THE INTERACTION BETWEEN OIL PRICE AND EXCHANGE RATE: A CASE STUDY IN MALAYSIA

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DECLARATION

We hereby declare that:

(1) This undergraduate research project is the end result of our own work and that due acknowledgement has been given in the references to ALL sources of information be they printed, electronic, or personal.

(2) No portion of this research project has been submitted in support of any application for any other degree or qualification of this or any other university, or other institutes of learning.

(3) Equal contribution has been made by each group member in completing the research project.

(4) The word count of this research report is 12,013words.

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TABLE OF CONTENTS

Page

Copyright Page ii
Declaration iii
Acknowledgement iv
Table of Contents v
List of Tables viii
List of Figures ix
List of Abbreviations x
List of Appendices xi
Preface xv
Abstract xvi

CHAPTER 1: RESEARCH OVERVIEW 1

1.0 Introduction 1
1.1 Research Background 1
1.2 Problem Statement 5
1.3 Research Objectives 9
1.3.1 General Objective 9
1.3.2 Specific Objectives 9
1.4 Research Questions 9
1.5 Hypotheses of the Study 9
1.6 Significance of the Study 10
1.7 Chapter Layout 11
1.7.1 Chapter 1 11
1.7.2 Chapter 2 11
1.7.3 Chapter 3 11
1.7.4 Chapter 4 12
1.7.5 Chapter 5 12
1.8 Conclusion 12

CHAPTER 2: LITERATURE REVIEW ···· **13**
2.0 Introduction ···· 13
2.1 Review of the literature ···· 13
2.1.1 Exchange rate ···· 13
2.1.2 Oil Price ···· 15
2.1.2.1 Review of Relevant Theoretical Models ···· 15
2.1.2.2 Review of Relevant Empirical Models ···· 16
2.1.3 Interest Rate ···· 17
2.1.3.1 Review of Relevant Theoretical Models ···· 17
2.1.3.2 Review of Relevant Empirical Models ···· 18
2.1.4 Stock Price ···· 19
2.1.4.1 Review of Relevant Theoretical Models ···· 20
2.1.4.2 Review of Relevant Empirical Models ···· 21
2.2 Proposed conceptual framework ···· 23
2.3 Hypotheses Development ···· 24
2.4 Conclusion ···· 24
CHAPTER 3: METHODOLOGY ···· **25**
3.0 Introduction ···· 25
3.1 Research Design ···· 25
3.2 Data Collection Method ···· 25
3.3 Data Analysis ···· 26
3.3.1 Jarque-Bera Test (JB Test) ···· 26
3.3.2 Unit Root Test and Stationarity Test ···· 27
3.3.3 Vector Autoregression Model (VAR) ···· 29
3.3.4 Lag Length Selection ···· 30
3.3.5 Johansen Cointegration Test ···· 31
3.3.6 Vector Error Correction Model (VECM) ···· 32
3.3.7 Granger Causality Test ···· 33
3.3.8 Wald Test ···· 35

3.4 Conclusion 35
CHAPTER 4: DATA ANALYSIS 36
4.0 Introduction 36
4.1 Descriptive Analysis 37
4.2 Scale Measurement 38
4.2.1 Normality test 38
4.3 Unit Root and Stationary Test 39
4.4 Lag Length selection 40
4.5 Johansen Cointegration Test 41
4.6 Granger causality and findings 43
4.7 Conclusion 46
CHAPTER 5: DISCUSSION, CONCLUSION AND IMPLICATIONS 47
5.0 Introduction 47
5.1 Summary of statistical analyses 47
5.2 Discussions of Major Findings 48
5.3 Implications of the Study 49
5.4 Limitations of the study 51
5.5 Recommendation for Future Research 52
5.6 Conclusion 52
References 53
Appendices 60

LIST OF TABLES

		Page
Table 1.1	Return of crude oil prices and spot exchange rate of Malaysia and selected OPEC countries from period 2010-2017	7
Table 3.1	Source of data	26
Table 4.1	Summary Descriptive Statistic	37
Table 4.2	Normality test	38
Table 4.3	Results of unit root test	39
Table 4.4	Result for Lag Length Selection	40
Table 4.5	Result of the Johansen Co-integration Test	41
Table 4.6	Granger Causality Result	43
Table 5.1	Summary of Statistical Analysis I	47
Table 5.2	Summary of Statistical Analysis II	48

LIST OF FIGURES

		Page
Figure 1.1	Movement of oil price and exchange rate for the period 2007-2016	4
Figure 2.1	The interaction between exchange rates, oil prices and control variables	23

LIST OF ABBREVIATIONS

ADF	Augmented Dickey-Fuller
AIC	Akaike information criterion
ANOVA	Analysis of variance
BNM	Bank Negara Malaysia
DJIM	Dow Jones Islamic Market
ECT	Error Correction Term
GARCH	Generalized Autoregressive Conditional Heteroskedasticity
HQC	Hannan- Quinn criterion
IFE	International Fisher Effect
JB	Jarque-Bera
KLCI	Kuala Lumpur Composite Index
KPSS	Kwiatkowski-Philips-Schmidt-Shin (KPSS)
MF-DCCA	Multifractal detrended cross-correlation analysis
MYR	Malaysian Ringgit
NGN	Nigerian Naira
OLS	Ordinary Least Square
OPEC	Organization of the Petroleum Exporting Countries
SIC	Schwarz information criterion
SPAS	S&P Asia
SPEU	S&P Europe
SPUS	S&P United States
USD	United States Dollar
VAR	Vector Autoregression
VECM	Vector Error Correction Model

LIST OF APPENDICES

		Page
Appendix 1.1	Return of crude oil prices and spot exchange rates of Malaysia and selected OPEC countries from period 2010-2017	60
Appendix 4.1	Histogram Normality test	63
Appendix 4.2	Augmented Dickey-Fuller Test for Exchange rate (Level, intercept)	63
Appendix 4.3	Augmented Dickey-Fuller Test for Exchange rate (Level, intercept & trend)	64
Appendix 4.4	Augmented Dickey-Fuller Test for Exchange rate (1st difference, intercept)	65
Appendix 4.5	Augmented Dickey-Fuller Test for Exchange rate (1st difference, intercept & trend)	66
Appendix 4.6	Augmented Dickey-Fuller Test for Interest rate (Level, intercept)	67
Appendix 4.7	Augmented Dickey-Fuller Test for Interest rate (Level, intercept & trend)	68
Appendix 4.8	Augmented Dickey-Fuller Test for Interest rate (1st difference, intercept)	69
Appendix 4.9	Augmented Dickey-Fuller Test for Interest rate (1st difference, intercept & trend)	70
Appendix 4.10	Augmented Dickey-Fuller Test for Stock price (Level, intercept)	71
Appendix 4.11	Augmented Dickey-Fuller Test for Stock price (Level, intercept & trend)	72
Appendix 4.12	Augmented Dickey-Fuller Test for Stock price (1st difference, intercept)	73

Appendix 4.13	Augmented Dickey-Fuller Test for Stock price (1st difference, intercept & trend)	74
Appendix 4.14	Augmented Dickey-Fuller Test for Oil price (Level, intercept)	75
Appendix 4.15	Augmented Dickey-Fuller Test for Oil price (Level, intercept & trend)	76
Appendix 4.16	Augmented Dickey-Fuller Test for Oil price (1st difference, intercept)	77
Appendix 4.17	Augmented Dickey-Fuller Test for Oil price (1st difference, intercept & trend)	78
Appendix 4.18	Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Exchange rate (Level, intercept)	79
Appendix 4.19	Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Exchange rate (Level, intercept & trend)	80
Appendix 4.20	Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Exchange rate (1st difference, intercept)	81
Appendix 4.21	Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Exchange rate (1st difference, intercept & trend)	82
Appendix 4.22	Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Interest rate (Level, intercept)	83
Appendix 4.23	Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Interest rate (Level, intercept & trend)	84
Appendix 4.24	Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Interest rate (1st difference, intercept)	85
Appendix 4.25	Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Interest rate (1st difference, intercept & trend)	86
Appendix 4.26	Kwiatkoski-Philips-Schmidt-Shin (KPSS) for	87

	Stock price (Level, intercept)	
Appendix 4.27	Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Stock price (Level, intercept & trend)	88
Appendix 4.28	Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Stock price (1st difference, intercept)	89
Appendix 4.29	Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Stock price (1st difference, intercept & trend)	90
Appendix 4.30	Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Oil price (Level, intercept)	91
Appendix 4.31	Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Oil price (Level, intercept & trend)	92
Appendix 4.32	Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Oil price (1^{st} difference, intercept)	93
Appendix 4.33	Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Oil price (1^{st} difference, intercept & trend)	94
Appendix 4.34	Unrestricted Var	95
Appendix 4.35	Inverse Roots of AR Characteristic Polynomial	96
Appendix 4.36	Lag Length Selection	97
Appendix 4.37	Johansen Cointegration Test	99
Appendix 4.38	Vector Error Correction Estimates	101
Appendix 4.39	Least Square with Exchange rate as dependent variable	103
Appendix 4.40	Wald test: Exchange rate and Interest rate	103
Appendix 4.41	Wald test: Exchange rate and Stock price	104
Appendix 4.42	Wald test: Exchange rate and OIL	104
Appendix 4.43	Least Square with interest rate as dependent variable	105

Appendix 4.44	Wald test: Interest rate and Exchange rate	105
Appendix 4.45	Wald test: Interest rate and Stock price	106
Appendix 4.46	Wald test: Interest rate and Oil price	106
Appendix 4.47	Least Square with Stock price as dependent variable	107
Appendix 4.48	Wald test: Stock price and Exchange rate	107
Appendix 4.49	Wald test: Stock price and Interest rate	108
Appendix 4.50	Wald test: Stock price and Oil price	108
Appendix 4.51	Least Square with Stock price as dependent variable	109
Appendix 4.52	Wald test: Oil price and Exchange rate	109
Appendix 4.53	Wald test: Oil price and Interest rate	110
Appendix 4.54	Wald test: Oil price and Stock price	110

PREFACE

The Bachelor of Business Administration (HONS) Banking and Finance degree lies in the assessment of Research Project that requires graduating students to conduct a paper in the final year.

This research project is conducted under title of “The Interaction between Oil Price and Exchange Rate: A Case Study in Malaysia”. It is accomplished within 28 weeks.

Oil price plays a vital role in Malaysia as it is a trader of crude oil, therefore it is certain that fluctuation of oil price will bring an impact on foreign exchange rate. The heavy oil price drop in recent year impact most OPEC countries as well as Malaysia. However, majority of the researches pay significant focus on OPEC nations and there is lack of studies emphasize on Malaysia. Thus, this is one of the reason behind why this research is conducted, as it is essential to outline the impact of oil price on Malaysia exchange rate.

The study would like to create a significant contribution to public to have better understanding on the impact of macroeconomic variables like oil price, interest rate and stock price on exchange rate in Malaysia.

ABSTRACT

The objective of the study examines the relationship between oil price and exchange rate in Malaysia. Daily data including crude oil price, MYR/USD are among the proxy chosen and the data is obtained from the period of 2007 to 2016. Two additional control variables which are interest rate and stock price are added in the model.

After conducting the data analysis, there is a significant bidirectional granger causal relationship between oil price and exchange rate. Other combination of macroeconomic variables also exhibit significant bidirectional granger causal relationship.

Based on the analysis result, implications and findings were interpreted in the last chapter. Furthermore, the limitation and recommendation have been discussed to assist future researchers to conduct further studies effectively which are related to this topic.

CHAPTER 1: RESEARCH OVERVIEW

1.0 Introduction

This chapter will present the scope of research through background of research and problem statement. Research objective, research questions and hypothesis of the study are provided and served as the guide for the progress of the research. Besides, the significance of the study has been identified in this paper. In addition, the layout of each chapter and a conclusion are stated at the end of this chapter.

1.1 Research Background

Exchange Rate Regime in Malaysia

Exchange rate regime can be defined as the government policy on exchange rate. It is closely related to monetary policy as both are considered as the fundamental instrument to attain the financial and economics objective set by a particular country (Sangaré, 2016). There are several types of exchange rate regime such as floating, pegged, managed float and fixed exchange rate.

Floating rate exchange system had been implemented in Malaysia during the second quarter of 1973. Under floating exchange rate system, the value of currency is purely determined by the supply and demand of money (Bunjaku, 2015). Besides, it is also known as "clean float" since it is not intervened by government. Each country may shield from the economic problems such as inflation faced by the other countries when adopting floating rate exchange system. This is because international trade is carry out based on real values whereby inflation had been taken into consideration instead of applying nominal values.

Prior to August 1975, currency in Malaysia was known as "Malaysian dollars". After the implementation of floating rate exchange system, Malaysian dollar started to float. During that period, each commercial bank was granted the right to determine its own foreign exchange rates and therefore no longer obligated to purchase the United States Dollar (USD) at the floor rate of M$2.4805/USD (Bank Negara Malaysia [BNM], 2016).

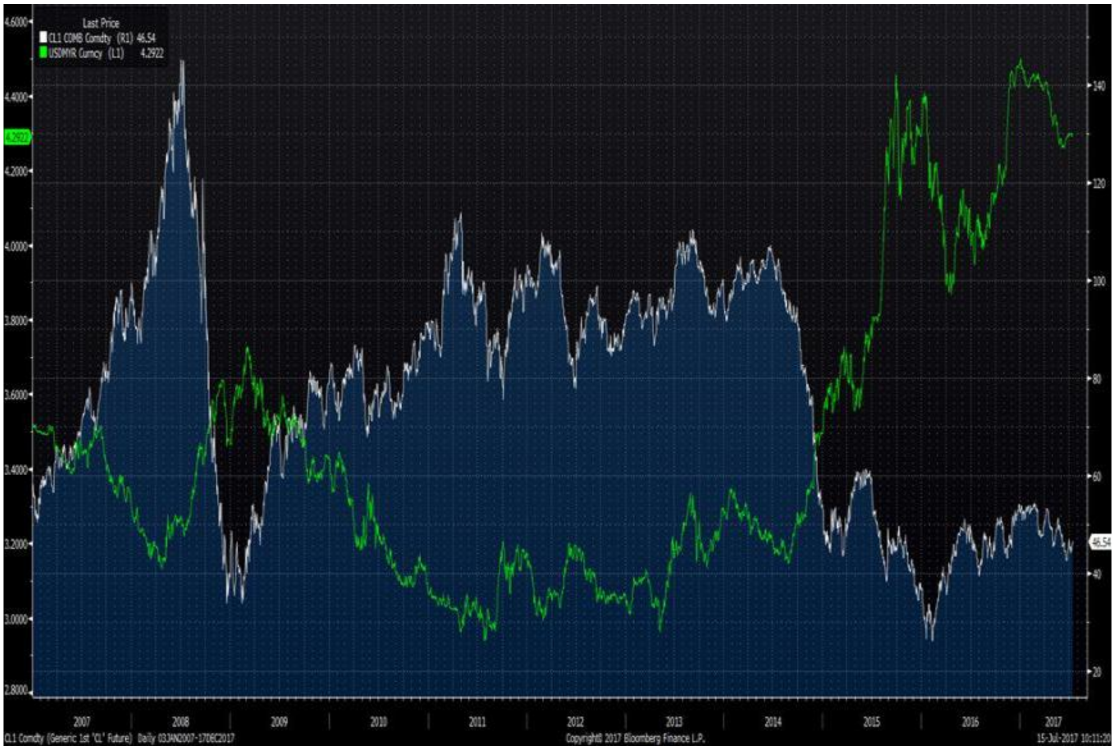
In the early 1974, an amendment on the standard deals had been made to be aligned with the international practice. "Value today" was altered into "value spot" which indicates the settlement of a trade will only take place in two business days after the transaction date. During the third quarter of 1975, Malaysian government had decided to determine the exchange rate based on a basket of currencies such as Pound and Australian Dollar instead purely depends on USD (BNM, 2016).

Apart from that, a new official symbol of Malaysian currency was launched on 1st December 1992. The new currency symbol, Ringgit Malaysia (MYR) was established to replace Malaysian Dollar. During the summer of 1997, Asian financial crisis also known as "Asian Contagion" had spread throughout most of the Asian markets. The crisis had led to a sharp depreciation in the currency value and eventually deteriorated the stock market. Therefore, a pegged exchange rate system and selective exchange controls was imposed on 1st September 1998 to safeguard Malaysian economy and restore financial stability (BNM, 2016). Pegged exchange rate system is a type of exchange rate regime where the home currency's value is pegged to a strong foreign currency and thus there will be a parallel movement between home currency values with the foreign currency values (Bunjaku, 2015). Under this exchange rate system, MYR was pegged to the USD at the rate of RM3.80/USD. Although this exchange rate system might lead to a slower economic growth, it could help to reduce and stabilize inflation rates (Bohl, Michaelis & Siklos, 2016). Thus, international trade can be carried out smoothly with the stable international prices. Besides, Karimi and Voia (as cited in Bohl, Michaelis & Siklos, 2016) found that pegged regimes could reduce the probability of financial crisis by using the quarterly panel of 21 countries for the period between 1970 and 1998.

Despite having the strength of lowering the occurrence of financial crisis, this exchange rate system was abandoned and replaced by managed float exchange rate system on 21st July 2005. Managed float exchange rate system allows the exchange rate to move freely based on the market forces, which is the supply and demand of money supply, with certain level of government intervention (Bunjaku, 2015). It also was recognized as “dirty floating” because government has the rights to intervene and manipulate if the exchange rate pattern does not indicate a favorable direction for their country. The shift of the exchange rate regime allowed Malaysia to obtain the capability to respond and gain advantage from the structural changes that occur internationally.

A huge incident has taken place along 2015. MYR has fallen against the USD to its lowest levels in seventeen years. However, Tan Sri Dr Zeti Akhtar Aziz, Governor of Malaysia’s central bank announced that central bank does not intend to peg the ringgit and undertake any kinds of capital controls for the country. In fact, the current exchange rate regime allows the country to adjust according to the changes in the foreign exchange market without changing the price and demand in the market. Hence, managed float exchange rate system continues to be implemented in Malaysia (Sidhu, 2015).

Figure 1.1: Movement of oil price and exchange rate for the period 2007-2016



Source: Bloomberg

Note: The white color line (CL1 COMB commodity) refers to oil price while the green color line (Daily USD to MYR) refers to exchange rate.

Figure 1.1 illustrates the movement of exchange rate and oil price for the period from 2007 to 2016. Noticeable, there is an inverse relationship between MYR and oil prices. MYR moves adversely with oil price throughout the period. During the financial crisis of 2007 to 2008, oil price fluctuated with a greater magnitude as compared to exchange rate. Besides, it was obvious that both of them move inversely with each other during the same period.

At first, oil price experienced a generally increasing trend and reached a peak at $145.18 per barrel during the second quarter of 2008. It was recorded as the highest price in the time frame. Nevertheless, there is a dramatic fall for exchange rate from 2007 to the first quarter of 2008. However, it shows a minimal increase before the second quarter of 2008.

After that, oil price went through a sharply decline until the fourth quarter of 2008 before it starts to rise. On the other hand, exchange rate moves the other way around where it increase steadily and experienced a minimally reduction at the same time.

In the beginning of 2009, both the oil price and exchange rate exhibit a similar movement. However, exchange rate and oil price begin to fluctuate started from the second quarter of 2009 until the end of 2014. Nevertheless, the fluctuation takes place in a smaller range as compared to the other period. During that period, both of them show a same trend during end of 2010 as well as the second and third quarter of 2011. Moreover, a similar trend was detected for both of them before entered year 2014.
From 2015 onwards, exchange rate and oil price started to move in a opposite direction again. Both of them fluctuate in a larger magnitude for one year from the second quarter of 2015.

As a conclusion, it is obvious that MYR and oil price tend to move in an opposite direction for most of the time. In other words, it can be say that there is a negative correlation between oil price and exchange rate. Nevertheless, there are some similar trends where both of them increase or decrease together during the same period. Therefore, it is important and worth for us to carry out this research and investigate their relationship further.

1.2 Problem Statement

Understanding on the interaction between the exchange rates and oil prices becomes crucial since the interaction between them will affect both oil-exporting country and oil-importing country. Based on the perspective of oil-importing country, when the oil price increase, they tend to import lesser and cause a decrease in exchange rate. In contrast, an oil-exporting country will export more and cause an increase in exchange rate when the oil price increases. Hence, the interactions between them will presence a significant impact to the country that mainly focus on oil exporting. This is because the exchange rate of the country is heavily affected by the export activity.

Moreover, there is an increasing number of studies regarding the interaction between exchange rates and oil prices, and yet remain inconclusive. Volkov and Yuhn (2016) show that the relationship between exchange rates and oil prices varies in advanced markets and emerging markets. They found that the fluctuation of the exchange rate with oil price shock is significant in the emerging markets (i.e. Russia, Brazil, and Mexico) but not in the advanced markets (i.e. Canada and Norway). Besides, Bal and Rath (2015) also claim that oil price and exchange rate fluctuation are significant in emerging countries (i.e. China and India).

In addition, crude oil price decreases dramatically from $61.43 per barrel in Jun 2015 to $26.55 per barrel in January 2016. The data indicates that there is more that 50% drop in the oil price. Since Malaysia is also an importer of crude oil, therefore it is certain that this situation will bring an impact on foreign exchange rate. Furthermore, decrease in oil price also may lead to decrease in exchange rate. For instance, Malaysia currency devalues when oil prices crashed from $110 in 2014 to $27 in January 2015 (Tee, 2017). This situation will affect the foreign direct investment in Malaysia since most of the investors will prefer to invest in a stable economy that will generate a higher return on their investment. Hence, the economy growth of a country will be restricted. According to Volkov and Yuhn (2016), exchange rate can be affected by oil prices through various channels. Fluctuations in oil price will affect domestic economic activity such as interest rate, inflation and GDP for both oil-exporting and oil-importing countries. Moreover, the international transactions for crude oil are denominated in US dollar. Therefore, changes in oil price will indirectly bring an impact on the exchange rate on either an oil-exporting or oil-importing country relative to the US dollar.

Other than that, most of the empirical researches focus on widely traded currencies and paying less attention on currency from emerging markets (Tsuyuguchi &

Wooldridge, 2008). In fact, different market will generate a different result. Therefore, to obtain a clearer result, Malaysia was chosen as the research area in this paper.

Lastly, two control variables are included in the study, namely stock price and interest rate. Some empirical studies suggest that other macroeconomic variables influence the relationship between exchange rates and oil prices. For example, includes (Tsagkanos & Siriopoulos, 2013), (Wu, 2000), (Hatemi & Irandoust, 2002), (Tafa, 2015) and (Cho & West, 2003).

