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DETERMINATION OF REAL EXCHANGE RATE: THE CASE OF MALAYSIA

BY

HOR LI GEAN
JOCELYN EO
NG LI KIAT
ONG YI HAN
TAN XUE YING

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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 17404 words.

Name of Student:	Student ID:	Signature:
1. Hor Li Gean	14ABB00506	____________________
2. Jocelyn Eo	14ABB00350	____________________
3. Ng Li Kiat	14ABB00111	____________________
4. Ong Yi Han	14ABB00683	____________________
5. Tan Xue Ying	14ABB00907	____________________

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TABLE OF CONTENTS

		Page
Copyright ……………………………………………………………………		ii
Declaration ……………………………………………………………………..		iii
Acknowledgements …………………………………………………………….		iv
Table of Contents ……………………………………………………………..		v
List of Tables ……………………………………………………………….		ix
List of Figures ………………………………………………………………		x
List of Abbreviations ………………………………………………………..		xi
List of Appendices …………………………………………………………..		xiv
Preface …………………………………………………………………………		xviii
Abstract ………………………………………………………………………		xix
CHAPTER 1	RESEARCH OVERVIEW	1
1.0	Introduction ………………………………………………..	1
1.1	Background of Research……………………………………….	1
1.2	Problem Statement …………………………………………..	5
1.3	Research Objective ……………………………………………	7
	1.3.1 General Objective ……………………………………..	7
	1.3.2 Specific Objective …………………………………….	8
1.4	Research Question …………………………………………..	8
1.5	Hypotheses of the Study ……………………………………	9
	1.5.1 Terms of Trade ……………………………………..	9
	1.5.2 Crude Palm Oil (CPO) Price ……………………….	9
	1.5.3 Productivity Differential ……………………………	10
	1.5.4 Real Interest Rate Differential ………………………	11
1.6	Significance of Study ………………………………………..	12
1.7	Chapter Layout …………………………………………….	13
1.8	Conclusion …………………………………………………….	13

CHAPTER 2 LITERATURE REVIEW 14
2.0 Introduction …………………………………………………… 14
2.1 Review of Literature ……………………………………….. 14
2.1.1 Terms of Trade ………………………………………. 14
2.1.2 Commodity Price …………………………………….. 17
2.1.3 Productivity Differential ……………………………... 19
2.1.4 Real Interest Rate Differential ……………………….. 21
2.2 Review of Relevant Theoretical Models ……………………. 23
2.2.1 Neary (1988) Model …………………………………. 23
2.2.2 Balassa-Samuelson Hypothesis ……………………… 24
2.2.3 Real Interest Rate Differential Models………………. 25
2.3 Proposed Theoretical Framework ………………………….. 27
2.4 Hypothesis Development …………………………………… 28
2.4.1 Terms of Trade ………………………………………. 28
2.4.2 Crude Palm Oil Price ………………………………. 29
2.4.3 Productivity Differential …………………………… 29
2.4.4 Real Interest Rate Differential …………………….. 30
2.5 Conclusion ....…………………….... 31

CHAPTER 3 METHODOLOGY 32
3.0 Introduction …………………………………………………… 32
3.1 Research Design …………………………………………… 32
3.2 Data Collection Method …………………………………….. 33
3.2.1 Data Source ………..…………………………………. 33
3.3 Sampling Design ……………………………………………. 34
3.3.1 Target Population ……………………………………. 34
3.3.2 Sampling Technique ………………………………… 35
3.4 Data Processing ……………………………………………... 36
3.5 Econometric Model ………………………………………… 37
3.6 Data Analysis ……………………………………………….. 38

3.6.1 Descriptive Statistics ……………………………….. 38
3.6.2 Diagnostic Checking ……………………………….. 38
3.6.2.1 Multicollinearity …..…..…..…..…..…..…..… 38
3.6.2.2 Normality ………………………………….……… 39
3.6.2.3 Autocorrelation ………………………………..…. 40
3.6.2.4 Heteroscedasticity …………………………… 41
3.6.2.5 Stability Test ………………………………… 42
3.6.3 Inferential Analysis ………………..…..…..…..…..… 42
3.6.3.1 Unit Root Tests…..…..…..……..…..…..…… 42
3.6.3.2 Johansen & Juselius Test ..……..…. ..…….. . 43
3.6.3.3 Vector Error Correction Model ..…….. . ..….. 45
3.6.3.4 Granger Causality ..…….. . ..…… ..…….. . .. 46
3.7 Conclusion ………………………………………………….. 47

