 4.6 percent and 25.3 percent, respectively, when oil price and GDP growth by 10 percent. ▪ ECM for short-run analysis has shown that oil price and real exchange rate, respectively, have positive and negative influences on GDP and fiscal revenue. ▪ Real exchange rate may have a balancing power on the GDP growth, which offset the gain from oil price changes.

Appendix 3.2: Summary for the Review on the Impact of Oil Prices on the Macroeconomic Activities in Non-OECD Countries (continued)

Author	Country / Year	Variables	Methodology	Findings
Asian Development Bank (2004)	Asian economies/ 2004 and 2005*	Oil price, GDP, trade balance and CPI	▪ OEF model	▪ Sustained oil price hikes would dampen economic growth that damage inflationary pressure and balance of payment. ▪ The duration of shocks are more pronounce than the price increases in affecting trade balance.
Cunado and de Gracia (2005)	6 Asian economies/ 1975:Q1-2002:Q2	Oil price (in US dollar, in local currency), CPI and economic activity	▪ PP (1988) unit root test ▪ Phillips and Ouliaris (1990) and Gregory and Hansen (1996) cointegration tests ▪ Granger causality test ▪ Asymmetry test	▪ Oil prices do not have long-run cointegration relation with inflation and economic activity. ▪ The short-run relationship between oil prices and economic growth and inflation are more significant when express in local currency and in non-linear specifications.
Raguindin and Reyes (2005)	The Philippines/ 1981:Q1-2003:Q4	Linear and non-linear specification of oil prices, real GDP, CPI, real effective exchange rate, real wages and money supply	▪ VAR approach ▪ ADF unit root test ▪ IRFs and VDCs	▪ Real GDP responses negatively while inflation response positively to the oil price shock with less enduring effects. ▪ For the remaining indicators, the effects receive from the oil price shock is marginal. ▪ VDCs indicate that shocks in oil price have significantly contributed to the variation in real GDP and inflation. ▪ Nevertheless, non-linear specification's role is more important than the linear specification in explaining such variation.
Olomola and Adejumo (2006)	Nigeria/ 1970:Q1-2003:Q4	Real oil price, real GDP, CPI and real exchange rate	▪ VAR model ▪ ADF (1979) and PP (1988) unit root tests ▪ JJ (1990) LR test ▪ VDCs	▪ Output growth and inflation in Nigeria do not affect by oil price shocks. ▪ Oil price is instead affecting the real exchange rate and in long-run affecting the money supply in Nigeria.

Note: * denotes projection period.

Appendix 3.3: Summary for the Review on the Impact of Oil Prices on the Sectoral Performances

Author	Country / Year	Variables	Methodology	Findings
Bauer and Byrne (1991)	The US	Transportation, industrial, residential, commercial and electric utilities sectors and the US regions	▪ Descriptive and statistical estimation	▪ Transportation sector's spending on oil has accounted for large share of total costs. Therefore, its impact from oil price surges is greater than other sectors. ▪ The South region has high usage of oil in manufacturing sector is likely to suffer from the shocks. ▪ Alaska, Texas, Louisiana and California are benefiting from oil price surges in short term, but in long-run it will be offset by the total loss.
Zind (1999)	The Gulf Cooperation Council member countries/ 1972-1980 and 1981-1996	Mining sector, all other goods sectors, all other services sectors, manufacturing sector and government sector	▪ Analysis of Variance (ANOVA)	▪ The shock in second phase has leads to the overall increase in GCC economy but at a lower growth rate. ▪ Across the five major sectors, mining sector has the lowest growth rate preceded by all other goods sectors, all other services sectors, manufacturing sector and government sector in the second phase.
Schintke, *et al.* (2000)	German/ 1995,1999 and 2000	58 industrial sectors	▪ Input-output analysis	▪ Out of 58 examined sectors, there are only 10 sectors and 16 sectors have the total effects of more than 1 percent in between 1995 and 1999 and 1999 and 2000, respectively.
Jiménez-Rodriguez (2007)	German, Italy, the UK and the US/ 1975:M1-1998:M12 France and Spain/ 1980:M1-1998:M12	Aggregate manufacturing industry, eight individual manufacturing industries and real oil price	▪ Standard structural VAR approach ▪ IRFs	▪ Cross-country and cross-industry heterogeneous responses exist in the EMU countries while homogenous responses exist in the Anglo-Saxon countries. ▪ Such identification is likely related to the manufacturing industrial structure rather than the oil consumption. ▪ The results seem to be robust when the changes in the number of lags, identification assumptions and real oil price definition have drawn the similar output responses.