Table 1.1: Returns of crude oil prices and spot exchange rates of Malaysia and selected OPEC countries from period 2010-2017

Date	Percentage Change (%)							
	CL1 Commodity	USD MYR	USD AED	USD IRR	USD IQD	USD KWD	USD NGN	USD SAR
30/6/2016	26.06	3.39	0.00	1.11	0.17	-0.01	40.92	0.00
30/9/2015	-24.18	16.5	0.00	2.73	0.62	0.03	0.06	0.00
30/6/2015	24.94	1.88	0.01	4.17	0.21	0.37	-0.07	-0.02
31/12/2014	-41.56	6.58	0.01	2.09	-0.83	1.61	11.98	0.08
31/12/2011	24.79	-0.65	0.00	3.79	0.00	0.81	1.62	-0.01

Source: Bloomberg

Note: Please refer to Appendix 1.1 for the full data set from 2010 to 2017.

Table 1.1 shows the returns of crude oil prices and spot exchange rates of Malaysia and selected OPEC countries from period 2010 to 2017. All the data obtained is measured by quarterly basis. During the third quarter of 2015, MYR depreciated the most compared to the other Organization of the Petroleum Exporting Countries (OPEC) when the crude oil prices decrease by 24.18%. For instance, the depreciation of MYR is significant among all the selected OPEC countries which recorded as 16.5%.

Besides, crude oil prices fell sharply by 41.56% at the end of 2014 as compared to the previous quarter. The dramatic fall of the crude oil price arise due to the oversupply of crude oil in the global production. In this case, Nigerian naira (NGN) drop from ₦163.82/USD to ₦183.45/USD which accounted for 11.98% while MYR drop from RM 3.2805/USD to RM 3.4965/USD which is 6.58%. During this period, the drop in Nigeria currency outweigh the drop in Malaysia currency. However, the dropping in crude oil price does not affect much on the OPEC countries currency but it affected Malaysia currency significantly. According to Petroff (2014), the OPEC members such as Saudi Arabia, Kuwait, Qatar and the United Arab Emirates have cushion themselves with a combined savings of $2.5 trillion dollars. Thus, they are less concerned about the falling of oil prices since it was relatively affordable for them. Furthermore, Saudi Arabia which has the most controlling power among the OPEC members requested the production levels of oil price to remain unchanged. Their decision is considered as bad news for some oil-producing countries such as Russia, Nigeria and Venezuela since they need to meet their economic targets at the prices of at least $90 per barrel (Petroff, 2014). Moreover, small oil-exporting countries such as Malaysia will be resulting a larger amount of losses since Malaysia is forced to trade the crude oil at a much lower price.

Over the past twelve months, MYR against USD is ranked as the second-worst performing currency among Asian countries after yen. The falling of oil prices has greatly reduced the revenue of government since the proceeds from crude oil production is recorded for slightly less than 30% of total income (Sidhu, 2015). Japan is not selected as the research area in our study since it is not an oil exporting country. Therefore, Malaysia is selected as the research area in this paper.

1.3 Research Objectives

1.3.1 General Objective

This research paper aims to examine the relationship between oil price and exchange rate in Malaysia. Additionally, two control variables are included in the study as endogenous variable, which are stock price and interest rate.

1.3.2 Specific Objectives

To determine the causality relationship between oil price and exchange rate in Malaysia.

1.4 Research Questions

Is there any significant causality relationship between oil price and exchange rate in Malaysia?

1.5 Hypotheses of the Study

$H_{0:}$ There is no significant causality relationship between oil price and exchange rate in Malaysia.

$H_{1:}$ There is a significant causality relationship between oil price and exchange rate in Malaysia.

1.6 Significance of the Study

This research aims to examine the relationship between exchange rates and oil prices by including stock price and interest rate as control variables. Three significances of the study are highlighted as below.

First, this research could benefit the fund manager by illustrating a clearer picture on the relationship between exchange rate and oil price. In practice, the analyst's team of fund manager will carry out research before they make any recommendation to the fund manager on which instrument to be invest. This is because the outcome of a research would be more reliable when considering on the past information and research. Hence, the process of implementing fund investing strategy could be enhancing. Subsequently, the probability of losses that might occur on their clients could be reduced.

Besides, this research also could help the government and policy makers to adopt a more efficient and effective fiscal and monetary policy. Government can control the currency value and adjust it accordingly based on the interaction between exchange rate and oil price. On the other hand, the interaction between them are useful for policy makers to execute a better exchange rate policy to match with the increase and decrease of currency value. Hence, the stability of a country can be preserve with the tight supervision of exchange rate. As a result, the economy of a country can be strengthened when the allocation of funds to each sector is appropriate and sufficient.

In addition, this research could benefit the future researcher who intends to carry out study with a similar research area. Moreover, the finding of this study can be treated as a reference for future researchers. It also able to help them to save time and cost since they do not require to repeat the research on the same variables. Thus, there is a higher possibility for them to produce a complete research on the factors that will influence the exchange rate.

1.7 Chapter Layout

1.7.1 Chapter 1

This chapter comprised of a brief on the whole research paper. It includes an introduction, background of Malaysia's exchange rate regime, problem statement, research objective, research questions and hypotheses of the study. Lastly, significance of the study is identified and conclusion was drawn for the chapter.

1.7.2 Chapter 2

This chapter covered the literature review based on the finding related to this study established by the past researchers. The further explanation of each independent variable (crude oil price, interest rate and stock price) and dependent variable (exchange rate) also has been included in this chapter. Moreover, this chapter also comprises of the review of theoretical models, proposed conceptual framework and hypotheses development. Lastly, a conclusion was drawn to summarize the whole chapter.

1.7.3 Chapter 3

This chapter presented the research design and data collection. Besides, the data was analyzed by employing various type of econometric models before the conclusion was made. This chapter is important because it will link with the next chapter.

1.7.4 Chapter 4

This chapter demonstrated the empirical finding and analysis of data. Test such as LM Test and JB test had been applied for diagnostic checking. Besides, the statistical test in this chapter includes Augmented Dickey-Fuller (ADF), Kwiatkowski-Philips-Schmidt-Shin (KPSS) unit root test, Johansen Cointegration, lag length selection and Granger causality test.

1.7.5 Chapter 5

This chapter highlighted the summary of the research, implications and limitations obtained from the study. In addition, it also comprises of recommendations for future researchers on the future research field before the overall conclusion of the whole research is make.

1.8 Conclusion

Overall, this research presents the relationship between the crude oil price and exchange rate. Based on the research background, crude oil price and exchange rate have a negative relationship with each other as the theoretical framework. Eventually, it has provided us a clearer direction for the remaining research chapter. Besides, the other control variables such as interest rate and stock price also have been included to determine whether are they related and influence the exchange rate. Therefore, chapter two provides further discussion.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

The main theme of this research is to analyze the relation between exchange rate, oil price, interest rate and stock price. By using past studies and researches which focus on the mentioned macroeconomic variables, the literature review is conducted to prove the existence of linkage between the variables. This section will provide a thorough understanding and discussions on the present progress of the research field.

2.1 Review of the literature

2.1.1 Exchange rate

Exchange rate is the price of a nation's currency in terms of another currency (Oxford dictionaries online, 2017). When conversion of currency takes place, the exchange rates change and tend to fluctuate until it reaches equilibrium. Such movement is known as volatility and exchange rate volatility implies the degree of the appreciation or depreciation of foreign currencies, which will influence the stability of a country. In this research, daily exchange rate of MYR/USD is applied as the proxy to measure exchange rate.

Exchange rate is affected by various macroeconomic factors such as stock price, risk free rate, interest rate, inflation, and oil price. There is increasing numbers of studies concern on the relationship between exchange rate and various macroeconomic variables. Oil prices are chosen to study on the exchange rates, while stock price and interest rate act as control variable.

Empirical studies have been undertaken to identify the connection between oil price and exchange rate. Li, Lu and Zhou (2016) attempted to inspect the bidirectional connection between these two variables by using daily data, covering period from 1 January 1996 to 31 December 2014. Five sample currencies are tested in this study, including Australia (AUD), Canada (CAD), Mexico (MXN), Russia (RUB), and South Africa (ZAR). Multifractal detrended cross-correlation analysis (MF-DCCA) was employed in the study. The findings show that there is presence of cross-correlations behavior among crude oil and exchange rate. Novotný (2012) discovers a negative impact of US exchange rate ($) on Brent fuel price by utilizing Granger causality test with a set of monthly historical data from January 1982 to September 2010. Thus, these paper empirical results prove that fluctuation in oil prices and exchange rates will be significantly influence each other in both direction.

Numbers of researches had been done in the past, studying the relation between interest rate and exchange rate. Paramati and Gupta (2013) study the causality relationship between money rates and foreign exchange rates in India by employing monthly data from April 1992 to March 2011. The test results showed that there is bidirectional relationship between money rates and foreign exchange rates. Ali, Mahmood and Bashir (2015) investigated the relationship between interest rate and money rate in Pakistan economy by applying data from July 2000 to June 2009. The paper employed Granger causality test and find out a unidirectional connection between interest rate and money rate.

Mixed evidence found in the interaction between stock price and exchange rate by using Granger causality analysis. Abdalla and Murinde (1997) find that the exchange rates Granger-cause stock prices by examining four countries, which are India, Korea, Pakistan and Philippines. On the contrary, Pan et al. (2007) show there is a unidirectional causality from exchange rate to stock prices. Agus and Carl (2004) reveal exchange rate Granger cause stock prices in their research using data from Indonesia, Philippines, Singapore and Thailand.

2.1.2 Oil Price

Crude oil refers to raw fossil fuel or petroleum as one of the pure non-renewable limited resources that presence naturally (Oxford dictionaries online, 2017). Meanwhile, the consumption and demand rate for crude oil is rising continuously due to high utilization of machinery products such as automobile vehicles. Thus, the variation of supply and demand in the economy can be considered as one of the essential factors that significantly affects crude oil prices. In this research, the proxy used to determine oil price is the daily crude oil price in USD.

2.1.2.1 Review of Relevant Theoretical Models

Bodenstein et al. (2011) indicate that there are two general theories regarding the impact of oil prices fluctuation towards the exchange rates in economy:

- Terms of trade: In oil exporter perspective, a negative oil price shock will decrease the price of non-traded goods in its country. Hence, this incident will cause real exchange rate of oil exporter countries to depreciate in certain period, vice versa.
- Wealth effects: Oil exporters will suffer loss due to decline in crude oil price, thus oil importers will gain more wealth by importing cheaper fuel in the market. Kilian (2007) express that the case will cause wide shifting of current account balances and portfolio reallocation between both oil trading countries. Therefore, changes in real exchange rate are essential in order to restore and improve the trade balance among both countries.

As a result, the historical theories from several sources tend to propose that the connection among crude oil price and foreign exchange rate are positively related for oil exporters' countries perspective, which indicated oil exporters' currencies will tend to appreciate due to higher crude oil price in the market.

2.1.2.2 Review of Relevant Empirical Models

Using nonlinear Granger causality test, Bal and Rath (2015) generate bidirectional nonlinear Granger causality between these two variables by employing monthly data from January 1994 until March 2013 in India and China cases. However, the bidirectional relationship between oil price and exchange rate only remained for India but not China after the researchers further applied GARCH model. Brahmasrene, Huang, and Sissoko (2014) applied the Granger causality test using monthly data from January 1996 to December 2009. The results show that in short-run, exchange rates do significantly Granger cause oil prices. Meanwhile in long-run, oil prices do conversely Granger cause exchange rates. Tiwari and Albulescu (2016) propose a contrasting view, stating foreign exchange rates does Granger cause by crude oil prices in short-run and crude oil prices does Granger cause by foreign exchange rates in long-run after testing the monthly data of oil prices and exchange rates from 1980 to 2016.

Aside from causality relation, there are researches which test the positive or negative relation among the two specific variables which are oil price and exchange rate. Coronado and Rojas (2016) and Narayan, Narayan and Prasad (2008) were able to discover a positive connection among crude oil price and foreign exchange rate by using cross-bicorrelation statistical analysis and GARCH models respectively. However, the result of Ghosh (2011) and Muhammad, Suleiman and Kouhy (2012) contradict the previous researches despite using the same method, GARCH model, as they found the crude oil price and foreign exchange rate are negative related.

In short, most researchers found both crude oil value and foreign exchange ratio are indeed connected in some extent, either granger causing each other or being positively/ negatively related to one another. The different results generated may be caused by trade regime, timelines of research and other relevant factors.

2.1.3 Interest Rate

Interest rate refers to the value charged for the use of assets such as cash, vehicle, machinery and land in a certain period of time (Oxford dictionaries online, 2017). Basically, lender of assets will charge interest rate on borrower of assets as compensation for the loss of their assets in order to generate profits for themselves. In this research, Malaysia overnight interest rate is used as the proxy for interest rate, in the unit of percentage.

2.1.3.1 Review of Relevant Theoretical Models

For nexus between domestic interest rates and domestic currency, there are multiple theoretical findings suggested an inverse relation among these two particular variables. A rise in interest rates for a domestic country will cause its domestic currency to depreciate against foreign currency. There is a valid concept that supports the economic theory with relevant explanation, which is International Fisher Effect (IFE).

International Fisher Effect (IFE)

IFE is originated from Fisher effect theory which invented by Irving Fisher. IFE refers to an interest rate theory that indicates an expected exchange rate changes in value of two different currencies is approximately equivalent to the difference of nominal interest rates among the two particular countries for a certain period of time (Shalishali & Ho, 2002).

The formula for computation of IFE is as below:

$$E = \frac{i_1 - i_2}{1 + i_2} \approx i_1 - i_2$$

Where:
E = exchange rate fluctuation (%)
i_1 = interest rate for country's 1 (%)
i_2 = interest rate for country's 2 (%)

In fact, the IFE theory state nominal interest rate and expected foreign exchange rate are negatively related. For instance, a country with high domestic nominal interest rate will reflected to an inflation, thus lead to a depreciation in domestic currency of the particular country against other foreign countries. Therefore, the IFE theory is an important concept to explain the correlation between interest rates and exchange rates by taken inflation rates into consideration (Shalishali & Ho, 2002).

2.1.3.2 Review of Relevant Empirical Models

Kisaka, Kithitu and Kamuti (2014) attempted to explore whether there is a causal relations between two respective variables which are interest rates and foreign exchange rates in Kenya cases. The researchers have utilized monthly data of Treasury bill rates and closing exchange rates from January 1993 to June 2006 and conducted the causality investigation through Granger causality test by error rectification modelling technique. The statistic results show that interest rates does statistically Granger cause exchange rate.

Despite causality relation, there are researches that shown contradict result in same paper. Tafa (2015) employed approximately 13 years' month historical data which from January 2002 to December 2014 to test the connection between interest rate and exchange rate. By conducting regression analysis, the author find out both negative and positive relationship between the variables, the negative relation being interest rate and USD/ALL and the positive relation being interest rate and EUR/ALL. Cho and West (2003) through the application of vector autoregression (VAR), express that the interest rates and exchange rates are directly related in Korea and Philippines, meanwhile indirectly connection of the variables for Thailand cases.

The last category of research shows absence of relation between the two variables. Wilson and Sheefeni (2014) attempted to probe the exact relations for interest rates and exchange rates in Namibia perspective by applying quarterly historical data from 1993 to 2012 and conducted time series techniques such as cointegration test for the investigation. The authors claim that the findings of this study is unexpected by showing incapability for disclosing of any cointegration or systematic connection among interest rates and exchange rates in Namibia cases. Similarly, Saraç and Karagöz (2016) research paper attempted to examine the impact of short-term interest rates fluctuation on exchange rates in dollar for Turkey cases. This paper adopted monthly historical data from February 2003 to August 2015 and conduct frequency domain Granger causality test in order to obtain the results for nexus between these two variables. The statistics result shows no relation between these two variables.

2.1.4 Stock Price

Stock price or share price is referred to the price of a given company's stock which represent partial ownership of the company (Cambridge dictionaries online, 2017) Previous researches prove numerous relationship between stock price and the exchange rate. However, it is cumbersome to get an overall market stock price in practice since the number of listed companies is huge. Hence, the adopted proxy to calculate stock price in this research is Kuala Lumpur Composite Index (KLCI). KLCI is a stock market index which consists of 30 largest companies in terms of market capitalization. This section discusses the possible impact of stock price on exchange rate.

2.1.4.1 Review of Relevant Theoretical Models

The performance of domestic stock market over the few decades has played important roles in influencing the capital inflow or outflow. Dornbusch and Fischer (1980) propose goods market approach to discuss the nexus between stock price and exchange rate. The competitiveness of a firm is affected by changes in exchange rates, which in turn has an impact on the firm's earnings and ultimately its stock price. The international trading effect states that when the depreciating exchange rate is linked with the increasing competitiveness of both exports and the input cost of imports. Hence, depreciation of currency will affect export firms positively and increase their stock prices.

Frankel (1984) introduced portfolio balance approach to explain the connection between the variables. A dropping stock market would decrease the demand for domestic currency and resulting a depreciation in exchange rate. The portfolio balance effect may not present all the time, since foreign capital will only be absorbed in the highly volatile stock market. However, if the arbitrage opportunity is distinct and resulting a significant amount of foreign capital to flow in or out of the stock market, then clear influence on exchange rate is more likely to be detected. Hence, under normal circumstance when no apparent inflow or outflow of capital, the two markets are solely affected by international trading effect and are negatively related.

2.1.4.2 Review of Relevant Empirical Models

Wu (2000) and Hatemi and Irandoust (2002) manage to show a unidirectional causality from stock market to exchange rates. The test countries are Singapore and Sweden respectively. Tsagkanos and Siriopoulos (2013) reveal stock prices cause exchange rates in EU and USA using both daily and monthly data 2008 to 2012.

Conversely, Dimitrova (2005) find that there is absence of causality between the variables for UK and US from 1990 to 2004. Using monthly data from April 2001 to December 2011, Zubair (2013) conclude no causality relation between the variables in Nigeria.

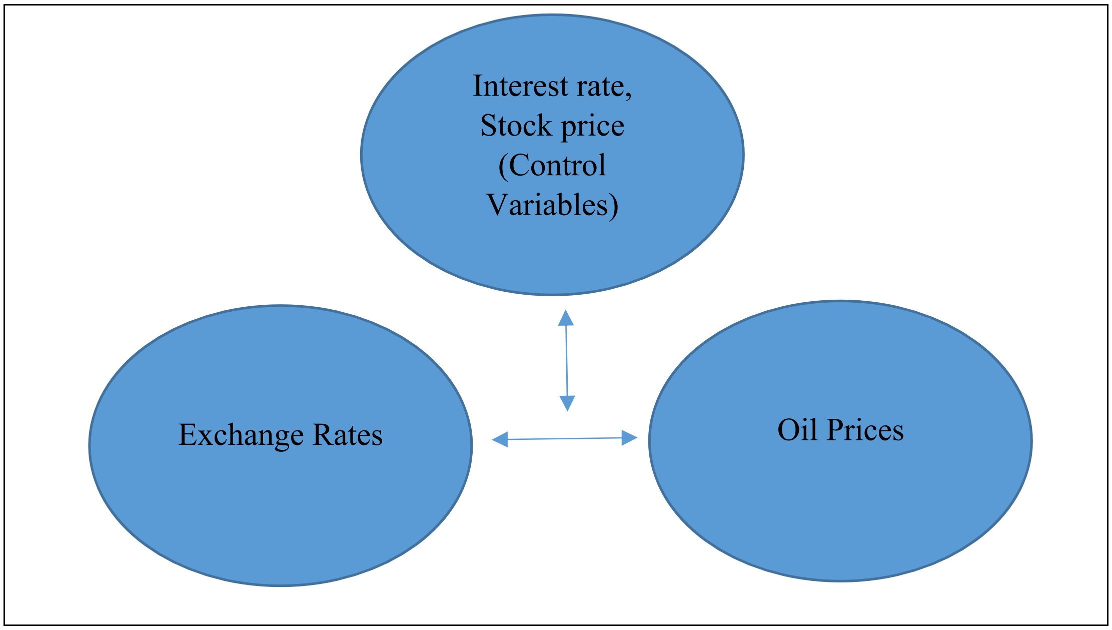
Distinctive results are found when researchers choose to test multiple nations at the same time. Granger et al. (2000) used data of nine countries in Asia during financial crisis period to determine the connection between variables. Each country shows dissimilar relation between the variables; foreign exchange rate lead stock price in Thailand and Japan; stock price lead exchange rate in Taiwan; no nexus exists in Singapore; and the remaining countries show bidirectional relationship. Pan, Fok and Liu (2007) examined the linkages between the variables for seven East Asian countries (Hong Kong, Japan, Korea, Malaysia, Singapore, Taiwan, and Thailand) for the period January 1988 to October 1998. The result show exchange rates cause stock prices for Hong Kong, Japan, Malaysia, and Thailand prior to 1997 Asian financial crisis. In addition, the stock price causes foreign exchange market for Hong Kong, Korea, and Singapore. Bidirectional causal relation seems to be only happening in the economy of Hong Kong. During the financial crisis, all test countries experienced causal relation from exchange rates to stock prices except Malaysia. Hence, the causal relations between exchange rates and stock prices are still doubtful despite numerous researches had been carried out using the same method, namely Granger causality model.

Aside than causality relations, Diamandis and Drakos (2011) discover a positive relationship between the variables in several South America countries after applying the VECM model to test the monthly data from 1980 to 2009. However, Tsai (2012) and Kubo (2012) manage to detect a negative relationship between the variables in several Asia countries. Using monthly data from 1997 to 2012, Tudor and Popescu-Dutaa (2012) who adopted VAR model prove that no relation exists between two variables.

In short, most of the past studies exhibit different empirical results, for instance causality relation between the variables was shown in some paper while missing in the others. In order to further explain the connection between the variables, this research shall explore the potential relationship in several methods.

2.2 Proposed conceptual framework

Figure 2.1: The interaction between exchange rates, oil prices and control variables



Past studies prove exchange rate is related to oil price. Bal and Rath (2015), Brahmasrene, Huang, and Sissoko (2014), Tiwari and Albulescu (2016) prove causality exist between the two variables. Bodenstein et al. (2011), Coronado and Rojas (2016), and Narayan, Narayan and Prasad (2008) prove a positive relation between the two variables. Ghosh (2011), Muhammad, Suleiman and Kouhy (2012) prove negative relationship between the variables.

For interest rate, various researches confirm the variable is related to exchange rate, either in causality, positive or negative correlation (Kisaka, Kithitu & Kamuti, 2014; Tafa, 2015; Cho & West, 2003). Besides, numerous researches verify stock price is correlated to exchange rate (Dornbusch & Fischer, 1980; Frankel, 1993; Wu, 2000; Hatemi & Irandoust, 2002; Tsagkanos & Siriopoulos, 2013; Granger et al., 2000; Pan, Fok & Liu, 2007; Diamandis & Drakos, 2011; Tsai, 2012; Kubo, 2012).