CHAPTER 4 DATA ANALYSIS 48
4.0 Introduction ………………………………………………… 48
4.1 Descriptive Analysis …………………………………….... 48
4.2 Diagnostic Checking …………………………………….... 50
4.2.1 Multicollinearity ………………...……..………… 50
4.2.2 Normality Test ……………………………………. 51
4.2.3 Autocorrelation (Breusch-Godfrey Serial Correlation LM Test)…………………………………………… 52
4.2.4 Heteroscedasticity Test (White Test) ………………. 53
4.2.5 Stability test (CUSUM Test) ………………………… 55
4.3 Inferential Analysis ……………………..………………… 56
4.3.1 Unit Root Test …………………...…………………... 56
4.3.2 Johansen & Juselius (JJ) Cointegration Test ………… 60
4.3.3 Vector Error Correction Model ……………………… 63
4.3.4 Granger Causality Test ………………………………. 66
4.4 Conclusion ………………………………………………… 68

CHAPTER 5 DISCUSSION, CONCLUSION AND IMPLICATIONS 69
5.0 Introduction …………………………………………………….. 69
5.1 Summary of Statistical Analysis …………………………….. 70
5.2 Discussion of Major Findings ……………………………….. 74
5.2.1 Terms of Trade ………………………………………. 74
5.2.2 Crude Palm Oil Price ………………………………… 75
5.2.3 Productivity Differential ……………………………... 77
5.2.4 Real Interest Rate Differential ………………………. 78
5.3 Implication of Study …………………………………………. 80
5.3.1 Policy Makers ………………………......................... 80
5.3.2 Firm…………………… ……………………………. 81
5.3.3 Individuals …………………… …………………….. 82
5.3.4 Academician …………………………………………. 83
5.4 Limitations of study ………………………………………….. 83
5.5 Recommendations for Future Research ……………………… 84
5.6 Conclusion …………………………………………………… 86
References …………………………………………………………………… 87
Appendices ………………………………………………………………... 95

LIST OF TABLES

	Page
Table 3.1: Summary of variables used ……………………......……………………	33
Table 4.1: Descriptive analysis of all variables (2008Q1 – 2016Q4) …………	49
Table 4.2: Summary table of Variance Inflation Factor (VIF) ………………..	51
Table 4.3: Summary result of Normality test – Jarque Bera …………………...	52
Table 4.4: Summary result of Breusch-Godfrey Serial Correlation LM Test …	53
Table 4.5: Summary result of Heteroscedasticity White Test …………………	54
Table 4.6: Results of Unit Root Test (ADF) ……………………......……………	57
Table 4.7: Results of Unit Root Test (Phillips-Perron) ………………….........	58
Table 4.8: VAR lag length selection criteria ……………………......……………	61
Table 4.9: Johansen's cointegration tests results ……………………......………	62
Table 4.10: Overall fitness of the model ……………………......…………………	65
Table 4.11: Results of VEC Granger Causality/ Block Exogeneity Wald Test ..	66
Table 5.1: Summary table of diagnostic checking ……………………......………	70
Table 5.2: Summary of Vector Error Correction Model Test (Long run) ……..	71
Table 5.3: Summary of Vector Error Correction Model Test (Short run) …….	72
Table 5.4: VEC Granger Causality test ……………………......……………………	73

LIST OF FIGURES

	Page
Figure 1.1: CPO production in Malaysia from 1990 to 2016 ………………...	2
Figure 1.2: CPO price from 2008 to 2016 ……………...……………...……..	3
Figure 1.3: Malaysia nominal exchange rate from 1990M1 to 2017M1 …….	4
Figure 2.1: Proposed theoretical framework on the relationship between selected variables with real exchange rate. ……………...............	27
Figure 3.1: Data processing ……………...……………...……………...........	36
Figure 4.1: CUSUM Test ……………...……………...……………...………	55

LIST OF ABBREVIATIONS

ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criterion
AR	Autoregressive
BIC	Bayesian information criterion
BNM	Bank Negara Malaysia
BS	Balassa-Samuelson
CNLRM	Classical Normal Linear Regression Model
CPI	Consumer Price Index
CPO	Crude Palm Oil
CUSUM	Cumulative sum
DF	Dickey-Fuller
ECT	Error correction term
ESTAR	Exponential Smooth Transition Autoregressive
FCPO	Futures Crude Palm Oil
FOREX	Foreign exchange
FPE	Final prediction error
GDP	Gross Domestic Product
HQC	Hannan-Quinn Criterion
IFE	International Fisher Effect
IFS	International Financial Statistics