Appendix 3.3: Summary for the Review on the Impact of Oil Prices on the Sectoral Performances (continued)

Author	Country / Year	Variables	Methodology	Findings
Saari, *et al.* (2008)	Malaysia/ 2000	Eight agriculture industries and 18 agro-based industries, PPI, import prices and wage rates	▪ Input-output analysis	▪ Domestic materials constitutes larger portion of total production cost for these sectors. ▪ Increases of domestic petroleum prices have severely affected the cost of production for fishing, forestry and logging and oil palm industries. ▪ It has been suggested the fuel subsidy should be remained to safeguard the socio-economic welfare.
Valadkhani and Mitchell (2001)	Australia/ 1977-1978 and 1996-1997	35 economic sectors and petroleum price	▪ Modified version of the Leontief Input-Output price model	▪ The Australian economy and specific sectors in mid-1990s as compare to in late 1970s are less vulnerable to the petroleum price increase. ▪ But we cannot expect the current impact is insignificant. ▪ Measure of products and services price rise on the household expenditure is hard to get the clearer understanding. Hence, they tentatively conclude that the impacts from price hikes are regressive.
Doroodian and Boyd (2003)	The US/ 1994-2020*	Input-output matrix	▪ Dynamic Computable General Equilibrium (CGE) model	▪ PPI and CPI diverge from benchmark and tend to converge more quickly when there are substantial technological changes although economic growth is low. ▪ Technological efficiency is able to minimize the adverse impact of oil shocks.
Yeoman, *et al.* (2007)	Scotland/ 2005-2015*	Tourism sector	▪ Scenario planning	▪ The results expect that the further the traveling destination, the larger the percentage changes be created, as the shift to alternative sources is insufficient. ▪ The increase of value added tax (VAT) and carbon taxation in second scenario tends to have greater impact on the employment in tourism sector than government revenue. ▪ Subsidy provides to the rail transport is a benefit to this industry as tourist tends to shift from car to rail transport.

Note: * denotes projection period.

Appendix 3.4: Summary for Review of Other Impacts of Oil Price Fluctuations

Author	Country / Year	Variables	Methodology	Findings
Hoag and Wheeler (1996)	The US coal mining in Ohio/ 1957:Q1-1982:Q4	US oil price index, US coal price index, average hourly earning, total employment, surface employment and underground employment	▪ VAR model ▪ ADF (1979) unit root test ▪ Engle and Yoo (1987) cointegration test ▪ VDCs	▪ There is no cointegration among the examine variables. ▪ Oil price is an important factor in affecting the coal mining employment in Ohio than coal price. ▪ The surface employment is most probably affected by coal price and average hourly earning in long term.
Sadorsky (1999)	The US/ 1947:M1-1996:M4	Industrial production, interest rate and real oil price	▪ VAR model ▪ PP (1988) unit root test ▪ ZA (1992) structural break test ▪ Johansen (1991) cointegration test ▪ GARCH model estimates ▪ IRFs and VDCs	▪ Both oil price shock and oil price volatility have played a significant role in affecting the real stock return. ▪ Oil price shocks have an immediate negative impact on the real stock return and the effect is stabilized after three months. ▪ Oil price explains larger portion on real stock return than interest rate after 1986. ▪ Oil price volatility has an asymmetry relationship with the economic activity.
Maghyerah (2004)	22 emerging countries/ 1 January 1998-31 April 2004	Morgan Stanley Capital International (MSCI) indices and Brent crude oil prices	▪ Unrestrictive VAR model ▪ ADF (1979,1981), PP (1988) and KPSS (1992) unit root tests ▪ GVDCs and GIRFs	▪ Oil prices have less impact on emerging stock markets. ▪ GVDCs exhibit that oil price shocks explain less than 2 percent on the stock markets and reduce to less than 1 percent for 16 emerging countries. ▪ GIRFs justify that the stock markets respond slowly to oil price shocks.
Huang and Guo (2007)	China/ 1990:M1-2005:M10	Real oil price, relative industrial production, real effective exchange rate and relative consumer price index	▪ Im, *et al.* (2003) panel unit root test ▪ JJ (1990) cointegration test ▪ VDCs and IRFs	▪ Oil price shocks cause RMB to depreciate, but at shorter period. After three months, the RMB will appreciate 0.3 percent above the baseline. ▪ Oil price shocks explain larger portion on real exchange rate in long-run. ▪ This indicates that China does not heavily dependent on the imported oil and strict energy regulation imposes by the Chinese government.