This paper tends to test the relationship between oil price and exchange rate. With reference to past studies, interest rate and stock price are connected to exchange rate till some extent. Hence, the two variables are included as control variables in order to form a more comprehensive model.

2.3 Hypotheses Development

$H_{0:}$ There is no significant causality relationship between oil price and exchange rate in Malaysia.

$H_{1:}$ There is a significant causality relationship between oil price and exchange rate in Malaysia.

2.4 Conclusion

In short, this chapter provides a comprehensive detail about the linkage between exchange rate, oil price, interest rate and stock price. Theoretical concept between the exchange rate and respective chosen variable are discussed. Besides, the review is carried out based on past studies to cover the causality, positive or negative relationships between the variables. The results are ambiguous among researchers due to different test nations, period of study, and other factors. Thus, a proposed conceptual framework is formed which is to be tested in the next chapter in order to prove the relationship between the variables. More resolution techniques and detailed account methods are applied to test the model and further develop this research.

CHAPTER 3: METHODOLOGY

3.0 Introduction

This chapter discusses how the data collected from Bloomberg are used in the development of the various forms of methodologies and tests. Numerous methodologies and tests are applied in order to achieve the aim of this research which is to identify the relationship between the variables, namely exchange rate, oil price, interest rate and stock price.

There are six components in this chapter. Section 3.1 is the research design which is the blueprint of the study, section 3.2 discusses this method of data collection, section 3.3 discusses the functions and theory of the methodologies and test and the last section is a conclusion for the whole chapter.

3.1 Research Design

This research is carried out based on the data that extracted from Bloomberg terminal. Data that used in this study is 10 years daily data ranging from 3 January 2007 to 30 December 2016. Total observation for each variable is 2386. All the data that used in this research are quantitative data which is all in numerical form. Eviews 7.0 software is used for the data analysis in order to identify the relationship between the variables, namely exchange rate, oil price, interest rate and stock price.

3.2 Data Collection Method

Basically, all the data are secondary data which obtained from Bloomberg. Secondary data is the public historical data that made available to public (Cambridge dictionaries online, 2017). The data is on daily basis which is from 3 January 2007 to 30 December 2016.

Table 3.1: Data Sources

Variable	*Proxy*	*Unit*	*Description*	*Sources*
Exchange rate	EXC	MYR/USD	Conversion of one currency to another.	Bloomberg
Oil price	OIL	USD/barrel	Price of crude oil in dollar per barrel)	Bloomberg
Interest rate	INT	Malaysia Overnight Interest Rate (percentage (%)	Rate that charged by lender to borrower, normally it is on annually basis.	Bloomberg
Stock price	KLCI	Index Base value=100	Stock market index in Malaysia	Bloomberg

3.3 Data Analysis

3.3.1 Jarque-Bera Test (JB Test)

Jarque-Bera test is one of the most famous and the easiest method to test for the normality. JB test is a large sample (>2000) test and is based on the OLS residuals (Gujarati & Porter, 2009). According to Zivot and Wang (2003), the normally distributed variables always have skewness that equal to 0 and a kurtosis that equal to 3. The JB test statistic will be:-

$$\boldsymbol{JB = n\left[\frac{S^2}{6} + \frac{(K-3)^2}{24}\right]}$$

Where n=sample size, S=skewness coefficient and K=kurtosis coefficient.

Thus, the null hypothesis against the alternative hypothesis will be:-

H_0: The error terms are normally distributed.

H_1: The error terms are not normally distributed.

As we can see in the Model 2.1, both of the skewness and kurtosis are squared, thus it will never be negative. This can avoid the problem that a positive excess kurtosis will be offset by a negative skewness, eventually this will lead to wrong suggestion of normality. The JB test statistic can compare with the chi-square distribution with 2 degrees of freedom.

3.3.2 Unit Root Test and Stationarity Test

In recent years, unit root test is considered as the most popular and reliable test that used to measure the stationarity of variables (Gujarati & Porter, 2009). A stationary variable does not vary when time progress, thus ensuring the mean, variance and covariance of the stationary model always be constant. Unit root test is important to determine the permanent (stochastic trend or unit root) or transitory (deterministic trend) effects on shocks (Nielsen, 2005). A model is said to have unit root exists when the coefficient is one. Despite its popularity among researchers, the unit root test is yet to be perfect as criticisms against unit root tests arise, for instance the low power of the test which in turn might cause the wrong decision to accept the null hypothesis (Ng & Perron, 2001). Among various types of unit root test, Augmented Dicker-Fuller Test measures the unit root whereas Kwiatkowsi-Philips-Schmidt-Shin Test (KPSS) measures the stationarity of the data.

1. <u>Augmented Dicker-Fuller Test</u>

In order to construct the Augmented Dicker-Fuller Test, the model of the normal Dicker-Fuller Test will be amended:-

Dicker-Fuller Autoregressive model:

$$\boldsymbol{Y_t = \beta_0 + \beta_1 Y_{t-1} + u_t}$$

Where:

Y_t = variable of interest

T= time or trend variable

u_t =error term

However, the model cannot be estimated by Ordinary Least Square (OLS) or undergo hypothesis testing using the normal t-test as both tests are biased and violate the theory of unit root. Hence, the model is amended by subtracting $\boldsymbol{Y_{t-1}}$ for the both sides.

$$\boldsymbol{Y_t - Y_{t-1} = \beta_0 + \beta_1 Y_{t-1} - Y_{t-1} + u_t}$$

$$\boldsymbol{Y_t - Y_{t-1} = Y_{t-1}(\beta_1 - 1) + \beta_0 + u_t}$$

$$\boldsymbol{\vartriangle Y_t = \beta_0 + \delta Y_{t-1} + u_t}$$

where $\vartriangle$ is the first different estimator and $\delta = \beta_1 - 1$.

Thus, the null hypothesis against the alternative hypothesis become:-

$$\boldsymbol{H_0 : \delta = 0 \;\; vs. \;\; H_1 : \delta} < 0$$

In both model, the error term $\boldsymbol{u_t}$ is presumed to be uncorrelated. Another assumption is that the error term $\boldsymbol{u_t}$ is correlated and $\boldsymbol{H_1}$ is stationary around the deterministic linear time trend (t). Therefore, the model is amended by adding the lagged value of Y and new regressor.

$$\boldsymbol{Y_t = \beta_0 + \alpha t + \delta Y_{t-1} + \gamma_1 \vartriangle Y_{t-1} + \gamma_2 \vartriangle Y_{t-2} + \cdots + \gamma_p \vartriangle Y_{t-p} + u_t}$$

where p is the number of lags and αt is the new regressor.

2. <u>Kwiatkowsi-Philips-Schmidt-Shin Test (KPSS)</u>

According to Su et al. (2012), the main difference between the ADF and KPSS is that, the unit root is present in the alternative hypothesis while the time series data is stationarity in the null hypothesis. Assuming there is no trend, thus the starting point of KPSS test will be:-

$$\boldsymbol{Y_t = \xi_t + e_t}$$

Where ξ_t is a random walk and $e_t$is stationary error.

$$\xi_t = \xi_{t-1} + u_t$$

Where u_t is IID $(0,\sigma_u^2)$, IID stands for independent and identically distributed. Thus, the null hypothesis against the alternative hypothesis will be:-

$$H_0: \sigma_u^2 = 0 \ \ vs. \ H_1: \sigma_u^2 \neq 0$$

3.3.3 Vector Autoregression Model (VAR)

In recent years, the usage of VAR model in describing the time series data is rising due to its easy and simple method of estimation, the OLS (Juselius, 2006). Besides, VAR makes use of the cointegration nature, in order to merge the long run and short run information of the time series data. Moreover, it can forecast more than one variable with a single model by augmenting the uni-variate autoregression to multivariate autoregression. Assume that EXC and OIL are the only time series variables, the VAR model will be:

$$EXC_t = \beta_{10} + \beta_{11}EXC_{t-1} + \cdots + \beta_{1p}EXC_{t-p} + \gamma_{11}OIL_{t-1} + \cdots + \gamma_{1p}OIL_{t-p} + u_{1t}$$

$$OIL_t = \beta_{20} + \beta_{21}OIL_{t-1} + \cdots + \beta_{2p}OIL_{t-p} + \gamma_{21}EXC_{t-1} + \cdots + \gamma_{2p}EXC_{t-p} + u_{2t}$$

where β's and γ's are the unknown coefficients; u_{1t} and u_{2t} are the error terms.

Despite its high practicality among researchers, there are some criticisms against VAR model. According to Gujarati and Porter (2009), lag length selection will be challenging in the VAR modeling when the sample size is not large enough and too much lags are included in the variables. The parameters that need to be estimated increase, in correspond to the increase on degree of freedom, which may cause a handy of mathematical issues. Furthermore, VAR model is not valid whenever the cointegration exists in the model.

3.3.4 Lag Length Selection

The most important practice in the autoregressive process is the selection of lag length as it is the key point to test the serial correlation. Lag length is the days that prior to the autoregressive process that needed to be tested on. The lag length cannot be too small or too large, otherwise the test will become bias or suffer. In normal circumstance, the lag length is unknown, therefore, the number of lags can be chosen by estimating through various lag length selection criteria (Venus, 2004). In this research, Schwarz information criterion (SIC/BIC), Akaike information criterion (AIC) and Hannan-Quinn criterion (HQC) are selected for the estimation. The smallest figure for each BIC, AIC and HQC are chosen as the lag length.

1. <u>Schwarz information criterion (SIC/BIC)</u>

$$\boldsymbol{BIC(p) = ln\left[\frac{SSR(p)}{T}\right] + (p+1)\frac{ln\,T}{T}}$$

Where:

SSR(p)=sum of squared residuals of the estimate autoregressive lag length (p)

T=sample size.

In the theory of BIC, the sum of squared residuals must be either decrease or stay constant when a lag is added because OLS is used in order to estimate the regression coefficient (Stock & Watson, 2007).

2. <u>Akaike information criterion (AIC)</u>

$$\boldsymbol{AIC(p) = ln\left[\frac{SSR(p)}{T}\right] + (p+1)\frac{2}{T}}$$

AIC and BIC are almost the same. The only difference is that, the "***ln T***" replaced "***2***". In this case, the lag length can't be chosen correctly because the second term of AIC is not big enough. Some researchers suggest that the large sample can avoid this problem, but there is possibility of overestimate of lag length with larger sample (Stock & Watson, 2007). However, according to Venus (2004), AIC provides the best result for small sample.

3. Hannan-Quinn criterion (HQC)

$$HQC(p) = ln\left[\frac{SSR(p)}{T}\right] + 2T^{-1}p[ln(T)]$$

Based on Venus (2004), among all the criterions, HQC is more accurate in estimating the true lag length when the sample size is large.

3.3.5 Johansen Cointegration Test

According to Stock and Watson (2007), two or more time series sharing same stochastic trend can shift together closely over the time. The main purpose of this test is to determine how many variables are actually cointegrated. Dwyer (2015) proposed the use of maximum likelihood estimation to determine the cointegration relationship between two or more variables.

1. Trace Test

$$J_{trace} = -T \sum_{i=r+1}^{n} \ln(1 - \hat{\lambda}_i)$$

Where:

T= sample size

r= number of cointegrating vector

$\hat{\lambda}_i$= the largest canonical correlation

Thus, the null hypothesis against the alternative hypothesis will be:-

H_0: R cointegrating relationship exists.

H_1: More than R cointegrating relationships exist.

3.3.6 Vector Error Correction Model (VECM)

The Johansen Cointegration test examines the existence of cointegration. A detection of cointegration indicates the existence of long term equilibrium relationship. If Johansen Cointegration test show there is a cointegration relationship, Vector Error Correction Model (VECM) is estimated since VAR is no longer valid whenever cointegration relation arise. Thus, error term is added in order to measure the short run behavior (Gujarati & Porter, 2009). However, if there is no cointegration, VAR model will be estimated to analyze Granger Causality test and determine the causality effect. Assume there are four variables, the VECM is as below:

$$\Delta y_{1t} = a_0 + \alpha_{11}(ect_{1t-1}) + \alpha_{12}(ect_{2t-1}) + \sum_{j=1}^{p} a_{1j}\ \Delta y_{1t-j} + \sum_{j=1}^{p} a_{2j}\ \Delta y_{2t-j} + \sum_{j=1}^{p} a_{3j}\ \Delta y_{3t-j} + u_{1t}$$

$$\Delta y_{2t} = b_0 + \alpha_{21}(ect_{1t-1}) + \alpha_{22}(ect_{2t-1}) + \sum_{j=1}^{p} b_{1j}\ \Delta y_{1t-j} + \sum_{j=1}^{p} b_{2j}\ \Delta y_{2t-j} + \sum_{j=1}^{p} b_{3j}\ \Delta y_{3t-j} + u_{2t}$$

$$\Delta y_{3t} = c_0 + \alpha_{31}(ect_{1t-1}) + \alpha_{32}(ect_{2t-1}) + \sum_{j=1}^{p} c_{1j}\ \Delta y_{1t-j} + \sum_{j=1}^{p} c_{2j}\ \Delta y_{2t-j} + \sum_{j=1}^{p} c_{3j}\ \Delta y_{3t-j} + u_{3t}$$

$$\Delta y_{4t} = d_0 + \alpha_{41}(ect_{1t-1}) + \alpha_{42}(ect_{2t-1}) + \sum_{j=1}^{p} d_{1j}\ \Delta y_{1t-j} + \sum_{j=1}^{p} d_{2j}\ \Delta y_{2t-j} + \sum_{j=1}^{p} d_{3j}\ \Delta y_{3t-j} + u_{4t}$$

Where:

$\boldsymbol{ect_{1t-1} = \beta_{11}y_{1t-1} + \beta_{12}y_{2t-1} + \beta_{13}y_{3t-1}}$

$\boldsymbol{ect_{2t-1} = \beta_{21}y_{1t-1} + \beta_{22}y_{2t-1} + \beta_{23}y_{3t-1}}$

Normally, some variables can be normalized by making the coefficient equal to one. Besides, the long run equation will be constructed by making the error correction term (ECT) equal to 0. The long run equations are as below:

$\boldsymbol{\beta_{11}y_{1t} + \beta_{12}y_{2t} + \beta_{13}y_{3t} = 0}$

Or, $\boldsymbol{y_{1t} = -(\beta_{12} \div \beta_{11})y_{2t} - (\beta_{13} \div \beta_{11})y_{3t}}$ (normalized on y_{1t})

$\boldsymbol{\beta_{21}y_{1t} + \beta_{22}y_{2t} + \beta_{23}y_{3t} = 0}$

Or, $\boldsymbol{y_{2t} = -(\beta_{21} \div \beta_{22})y_{1t} - (\beta_{23} \div \beta_{22})y_{3t}}$ (normalized on y_{2t})

$\boldsymbol{\alpha}$ acts as speed of adjustment coefficient. It helps to determine how fast the variables react on the return in order to meet long run equilibrium.

3.3.7 Granger Causality Test

In 1969, Granger developed a method to determine the causality effect or the direction of influence between the chosen variables (Foresti, 2006). The model is useful in determining whether one time series regression is applicable to forecast another. Gujarati and Porter (2009) concluded that the number of lagged terms may significantly affect the direction of causality effect. The regression models of Granger Causality test are as below:-

$$\boldsymbol{Y_t = \sum_{i=1}^{n} a_i X_{t-i} + \sum_{j=1}^{n} \beta_j Y_{t-j} + u_{1t}}$$

$$\boldsymbol{X_t = \sum_{i=1}^{n} \lambda_i X_{t-i} + \sum_{j=1}^{n} \delta_j Y_{t-j} + u_{2t}}$$

Where:

u_{1t} and u_{2t} = error terms

Let assumed both of the error terms are not correlated.

Thus, the null hypothesis against the alternative hypothesis will be:-

H_0: Granger cause relationship is not exists between the dependent variable and explanatory variables.

H_1: Granger cause relationship is exists between the dependent variable and explanatory variables.

In order to test the hypothesis, F-test is applied:-

$$F = \frac{(RSS_R - RSS_U) \div (k_u - k_r)}{RSS_u \div (n - k - 1)}$$

where RSS_R is the sum square of residuals for restricted model, RSS_U is the sum square of residuals for unrestricted model, the number of independent variables in restricted model refers to k_r while the number of independent variables in unrestricted model refers to k_u and the number of observations equal to *n*.

Decision Rule: Reject $\boldsymbol{H_0}$ if the F-test statistic value is greater than the critical F value ($\boldsymbol{F_{\sigma,(k_u-k_r),(n-k_u-1)}}$) at a specific significance level. Otherwise, do not reject $\boldsymbol{H_0}$.

There are four possible results:-

i. **X causes Y**. This will be happened when the lagged X coefficients are statistically distinct from zero and the lagged Y coefficients aren't statistically distinct from zero.

ii. **Y causes X**. This will be happened when the lagged Y coefficients are statistically distinct from zero and the lagged X coefficients aren't statistically distinct from zero in both models.

iii. **Feedback or Bilateral Causality**. Coefficients of X and Y are both significantly distinct from zero in both models.

iv. **Independence**. Coefficients of X and Y aren't significantly distinct from zero in both models.

3.3.8 Wald Test

When the cointegration is found, Ordinary Lease Square (OLS) models will be estimated to analyze Wald Test. Wald test is a tool of Granger Causality Test. Wald test is used to test the interaction between variables (Enders, 2010).

Thus, the null hypothesis against the alternative hypothesis will be:-

$\boldsymbol{H_0}$: $\boldsymbol{C_1 = C_2 = C_3 = C_4 \dots C_i = 0}$

$\boldsymbol{H_1}$: $\boldsymbol{C_1 = C_2 = C_3 = C_4 \dots C_i \neq 0}$

where $\boldsymbol{C_i}$ is the parameters.

The null hypothesis states that any of the independent variables will not affect the dependent variable which means it is not significant, while the alternative hypothesis states that one of the independent variables will affect the dependent which means it is significant.

3.4 Conclusion

In a nutshell, the chapter clearly discuss about the research design, data collection method and method of analyze the data. All the data are daily basis secondary data that obtained from Bloomberg. There is total of 9544 observations which are from year 2007 to 2016. Furthermore, in order to detect the econometric problem and relationship among the dependent and independent variables, Eviews 7.0 software is used in Chapter 4.

CHAPTER 4: DATA ANALYSIS

4.0 Introduction

This chapter presents the relationship between exchange rate, oil price, stock price and interest rate by using the methodologies discussed in chapter 3. Most of the results are generated through Eviews 7.0, which is an econometrics software used largely for time-series oriented econometric study. In this research, scale measurements such as the tests for normality and kurtosis were included. First, ADF and KPSS unit root and stationary test are used to determine stationary of the variable. Next, we proceed to the lag order selection to choose proper lag according to the minimum AIC, HQC and SIC. From Johansen cointegration test, we get sufficient evidence to conclude that there are two cointegrating vectors exist in the model. The main highlighted of this chapter is Granger Causality test which is used to determine causal relationship between all the variables.

4.1 Descriptive Analysis

Table 4.1: Summary Descriptive Statistic

Variables	Exchange rate	Oil price
Mean	3.413992	3.413992
Median	3.294600	82.41000
Standard deviation	0.366450	23.59304
Kurtosis	**3.621136**	**2.238567**
Observation	2386	2386

Note: The results are based on the daily basis observations for the period from 2007 to 2016.

Table 4.1 shows a statistical summary of the exchange rate and oil prices variables for ten years between 2007 and 2016. The mean shows the average values of the data in exchanges rate and oil price which is 3.413992 and 3.413992 respectively. The standard deviation measures the average difference between the mean and the volatility of the variables. The oil price is more volatile than exchanges rate as the oil price presents larges standard deviations. The wide range of sampled data used is the main reason that caused the standard deviation to be huge but this does not raise an issue. The median exchange rate is approximately 3.294600. Additionally, the kurtosis coefficient of a normal distribution is 3. The data of exchange rate in Malaysia is slightly high volatile because the kurtosis 3.621136 is more than 3. While the data of exchange rate of MYR to USD is less volatile because the Kurtosis is less than 3, only 2.238567. Lastly, both variables with same observations follow the normal distribution.

4.2 Scale Measurement

4.2.1 Normality test

Jarque-Bera Normality Test (JB test) has been conducted in order to detect the normal distribution of error term at significant level of 5%. The decision rule is to reject null hypothesis when p-value is smaller than significance level. Otherwise, do not reject H_0.

Hypothesis

H_0: The error term is normally distributed.

H_1: The error term is not normally distributed.

Table 4.2: Normality test

Jarque-Bera Test Statistic	304.4814
Probability	0.000000<0.05

Decision Making

Reject H_0 since the p-value (0.000000) is smaller than the significant level (0.05).

Conclusion

There is sufficient evidence to conclude that the error term is normally distributed in the model.

4.3 Unit Root and Stationary Test

Table 4.3: Results of unit root test

Variable	Augmented Dickey-Fuller				Kwiatkowski-Philips-Schmidt-Shin (KPSS)			
	No Trend (Constant)		With Trend		No Trend (Constant)		With Trend	
	Level	First Difference	Level	First Difference	Level	First Difference	Level	First Difference
Exchange rate	0.70 (0)	-47.79*** (0)	-0.41 (0)	-47.89*** (0)	1.96*** (39)	0.58** (15)	1.19*** (39)	0.065 (13)
Interest rate	-1.97 (19)	-8.16*** (18)	-2.03 (19)	-8.18*** (18)	0.74** (39)	0.23 (0)	0.63*** (39)	0.15 (1)
KLCI index	-1.51 (1)	-44.04*** (0)	-1.57 (1)	-44.04*** (0)	4.55*** (39)	0.13 (3)	0.53*** (39)	0.08 (3)
Oil price	-1.78 (0)	-51.46*** (0)	-2.15 (0)	-51.46*** (0)	1.07*** (39)	0.15 (1)	0.66*** (39)	0.05 (0)

*Notes: *, **, *** denote that reject null hypothesis at the level of significant of 10%, 5% and 1% respectively. Number of parentheses is the number of the lag length.*

Augmented Dickey-Fuller (ADF) test

H_0: The series is unit root.

H_1: The series is no unit root.

Kwiatkowski-Philips-Schmidt-Shin (KPSS) test

H_0: The series is stationary.

H_1: There series is non-stationary.

According to the table 4.3, we have utilized unit root and stationary methods which is Augmented Dickey-Fuller (ADF) test and Kwiatkowski-Philips-Schmidt-Shin (KPSS) test. ADF results indicated that the entire variables can be accepted at the null hypothesis which mean has a unit root in level form at significant level of 1%. While under KPSS, indicated that all the variables are significant at 1% significant level, other than the interest rate is significant at 5% significant level. Hence, both methods show consistent result by proving the existence of unit root and non-stationary within the variables in the level.