IMF	International Monetary Fund
JB	Jarque-Bera
JJ	Johansen & Juselius
KB	Koenker-Bassett
LM	Lagrange Multiplier
MPOB	Malaysia Palm Oil Board
MYR	Malaysian Ringgit
OLS	Ordinary Least Squares
PD	Productivity differential
PP	Phillips-Perron
PPP	Purchasing Power Parity
RER	Real exchange rate
RIRD	Real interest rate differential
RM	Ringgit Malaysia
RMB	Renminbi
SIC	Schwarz Information Criterion
THB	Thai Baht
TOL	Tolerance
TOT	Terms of trade
U.K.	United Kingdom
U.S.	United States
UIP	Uncovered Interest Parity
USD	United States Dollar

VAR	Vector Autoregression
VECM	Vector Error Correction Model
VIF	Variance inflation factor

LIST OF APPENDICES

Page

Appendix 4.1: Multicollinearity for LNCPO …....................................... 95

Appendix 4.2: Multicollinearity for LNPD..……………….............. 96

Appendix 4.3: Multicollinearity for LNTOT ……………….............. 96

Appendix 4.4: Multicollinearity for RIRD………..………….............. 97

Appendix 4.5: Normality test Jarque-Bera ………………….................. 98

Appendix 4.6: Autocorrelation- Breusch-Godfrey Serial Correlation LM Test.. 99

Appendix 4.7: Heteroscedasticity Test: White Test……………………… 100

Appendix 4.8: ADF Test for LNRER include intercept in level form.. 101

Appendix 4.9: ADF Test for LNRER include intercept and linear trend in level form ………………………………… 101

Appendix 4.10: ADF Test for LNRER include intercept in first difference form 101

Appendix 4.11: ADF Test for LNRER include intercept and linear trend in first difference form……………………... 102

Appendix 4.12: ADF Test for LNTOT include intercept in level form.. 102

Appendix 4.13: ADF Test for LNTOT include intercept and linear trend in level form……………………………….. 102

Appendix 4.14: ADF Test LNTOT include intercept in first difference form.. 103

Appendix 4.15: ADF Test for LNTOT include intercept and linear trend in first difference form……….................... 103

Appendix 4.16: ADF Test for LNCPO include intercept in level form 103

Appendix 4.17: ADF Test for LNCPO include intercept and linear trend in level form……………………..................... 104

Appendix 4.18: ADF Test for LNCPO include intercept in first difference form……………..…............................... 104

Appendix 4.19: ADF Test for LNCPO include intercept and linear trend in first difference form……........................... 104

Appendix 4.20: ADF Test for LNPD include intercept in level form.. 105

Appendix 4.21: ADF Test for LNPD include intercept and linear trend in level form……………….......................... 105

Appendix 4.22: ADF Test for LNPD include intercept in first difference form... 105

Appendix 4.23: ADF Test for LNPD include intercept and linear trend in first difference form……......................... 106

Appendix 4.24: ADF Test for RIRD include intercept in level form.. 106

Appendix 4.25: ADF Test for RIRD include intercept and linear trend in level form………………........................ 106

Appendix 4.26: ADF Test for RIRD include intercept in first difference form …... 107

Appendix 4.27: ADF Test for RIRD include intercept and linear trend in first difference form…............................. 107

Appendix 4.28: PP Test for LNRER include intercept in level form.. 108

Appendix 4.29: PP Test for LNRER include intercept and linear trend in level form………………………………… 108

Appendix 4.30: PP Test for LNRER include intercept first difference form……... 109

Appendix 4.31: PP Test for LNRER include intercept and linear trend in first difference form………..................... 109

Appendix 4.32: PP Test for LNTOT include intercept in level form.. 110

Appendix 4.33: PP Test for LNTOT include intercept and linear trend in level form……..………………………… 110

Appendix 4.34: PP Test for LNTOT include intercept in first difference form…... 111

Appendix 4.35: PP Test for LNTOT include intercept and linear trend in first difference form…………………….. 111

Appendix 4.36: PP Test for LNCPO include intercept in level form... 112

Appendix 4.37: PP Test for LNCPO include intercept and linear trend in level form…………….......................... 112