Further proceeds to the First Difference, ADF result presented that all exogenous and endogenous variables are significant at 1% significant level. While, KPSS result showed that all exogenous and endogenous variables are insignificant at 1% significant level, except exchanges rate is significant at 5% significant level. Hence, both unit root methods show consistent result by proving the removed of unit root within the variables in the first difference. This result suggest that all the variables are constant and no unit root in the first difference but have unit root in the level based on both unit root methods.

4.4 Lag Length selection

Table 4.4: Result for Lag Length Selection

Lag Length selection			
Lag	AIC	SIC	HQC
0	23.73800	23.74803	23.74166
1	1.473741	1.523912	1.492038
2	**1.419762***	**1.510070***	**1.452698***
3	1.424363	1.554808	1.471937
4	1.426799	1.597381	1.489010
5	1.435601	1.646320	1.512450
6	1.444369	1.695225	1.535856
7	1.454605	1.745598	1.560730
8	1.455405	1.786535	1.576168
9	1.463006	1.834272	1.598407
10	1.466560	1.877963	1.616599
11	1.474942	1.926482	1.639619
12	1.478492	1.970169	1.657807

13	1.484304	2.016118	1.678257
14	1.490343	2.062293	1.698933
15	1.494556	1.494556	1.717784
16	1.502921	2.155146	1.740788
17	1.508339	2.200701	1.760844
18	1.519465	2.251963	1.786607
19	1.521065	2.293700	1.802845
20	1.436879	2.249651	1.733297

Note: Total 100 lags had tested refer to Appendix 4.36.
AIC: Akaike information criterion

SIC: Schwarz information criterion

HQC: Hannan- Quinn information criterion

Table 4.4 show result from Lag 0 to 2 under Akaike information criterion (AIC), Schwarz information criterion (SIC) and Hannan- Quinn information criterion (HQC). The smallest number from each criterion is chosen as optimum lag length. Refer to the data from Table 4.4, Lag 2 is chosen because it has the smallest number between SIC and HQC which is 1.510070and 1.452698 respectively. While AIC is the cross checking to ensure the adequate lag selected, its result is consistent with both SIC and HQC of Lag 2 selection. Thus, lag 2 was selected as the optimum lag length for this study because it has the smallest number in AIC, HQC and SIC.

4.5 Johansen Cointegration Test

<u>Table 4.5: Result of the Johansen Co-integration Test</u>

Hypothesized No. of CE(s)	Trace Statistic	Critical values (5%)
		Trace
r = 0	54.68703	47.85613
r = 1	29.91050	29.79707
r = 2	14.70050	15.49471

Table 4.5 show the Johansen Co-integration test results extract from Trace statistics with lag order 2 used to determine the number of cointegrated relationship that exist by referring to co-integrating vector.

The null hypothesis is rejected only when Trace statistic is greater than the critical value. According to the Table 4.5, while using trace statistic, the null hypothesis is rejected since trace statistic of rank 0 and rank 1 are 54.68703 and 29.91050, which are greater than the critical value at 5 per cent significant level. Hence, we have sufficient evidence to conclude that there are two cointegrating vectors in this model.

Therefore, in this model two co-integrating relationship were exists which determined between the variables after applied Johansen cointegration test. The test was performed at 5% level of significant, and the null hypothesis of no cointegration vector between all variables was rejected.

Hypothesis 1

H_0: There is no co-integrating vector ($r = 0$)

H_1: There is co-integrating vector ($r > 0$)

Decision Making

Reject H_0 since trace statistic (54.68703) is greater than the critical value (47.85613) at 5% significant level.

Conclusion

There is sufficient evidence to conclude that existing of co-integrating vector.

Hypothesis 2

H_0: There is no co-integrating vector ($r = 1$)

H_1: There is co-integrating vector ($r > 1$)

Decision Making

Reject H_0 since trace statistic (29.91050) is greater than the critical value (29.79707) at 5% significant level.

Conclusion

There is sufficient evidence to conclude that existing more than one co-integrating vector.

Hypothesis 3

H_0: There is no co-integrating vector (r = 2)

H_1: There is co-integrating vector (r > 2)

Decision Making

Do reject H_0 since trace statistic (14.70050) is greater than the critical value (15.49471) at 5% significant level.

Conclusion

There is sufficient evidence to conclude that exists two co-integrating vector.

4.6 Granger causality and findings

Table 4.6 Granger Causality Result

Dependent Variables	Variables					
	Δ exchange rate	Δ oil price	Δ KLCI index	Δ interest rate	ECT1	ECT2
Δ exchange rate		12.6315 [0.0132]**	33.1818 [0]***	8.9783 [0.0616]*	-0.004172 [0.0088] ***	-0.000702 [0.0556] *
Δ interest rate	14.9662 [0.0048]***	17.7447 [0.0014]***	11.4255 [0.0222]**		-0.001191 [0.5748]	0.001543 [0.0016] ***
Δ KLCI index	14.836 [0.0051]***	10.8658 [0.0281]**		10.1105 [0.0386]**	2.800878 [0.005] ***	0.361090 [0.1164]
Δ oil price	54.0941 [0]***		52.5424 [0]***	15.185 [0.0043]***	-0.394503 [0.0134]	0.069517 [0.0585] *

*Note: *, **, *** denotes rejection of the null hypothesis at significance level of 10%, 5%, 1% respectively. P-values are in square brackets [….]. Error corrected term (ECT) is a lagged error correction term derived from the cointegrating test.*

H_0 = The dependent variable has no Granger cause relationship on independent variable
H_1 = The dependent variable has Granger cause relationship on independent variable

First, the result shows the null hypothesis of oil price does not granger cause on exchange rate is rejected with p-value that is less than 1%. Additionally, the findings also show that exchange rate granger cause oil price at 5% significant level with a p-value of 0.0132. Hence, there is a bidirectional causality relation existing between oil prices and exchanges rate (Li, Lu & Zhou, 2016). Consistently, Li, Lu, and Zhou (2016), Bal and Rath (2015) suggest that fluctuation in oil prices and exchange rates will be significantly influencing each other in both direction.

The alternative hypothesis of stock price granger causes exchange rate was accepted with p-value. The findings also proved that p-value is significant at 1% significant level. The result is consistent with part of the literature reviews in chapter 2. Abdalla and Murinde (1997), Wu (2000), Hatemi-Iraandoust (2002), Tsagkanos and Siriopoulos (2013) managed to show that stock price granger cause exchange rate in their researches. Furthermore, exchange rate granger causes stock price. Similarity, Pan et al (1999) used the same method to test the relationship between stock prices and exchanges rates in China. Granger et al. (2000) who employs Malaysia as one of the test nations in their research also exhibit same bidirectional behavior between exchange rate and stock price. In addition, both stock price and exchange rate will significantly affect each other in both directions.

The result shows the null hypothesis of interest rate does not granger cause on exchange rate is rejected with p-value that is less than 1%. Additionally, the findings also show that exchange rate granger cause interest rate with p-value at 1% significant level. Similarly, the result shows that granger causality from exchange rate to interest rate at 1% significant level, with p-value of 0.0048. Consistently, Paramati and Gupta (2013) suggest a bidirectional relation from interest rate granger cause on exchange rate. Any changes in interest rate will cause exchange rate to fluctuate and vice versa. Kisaka, Kithitu and Kamuti (2014) prove in studying the connection between interest rate and exchange rate.

Furthermore, the null hypothesis of interest rate no granger causes on stock price is rejected with p-value that is less than 5% significant level. Moreover, stock price granger cause interest rate is significant based on the p-value approach. This means any fluctuation in interest rate can cause stock price to fluctuate in the same direction (positive correlation) and vice versa. Using Dow Jones Islamic Market (DJIM) index, S&P stock market indices for the United States (SPUS), Europe (SPEU) and Asia (SPAS50) as target under heteroscedasticity robust linear Granger causality and nonlinear Granger causality tests, Ajmi et al. (2014) found that there is impact on interest rates of returns in conventional and Islamic institution of stock markets.

Furthermore, the alternative hypothesis of interest rate granger cause oil price is accepted with p-value that is less than 1%significant level. Similarly, oil price also granger cause interest rate based on the p-value approach. Thus, we conclude that there is bidirectional relationship between the variables. According to Bernanke et al. (1997), central bank stipulate federal funds rate are based on oil price shock. Oil price shock consider as main factor of recession. Kilian and Park (2009) and Lewis (2011) suggest that oil price shock will lead central banks to stipulate their interest rate in order to cope with recession. Similarity to the studies of Aye et al. (2014); Chisadza et al. (2013) had proven using South Africa as test countries.

In addition, the null hypothesis of stock price does not granger causes oil price is rejected with p-value that is less than 5% significant level. In addition, stock price granger causes oil price based on the p-value approach. This is consistent with the result proposed by Jones and Kaul (1996) and Nandha and Faff (2008). Using Canada, U.S, and Greece as test countries, Chen (2010) propose that there is a negative linkage between oil prices and global industry indices. When there is increase in oil price, tend to a higher profitability with a falling S&P index. Miller and Ratti (2009) manage to reveal a unidirectional causality from oil price to stock prices in long run by using the data from 6 OECD countries.

4.7 Conclusion

The main concern of this chapter has been illustrated with Granger causality test, which show granger causality among all combination of variables. All related empirical results are presented in tables and charts form. Furthermore, this chapter also showed significant relationship between oil price and exchanges rate with consider additional variable included stock price and interest rate. Undeniably, those relationships among the variable had been proved by past researches. The results are consistent with numbers of previous researches. Further discussion included summary of statistical analyses and finding, implication, limitations, recommendation and conclusion will be presented in chapter 5.

CHAPTER 5: DISCUSSION, CONCLUSION AND IMPLICATIONS

5.0 Introduction

The first section of this chapter is the summary of the statistical results of previous chapter mentioning the relation between exchange rate, oil price, interest rate and stock price. By using the results generated, implications are suggested to various parties, including policy makers, investors, researchers and oil traders. Limitation and corresponding recommendation are discussed to assist the further studies. This section end with the conclusion of the research, showing the relationship between oil price and various macroeconomic variables.

5.1 Summary of statistical analyses

Table 5.1: Summary of Statistical Analysis I

Variable	Details	Results
Augmented Dickey-Fuller Test	Level	Non-stationary / unit root
	1st difference	Stationary / no unit root
Kwiatkowski-Philips-Schmidt-Shin (KPSS)	Level	Non-stationary/ unit root
	1st difference	Stationary/ no unit root
Lag Length selection	Akaike information criterion(AIC)	Lag 2
	Schwarz information criterion (SIC)	Lag 2
	Hannan- Quinn information criterion (HQC)	Lag 2

Inverse Roots of AR Characteristic Polynomial	All modulus inside the circle	Stable

The main purpose of this study is to examine the relationship between the oil price and exchange rate, and typically showing how oil price impacts exchange rate (causal relationship) by using Granger causality approach and using time-series data that extract from Bloomberg from year 2007 to 2016. This study also takes into account of other variables such as sock price, and interest rate.

5.2 Discussions of Major Findings

Table 5.2: Summary of Statistical Analysis II

Dependent Variable	Independent Variable	Unit root test	Granger causality test
Exchanges rate	Oil price	*I(1)*	Significant
Exchanges rate	Stock price	*I(1)*	Significant
Exchanges rate	Oil price	*I(1)*	Significant
Interest rate	Oil price	*I(1)*	Significant
Interest rate	Stock price	*I(1)*	Significant
Interest rate	Exchanges rate	*I(1)*	Significant
Stock price	Oil price	*I(1)*	Significant
Stock price	Interest rate	*I(1)*	Significant
Stock price	Exchanges rate	*I(1)*	Significant
Oil price	Stock price	*I(1)*	Significant
Oil price	Interest rate	*I(1)*	Significant
Oil price	Exchanges rate	*I(1)*	Significant

The main concern of this research is the relationship between exchanges rate and various macroeconomics variables, with oil price chosen as the main independent variables, stock price and interest rate as control variable. The result of Granger Causality test shows all of the variables are significant to the exchanges rates.

According to Table 5.2, Granger cause relationship is exists between the exchange rate and oil price. It is consistent with the result of Li, Lu, and Zhou (2016), Bal and Rath (2015). Granger cause relationship is exists between the stock price and exchange rate. It is consistent with the result of Pan et al. (1999) and Granger et al. (2000). Granger cause relationship is exists between the interest rate and exchange rate. It is consistent with the result of Paramati and Gupta (2013). Granger cause relationship is exists between the stock price and interest rate. It is consistent with the result of Ajmi et al. (2014). Granger causality relationship is exists between the interest rate and oil price. It is consistent with the result of Bernanke et al. (1997), Lewis (2011), Aye et al. (2014) and Chisadza et al. (2013). Granger cause relationship is exists between the stock price and oil price. It is consistent with the result of Jones and Kaul (1996) and Nandha and Faff (2008).

5.3 Implications of the Study

a) Policy makers

Based on this research paper, a bidirectional negative relationship is revealed between oil price and exchange rates. So, policy makers should clearly identify the impact of oil price on exchange rate to formulate an effective policy for economy welfare. Oil price and exchange rate are very sensitive to one and another, thus the results of this study would provide supportive details and assist policy makers in policy setting. Next, policy makers could stabilize the exchange rates for their countries' currencies by generating an appropriate economic policy towards interest rate. They should emphasize on achieving market equilibrium for interest rate in order to meet demand with supply.

b) Researchers and Investigators

The results indicate that oil price is the most significant factor that will influence exchange rate. Thus, future researchers should take into account of the oil price while conducting further research. This is because the ignorance of important variables might produce an inaccurate result. In fact, this paper prove that stock price and exchange rate are statistically sensitive to each other. Therefore, future researchers should attach stock price with exchange rate for every country in both short-run and long-run in order to deduce a more accurate result. Then, this paper show interest rate as one of the important independent variable that will impact the exchange rate. Thus, interest rate should not be omitted by future investigators in their further studies due to the significance of the variable. Consequently, omission of significant variable will lead to model specification error in the research.

c) Oil exporters and oil importers

The results are beneficial to traders especially oil exporter's countries and oil importer's countries. When the relationship between oil price and exchange rate are clearly identified, oil exporters are able to control the volume of oil exportation in order to gain profit from the transaction. For instance, oil exporters should decrease their trading activities during period when the oil price is relatively low while oil importers should increase their trading activities when the oil price is relatively cheaper in the market and vice versa.

d) Multinational companies

This research paper shows that there is a bidirectional positive relationship between stock price and exchange rate. The results are relatively useful for stakeholders for decision making regarding international trades. Companies able to obtain more applicable solution after going through the research outcome. Stock price of a particular company is very important because it represents the performance of that company to outsiders. Therefore, companies should take action to improve their performance in order to attract more investors and thus enhance their reputation.

e) Investors

Ultimately, this paper is beneficial for market investors especially to those investors who traded their securities globally through foreign exchange market. Domestic investors should invest when the stock price in home country increase. When the stock price increases, domestic currency will increase as well. Therefore, local investors could generate a higher profit from the investment. Thus, local and foreign investors should focus on the movement of stock prices and analyze it before making decision for investment. The empirical finding regarding a bidirectional positive relationship between interest rate and exchange rate will assist various parties to achieve a better understanding of these variables. The historical details such as data and results that provided in this study are helpful for investors. Investors able to predict the movements of interest rate for a particular security or asset before making an investment. Eventually, investors are able to reduce the unsystematic risk in their investment.

5.4 Limitations of the study

There is drawback that should be overcome to make it an ideal reference for future researchers to carry out further research relating to this research area.

The data collected is not normally distributed. Hence, the data is not suitable for a number of statistical tools, such as individuals control charts, Cp/Cpk analysis, t-tests and the analysis of variance (ANOVA). Although the sample size is large in this research (more than 20), the results is still ambiguous due to the violation of assumptions of normal distribution. When data is not normally distributed, the reasons for non-normality should be determined and appropriate remedial actions should be taken. The possible cause of non-normal distribution in this research is due to the existence of extreme value within the data, for instance the data of oil price between the year of 2008 and 2009 showed major deviation from the mean value.

5.5 Recommendation for Future Research

This study provides some suggestions for the future researcher in order to help them prevent the same problems that we had faced in this research.

A skewed distribution is formed due to existence of enormous amount of extreme values in a data set. Remedial actions include deciding measurement errors, data-entry errors and outliers, and erasing them from the data. Such data 'cleaning' is essential to achieve normality of data. It is important that outliers are identified as truly special causes before they are eliminated. Extreme values should only be explained and removed from the data if there are more of them than expected under normal conditions.

5.6 Conclusion

This research has examined the relationship between oil price and exchange rate in Malaysia. The main purpose of this research is to determine whether there is any interaction between the macroeconomic variables with the exchange rate. The macroeconomic variables in this study include oil price, stock price and interest rate. Oil price is the main independent variable while stock price and interest rate are the control variables in this research. This chapter has summarized the result generated and provides several implications for policy makers and other practitioners. Besides, this research could benefit a few parties such as government, policy makers, fund managers and future researchers. Lastly, limitations have been discovered and relevant recommendation has been proposed for the reference of future researchers.

REFERENCES

Abdalla, I., & Murinde, V. (1997). Exchange rate and stock price interactions in emerging financial markets: Evidence on India, Korea, Pakistan and the Philippines. *Applied Financial Economics*, *7*(1), 25-35. http://dx.doi.org/10.1080/096031097333826

Agus, D., & Carl, B. (2004). Stock price and exchange rate causality: The case of four ASEAN Countries. *Applied Financial Economics, 6,* 5-15. Retrieved from http://swer.wtamu.edu/sites/default/files/Data/103-114-57-210-1-PB.pdf

Ali, T. M., Mahmood, M. T., & Bashir, T. (2015). Impact of interest rate, inflation and money supply on exchange rate volatility in Pakistan. *World Applied Sciences Journal*, *33*(4), 620-630.

Bal, D. P., & Rath, B. N. (2015). Nonlinear causality between crude oil price and exchange rate: A comparative study of China and India. *Energy Economics*, *51*, 149-156.

Bank Negara Malaysia. (2016). *Significant milestones in the Malaysian Foreign Exchange Market.* Retrieved form http://www.bnm.gov.my/index.php?ch=en_fxmm_mo&pg=en_fxmm_mo_overview&ac=438

Bodenstein, M., Erceg, C. J., & Guerrieri, L. (2011). Oil shocks and external adjustment. *Journal of International Economics*, *83*(2), 168-184. https://doi.org/10.1016/j.jinteco.2010.10.006

Bohl, M. T., Michaelis, P., & Siklos, P. L. (2016). Austerity and recovery: Exchange rate regime choice, economic growth, and financial crises. *Economic Modelling, 53,* 195-207.

Brahmasrene, T., Huang, J. C., & Sissoko, Y. (2014). Crude oil prices and exchange rates: Causality, variance decomposition and impulse response. *Energy Economics, 44*, 407-412.

Bunjaku, M. F. (2015). Exchange Rate Regimes – A periodical overview and a critical analysis of exchange rate regimes in Kosovo. *Academic Journal of Business, Administration, Law and Social Sciences, 1*(1), 40-46.

Cho, D., & West, K. D. (2003). Interest rates and exchange rates in the Korean, Philippine, and Thai exchange rate crises. *Managing Currency Crises in Emerging Markets*, 11-36.

Coronado, S., & Rojas, O. (2016). A study of co-movements between oil price, stock index and exchange rate under a cross-bicorrelation perspective: The case of Mexico. *UDLAP-UNAM-IPN, 13.*

Diamandis, P. F., & Drakos, A. A. (2011). Financial liberalization, exchange rates and stock prices: Exogenous shocks in four Latin America countries. *Journal of Policy Modeling, 33*,381-394.

Dimitrova, D. (2005). The relationship between exchange rate and stock prices: Studied in a multivariate model. *Issues in Political Economy*, *14*.

Dornbusch, R., & Fisher, S. (1980). Exchange rates and the current account. *The American Economic Review, 70*(5), 960-971.

Dwyer, G. P. (2015). *The Johansen Tests for Cointegration*. Retrieved from http://www.jerrydwyer.com/pdf/Clemson/Cointegration.pdf

Enders, C. (2010). *Applied missing data analysis*. New York: Guilford Press.

Foresti, P. (2006). *Testing for Granger causality between stock prices and economic growth.* Munich Personal RePEc Archive. Retrieved from https://mpra.ub.uni-muenchen.de/2962/1/MPRA_paper_2962.pdf

Frankel, J.A. (1984). Monetary and portfolio balance models of exchange rate determination. In: Bhandari, J.S., Putnam, B.H. (Eds.), *Economic Interdependence and Flexible Exchange Rates.* MIT Press, Cambridge, MA.

Ghosh, S. (2011). Examining crude oil price – Exchange rate nexus for India during the period of extreme oil price volatility. *Applied Energy*, *88*(5), 1886-1889.

Granger, C. W. J., Huang, B., & Yang, C.W. (2000). A bivariate causality between stock prices and exchange rates: Evidence from recent Asian flu. *The Quarterly Review of Economics and Finance, 40*, 337-354.

Gravetter, F., & Wallnau, L. (2008). *Essentials of Statistics for the Behavioral Science*. 6th ed. Belmont, CA: Thomson Wadsworth.

Gujarati, D., & Porter, D. (2009). *Basic econometrics*. 5th ed. Boston (Massachusetts): McGraw Hill International.

Hatemi-J, A., & Irandoust, M. (2002). On the causality between exchange rates and stock prices: A note. *Bulletin of Economic Research*, *54*(2), 197-203. Retrieved from http://onlinelibrary.wiley.com/doi/10.1111/1467-8586.00148/pdf

Jones, C. M., & Kaul, G. (1996). Oil and the stock markets. *The Journal of Finance, 51*(2), 463-491.

Juselius, K. (2006). *The Cointegrated VAR Model*. New York: Oxford University Press Inc.

Kilian, L. (2007, June 23). Oil price shocks, international risk sharing and external adjustment. Retrieved from http://voxeu.org/article/oil-price-shocks-and-external-adjustment

Kilian, L., & Park, C. (2009). The impact of oil price shocks on the U.S. stock market. *International Economic Review*, *50*(4), 1267–1287.

Kisaka, S. E., Kithitu, J. W., & Kamuti, H. M. (2014). The causal relationship between interest rates and foreign exchange rates in Kenya. *Research Journal of Finance and Accounting, 5*(14), 136-151.

Kubo, A. (2012). The US Tech Pulse, stock prices, and exchange rate dynamics:

Evidence from Asian developing countries. *Journal of Asian Economics, 23*(6), 680-687. http://dx.doi.org/10.1016/j.asieco.2012.06.007

Li, J. F., Lu, X. S., & Zhou, Y. (2016). Cross-correlations between crude oil and exchange markets for selected oil rich economies. *Physica A: Statistical Mechanics and its Applications, 453,* 131-143.