Appendix 4.38: PP Test for LNCPO include intercept in first difference form…………………………………… 113

Appendix 4.39: PP Test for LNCPO include intercept and linear trend in first difference form…………………….. 113

Appendix 4.40: PP Test for LNPD include intercept in level form... 114

Appendix 4.41: PP Test for LNPD include intercept and linear trend in level form…... 114

Appendix 4.42: PP Test for LNPD include intercept in first difference form……………………………………… 115

Appendix 4.43: PP Test for LNPD include intercept and linear trend in first difference form…………………… 115

Appendix 4.44: PP Test for RIRD include intercept in level form.. 116

Appendix 4.45: PP Test for RIRD include intercept and linear trend in level form……………………………… 116

Appendix 4.46: PP Test for RIRD include intercept in first difference form…... 117

Appendix 4.47: PP Test for RIRD include intercept and linear trend in first difference form…………………….. 117

Appendix 4.48: Var lag order selection criteria…………………………. 118

Appendix 4.49: Johansen & Jusellius Co-integration Test ……………… 119

Appendix 4.50: Vector Error Correction Model…………………………. 123

Appendix 4.51: Proxy system of LNRER equation in VECM model into OLS…... 125

Appendix 4.52: VEC Granger Causality………………………………… 126

Appendix 5.1.1: Malaysia's major export from 2008 to 2012…………… 128

Appendix 5.1.2: Malaysia's major export from 2013 to 2016…………… 129

Appendix 5.2: Crude Palm Oil Export from 1990-2016 in Malaysia…..... 130

Appendix 5.3: Crude oil prices ($/barrel) and crude palm
oil prices (RM/tonne) 130

Appendix 5.4: Malaysia's trading partners……………………………… 131

PREFACE

After Malaysia adopted managed floating exchange regime in 2005, Ringgit has been seen fluctuating frequently, especially during the episodes of mid-2008 subprime mortgage crisis and in 2016. During these two periods, Ringgit faced sharp depreciation against USD and this caused worry and uneasiness among individuals, business entities and government because they were impacted negatively by the effects of exchange rate fluctuation. Because of the importance of exchange rate, we are keen to know what factors, i.e., terms of trade, crude palm oil price, productivity differential and real interest rate differential, will affect the exchange rate in Malaysia and how much their magnitude of significance on the exchange rate is. By understanding these objectives, this can provide insight to all parties on the determinants of exchange rate in Malaysia.

ABSTRACT

This research attempts to investigate the relationship of the factors of exchange rate, such as terms of trade, crude palm oil price, productivity differential and real interest rate differential, with the real exchange rate in Malaysia. In the research, secondary data from 2008Q1 to 2016Q4 was collected from various databases and co-integration test and Vector Error Correction Model were employed to carry out the research. The results showed that in long run, terms of trade and crude palm oil price are statistically significant to the real exchange rate whereas productivity differential and real interest rate differential fail to show significance. Meanwhile, all variables are statistically important to real exchange rate in short run except for terms of trade, which is as predicted from the literature review. In the VEC granger causality test, only terms of trade do not granger cause the real exchange rate while crude palm oil price, productivity differential and real interest rate differential exhibit bi-directional and uni-directional causality respectively to the real exchange rate. Although this research has its own limitations, this study is still applicable for individuals, firms, government and academician on the relationship of these variables toward the real exchange rate of RM/USD.

CHAPTER 1: RESEARCH OVERVIEW

1.0 Introduction

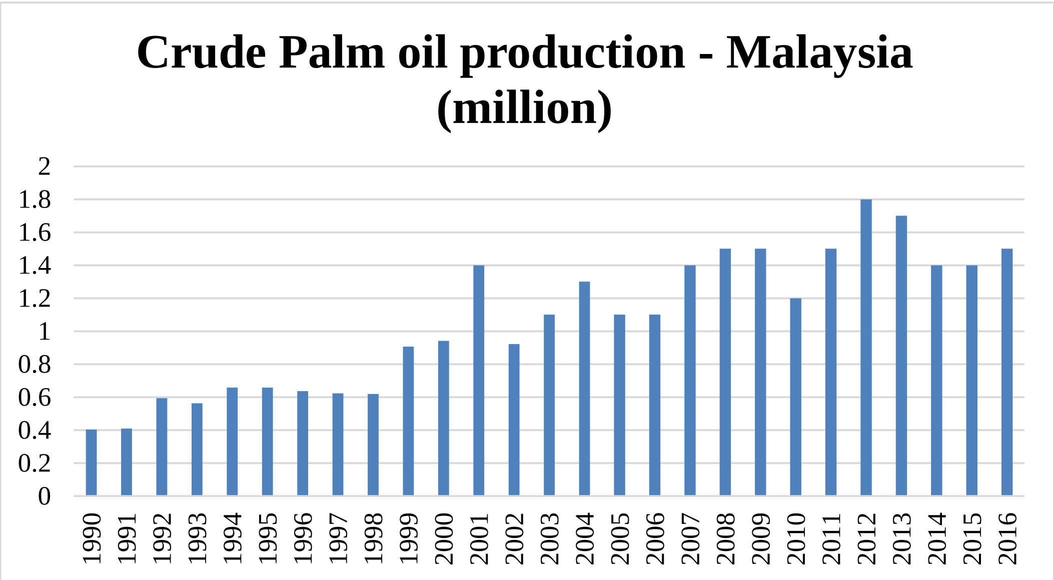
This research examines the relationship between real exchange rate and variables, such as terms of trade, crude palm oil price, productivity differential and real interest rate differential in Malaysia. Firstly, the study will highlight the background of Malaysia's economic situation and its exchange rate. Based on the research background, problem statement is identified for the study and research objectives as well as research questions are mapped out. Lastly, significance of the study will be discussed too.

1.1 Background of Research

Malaysia, a small and highly open economy, was well performed over the last few years and remained stable although the country faced slowdown in worldwide growth and exposed to commodity prices and financial market volatility. According to International Monetary Fund (IMF), Malaysia is the fastest growing economies among its neighbour countries despite the real gross domestic product (GDP) growth slowed down. The Malaysian economy grew by 5.6% in the first quarter of 2017, compared to 4.3% and 4.5% in the third and last quarter of 2016 respectively, which was above the market expectation. This contributed to the highest growth since the first quarter of 2015 (Bernama, 2017). Trade performance, on the other hand, was sustained with total trade of RM1.485 trillion, contributed by higher trade of RM10.09 trillion and RM6.87 billion with trading partners, such as China and United States respectively. Because of expansion of manufactured exports (electrical and electronic) by 3.2% and agricultural exports by 4.7%, they contributed to the export growth albeit a lower performance recorded in mining goods (Bernama, 2017).

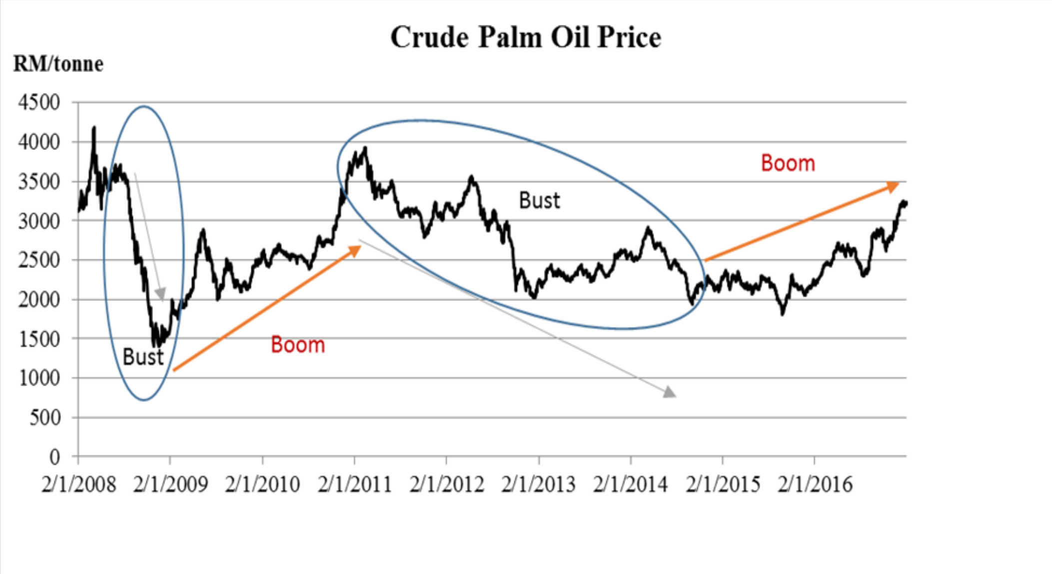
Besides, Malaysia's main commodity, crude palm oil (CPO) industry is looking more promising because of the higher worldwide demand for palm oil and strengthening of CPO price. According to leading vegetable oils analyst, Thomas Mielke, the global imports of vegetable oils are expected to be added by at least 3.0 million tonnes to meet the current demands (Puspadevi, 2017). This news is in fact favourable to Malaysia who is the second largest CPO producer in the world. Since 1990, production of CPO has now increased to four-fold amount in Figure 1.1 and constitutes about 40% of CPO global share after Indonesia.