Miller, J. I., & Ratti, R. A. (2009). Crude oil and stock markets: Stability, instability, and bubbles. *Energy Economics, 31*(4), 559–568.

Muhammad, Z., Suleiman, H., & Kouhy, R. (2012). Exploring oil price-exchange rate nexus for Nigeria. *OPEC Energy Review, 36*(4), 383-395.

Nandha, M., & Faff, R. (2008). Does oil move equity prices? A global view. *Energy Economics, 30*(3), 986-997.

Narayan, P. K., Narayan, S., & Prasad, A. (2008). Understanding the oil price-exchange rate nexus for the Fiji islands. *Energy Economics*, *30*(5), 2686-2696.

Ng, S., & Perron, P. (2001). Lag length selection and the construction of unit root tests with good size and power. *Econometrica, 69*(6), 1519-1554.

Novotný, F. (2012). The link between the Brent crude oil price and the US dollar exchange rate. *Prague Economic Papers*, *2*, 220-232.

Oxford dictionaries online. (2017). Retrieved from https://en.oxforddictionaries.com/definition/crude_oil

Oxford dictionaries online. (2017). Retrieved from https://en.oxforddictionaries.com/definition/exchange_rate

Oxford dictionaries online. (2017). Retrieved from https://en.oxforddictionaries.com/definition/interest_rate

Pan, M., Fok, R. C., & Liu, Y. A. (2007). Dynamic linkages between exchange rates and stock prices: Evidence from East Asian Markets. *International Review of Economics and Finance, 16*(4), 503-520.

Paramati, S. R., & Gupta, R. (2013). An empirical relationship between exchange rates, interest rates and stock returns. *European Journal of Economics, Finance and Administrative Sciences, 56*, 169-181.

Petroff, A. (2014, November 28). Oil prices crash below $70. *CNNMoney*. Retrieved from http://money.cnn.com/2014/11/27/investing/oil-prices-opec-crude/index.html

Sangaré, I. (2016). External shocks and exchange rate regimes in Southeast Asia: A DSGE analysis. *Economic Modelling, 58*, 365-382.

Saraç, T. B., & Karagöz, K. (2016). Impact of short-term interest rate on exchange rate: The case of Turkey. *Procedia Economics and Finance, 38*, 195-202.

Shalishali, M. K., & Ho, J. C. (2002). Inflation, interest rate, and exchange rate: What is the relationship? *Journal of Economics and Economic Education Research, 3*(1), 107-117.

Sharma, J. (2007). *Business statistics.* 2nd ed. New Delhi: Dorling Kindersley.

Sidhu, J. S. (2015, January 31). Pressure on currency war. *The Star Online*. Retrieved from http://www.thestar.com.my/business/business-news/2015/01/31/pressure-on-currency-war/

Sidhu, J. S. (2015, August 14). Bank Negara to maintain managed exchange-rate regime. *The Star Online.* Retrieved from http://www.thestar.com.my/business/business-news/2015/08/14/no-peg-no-controls/

Stock, J., & Watson, M. (2007). *Introduction to econometrics*. 2nd ed. Boston, MA Pearson Education, Inc.

Tafa, J. (2015). Relationship between exchange rates and interest rates: Case of Albania. *Mediterranean Journal of Social Sciences, 6*(4), 163-170.

Tee, L.S. (2017, January 7). Oil price on the mend but not ringgit. *The Star Online*. Retrieved from http://www.thestar.com.my/business/business-news/2017/01/07/oil-price-on-the-mend-but-not-ringgit/

Tiwari, A. K., & Albulescu, C. T. (2016). Oil price and exchange rate in India: Fresh evidence from continuous wavelet approach and asymmetric, multi-horizon Granger-causalitytests. *Applied Energy, 179*, 272-283.

Tsagkanos, A., & Siriopoulos, C. (2013). A long-run relationship between stock price index and exchange rate: A structural nonparametric cointegrating regression approach. *Journal of International Financial Markets, Institutions & Money*, *25*, 106-118.

Tsai, I. (2012). The relationship between stock price index and exchange rate in Asian Markets: A quantile regression approach. *Journal of International Financial Markets, Institutions and Money*, *22*(3), 609–621.

Tsuyuguchi, Y., & Wooldridge, P. D. (2008). The evolution of trading activity in Asian foreign exchange markets. *Emerging Markets Review, 9*(4), 231-246.

Tudor, C., & Popescu-Dutaa, C. (2012). On the causal relationship between stock returns and exchange rates changes for 13 developed and emerging markets. *Procedia – Social and Behavioral Sciences, 57,* 275-282.

Volkov, N. I., & Yuhn, K. (2016). Oil price shocks and exchange rate movements. *Global Finance Journal, 31*, 18-30.

Wilson, L., & Sheefeni, J. P. (2014). The relationship between interest rate and exchange rate in Namibia. *Journal of Emerging Issues in Economics, Finance and Banking, 3*(1), 947-961.

Wu, Y. (2000). Stock prices and exchange rates in VEC model—The case of Singapore in the 1990s. *Journal of Economics and Finance*, *24*(3), 260-274. Retrieved from https://link.springer.com/article/10.1007/BF02752607

Zivot, E., & Wang, J. (2003). *Modeling Financial Time Series with S-Plus*. New York: Springer-Verlag New York, Inc.

Zubair, A. (2013). Causal relationship between stock market index and exchange rate: Evidence from Nigeria. *CBN Journal of Applied Statistics, 4*(2), 87-110.

APPENDICES

Appendix 1.1: Returns of crude oil prices and spot exchange rates of Malaysia and selected OPEC countries from period 2010-2017

Date	CL1 Comdty	%Δ	USDMYR	% Δ	USDAED	% Δ	USDIRR	% Δ
15/8/2017	47.61	3.41	4.2933	0.00	3.673	0.00	-	-
30/6/2017	46.04	-9.01	4.2933	-2.99	3.673	0.00	-	-
31/3/2017	50.6	-5.81	4.4255	-1.35	3.6729	0.00	-	-
31/12/2016	53.72	11.36	4.4862	8.47	3.673	0.00	35432	0.23
30/9/2016	48.24	-0.19	4.1357	2.58	3.673	0.00	35352	15.57
30/6/2016	48.33	26.06	4.0315	3.39	3.6729	0.00	30589	1.11
31/3/2016	38.34	3.51	3.8995	-9.16	3.673	0.00	30252	0.45
31/12/2015	37.04	-17.85	4.2925	-2.34	3.673	0.00	30117	0.54
30/9/2015	45.09	-24.18	4.3955	16.50	3.673	0.00	29956	2.73
30/6/2015	59.47	24.94	3.773	1.88	3.673	0.01	29160	4.17
31/3/2015	47.6	-10.64	3.7035	5.92	3.6728	-0.01	27993	3.40
31/12/2014	53.27	-41.56	3.4965	6.58	3.673	0.01	27073	2.09
30/9/2014	91.16	-13.49	3.2805	2.16	3.6728	0.00	26519	4.08
30/6/2014	105.37	3.73	3.211	-1.67	3.6728	-0.01	25480	2.34
31/3/2014	101.58	3.21	3.2655	-0.31	3.673	0.00	24897	0.99
31/12/2013	98.42	-3.82	3.2755	0.49	3.6729	0.00	24653	-0.55
30/9/2013	102.33	5.98	3.2595	3.13	3.673	0.00	24788.9492	101.94
30/6/2013	96.56	-0.69	3.1605	2.16	3.673	0.00	12275.4502	0.02
31/3/2013	97.23	5.89	3.0938	1.15	3.6729	0.00	12272.9502	-0.02
31/12/2012	91.82	-0.40	3.0585	0.00	3.673	0.00	12274.9502	-0.06
30/9/2012	92.19	8.51	3.0585	-3.79	3.673	0.00	12282.4502	-0.06
30/6/2012	84.96	-17.53	3.179	3.77	3.6729	0.00	12289.9502	-0.04
31/3/2012	103.02	4.24	3.0635	-3.30	3.673	0.00	12294.9502	10.05
31/12/2011	98.83	24.79	3.1682	-0.65	3.6731	0.00	11172.4502	3.79
30/9/2011	79.2	-17.00	3.189	5.61	3.673	0.00	10764.9502	1.19
30/6/2011	95.42	-10.59	3.0195	-0.20	3.6729	0.01	10637.9502	2.09
31/3/2011	106.72	16.79	3.0255	-1.88	3.6727	-0.01	10419.9502	0.68
31/12/2010	91.38	14.27	3.0835	-0.12	3.673	0.00	10349.9502	1.12
30/9/2010	79.97	5.74	3.0873	-4.61	3.673	0.00	10234.9502	2.35
30/6/2010	75.63	-9.71	3.2365	-0.84	3.6729	0.00	9999.9502	1.01
31/3/2010	83.76	-	3.2638	-	3.6729	-	9899.9502	-

Note: USDMYR refers to United States Dollar to Malaysian Ringgit

USDAED refers to United States Dollar to United Arab Emirates Dirham

USDIRR refers to United States Dollar to Iranian Rial

Date	CL1 Comdty	% Δ	USDMYR	% Δ	USDIQD	% Δ	USDKWD	% Δ
15/8/2017	47.61	3.41	4.2933	0.00	1178.5239	1.16	0.30198	-0.40
30/6/2017	46.04	-9.01	4.2933	-2.99	1165	-2.69	0.3032	-0.57
31/3/2017	50.6	-5.81	4.4255	-1.35	1197.1548	0.00	0.30495	-0.25
31/12/2016	53.72	11.36	4.4862	8.47	1197.1548	0.20	0.3057	1.38
30/9/2016	48.24	-0.19	4.1357	2.58	1194.7407	0.10	0.30155	-0.09
30/6/2016	48.33	26.06	4.0315	3.39	1193.6045	0.17	0.30182	-0.01
31/3/2016	38.34	3.51	3.8995	-9.16	1191.5925	2.28	0.30185	-0.57
31/12/2015	37.04	-17.85	4.2925	-2.34	1165	-4.12	0.30357	0.49
30/9/2015	45.09	-24.18	4.3955	16.5	1215	0.62	0.3021	0.03
30/6/2015	59.47	24.94	3.773	1.88	1207.5126	0.21	0.302	0.37
31/3/2015	47.6	-10.64	3.7035	5.92	1205.025	0.84	0.30088	2.74
31/12/2014	53.27	-41.56	3.4965	6.58	1195.025	-0.83	0.29285	1.61
30/9/2014	91.16	-13.49	3.2805	2.16	1205.0751	0.00	0.28822	2.22
30/6/2014	105.37	3.73	3.211	-1.67	1205.0751	3.44	0.28195	0.11
31/3/2014	101.58	3.21	3.2655	-0.31	1165	0.00	0.28165	-0.14
31/12/2013	98.42	-3.82	3.2755	0.49	1165	0.55	0.28205	-0.33
30/9/2013	102.33	5.98	3.2595	3.13	1158.605	-0.30	0.28298	-0.76
30/6/2013	96.56	-0.69	3.1605	2.16	1162.0649	-0.25	0.28514	-0.15
31/3/2013	97.23	5.89	3.0938	1.15	1165	0.00	0.28558	1.56
31/12/2012	91.82	-0.40	3.0585	0.00	1165	0.00	0.2812	0.13
30/9/2012	92.19	8.51	3.0585	-3.79	1165	0.00	0.28083	0.21
30/6/2012	84.96	-17.53	3.179	3.77	1165	0.00	0.28024	0.91
31/3/2012	103.02	4.24	3.0635	-3.30	1165	-0.34	0.2777	-0.34
31/12/2011	98.83	24.79	3.1682	-0.65	1169	0.00	0.27865	0.81
30/9/2011	79.2	-17.00	3.189	5.61	1169	0.00	0.2764	0.57
30/6/2011	95.42	-10.59	3.0195	-0.20	1169	0.00	0.27483	-0.85
31/3/2011	106.72	16.79	3.0255	-1.88	1169	0.00	0.2772	-1.46
31/12/2010	91.38	14.27	3.0835	-0.12	1169	0.00	0.2813	-1.19
30/9/2010	79.97	5.74	3.0873	-4.61	1169	0.00	0.2847	-2.22
30/6/2010	75.63	-9.71	3.2365	-0.84	1169	0.00	0.29115	0.86
31/3/2010	83.76	-	3.2638	-	1169	-	0.28868	-

Note: USDMYR refers to United States Dollar to Malaysian Ringgit

USDIQD refers to United States Dollar to Iraqi Dinar

USDKWD refers to United States Dollar to Kuwaiti Dinar

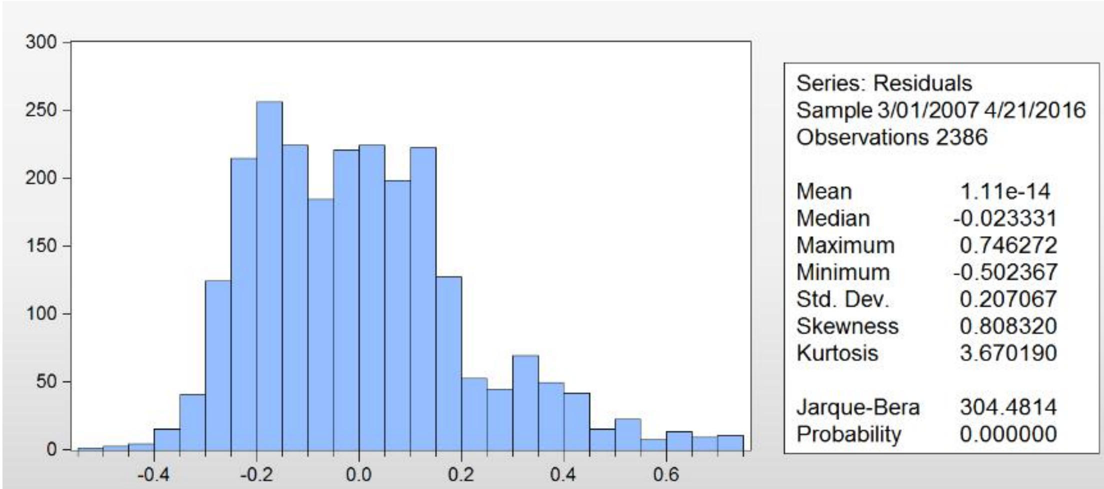
Date	CL1 Comdty	% Δ	USDMYR	% Δ	USDNGN	% Δ	USDSAR	% Δ
15/8/2017	47.61	3.41	4.2933	0.00	366.05	13.59	3.7502	0.00
30/6/2017	46.04	-9.01	4.2933	-2.99	322.25	2.53	3.7502	0.00
31/3/2017	50.6	-5.81	4.4255	-1.35	314.29	-0.33	3.7503	-0.03
31/12/2016	53.72	11.36	4.4862	8.47	315.33	0.10	3.7515	-0.09
30/9/2016	48.24	-0.19	4.1357	2.58	315	12.30	3.7548	0.12
30/6/2016	48.33	26.06	4.0315	3.39	280.5	40.92	3.7502	0.00
31/3/2016	38.34	3.51	3.8995	-9.16	199.05	-0.13	3.7503	-0.14
31/12/2015	37.04	-17.85	4.2925	-2.34	199.3	0.02	3.7556	0.14
30/9/2015	45.09	-24.18	4.3955	16.50	199.26	0.06	3.7505	0.00
30/6/2015	59.47	24.94	3.773	1.88	199.15	-0.07	3.7505	-0.02
31/3/2015	47.6	-10.64	3.7035	5.92	199.28	8.63	3.7511	-0.09
31/12/2014	53.27	-41.56	3.4965	6.58	183.45	11.98	3.7545	0.08
30/9/2014	91.16	-13.49	3.2805	2.16	163.82	0.57	3.7516	0.02
30/6/2014	105.37	3.73	3.211	-1.67	162.89	-1.31	3.7507	0.01
31/3/2014	101.58	3.21	3.2655	-0.31	165.05	2.96	3.7503	-0.01
31/12/2013	98.42	-3.82	3.2755	0.49	160.3	-0.60	3.7506	0.01
30/9/2013	102.33	5.98	3.2595	3.13	161.27	-0.78	3.7502	0.00
30/6/2013	96.56	-0.69	3.1605	2.16	162.53	2.51	3.7503	0.00
31/3/2013	97.23	5.89	3.0938	1.15	158.55	1.54	3.7503	-0.01
31/12/2012	91.82	-0.40	3.0585	0.00	156.15	-0.67	3.7506	0.01
30/9/2012	92.19	8.51	3.0585	-3.79	157.2	-3.41	3.7502	0.00
30/6/2012	84.96	-17.53	3.179	3.77	162.75	3.20	3.7503	0.00
31/3/2012	103.02	4.24	3.0635	-3.30	157.7	-2.83	3.7503	0.00
31/12/2011	98.83	24.79	3.1682	-0.65	162.3	1.62	3.7502	-0.01
30/9/2011	79.2	-17.00	3.189	5.61	159.72	4.89	3.7504	0.01
30/6/2011	95.42	-10.59	3.0195	-0.20	152.28	-1.82	3.7502	0.00
31/3/2011	106.72	16.79	3.0255	-1.88	155.1	2.04	3.7502	0.00
31/12/2010	91.38	14.27	3.0835	-0.12	152	-1.62	3.7502	-0.01
30/9/2010	79.97	5.74	3.0873	-4.61	154.51	3.14	3.7504	0.00
30/6/2010	75.63	-9.71	3.2365	-0.84	149.8	-0.10	3.7504	0.01
31/3/2010	83.76	-	3.2638	-	149.95	-	3.7502	-

Note: USDMYR refers to United States Dollar to Malaysian Ringgit

USDNGN refers to United States Dollar to Nigerian Naira

USDSAR refers to United States Dollar to Saudi Arabian Riyal

Appendix 4.1: Histogram Normality test



Appendix 4.2: Augmented Dickey-Fuller Test for Exchange rate (Level, intercept)

Null Hypothesis: EXCHANGE_RATE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=26)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.696446	0.9921
Test critical values:	1% level	-3.432897	
	5% level	-2.862551	
	10% level	-2.567354	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXCHANGE_RATE)
Method: Least Squares
Date: 05/25/17 Time: 21:40
Sample (adjusted): 1/04/2007 12/30/2016
Included observations: 2385 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXCHANGE_RATE(-1)	0.000672	0.000965	0.696446	0.4862
C	-0.001892	0.003312	-0.571424	0.5678

R-squared	0.000203	Mean dependent var	0.000401
Adjusted R-squared	-0.000216	S.D. dependent var	0.017231
S.E. of regression	0.017233	Akaike info criterion	-5.283134
Sum squared resid	0.707701	Schwarz criterion	-5.278290
Log likelihood	6302.137	Hannan-Quinn criter.	-5.281371
F-statistic	0.485037	Durbin-Watson stat	1.959361
Prob(F-statistic)	0.486217		

Appendix 4.3: Augmented Dickey-Fuller Test for Exchange rate (Level, intercept & trend)

Null Hypothesis: EXCHANGE_RATE has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=26)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.409655	0.9872
Test critical values:	1% level	-3.961893	
	5% level	-3.411692	
	10% level	-3.127724	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXCHANGE_RATE)
Method: Least Squares
Date: 05/25/17 Time: 21:49
Sample (adjusted): 1/04/2007 12/30/2016
Included observations: 2385 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXCHANGE_RATE(-1)	-0.000439	0.001070	-0.409655	0.6821
C	0.000281	0.003432	0.081873	0.9348
@TREND(1/03/2007)	1.36E-06	5.69E-07	2.382971	0.0173

R-squared	0.002581	Mean dependent var	0.000401
Adjusted R-squared	0.001744	S.D. dependent var	0.017231
S.E. of regression	0.017216	Akaike info criterion	-5.284677
Sum squared resid	0.706018	Schwarz criterion	-5.277410
Log likelihood	6304.977	Hannan-Quinn criter.	-5.282032
F-statistic	3.082269	Durbin-Watson stat	1.961852
Prob(F-statistic)	0.046038		

Appendix 4.4: Augmented Dickey-Fuller Test for Exchange rate (1st difference, intercept)

Null Hypothesis: D(EXCHANGE_RATE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=26)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-47.78826	0.0001
Test critical values:	1% level	-3.432898	
	5% level	-2.862552	
	10% level	-2.567354	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXCHANGE_RATE,2)
Method: Least Squares
Date: 05/25/17 Time: 21:56
Sample (adjusted): 1/05/2007 12/30/2016
Included observations: 2384 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EXCHANGE_RATE(-1))	-0.978880	0.020484	-47.78826	0.0000
C	0.000396	0.000353	1.122195	0.2619

R-squared	0.489468	Mean dependent var	4.07E-06
Adjusted R-squared	0.489253	S.D. dependent var	0.024114
S.E. of regression	0.017234	Akaike info criterion	-5.283069
Sum squared resid	0.707450	Schwarz criterion	-5.278223
Log likelihood	6299.418	Hannan-Quinn criter.	-5.281305
F-statistic	2283.718	Durbin-Watson stat	2.002163
Prob(F-statistic)	0.000000		

Appendix 4.5: Augmented Dickey-Fuller Test for Exchange rate (1st difference, intercept & trend)

Null Hypothesis: D(EXCHANGE_RATE) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=26)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-47.89451	0.0000
Test critical values:	1% level	-3.961894	
	5% level	-3.411693	
	10% level	-3.127724	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(EXCHANGE_RATE,2)
Method: Least Squares
Date: 05/25/17 Time: 21:57
Sample (adjusted): 1/05/2007 12/30/2016
Included observations: 2384 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(EXCHANGE_RATE(-1))	-0.981326	0.020489	-47.89451	0.0000
C	-0.001062	0.000706	-1.503748	0.1328
@TREND(1/03/2007)	1.22E-06	5.13E-07	2.383214	0.0172

R-squared	0.490683	Mean dependent var	4.07E-06
Adjusted R-squared	0.490255	S.D. dependent var	0.024114
S.E. of regression	0.017217	Akaike info criterion	-5.284612
Sum squared resid	0.705766	Schwarz criterion	-5.277343
Log likelihood	6302.258	Hannan-Quinn criter.	-5.281967
F-statistic	1146.942	Durbin-Watson stat	2.001807
Prob(F-statistic)	0.000000		

Appendix 4.6: Augmented Dickey-Fuller Test for Interest rate (Level, intercept)