Figure 1.1: CPO production in Malaysia from 1990 to 2016



Adapted from: Palm Oil Analytics

Figure 1.2: CPO price from 2008 to 2016

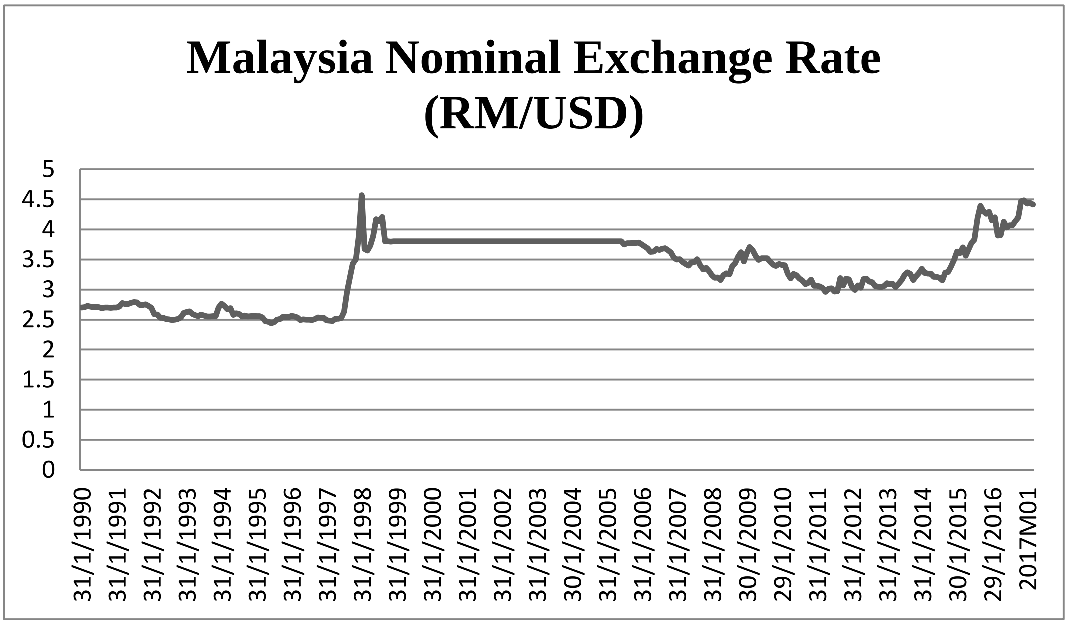


Adapted from: Bloomberg

After global financial crisis, CPO price in Figure 1.2 hit all-time high in 2011 because of growing demand from Malaysia's largest CPO importers like India and China (Malaysia Palm Oil Board, 2012), as well as the introduction of biodiesel as an alternative fuel for the crude oil (Johari et al., 2015). However, in 2011 to 2014, CPO price hit bottom because of export tax of CPO from Indonesia (Abdulla, Arshad, Bala, Noh, & Tasrif, 2014) and availability of cheaper substitution of vegetable oil, like soybean oil (Malaysian Palm Oil Council, 2013). After that, CPO price recovered and rose up again in 2016 because of weather problem which reduced the country's fresh fruit bunch production by about 20%-30%, leading to demand higher than supply subsequently. Because of the current high crude palm oil prices, March inflation rate hit an eight-year-high at 5.1% (Intan, 2017).

Since Malaysia is an export-dependent country with export contributing 71% of Malaysia GDP (Malaysia Country Risk Report, 2017), much of its revenue comes from export activities. If there is high exchange rate fluctuation in Malaysia, international trade and foreign direct investment would be negatively affected (Tsen, 2013). Therefore, maintaining the stability of exchange rate is important as it reflects the price competitiveness of a country. However, since ever Malaysia adopted managed float exchange regime, the currency has been fluctuating a lot against USD. Before 1972, Malaysia adopted fixed exchange rate regime by pegging Malaysia dollar to pound and changed to USD lately due to devaluation of pound. During Asian financial crisis, Malaysia imposed capital control and was forced to adopt fixed exchange rate regime that pegged MYR to USD at RM3.80/USD in September 1998 in order to stabilize the financial market. After 7 years of pegging towards USD, managed float exchange regime was adopted in July 2005 (Chan, Lye & Hooy, 2010). Since then, the exchange rate moves freely according to the market forces and Bank Negara Malaysia (BNM) intervenes only when there is large currency fluctuation in either direction to maintain the foreign exchange market's stability.