Null Hypothesis: INTEREST has a unit root
Exogenous: Constant
Lag Length: 19 (Automatic - based on SIC, maxlag=26)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.967159	0.3016
Test critical values:	1% level	-3.432919	
	5% level	-2.862561	
	10% level	-2.567359	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INTEREST)
Method: Least Squares
Date: 05/25/17 Time: 22:00
Sample (adjusted): 2/02/2007 12/30/2016
Included observations: 2366 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INTEREST(-1)	-0.002076	0.001055	-1.967159	0.0493
D(INTEREST(-1))	0.000765	0.019688	0.038866	0.9690
D(INTEREST(-2))	0.000765	0.019688	0.038866	0.9690
D(INTEREST(-3))	0.000765	0.019688	0.038866	0.9690
D(INTEREST(-4))	0.000765	0.019688	0.038866	0.9690
D(INTEREST(-5))	0.000765	0.019688	0.038866	0.9690
D(INTEREST(-6))	0.000765	0.019688	0.038866	0.9690
D(INTEREST(-7))	0.000765	0.019688	0.038866	0.9690
D(INTEREST(-8))	0.000765	0.019688	0.038866	0.9690
D(INTEREST(-9))	0.000765	0.019688	0.038866	0.9690
D(INTEREST(-10))	0.000765	0.019688	0.038866	0.9690
D(INTEREST(-11))	0.000765	0.019688	0.038866	0.9690
D(INTEREST(-12))	0.000765	0.019688	0.038866	0.9690
D(INTEREST(-13))	0.000765	0.019688	0.038866	0.9690
D(INTEREST(-14))	0.000765	0.019688	0.038866	0.9690
D(INTEREST(-15))	0.000765	0.019688	0.038866	0.9690
D(INTEREST(-16))	0.000765	0.019688	0.038866	0.9690
D(INTEREST(-17))	0.000765	0.019688	0.038866	0.9690
D(INTEREST(-18))	0.000765	0.019688	0.038866	0.9690
D(INTEREST(-19))	0.300765	0.019688	15.27670	0.0000
C	0.006065	0.003191	1.900823	0.0574

R-squared	0.091464	Mean dependent var	-0.000211
Adjusted R-squared	0.083715	S.D. dependent var	0.022989
S.E. of regression	0.022006	Akaike info criterion	-4.786189
Sum squared resid	1.135574	Schwarz criterion	-4.734985
Log likelihood	5683.062	Hannan-Quinn criter.	-4.767548
F-statistic	11.80375	Durbin-Watson stat	2.000768
Prob(F-statistic)	0.000000		

Appendix 4.7: Augmented Dickey-Fuller Test for Interest rate (Level, intercept & trend)

Null Hypothesis: INTEREST has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 19 (Automatic - based on SIC, maxlag=26)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.037234	0.5800
Test critical values:	1% level	-3.961924	
	5% level	-3.411707	
	10% level	-3.127733	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INTEREST)
Method: Least Squares
Date: 05/25/17 Time: 22:02
Sample (adjusted): 2/02/2007 12/30/2016
Included observations: 2366 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INTEREST(-1)	-0.002161	0.001061	-2.037234	0.0417
D(INTEREST(-1))	0.000538	0.019691	0.027346	0.9782
D(INTEREST(-2))	0.000539	0.019691	0.027357	0.9782
D(INTEREST(-3))	0.000539	0.019691	0.027368	0.9782
D(INTEREST(-4))	0.000539	0.019691	0.027379	0.9782
D(INTEREST(-5))	0.000539	0.019691	0.027389	0.9782
D(INTEREST(-6))	0.000540	0.019691	0.027400	0.9781
D(INTEREST(-7))	0.000540	0.019691	0.027411	0.9781
D(INTEREST(-8))	0.000540	0.019691	0.027422	0.9781
D(INTEREST(-9))	0.000540	0.019691	0.027433	0.9781
D(INTEREST(-10))	0.000540	0.019691	0.027443	0.9781
D(INTEREST(-11))	0.000541	0.019691	0.027454	0.9781
D(INTEREST(-12))	0.000541	0.019691	0.027465	0.9781
D(INTEREST(-13))	0.000541	0.019691	0.027476	0.9781
D(INTEREST(-14))	0.000541	0.019691	0.027487	0.9781
D(INTEREST(-15))	0.000541	0.019691	0.027497	0.9781
D(INTEREST(-16))	0.000542	0.019691	0.027508	0.9781
D(INTEREST(-17))	0.000542	0.019691	0.027519	0.9780
D(INTEREST(-18))	0.000542	0.019691	0.027530	0.9780
D(INTEREST(-19))	0.300542	0.019691	15.26264	0.0000
C	0.005681	0.003228	1.760012	0.0785
@TREND(1/03/2007)	5.31E-07	6.68E-07	0.795525	0.4264

R-squared	0.091709	Mean dependent var	-0.000211
Adjusted R-squared	0.083572	S.D. dependent var	0.022989
S.E. of regression	0.022007	Akaike info criterion	-4.785614
Sum squared resid	1.135268	Schwarz criterion	-4.731972
Log likelihood	5683.381	Hannan-Quinn criter.	-4.766085
F-statistic	11.27004	Durbin-Watson stat	2.000684
Prob(F-statistic)	0.000000		

Appendix 4.8: Augmented Dickey-Fuller Test for Interest rate (1st difference, intercept)

Null Hypothesis: D(INTEREST) has a unit root
Exogenous: Constant
Lag Length: 18 (Automatic - based on SIC, maxlag=26)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.160626	0.0000
Test critical values:	1% level	-3.432919	
	5% level	-2.862561	
	10% level	-2.567359	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INTEREST,2)
Method: Least Squares
Date: 05/25/17 Time: 22:03
Sample (adjusted): 2/02/2007 12/30/2016
Included observations: 2366 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INTEREST(-1))	-0.701126	0.085916	-8.160626	0.0000
D(INTEREST(-1),2)	-0.298933	0.083621	-3.574871	0.0004
D(INTEREST(-2),2)	-0.298992	0.081261	-3.679397	0.0002
D(INTEREST(-3),2)	-0.299052	0.078832	-3.793548	0.0002
D(INTEREST(-4),2)	-0.299111	0.076325	-3.918902	0.0001
D(INTEREST(-5),2)	-0.299170	0.073734	-4.057424	0.0001
D(INTEREST(-6),2)	-0.299230	0.071049	-4.211600	0.0000
D(INTEREST(-7),2)	-0.299289	0.068259	-4.384626	0.0000
D(INTEREST(-8),2)	-0.299348	0.065350	-4.580693	0.0000
D(INTEREST(-9),2)	-0.299407	0.062306	-4.805426	0.0000
D(INTEREST(-10),2)	-0.299467	0.059106	-5.066580	0.0000
D(INTEREST(-11),2)	-0.299526	0.055724	-5.375211	0.0000
D(INTEREST(-12),2)	-0.299585	0.052122	-5.747722	0.0000
D(INTEREST(-13),2)	-0.299644	0.048254	-6.209741	0.0000
D(INTEREST(-14),2)	-0.299704	0.044048	-6.804063	0.0000
D(INTEREST(-15),2)	-0.299763	0.039396	-7.609001	0.0000
D(INTEREST(-16),2)	-0.299822	0.034116	-8.788226	0.0000
D(INTEREST(-17),2)	-0.299881	0.027855	-10.76592	0.0000
D(INTEREST(-18),2)	-0.299941	0.019695	-15.22896	0.0000
C	-0.000148	0.000453	-0.327045	0.7437

R-squared	0.545021	Mean dependent var	0.000000
Adjusted R-squared	0.541336	S.D. dependent var	0.032513
S.E. of regression	0.022019	Akaike info criterion	-4.785386
Sum squared resid	1.137448	Schwarz criterion	-4.736620
Log likelihood	5681.111	Hannan-Quinn criter.	-4.767632
F-statistic	147.9094	Durbin-Watson stat	1.999973
Prob(F-statistic)	0.000000		

Appendix 4.9: Augmented Dickey-Fuller Test for Interest rate (1st difference, intercept & trend)

Null Hypothesis: D(INTEREST) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 18 (Automatic - based on SIC, maxlag=26)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.180984	0.0000
Test critical values:	1% level	-3.961924	
	5% level	-3.411707	
	10% level	-3.127733	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(INTEREST,2)
Method: Least Squares
Date: 05/25/17 Time: 22:04
Sample (adjusted): 2/02/2007 12/30/2016
Included observations: 2366 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INTEREST(-1))	-0.704770	0.086147	-8.180984	0.0000
D(INTEREST(-1),2)	-0.295482	0.083835	-3.524584	0.0004
D(INTEREST(-2),2)	-0.295735	0.081458	-3.630510	0.0003
D(INTEREST(-3),2)	-0.295987	0.079012	-3.746100	0.0002
D(INTEREST(-4),2)	-0.296239	0.076489	-3.872938	0.0001
D(INTEREST(-5),2)	-0.296491	0.073883	-4.012992	0.0001
D(INTEREST(-6),2)	-0.296742	0.071183	-4.168753	0.0000
D(INTEREST(-7),2)	-0.296994	0.068378	-4.343423	0.0000
D(INTEREST(-8),2)	-0.297245	0.065455	-4.541201	0.0000
D(INTEREST(-9),2)	-0.297497	0.062398	-4.767720	0.0000
D(INTEREST(-10),2)	-0.297748	0.059186	-5.030748	0.0000
D(INTEREST(-11),2)	-0.297999	0.055791	-5.341353	0.0000
D(INTEREST(-12),2)	-0.298249	0.052178	-5.715960	0.0000
D(INTEREST(-13),2)	-0.298500	0.048299	-6.180218	0.0000
D(INTEREST(-14),2)	-0.298750	0.044083	-6.776963	0.0000
D(INTEREST(-15),2)	-0.299001	0.039422	-7.584556	0.0000
D(INTEREST(-16),2)	-0.299251	0.034135	-8.766757	0.0000
D(INTEREST(-17),2)	-0.299501	0.027866	-10.74790	0.0000
D(INTEREST(-18),2)	-0.299750	0.019701	-15.21517	0.0000
C	-0.000623	0.000920	-0.676793	0.4986
@TREND(1/03/2007)	3.94E-07	6.65E-07	0.592599	0.5535

R-squared	0.545089	Mean dependent var	0.000000
Adjusted R-squared	0.541209	S.D. dependent var	0.032513
S.E. of regression	0.022022	Akaike info criterion	-4.784690
Sum squared resid	1.137278	Schwarz criterion	-4.733486
Log likelihood	5681.288	Hannan-Quinn criter.	-4.766048
F-statistic	140.4926	Durbin-Watson stat	1.999886
Prob(F-statistic)	0.000000		

Appendix 4.10: Augmented Dickey-Fuller Test for Stock price (Level, intercept)

Null Hypothesis: KLCI_LAST_PRICE has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=26)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.510087	0.5285
Test critical values:	1% level	-3.432898	
	5% level	-2.862552	
	10% level	-2.567354	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(KLCI_LAST_PRICE)
Method: Least Squares
Date: 05/25/17 Time: 22:11
Sample (adjusted): 1/05/2007 12/30/2016
Included observations: 2384 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
KLCI_LAST_PRICE(-1)	-0.001255	0.000831	-1.510087	0.1312
D(KLCI_LAST_PRICE(-1))	0.102653	0.020378	5.037404	0.0000
C	2.079904	1.266032	1.642852	0.1005

R-squared	0.011414	Mean dependent var	0.219610
Adjusted R-squared	0.010584	S.D. dependent var	10.81268
S.E. of regression	10.75531	Akaike info criterion	7.589933
Sum squared resid	275426.1	Schwarz criterion	7.597203
Log likelihood	-9044.201	Hannan-Quinn criter.	7.592579
F-statistic	13.74585	Durbin-Watson stat	2.002264
Prob(F-statistic)	0.000001		

Appendix 4.11: Augmented Dickey-Fuller Test for Stock price (Level, intercept & trend)

Null Hypothesis: KLCI_LAST_PRICE has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=26)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.573199	0.8034
Test critical values:	1% level	-3.961894	
	5% level	-3.411693	
	10% level	-3.127724	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(KLCI_LAST_PRICE)
Method: Least Squares
Date: 05/25/17 Time: 22:12
Sample (adjusted): 1/05/2007 12/30/2016
Included observations: 2384 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
KLCI_LAST_PRICE(-1)	-0.002197	0.001396	-1.573199	0.1158
D(KLCI_LAST_PRICE(-1))	0.103382	0.020398	5.068297	0.0000
C	2.954410	1.639580	1.801931	0.0717
@TREND(1/03/2007)	0.000452	0.000538	0.839480	0.4013

R-squared	0.011707	Mean dependent var	0.219610
Adjusted R-squared	0.010461	S.D. dependent var	10.81268
S.E. of regression	10.75597	Akaike info criterion	7.590476
Sum squared resid	275344.6	Schwarz criterion	7.600168
Log likelihood	-9043.848	Hannan-Quinn criter.	7.594004
F-statistic	9.397672	Durbin-Watson stat	2.002450
Prob(F-statistic)	0.000004		

Appendix 4.12: Augmented Dickey-Fuller Test for Stock price (1st difference, intercept)

Null Hypothesis: D(KLCI_LAST_PRICE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=26)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-44.04240	0.0001
Test critical values:	1% level	-3.432898	
	5% level	-2.862552	
	10% level	-2.567354	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(KLCI_LAST_PRICE,2)
Method: Least Squares
Date: 05/25/17 Time: 22:15
Sample (adjusted): 1/05/2007 12/30/2016
Included observations: 2384 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(KLCI_LAST_PRICE(-1))	-0.897686	0.020382	-44.04240	0.0000
C	0.197257	0.220381	0.895071	0.3708

R-squared	0.448832	Mean dependent var	0.001137
Adjusted R-squared	0.448601	S.D. dependent var	14.48793
S.E. of regression	10.75820	Akaike info criterion	7.590052
Sum squared resid	275689.9	Schwarz criterion	7.594898
Log likelihood	-9045.342	Hannan-Quinn criter.	7.591815
F-statistic	1939.733	Durbin-Watson stat	2.002172
Prob(F-statistic)	0.000000		

Appendix 4.13: Augmented Dickey-Fuller Test for Stock price (1st difference, intercept & trend)

Null Hypothesis: D(KLCI_LAST_PRICE) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=26)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-44.04365	0.0000
Test critical values:	1% level	-3.961894	
	5% level	-3.411693	
	10% level	-3.127724	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(KLCI_LAST_PRICE,2)
Method: Least Squares
Date: 05/25/17 Time: 22:15
Sample (adjusted): 1/05/2007 12/30/2016
Included observations: 2384 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(KLCI_LAST_PRICE(-1))	-0.897927	0.020387	-44.04365	0.0000
C	0.470135	0.441266	1.065423	0.2868
@TREND(1/03/2007)	-0.000229	0.000320	-0.713818	0.4754

R-squared	0.448950	Mean dependent var	0.001137
Adjusted R-squared	0.448487	S.D. dependent var	14.48793
S.E. of regression	10.75931	Akaike info criterion	7.590677
Sum squared resid	275630.9	Schwarz criterion	7.597946
Log likelihood	-9045.087	Hannan-Quinn criter.	7.593322
F-statistic	969.9216	Durbin-Watson stat	2.002113
Prob(F-statistic)	0.000000		

Appendix 4.14: Augmented Dickey-Fuller Test for Oil price (Level, intercept)

Null Hypothesis: OIL_PRICE has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=26)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.776266	0.3927
Test critical values:	1% level	-3.432897	
	5% level	-2.862551	
	10% level	-2.567354	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OIL_PRICE)
Method: Least Squares
Date: 05/25/17 Time: 22:18
Sample (adjusted): 1/04/2007 12/30/2016
Included observations: 2385 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OIL_PRICE(-1)	-0.002721	0.001532	-1.776266	0.0758
C	0.211929	0.125701	1.685976	0.0919

R-squared	0.001322	Mean dependent var	-0.001929
Adjusted R-squared	0.000903	S.D. dependent var	1.765159
S.E. of regression	1.764362	Akaike info criterion	3.974294
Sum squared resid	7418.215	Schwarz criterion	3.979138
Log likelihood	-4737.345	Hannan-Quinn criter.	3.976057
F-statistic	3.155120	Durbin-Watson stat	2.100615
Prob(F-statistic)	0.075817		

Appendix 4.15: Augmented Dickey-Fuller Test for Oil price (Level, intercept & trend)

Null Hypothesis: OIL_PRICE has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=26)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.151881	0.5158
Test critical values:	1% level	-3.961893	
	5% level	-3.411692	
	10% level	-3.127724	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OIL_PRICE)
Method: Least Squares
Date: 05/25/17 Time: 22:22
Sample (adjusted): 1/04/2007 12/30/2016
Included observations: 2385 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OIL_PRICE(-1)	-0.003457	0.001606	-2.151881	0.0315
C	0.369330	0.163004	2.265774	0.0236
@TREND(1/03/2007)	-8.34E-05	5.50E-05	-1.516129	0.1296

R-squared	0.002285	Mean dependent var	-0.001929
Adjusted R-squared	0.001447	S.D. dependent var	1.765159
S.E. of regression	1.763881	Akaike info criterion	3.974168
Sum squared resid	7411.064	Schwarz criterion	3.981434
Log likelihood	-4736.195	Hannan-Quinn criter.	3.976812
F-statistic	2.727743	Durbin-Watson stat	2.101094
Prob(F-statistic)	0.065571		

Appendix 4.16: Augmented Dickey-Fuller Test for Oil price (1st difference, intercept)

Null Hypothesis: D(OIL_PRICE) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=26)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-51.45345	0.0001
Test critical values:	1% level	-3.432898	
	5% level	-2.862552	
	10% level	-2.567354	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OIL_PRICE,2)
Method: Least Squares
Date: 05/25/17 Time: 22:23
Sample (adjusted): 1/05/2007 12/30/2016
Included observations: 2384 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(OIL_PRICE(-1))	-1.052279	0.020451	-51.45345	0.0000
C	-0.000884	0.036099	-0.024493	0.9805

R-squared	0.526390	Mean dependent var	0.001124
Adjusted R-squared	0.526191	S.D. dependent var	2.560661
S.E. of regression	1.762599	Akaike info criterion	3.972294
Sum squared resid	7400.290	Schwarz criterion	3.977140
Log likelihood	-4732.975	Hannan-Quinn criter.	3.974058
F-statistic	2647.457	Durbin-Watson stat	2.001054
Prob(F-statistic)	0.000000		

Appendix 4.17: Augmented Dickey-Fuller Test for Oil price (1st difference, intercept & trend)

Null Hypothesis: D(OIL_PRICE) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=26)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-51.46363	0.0000
Test critical values:	1% level	-3.961894	
	5% level	-3.411693	
	10% level	-3.127724	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(OIL_PRICE,2)
Method: Least Squares
Date: 05/25/17 Time: 22:25
Sample (adjusted): 1/05/2007 12/30/2016
Included observations: 2384 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(OIL_PRICE(-1))	-1.052664	0.020455	-51.46363	0.0000
C	0.062486	0.072275	0.864558	0.3874
@TREND(1/03/2007)	-5.31E-05	5.25E-05	-1.012073	0.3116

R-squared	0.526594	Mean dependent var	0.001124
Adjusted R-squared	0.526196	S.D. dependent var	2.560661
S.E. of regression	1.762590	Akaike info criterion	3.972703
Sum squared resid	7397.108	Schwarz criterion	3.979972
Log likelihood	-4732.462	Hannan-Quinn criter.	3.975349
F-statistic	1324.254	Durbin-Watson stat	2.001157
Prob(F-statistic)	0.000000		

Appendix 4.18: Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Exchange rate (Level, intercept)

Null Hypothesis: EXCHANGE_RATE is stationary
Exogenous: Constant
Bandwidth: 39 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		1.963672
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	0.134230
HAC corrected variance (Bartlett kernel)	5.151285

KPSS Test Equation
Dependent Variable: EXCHANGE_RATE
Method: Least Squares
Date: 05/30/17 Time: 13:35
Sample: 1/03/2007 12/30/2016
Included observations: 2386

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.413992	0.007502	455.0747	0.0000

R-squared	0.000000	Mean dependent var	3.413992
Adjusted R-squared	0.000000	S.D. dependent var	0.366450
S.E. of regression	0.366450	Akaike info criterion	0.830511
Sum squared resid	320.2716	Schwarz criterion	0.832932
Log likelihood	-989.7997	Hannan-Quinn criter.	0.831392
Durbin-Watson stat	0.002211		

Appendix 4.19: Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Exchange rate (Level, intercept & trend)

Null Hypothesis: EXCHANGE_RATE is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 39 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		1.187517
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	0.108671
HAC corrected variance (Bartlett kernel)	4.171312

KPSS Test Equation
Dependent Variable: EXCHANGE_RATE
Method: Least Squares
Date: 05/30/17 Time: 13:31
Sample: 1/03/2007 12/30/2016
Included observations: 2386

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.137207	0.013499	232.4048	0.0000
@TREND("1/03/2007")	0.000232	9.80E-06	23.67881	0.0000

R-squared	0.190406	Mean dependent var	3.413992
Adjusted R-squared	0.190066	S.D. dependent var	0.366450
S.E. of regression	0.329792	Akaike info criterion	0.620127
Sum squared resid	259.2899	Schwarz criterion	0.624970
Log likelihood	-737.8113	Hannan-Quinn criter.	0.621889
F-statistic	560.6862	Durbin-Watson stat	0.002730
Prob(F-statistic)	0.000000		

Appendix 4.20: Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Exchange rate volatility (1st difference, intercept)

Null Hypothesis: D(EXCHANGE_RATE) is stationary
Exogenous: Constant
Bandwidth: 15 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.575189
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	0.000297
HAC corrected variance (Bartlett kernel)	0.000347

KPSS Test Equation
Dependent Variable: D(EXCHANGE_RATE)
Method: Least Squares
Date: 05/30/17 Time: 13:37
Sample (adjusted): 1/04/2007 12/30/2016
Included observations: 2385 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000401	0.000353	1.136289	0.2560

R-squared	0.000000	Mean dependent var	0.000401
Adjusted R-squared	0.000000	S.D. dependent var	0.017231
S.E. of regression	0.017231	Akaike info criterion	-5.283769
Sum squared resid	0.707845	Schwarz criterion	-5.281347
Log likelihood	6301.895	Hannan-Quinn criter.	-5.282888
Durbin-Watson stat	1.957647		

Appendix 4.21: Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Exchange rate volatility (1st difference, intercept & trend)

Null Hypothesis: D(EXCHANGE_RATE) is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 13 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.064845
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	0.000296
HAC corrected variance (Bartlett kernel)	0.000331

KPSS Test Equation
Dependent Variable: D(EXCHANGE_RATE)
Method: Least Squares
Date: 05/30/17 Time: 13:37
Sample (adjusted): 1/04/2007 12/30/2016
Included observations: 2385 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001095	0.000705	-1.552773	0.1206
@TREND("1/03/2007")	1.25E-06	5.12E-07	2.449248	0.0144

R-squared	0.002511	Mean dependent var	0.000401
Adjusted R-squared	0.002092	S.D. dependent var	0.017231
S.E. of regression	0.017213	Akaike info criterion	-5.285445
Sum squared resid	0.706067	Schwarz criterion	-5.280600
Log likelihood	6304.893	Hannan-Quinn criter.	-5.283682
F-statistic	5.998816	Durbin-Watson stat	1.962575
Prob(F-statistic)	0.014387		

Appendix 4.22: Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Interest rate (Level, intercept)

Null Hypothesis: INTEREST_RATE is stationary
Exogenous: Constant
Bandwidth: 39 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.738486
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	0.185800
HAC corrected variance (Bartlett kernel)	7.251807

KPSS Test Equation
Dependent Variable: INTEREST_RATE
Method: Least Squares
Date: 05/30/17 Time: 13:39
Sample: 1/03/2007 12/30/2016
Included observations: 2386

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.995180	0.008826	339.3469	0.0000

R-squared	0.000000	Mean dependent var	2.995180
Adjusted R-squared	0.000000	S.D. dependent var	0.431136
S.E. of regression	0.431136	Akaike info criterion	1.155633
Sum squared resid	443.3196	Schwarz criterion	1.158054
Log likelihood	-1377.670	Hannan-Quinn criter.	1.156514
Durbin-Watson stat	0.002820		

Appendix 4.23: Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Interest rate (Level, intercept & trend)

Null Hypothesis: INTEREST_RATE is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 39 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.634440
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	0.184337
HAC corrected variance (Bartlett kernel)	7.184836

KPSS Test Equation
Dependent Variable: INTEREST_RATE
Method: Least Squares
Date: 05/30/17 Time: 13:39
Sample: 1/03/2007 12/30/2016
Included observations: 2386

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.928954	0.017581	166.5965	0.0000
@TREND("1/03/2007")	5.55E-05	1.28E-05	4.350093	0.0000

R-squared	0.007875	Mean dependent var	2.995180
Adjusted R-squared	0.007459	S.D. dependent var	0.431136
S.E. of regression	0.429525	Akaike info criterion	1.148565
Sum squared resid	439.8284	Schwarz criterion	1.153407
Log likelihood	-1368.237	Hannan-Quinn criter.	1.150327
F-statistic	18.92331	Durbin-Watson stat	0.002842
Prob(F-statistic)	0.000014		

Appendix 4.24: Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Interest rate (1st difference, intercept)

Null Hypothesis: D(INTEREST_RATE) is stationary
Exogenous: Constant
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.226219
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	0.000524
HAC corrected variance (Bartlett kernel)	0.000524

KPSS Test Equation
Dependent Variable: D(INTEREST_RATE)
Method: Least Squares
Date: 05/30/17 Time: 13:40
Sample (adjusted): 1/04/2007 12/30/2016
Included observations: 2385 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000210	0.000469	-0.447139	0.6548

R-squared	0.000000	Mean dependent var	-0.000210
Adjusted R-squared	0.000000	S.D. dependent var	0.022897
S.E. of regression	0.022897	Akaike info criterion	-4.715179
Sum squared resid	1.249895	Schwarz criterion	-4.712757
Log likelihood	5623.851	Hannan-Quinn criter.	-4.714298
Durbin-Watson stat	2.000168		

Appendix 4.25: Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Interest rate (1st difference, intercept & trend)

Null Hypothesis: D(INTEREST_RATE) is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.147058
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	0.000524
HAC corrected variance (Bartlett kernel)	0.000524

KPSS Test Equation
Dependent Variable: D(INTEREST_RATE)
Method: Least Squares
Date: 05/30/17 Time: 13:40
Sample (adjusted): 1/04/2007 12/30/2016
Included observations: 2385 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000851	0.000938	-0.907424	0.3643
@TREND("1/03/2007")	5.38E-07	6.81E-07	0.789666	0.4298

R-squared	0.000262	Mean dependent var	-0.000210
Adjusted R-squared	-0.000158	S.D. dependent var	0.022897
S.E. of regression	0.022899	Akaike info criterion	-4.714602
Sum squared resid	1.249568	Schwarz criterion	-4.709758
Log likelihood	5624.163	Hannan-Quinn criter.	-4.712839
F-statistic	0.623573	Durbin-Watson stat	2.000691
Prob(F-statistic)	0.429801		

Appendix 4.26: Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Stock price (Level, intercept)

Null Hypothesis: KLCI_INDEX is stationary
Exogenous: Constant
Bandwidth: 39 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		4.552014
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	70317.62
HAC corrected variance (Bartlett kernel)	2759455.

KPSS Test Equation
Dependent Variable: KLCI_INDEX
Method: Least Squares
Date: 05/30/17 Time: 13:41
Sample: 1/03/2007 12/30/2016
Included observations: 2386

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1500.570	5.429851	276.3557	0.0000

R-squared	0.000000	Mean dependent var	1500.570
Adjusted R-squared	0.000000	S.D. dependent var	265.2303
S.E. of regression	265.2303	Akaike info criterion	13.99949
Sum squared resid	1.68E+08	Schwarz criterion	14.00191
Log likelihood	-16700.40	Hannan-Quinn criter.	14.00037
Durbin-Watson stat	0.001661		

Appendix 4.27: Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Stock price (Level, intercept & trend)

Null Hypothesis: KLCI_INDEX is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 39 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.532735
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	24933.62
HAC corrected variance (Bartlett kernel)	953896.7

KPSS Test Equation
Dependent Variable: KLCI_INDEX
Method: Least Squares
Date: 05/30/17 Time: 13:42
Sample: 1/03/2007 12/30/2016
Included observations: 2386

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1131.737	6.465960	175.0300	0.0000
@TREND("1/03/2007")	0.309294	0.004695	65.87367	0.0000

R-squared	0.645414	Mean dependent var	1500.570
Adjusted R-squared	0.645266	S.D. dependent var	265.2303
S.E. of regression	157.9700	Akaike info criterion	12.96353
Sum squared resid	59491614	Schwarz criterion	12.96837
Log likelihood	-15463.49	Hannan-Quinn criter.	12.96529
F-statistic	4339.341	Durbin-Watson stat	0.004683
Prob(F-statistic)	0.000000		

Appendix 4.28: Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Stock price (1st difference, intercept)

Null Hypothesis: D(KLCI_INDEX) is stationary
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.130513
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	116.8164
HAC corrected variance (Bartlett kernel)	139.4797

KPSS Test Equation
Dependent Variable: D(KLCI_INDEX)
Method: Least Squares
Date: 05/30/17 Time: 13:45
Sample (adjusted): 1/04/2007 12/30/2016
Included observations: 2385 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.219975	0.221360	0.993744	0.3204

R-squared	0.000000	Mean dependent var	0.219975
Adjusted R-squared	0.000000	S.D. dependent var	10.81043
S.E. of regression	10.81043	Akaike info criterion	7.599319
Sum squared resid	278607.0	Schwarz criterion	7.601741
Log likelihood	-9061.188	Hannan-Quinn criter.	7.600200
Durbin-Watson stat	1.795333		

Appendix 4.29: Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Stock price (1st difference, intercept & trend)

Null Hypothesis: D(KLCI_INDEX) is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.083635
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	116.7854
HAC corrected variance (Bartlett kernel)	139.3523

KPSS Test Equation
Dependent Variable: D(KLCI_INDEX)
Method: Least Squares
Date: 05/30/17 Time: 13:44
Sample (adjusted): 1/04/2007 12/30/2016
Included observations: 2385 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.525036	0.442893	1.185470	0.2359
@TREND("1/03/2007")	-0.000256	0.000322	-0.795266	0.4265

R-squared	0.000265	Mean dependent var	0.219975
Adjusted R-squared	-0.000154	S.D. dependent var	10.81043
S.E. of regression	10.81126	Akaike info criterion	7.599892
Sum squared resid	278533.1	Schwarz criterion	7.604736
Log likelihood	-9060.871	Hannan-Quinn criter.	7.601655
F-statistic	0.632448	Durbin-Watson stat	1.795809
Prob(F-statistic)	0.426538		

Appendix 4.30: Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Oil price (Level, intercept)

Null Hypothesis: OIL_PRICE is stationary
Exogenous: Constant
Bandwidth: 39 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		1.066260
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	556.3983
HAC corrected variance (Bartlett kernel)	21287.63

KPSS Test Equation
Dependent Variable: OIL_PRICE
Method: Least Squares
Date: 05/30/17 Time: 13:45
Sample: 1/03/2007 12/30/2016
Included observations: 2386

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	78.59565	0.483002	162.7233	0.0000

R-squared	0.000000	Mean dependent var	78.59565
Adjusted R-squared	0.000000	S.D. dependent var	23.59304
S.E. of regression	23.59304	Akaike info criterion	9.160200
Sum squared resid	1327566.	Schwarz criterion	9.162621
Log likelihood	-10927.12	Hannan-Quinn criter.	9.161081
Durbin-Watson stat	0.005595		

Appendix 4.31: Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Oil price (Level, intercept & trend)

Null Hypothesis: OIL_PRICE is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 39 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.663200
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	505.4048
HAC corrected variance (Bartlett kernel)	19222.69

KPSS Test Equation
Dependent Variable: OIL_PRICE
Method: Least Squares
Date: 05/30/17 Time: 13:46
Sample: 1/03/2007 12/30/2016
Included observations: 2386

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	90.95899	0.920577	98.80652	0.0000
@TREND("1/03/2007")	-0.010368	0.000668	-15.50925	0.0000

R-squared	0.091649	Mean dependent var	78.59565
Adjusted R-squared	0.091268	S.D. dependent var	23.59304
S.E. of regression	22.49064	Akaike info criterion	9.064913
Sum squared resid	1205896.	Schwarz criterion	9.069756
Log likelihood	-10812.44	Hannan-Quinn criter.	9.066676
F-statistic	240.5369	Durbin-Watson stat	0.006160
Prob(F-statistic)	0.000000		

Appendix 4.32: Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Oil price (1st difference, intercept)

Null Hypothesis: D(OIL_PRICE) is stationary
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.149053
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	3.114481
HAC corrected variance (Bartlett kernel)	2.951658

KPSS Test Equation
Dependent Variable: D(OIL_PRICE)
Method: Least Squares
Date: 05/30/17 Time: 13:47
Sample (adjusted): 1/04/2007 12/30/2016
Included observations: 2385 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.001929	0.036144	-0.053362	0.9574

R-squared	0.000000	Mean dependent var	-0.001929
Adjusted R-squared	0.000000	S.D. dependent var	1.765159
S.E. of regression	1.765159	Akaike info criterion	3.974778
Sum squared resid	7428.037	Schwarz criterion	3.977200
Log likelihood	-4738.923	Hannan-Quinn criter.	3.975660
Durbin-Watson stat	2.103556		

Appendix 4.33: Kwiatkoski-Philips-Schmidt-Shin (KPSS) for Oil price (1st difference, intercept & trend)

Null Hypothesis: D(OIL_PRICE) is stationary
Exogenous: Constant, Linear Trend
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.052125
Asymptotic critical values*:	1% level	0.216000
	5% level	0.146000
	10% level	0.119000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Residual variance (no correction)	3.113405
HAC corrected variance (Bartlett kernel)	3.113405

KPSS Test Equation
Dependent Variable: D(OIL_PRICE)
Method: Least Squares
Date: 05/30/17 Time: 13:47
Sample (adjusted): 1/04/2007 12/30/2016
Included observations: 2385 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.054913	0.072314	0.759369	0.4477
@TREND("1/03/2007")	-4.76E-05	5.25E-05	-0.907546	0.3642

R-squared	0.000346	Mean dependent var	-0.001929
Adjusted R-squared	-0.000074	S.D. dependent var	1.765159
S.E. of regression	1.765225	Akaike info criterion	3.975271
Sum squared resid	7425.471	Schwarz criterion	3.980116
Log likelihood	-4738.511	Hannan-Quinn criter.	3.977034
F-statistic	0.823640	Durbin-Watson stat	2.104283
Prob(F-statistic)	0.364210		

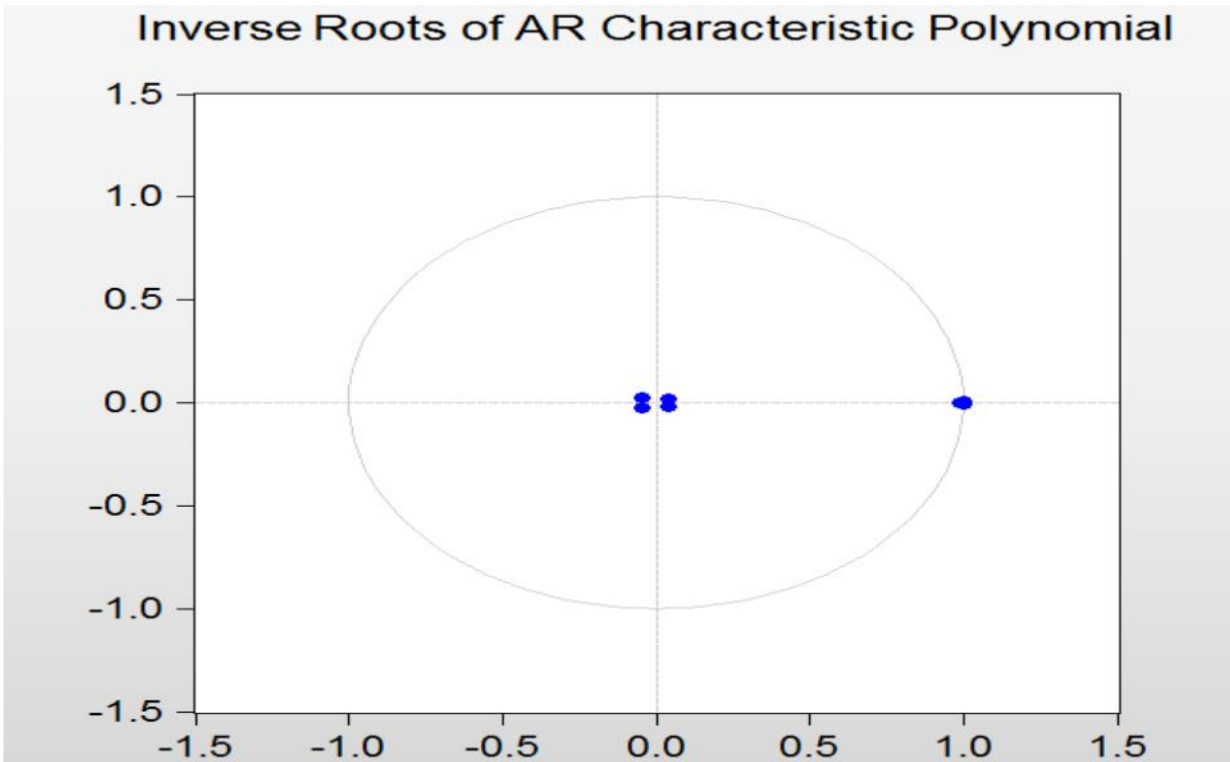
Appendix 4.34: Unrestricted Var

Vector Autoregression Estimates
Date: 06/06/17 Time: 18:51
Sample (adjusted): 3/05/2007 4/21/2016
Included observations: 2384 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	EXC	INT	KLCI	OIL
EXC(-1)	0.979135	0.023756	19.19069	-14.64664
	(0.02226)	(0.02971)	(13.9553)	(2.22847)
	[43.9906]	[0.79955]	[1.37516]	[-6.57251]
EXC(-2)	0.016792	-0.023868	-17.21952	14.15568
	(0.02224)	(0.02969)	(13.9463)	(2.22703)
	[0.75493]	[-0.80386]	[-1.23470]	[6.35630]
INT(-1)	-0.001094	0.992376	9.902843	-2.770779
	(0.01542)	(0.02058)	(9.66573)	(1.54348)
	[-0.07096]	[48.2234]	[1.02453]	[-1.79515]
INT(-2)	0.000289	0.007532	-8.629152	2.977938
	(0.01544)	(0.02061)	(9.68154)	(1.54601)
	[0.01870]	[0.36541]	[-0.89130]	[1.92621]
KLCI(-1)	-0.000170	6.87E-06	1.108936	0.021784
	(3.5E-05)	(4.7E-05)	(0.02208)	(0.00353)
	[-4.83990]	[0.14609]	[50.2327]	[6.17949]
KLCI(-2)	0.000170	-1.15E-05	-0.110293	-0.021872
	(3.5E-05)	(4.7E-05)	(0.02206)	(0.00352)
	[4.83243]	[-0.24564]	[-4.99944]	[-6.20855]
OIL(-1)	0.000229	-0.000327	-0.049263	0.901785
	(0.00020)	(0.00027)	(0.12730)	(0.02033)
	[1.12870]	[-1.20753]	[-0.38697]	[44.3604]
OIL(-2)	-0.000254	0.000278	0.079941	0.089095
	(0.00020)	(0.00027)	(0.12706)	(0.02029)
	[-1.25335]	[1.02867]	[0.62918]	[4.39128]
C	0.018387	0.011747	-11.10853	1.905539
	(0.00730)	(0.00975)	(4.57862)	(0.73114)
	[2.51782]	[1.20504]	[-2.42617]	[2.60625]
R-squared	0.997809	0.997200	0.998367	0.994735
Adj. R-squared	0.997802	0.997190	0.998362	0.994717
Sum sq. resids	0.696663	1.241377	273864.5	6983.460
S.E. equation	0.017127	0.022862	10.73831	1.714761
F-statistic	135203.7	105722.9	181535.8	56086.96
Log likelihood	6317.733	5629.145	-9037.423	-4663.869
Akaike AIC	-5.292561	-4.714886	7.589281	3.920192
Schwarz SC	-5.270754	-4.693079	7.611088	3.942000
Mean dependent	3.413093	2.995176	1500.453	78.61649
S.D. dependent	0.365286	0.431317	265.3109	23.59195

Determinant resid covariance (dof adj.)	4.34E-05
Determinant resid covariance	4.28E-05
Log likelihood	-1539.501
Akaike information criterion	1.321729
Schwarz criterion	1.408958

Appendix 4.35: Inverse Roots of AR Characteristic Polynomial



Appendix 4.36: Lag Length Selection

VAR Lag Order Selection Criteria
Endogenous variables: EXC INT KLCI OIL
Exogenous variables: C
Date: 08/08/17 Time: 15:18
Sample: 3/01/2007 12/30/2016
Included observations: 2286

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-27128.53	NA	239543.6	23.73800	23.74803	23.74166
1	-1664.486	50816.70	5.13e-05	1.473741	1.523912	1.492038
2	-1586.789	154.7827	4.86e-05*	1.419762*	1.510070*	1.452698*
3	-1576.047	21.35992	4.88e-05	1.424363	1.554808	1.471937
4	-1562.831	26.23630	4.90e-05	1.426799	1.597381	1.489010
5	-1556.892	11.76874	4.94e-05	1.435601	1.646320	1.512450
6	-1550.914	11.82568	4.98e-05	1.444369	1.695225	1.535856
7	-1546.614	8.491205	5.03e-05	1.454605	1.745598	1.560730
8	-1531.528	29.73546	5.04e-05	1.455405	1.786535	1.576168
9	-1524.216	14.38858	5.08e-05	1.463006	1.834272	1.598407
10	-1512.278	23.44783	5.09e-05	1.466560	1.877963	1.616599
11	-1505.859	12.58522	5.14e-05	1.474942	1.926482	1.639619
12	-1493.917	23.37159	5.15e-05	1.478492	1.970169	1.657807
13	-1484.560	18.28031	5.18e-05	1.484304	2.016118	1.678257
14	-1475.461	17.74279	5.22e-05	1.490343	2.062293	1.698933
15	-1464.277	21.77179	5.24e-05	1.494556	1.494556	1.717784
16	-1457.839	12.50993	5.28e-05	1.502921	2.155146	1.740788
17	-1448.032	19.02296	5.31e-05	1.508339	2.200701	1.760844
18	-1444.748	6.356970	5.37e-05	1.519465	2.251963	1.786607
19	-1430.577	27.38803	5.38e-05	1.521065	2.293700	1.802845
20	-1318.352	216.4961	4.95e-05	1.436879	2.249651	1.733297
21	-1303.815	27.99407	4.95e-05	1.438158	2.291067	1.749215
22	-1289.758	27.01926	4.96e-05	1.439858	2.332904	1.765553
23	-1279.606	19.47769	4.99e-05	1.444975	2.378157	1.785307
24	-1270.925	16.62468	5.02e-05	1.451378	2.424698	1.806349
25	-1257.052	26.52182	5.03e-05	1.453238	2.466695	1.822847
26	-1244.061	24.78677	5.04e-05	1.455872	2.509465	1.840118
27	-1233.125	20.83023	5.06e-05	1.460302	2.554032	1.859186
28	-1220.989	23.07282	5.08e-05	1.463682	2.597549	1.877204
29	-1211.949	17.15467	5.11e-05	1.469771	2.643775	1.897931
30	-1202.189	18.48623	5.14e-05	1.475231	2.689372	1.918029
31	-1185.735	31.10858	5.14e-05	1.474834	2.729112	1.932270
32	-1177.491	15.55687	5.17e-05	1.481620	2.776034	1.953693
33	-1173.399	7.708293	5.23e-05	1.492038	2.826589	1.978749
34	-1166.851	12.31168	5.27e-05	1.500307	2.874995	2.001657
35	-1156.249	19.89500	5.30e-05	1.505030	2.919856	2.021018
36	-1144.065	22.82209	5.31e-05	1.508369	2.963331	2.038994
37	-1133.445	19.85567	5.34e-05	1.513076	3.008175	2.058339
38	-1070.594	117.2896	5.13e-05	1.472086	3.007322	2.031987
39	-1047.705	42.63340	5.10e-05	1.466059	3.041432	2.040598
40	-1042.082	10.45386	5.14e-05	1.475138	3.090648	2.064315
41	-1037.166	9.123244	5.19e-05	1.484835	3.140481	2.088650
42	-1027.007	18.81611	5.22e-05	1.489945	3.185729	2.108398
43	-1015.486	21.29839	5.24e-05	1.493863	3.229784	2.126955
44	-1009.736	10.60933	5.29e-05	1.502831	3.278889	2.150560
45	-998.9917	19.78694	5.31e-05	1.507429	3.323624	2.169796