Figure 1.3: Malaysia nominal exchange rate from 1990M1 to 2017M1



Adapted from: Bloomberg

During the global financial crisis in the late 2008 in Figure 1.3, exchange rate was highly volatile and Malaysia suffered from capital flight since the second quarter of 2008. Capital flows had a large impact on the Ringgit stabilization. The exchange rate depreciated from RM3.46/USD in December 2008 to RM3.64/USD in March 2009, an approximately 5% loss of its value before recovering back in 2010 and 2011 to RM3.10/USD. However, this was short lived as the exchange rate of Malaysia started to depreciate at the end of 2014 from RM3.49/USD to as high as RM4.48/USD to end the year of 2016. Among the region, ringgit has performed the worst in that year and this becomes a major concern to individuals, firms, financial institutions and government. With depreciation of ringgit, households need to spend more to buy imported and domestic goods and this decreases their purchasing power while firms have to fork out more to buy imported materials, leading to higher costs to their products and lower profitability (Khoo, 2015). Meanwhile, Malaysian financial institutions and government could be worst affected too because of the high debt servicing cost from the appreciation of dollar as most of the debts are denominated in dollar (Langner, 2016). Given these adverse effects of exchange rate fluctuation, it becomes clear that exchange rate determination needs to be thoroughly studied in order to avoid such circumstances to Malaysia.

1.2 Problem Statement

Real exchange rate plays a vital role in investment decision and international trade because changes of it can affect foreign direct investment inflows and exports. When the exchange rate is volatile, it not only affects its host country, but its trading partners too, whereby this phenomenon is evident from Asian financial crisis and the global financial crisis. Because of that, the policy makers in developing countries are very concern on the exchange rate fluctuation as it can bring many problems to individuals, business and government (Afzal & Hamid, 2013).

After Malaysia adopted managed floating exchange regime in 2005, ringgit has since been fluctuating frequently and becomes the main centre of attention to consider in any decision making process. In just a decade, the ringgit faced sharp devaluation twice in mid-2008 and 2016. Because of mortgage crisis happened in United States in mid-2008, it created a global recession and hit Malaysia, causing a sharp loss of almost 6% of its value against USD in just six months' time. This created fear among all parties as they were impacted negatively by the sharp depreciation of Ringgit, but, fortunately, the effect was short-lived. However, in 2016, Ringgit Malaysia (MYR) becomes a hot topic again in the nationwide due to its sharp devaluation in domestic currency. Started in late 2014, MYR depreciated against USD and finally, on December 2016, it reached RM4.48/$, prompting shock and worry to the whole nation that another crisis similar to 2008 subprime mortgage crisis might strike again. However, crisis did not happen, but the exchange rate still hovers above RM4.20/$ as of now.

The sudden depreciation of MYR especially in 2016 becomes a main concern to the government because they play essential role in maintaining the stability of exchange rate. Government officials and experts believed that the ringgit was undervalued and did not reflect the true economy as the country's growth of 4.2% and 4% were better than expected for the first two quarters of the year (Bernama, 2016), yet the ringgit performance was not as expected. As a result, this becomes a puzzle to the government. To address this puzzle, we intend to determine the factors of real exchange rate in Malaysia in order to understand how the magnitude of the following macroeconomic variables can affect the real exchange rate.

Cashin, Cé spedes and Sahay (2004) mentioned that the fluctuations in international commodity prices are likely to affect the real exchange rate. In Malaysia case, most of the empirical literatures focus on how oil price affects the real exchange rate (Tsen, 2014; Basnet & Upadhyaya, 2015; Hussain, Zebende, Bashir & Donghong, 2017), but surprisingly, there are not much literature reviews done on the relationship between crude palm oil (CPO) price with real exchange rate except for Aprina (2014) in Indonesia. Among all the commodities, CPO has been one of Malaysia's major export commodities since 2008 and Malaysia constitutes 39% of global palm oil production and 44% of global exports (Nordin Nordin & Ismail, 2014). Given that the contribution of CPO to Malaysia's export is this huge, fluctuations of CPO price during boom and bust cycles can affect export earnings and add pressure to the country's current account and exchange rate. Therefore, to fill this gap, we intend to use CPO price as one of our main commodity factors of exchange rate. Other than CPO price, we have also included terms of trade, productivity differential and real interest rate differential as our macroeconomic factors because they are relevant to Malaysia, whose main dependence is on trade, is a rapid-growth developing country and is highly sensitive towards changes in the U.S. interest rates.