46	-986.8857	22.25261	5.33e-05	1.510836	3.367168	2.187841
47	-982.5799	7.899645	5.39e-05	1.521067	3.417536	2.212710
48	-977.0140	10.19191	5.44e-05	1.530196	3.466801	2.236477
49	-965.6814	20.71195	5.46e-05	1.534279	3.511022	2.255198
50	-946.2357	35.47184	5.44e-05	1.531265	3.548144	2.266822
51	-926.0832	36.69065	5.42e-05	1.527632	3.584648	2.277827
52	-918.5542	13.68134	5.47e-05	1.535043	3.632196	2.299876
53	-903.7692	26.81480	5.47e-05	1.536106	3.673396	2.315577
54	-890.7491	23.56815	5.49e-05	1.538713	3.716140	2.332822
55	-873.3666	31.40420	5.48e-05	1.537504	3.755067	2.346250
56	-865.9138	13.43844	5.52e-05	1.544981	3.802682	2.368366
57	-856.5897	16.78015	5.56e-05	1.550822	3.848659	2.388845
58	-851.2044	9.672833	5.61e-05	1.560109	3.898083	2.412769
59	-839.6511	20.71097	5.63e-05	1.563999	3.942110	2.431298
60	-827.5193	21.70568	5.65e-05	1.567383	3.985631	2.449320
61	-819.8404	13.71191	5.69e-05	1.574663	4.033048	2.471238
62	-815.1325	8.390041	5.75e-05	1.584543	4.083065	2.495755
63	-806.5062	15.34335	5.79e-05	1.590994	4.129653	2.516844
64	-795.5818	19.39232	5.82e-05	1.595435	4.174230	2.535923
65	-790.0123	9.867349	5.87e-05	1.604560	4.223493	2.559686
66	-778.6312	20.12346	5.90e-05	1.608601	4.267671	2.578365
67	-772.3699	11.04913	5.95e-05	1.617121	4.316328	2.601524
68	-755.5216	29.67247	5.94e-05	1.616379	4.355722	2.615419
69	-744.4841	19.39996	5.97e-05	1.620721	4.400201	2.634399
70	-738.9613	9.688025	6.03e-05	1.629887	4.449504	2.658203
71	-725.2814	23.94872	6.04e-05	1.631917	4.491671	2.674871
72	-711.5851	23.92953	6.05e-05	1.633933	4.533823	2.691525
73	-696.0708	27.05167	6.06e-05	1.634358	4.574385	2.706587
74	-687.2446	15.35896	6.10e-05	1.640634	4.620798	2.727502
75	-674.2107	22.63541	6.12e-05	1.643229	4.663530	2.744735
76	-664.6624	16.54877	6.15e-05	1.648873	4.709312	2.765017
77	-657.0338	13.19486	6.20e-05	1.656198	4.756773	2.786979
78	-652.3664	8.056750	6.26e-05	1.666112	4.806824	2.811532
79	-623.5499	49.64098	6.19e-05	1.654899	4.835748	2.814957
80	-601.7108	37.54483	6.16e-05	1.649791	4.870777	2.824486
81	-583.4631	31.30687	6.15e-05	1.647824	4.908947	2.837158
82	-572.4005	18.94096	6.18e-05	1.652144	4.953404	2.856115
83	-563.1408	15.82173	6.22e-05	1.658041	4.999437	2.876650
84	-553.6595	16.16709	6.26e-05	1.663744	5.045278	2.896991
85	-544.1036	16.26099	6.30e-05	1.669382	5.091052	2.917267
86	-534.1603	16.88536	6.33e-05	1.674681	5.136488	2.937204
87	-519.0511	25.60494	6.34e-05	1.675460	5.177404	2.952621
88	-511.2320	13.22341	6.39e-05	1.682618	5.224699	2.974417
89	-502.4509	14.81956	6.43e-05	1.688933	5.271151	2.995370
90	-491.0952	19.12492	6.46e-05	1.692997	5.315351	3.014071
91	-478.3097	21.48805	6.48e-05	1.695809	5.358301	3.031522
92	-471.2463	11.84646	6.53e-05	1.703628	5.406256	3.053978
93	-458.1169	21.97424	6.55e-05	1.706139	5.448904	3.071128
94	-435.7593	37.34094*	6.52e-05	1.700577	5.483479	3.080203
95	-424.5141	18.74202	6.55e-05	1.704737	5.527776	3.099001
96	-414.2777	17.02486	6.58e-05	1.709779	5.572955	3.118682
97	-408.7629	9.152743	6.64e-05	1.718953	5.622266	3.142493
98	-403.0378	9.481604	6.71e-05	1.727942	5.671392	3.166121
99	-397.2755	9.523238	6.77e-05	1.736899	5.720486	3.189715
100	-383.1514	23.29307	6.78e-05	1.738540	5.762264	3.205994

* indicates lag order selected by the criterion

LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix 4.37: Johansen Cointegration Test

Date: 06/06/17 Time: 18:51
Sample (adjusted): 3/06/2007 4/21/2016
Included observations: 2383 after adjustments
Trend assumption: Linear deterministic trend
Series: EXC INT KLCI OIL
Lags interval (in first differences): 1 to 2

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.010343	54.68703	47.85613	0.0100
At most 1 *	0.006362	29.91050	29.79707	0.0485
At most 2	0.003710	14.70050	15.49471	0.0656
At most 3 *	0.002449	5.841970	3.841466	0.0156

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.010343	24.77652	27.58434	0.1098
At most 1	0.006362	15.21000	21.13162	0.2745
At most 2	0.003710	8.858533	14.26460	0.2981
At most 3 *	0.002449	5.841970	3.841466	0.0156

Max-eigenvalue test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

EXC	INT	KLCI	OIL
3.359948	-0.536109	0.001378	0.066766
-3.046440	-0.897229	0.002049	-0.019763
1.619760	-2.059992	0.001228	-0.001274
-0.705545	0.971174	0.002848	-0.029554

Unrestricted Adjustment Coefficients (alpha):

D(EXC)	-0.000343	0.000989	-0.000221	-0.000530

D(INT)	-0.001242	-0.000978	0.000490	-0.000623
D(KLCI)	0.304893	-0.584036	-0.440457	-0.029409
D(OIL)	-0.121738	-0.004751	-0.045902	0.047990

1 Cointegrating Equation(s):	Log likelihood	-1544.629	
Normalized cointegrating coefficients (standard error in parentheses)			
EXC	INT	KLCI	OIL
1.000000	-0.159559	0.000410	0.019871
	(0.14487)	(0.00024)	(0.00256)
Adjustment coefficients (standard error in parentheses)			
D(EXC)	-0.001153		
	(0.00118)		
D(INT)	-0.004174		
	(0.00157)		
D(KLCI)	1.024423		
	(0.74012)		
D(OIL)	-0.409032		
	(0.11806)		

2 Cointegrating Equation(s):	Log likelihood	-1537.024	
Normalized cointegrating coefficients (standard error in parentheses)			
EXC	INT	KLCI	OIL
1.000000	0.000000	2.96E-05	0.015168
		(0.00019)	(0.00209)
0.000000	1.000000	-0.002384	-0.029475
		(0.00087)	(0.00974)
Adjustment coefficients (standard error in parentheses)			
D(EXC)	-0.004166	-0.000703	
	(0.00159)	(0.00037)	
D(INT)	-0.001194	0.001543	
	(0.00212)	(0.00049)	
D(KLCI)	2.803655	0.360559	
	(0.99758)	(0.22989)	
D(OIL)	-0.394558	0.069528	
	(0.15937)	(0.03673)	

3 Cointegrating Equation(s):	Log likelihood	-1532.594	
Normalized cointegrating coefficients (standard error in parentheses)			
EXC	INT	KLCI	OIL
1.000000	0.000000	0.000000	0.014482
			(0.00207)
0.000000	1.000000	0.000000	0.025829
			(0.00988)
0.000000	0.000000	1.000000	23.19569
			(6.62936)
Adjustment coefficients (standard error in parentheses)			
D(EXC)	-0.004523	-0.000248	1.28E-06
	(0.00169)	(0.00081)	(9.7E-07)

D(INT)	-0.000400	0.000534	-3.11E-06
	(0.00225)	(0.00108)	(1.3E-06)
D(KLCI)	2.090220	1.267896	-0.001317
	(1.05839)	(0.50765)	(0.00061)
D(OIL)	-0.468908	0.164086	-0.000234
	(0.16917)	(0.08114)	(9.7E-05)

Appendix 4.38: Vector Error Correction Estimates

Vector Error Correction Estimates
Date: 06/06/17 Time: 18:54
Sample (adjusted): 3/06/2007 4/21/2016
Included observations: 2383 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1	CointEq2
EXC(-1)	1.000000	0.000000
INT(-1)	0.000000	1.000000
KLCI(-1)	2.96E-05	-0.002384
	(0.00019)	(0.00087)
	[0.15924]	[-2.75320]
OIL(-1)	0.015168	-0.029475
	(0.00209)	(0.00975)
	[7.25702]	[-3.02404]
C	-4.650014	2.900256

Error Correction:	D(EXC)	D(INT)	D(KLCI)	D(OIL)
CointEq1	-0.004166	-0.001194	2.803655	-0.394558
	(0.00159)	(0.00212)	(0.99779)	(0.15940)
	[-2.61896]	[-0.56237]	[2.80988]	[-2.47525]
CointEq2	-0.000703	0.001543	0.360559	0.069528
	(0.00037)	(0.00049)	(0.22994)	(0.03673)
	[-1.91827]	[3.15367]	[1.56805]	[1.89272]
D(EXC(-1))	-0.015360	0.025868	17.23808	-14.05948
	(0.02224)	(0.02970)	(13.9532)	(2.22909)
	[-0.69058]	[0.87106]	[1.23542]	[-6.30728]
D(EXC(-2))	0.054364	-0.049147	-29.01895	1.786605
	(0.02243)	(0.02994)	(14.0687)	(2.24754)
	[2.42405]	[-1.64139]	[-2.06267]	[0.79492]
D(INT(-1))	0.000247	-0.009169	8.994845	-3.002931
	(0.01544)	(0.02061)	(9.68459)	(1.54716)
	[0.01601]	[-0.44483]	[0.92878]	[-1.94093]
D(INT(-2))	0.005157	-0.011438	3.823869	-1.324171

	(0.01545)	(0.02062)	(9.69006)	(1.54803)
	[0.33382]	[-0.55463]	[0.39462]	[-0.85539]
D(KLCI(-1))	-0.000170	9.20E-06	0.111959	0.021823
	(3.5E-05)	(4.7E-05)	(0.02210)	(0.00353)
	[-4.81487]	[0.19563]	[5.06578]	[6.18079]
D(KLCI(-2))	-1.53E-05	1.15E-05	-0.000931	0.005987
	(3.6E-05)	(4.8E-05)	(0.02235)	(0.00357)
	[-0.42849]	[0.24236]	[-0.04167]	[1.67689]
D(OIL(-1))	0.000387	-0.000413	-0.129928	-0.092789
	(0.00021)	(0.00028)	(0.13026)	(0.02081)
	[1.86304]	[-1.48944]	[-0.99747]	[-4.45900]
D(OIL(-2))	0.000217	-0.000571	-0.161220	-0.014497
	(0.00020)	(0.00027)	(0.12757)	(0.02038)
	[1.06850]	[-2.10412]	[-1.26381]	[-0.71135]
C	-0.000426	0.000210	-0.198456	0.003898
	(0.00035)	(0.00047)	(0.22036)	(0.03520)
	[-1.21304]	[0.44771]	[-0.90059]	[0.11071]
R-squared	0.017867	0.008532	0.017820	0.060023
Adj. R-squared	0.013727	0.004353	0.013679	0.056060
Sum sq. resids	0.695196	1.239230	273575.8	6982.105
S.E. equation	0.017120	0.022857	10.73944	1.715678
F-statistic	4.315210	2.041314	4.303500	15.14656
Log likelihood	6317.095	5628.346	-9032.875	-4662.181
Akaike AIC	-5.292568	-4.714516	7.590328	3.922099
Schwarz SC	-5.265905	-4.687853	7.616990	3.948762
Mean dependent	-0.000400	0.000210	-0.215363	0.001788
S.D. dependent	0.017238	0.022907	10.81365	1.765890

Determinant resid covariance (dof adj.)	4.35E-05
Determinant resid covariance	4.27E-05
Log likelihood	-1537.024
Akaike information criterion	1.333633
Schwarz criterion	1.459675

Appendix 4.39: Least Square with Exchange rate as dependent variable

Dependent Variable: D(EXC)
Method: Least Squares
Date: 06/07/17 Time: 12:11
Sample (adjusted): 3/06/2007 4/21/2016
Included observations: 2383 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECT1	-0.004172	0.001591	-2.622460	0.0088
ECT2	-0.000702	0.000367	-1.914969	0.0556
D(EXC(-1))	-0.014412	0.022231	-0.648264	0.5169
D(EXC(-2))	0.055275	0.022416	2.465843	0.0137
D(INT(-1))	6.79E-05	0.015439	0.004400	0.9965
D(INT(-2))	0.004974	0.015448	0.322022	0.7475
D(KLCI(-1))	-0.000168	3.52E-05	-4.780782	0.0000
D(KLCI(-2))	-1.39E-05	3.56E-05	-0.390385	0.6963
D(OIL(-1))	0.000387	0.000208	1.865325	0.0623
D(OIL(-2))	0.000217	0.000203	1.069007	0.2852

R-squared	0.017258	Mean dependent var	-0.000400
Adjusted R-squared	0.013531	S.D. dependent var	0.017238
S.E. of regression	0.017121	Akaike info criterion	-5.292787
Sum squared resid	0.695627	Schwarz criterion	-5.268548
Log likelihood	6316.356	Hannan-Quinn criter.	-5.283966
Durbin-Watson stat	1.997257		

Appendix 4.40: Wald test: Exchange rate and Interest rate

Wald Test:
Equation: DEXC

Test Statistic	Value	df	Probability
F-statistic	2.244579	(4, 2373)	0.0620
Chi-square	8.978317	4	0.0616

Null Hypothesis: C(1)=C(2)=C(5)=C(6)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	-0.004172	0.001591
C(2)	-0.000702	0.000367
C(5)	6.79E-05	0.015439
C(6)	0.004974	0.015448

Restrictions are linear in coefficients.

Appendix 4.41: Wald test: Exchange rate and Stock price

Wald Test:
Equation: DEXC

Test Statistic	Value	df	Probability
F-statistic	8.295450	(4, 2373)	0.0000
Chi-square	33.18180	4	0.0000

Null Hypothesis: C(1)=C(2)=C(7)=C(8)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	-0.004172	0.001591
C(2)	-0.000702	0.000367
C(7)	-0.000168	3.52E-05
C(8)	-1.39E-05	3.56E-05

Restrictions are linear in coefficients.

Appendix 4.42: Wald test: Exchange rate and Oil price

Wald Test:
Equation: DEXC

Test Statistic	Value	df	Probability
F-statistic	3.157878	(4, 2373)	0.0134
Chi-square	12.63151	4	0.0132

Null Hypothesis: C(1)=C(2)=C(9)=C(10)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	-0.004172	0.001591
C(2)	-0.000702	0.000367
C(9)	0.000387	0.000208
C(10)	0.000217	0.000203

Restrictions are linear in coefficients.

Appendix 4.43: Least Square with Interest Rate as dependent variable

Dependent Variable: D(INT)
Method: Least Squares
Date: 06/07/17 Time: 13:04
Sample (adjusted): 3/06/2007 4/21/2016
Included observations: 2383 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECT1	-0.001191	0.002123	-0.561087	0.5748
ECT2	0.001543	0.000489	3.153062	0.0016
D(EXC(-1))	0.025400	0.029673	0.855993	0.3921
D(EXC(-2))	-0.049597	0.029921	-1.657603	0.0975
D(INT(-1))	-0.009081	0.020608	-0.440641	0.6595
D(INT(-2))	-0.011349	0.020619	-0.550395	0.5821
D(KLCI(-1))	8.58E-06	4.70E-05	0.182573	0.8551
D(KLCI(-2))	1.09E-05	4.75E-05	0.228395	0.8194
D(OIL(-1))	-0.000413	0.000277	-1.490608	0.1362
D(OIL(-2))	-0.000571	0.000271	-2.104704	0.0354

R-squared	0.008449	Mean dependent var	0.000210
Adjusted R-squared	0.004688	S.D. dependent var	0.022907
S.E. of regression	0.022853	Akaike info criterion	-4.715271
Sum squared resid	1.239335	Schwarz criterion	-4.691032
Log likelihood	5628.245	Hannan-Quinn criter.	-4.706449
Durbin-Watson stat	1.995097		

Appendix 4.44: Wald test: Interest rate and Exchange rate

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	3.741546	(4, 2373)	0.0049
Chi-square	14.96619	4	0.0048

Null Hypothesis: C(1)=C(2)=C(3)=C(4)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	-0.001191	0.002123
C(2)	0.001543	0.000489
C(3)	0.025400	0.029673
C(4)	-0.049597	0.029921

Restrictions are linear in coefficients.

Appendix 4.45: Wald test: Interest rate and Stock price

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	2.856369	(4, 2373)	0.0224
Chi-square	11.42547	4	0.0222

Null Hypothesis: C(1)=C(2)=C(7)=C(8)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	-0.001191	0.002123
C(2)	0.001543	0.000489
C(7)	8.58E-06	4.70E-05
C(8)	1.09E-05	4.75E-05

Restrictions are linear in coefficients.

Appendix 4.46: Wald test: Interest rate and Oil price

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	4.436177	(4, 2373)	0.0014
Chi-square	17.74471	4	0.0014

Null Hypothesis: C(1)=C(2)=C(9)=C(10)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	-0.001191	0.002123
C(2)	0.001543	0.000489
C(9)	-0.000413	0.000277
C(10)	-0.000571	0.000271

Restrictions are linear in coefficients.

Appendix 4.47: Least Square with Stock price as dependent variable

Dependent Variable: D(KLCI)
Method: Least Squares
Date: 06/07/17 Time: 13:36
Sample (adjusted): 3/06/2007 4/21/2016
Included observations: 2383 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECT1	2.800878	0.997741	2.807220	0.0050
ECT2	0.361090	0.229931	1.570427	0.1164
D(EXC(-1))	17.67991	13.94398	1.267925	0.2049
D(EXC(-2))	-28.59433	14.06020	-2.033708	0.0421
D(INT(-1))	8.911389	9.683759	0.920241	0.3575
D(INT(-2))	3.739087	9.689214	0.385902	0.6996
D(KLCI(-1))	0.112544	0.022091	5.094671	0.0000
D(KLCI(-2))	-0.000296	0.022336	-0.013271	0.9894
D(OIL(-1))	-0.129689	0.130252	-0.995681	0.3195
D(OIL(-2))	-0.161163	0.127562	-1.263410	0.2066

R-squared	0.017484	Mean dependent var	-0.215363
Adjusted R-squared	0.013757	S.D. dependent var	10.81365
S.E. of regression	10.73901	Akaike info criterion	7.589830
Sum squared resid	273669.3	Schwarz criterion	7.614069
Log likelihood	-9033.283	Hannan-Quinn criter.	7.598651
Durbin-Watson stat	2.000749		

Appendix 4.48: Wald test: Stock price and Exchange rate

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	3.709005	(4, 2373)	0.0051
Chi-square	14.83602	4	0.0051

Null Hypothesis: C(1)=C(2)=C(3)=C(4)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	2.800878	0.997741
C(2)	0.361090	0.229931
C(3)	17.67991	13.94398
C(4)	-28.59433	14.06020

Restrictions are linear in coefficients.

Appendix 4.49: Wald test: Stock price and Interest rate

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	2.527620	(4, 2373)	0.0389
Chi-square	10.11048	4	0.0386

Null Hypothesis: C(1)=C(2)=C(5)=C(6)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	2.800878	0.997741
C(2)	0.361090	0.229931
C(5)	8.911389	9.683759
C(6)	3.739087	9.689214

Restrictions are linear in coefficients.

Appendix 4.50: Wald test: Stock price and Oil price

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	2.716437	(4, 2373)	0.0284
Chi-square	10.86575	4	0.0281

Null Hypothesis: C(1)=C(2)=C(9)=C(10)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	2.800878	0.997741
C(2)	0.361090	0.229931
C(9)	-0.129689	0.130252
C(10)	-0.161163	0.127562

Restrictions are linear in coefficients.

Appendix 4.51: Least Square with Stock price as dependent variable

Dependent Variable: D(OIL)
Method: Least Squares
Date: 06/07/17 Time: 13:44
Sample (adjusted): 3/06/2007 4/21/2016
Included observations: 2383 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECT1	-0.394503	0.159367	-2.475435	0.0134
ECT2	0.069517	0.036727	1.892834	0.0585
D(EXC(-1))	-14.06815	2.227245	-6.316393	0.0000
D(EXC(-2))	1.778266	2.245808	0.791815	0.4285
D(INT(-1))	-3.001292	1.546768	-1.940363	0.0525
D(INT(-2))	-1.322506	1.547639	-0.854531	0.3929
D(KLCI(-1))	0.021811	0.003528	6.181492	0.0000
D(KLCI(-2))	0.005974	0.003568	1.674584	0.0941
D(OIL(-1))	-0.092793	0.020805	-4.460166	0.0000
D(OIL(-2))	-0.014498	0.020375	-0.711550	0.4768

R-squared	0.060018	Mean dependent var	0.001788
Adjusted R-squared	0.056453	S.D. dependent var	1.765890
S.E. of regression	1.715321	Akaike info criterion	3.921265
Sum squared resid	6982.141	Schwarz criterion	3.945504
Log likelihood	-4662.188	Hannan-Quinn criter.	3.930087
Durbin-Watson stat	1.999700		

Appendix 4.52: Wald test: Oil price and Exchange rate

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	13.52353	(4, 2373)	0.0000
Chi-square	54.09413	4	0.0000

Null Hypothesis: C(1)=C(2)=C(3)=C(4)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	-0.394503	0.159367
C(2)	0.069517	0.036727
C(3)	-14.06815	2.227245
C(4)	1.778266	2.245808

Restrictions are linear in coefficients.

Appendix 4.53: Wald test: Oil price and Interest rate

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	3.796248	(4, 2373)	0.0044
Chi-square	15.18499	4	0.0043

Null Hypothesis: C(1)=C(2)=C(5)=C(6)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	-0.394503	0.159367
C(2)	0.069517	0.036727
C(5)	-3.001292	1.546768
C(6)	-1.322506	1.547639

Restrictions are linear in coefficients.

Appendix 4.54: Wald test: Oil price and Stock price

Wald Test:
Equation: Untitled

Test Statistic	Value	df	Probability
F-statistic	13.13559	(4, 2373)	0.0000
Chi-square	52.54235	4	0.0000

Null Hypothesis: C(1)=C(2)=C(7)=C(8)=0
Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
C(1)	-0.394503	0.159367
C(2)	0.069517	0.036727
C(7)	0.021811	0.003528
C(8)	0.005974	0.003568

Restrictions are linear in coefficients.