Hence, based on such economic conditions, it is appropriate to employ these four macroeconomic variables as determinants of real exchange rate in Malaysia.

1.3 Research Objective

1.3.1 General Objective

The objective of this research is to study the macroeconomic determinants of real exchange rate in Malaysia in order to understand how these factors can affect the exchange rate against USD.

1.3.2 Specific Objectives

1. To investigate the relationship between terms of trade and real exchange rate.
2. To investigate the relationship between CPO price and real exchange rate.
3. To investigate the relationship between productivity differential and real exchange rate.
4. To investigate the relationship between real interest rate differential and real exchange rate.

1.4 Research Questions

There are four research questions in this research:

1. Is there a relationship between terms of trade and real exchange rate?
2. Is there a relationship between CPO price and real exchange rate?
3. Is there a relationship between productivity differential and real exchange rate?
4. Is there a relationship between real interest rate differential and real exchange rate?

1.5 Hypothesis of the Study

1.5.1 Terms of Trade

H_{1a}: There is no relationship between terms of trade and real exchange rate in the long run.

H_{1b}: There is a relationship between terms of trade and real exchange rate in the long run.

H_{1c}: There is no relationship between terms of trade and real exchange rate in the short run.

H_{1d}: There is a relationship between terms of trade and real exchange rate in the short run.

H_{1e}: Terms of trade does not Granger cause on real exchange rate.

H_{1f}: Terms of trade does Granger cause on real exchange rate.

H_{1g}: Real exchange rate does not Granger cause on terms of trade.

H_{1h}: Real exchange rate does Granger cause on terms of trade.

1.5.2. Crude Palm Oil (CPO) Price

H_{2a}: There is no relationship between CPO price and real exchange rate in the long run.

H_{2b}: There is a relationship between CPO price and real exchange rate in the long run.

H_{2c}: There is no relationship between CPO price and real exchange rate in the short run.

H_{2d}: There is a relationship between CPO price and real exchange rate in the short run.

H_{2e}: CPO price does not Granger cause on real exchange rate.

H_{2f}: CPO price does Granger cause on real exchange rate.

H_{2g}: Real exchange rate does not Granger cause on CPO price.

H_{2h}: Real exchange rate does Granger cause on CPO price.

1.5.3. Productivity Differential

H_{3a}: There is no relationship between productivity differential and real exchange rate in the long run.

H_{3b}: There is a relationship between productivity differential and real exchange rate in the long run.

H_{3c}: There is no relationship between productivity differential and real exchange rate in the short run.

H_{3d}: There is a relationship between productivity differential and real exchange rate in the short run.

H_{3e}: Productivity differential does not Granger cause on real exchange rate.

H_{3f}: Productivity differential does Granger cause on real exchange rate.

H_{3g}: Real exchange rate does not Granger cause on productivity differential.

H_{3h}: Real exchange rate does Granger cause on productivity differential.

1.5.4. Real Interest Rate Differential

H_{4a}: There is no relationship between real interest rate differential and real exchange rate in the long run.

H_{4b}: There is a relationship between real interest rate differential and real exchange rate in the long run.

H_{4c}: There is no relationship between real interest rate differential and real exchange rate in the short run.

H_{4d}: There is a relationship between real interest rate differential and real exchange rate in the short run.

H_{4e}: Real interest rate differential does not Granger cause on real exchange rate.

H_{4f}: Real interest rate differential does Granger cause on real exchange rate.

H_{4g}: Real exchange rate does not Granger cause on real interest rate differential.

H_{4h}: Real exchange rate does Granger cause on real interest rate differential.

1.6 Significance of Study

Maintaining the stability of exchange rate has always been the main tasks of government and policy makers because high exchange rate fluctuations will affect a country's economic growth. To determine the macroeconomic factors associated with foreign exchange rate, this research would assist them in identifying the possible determinants of exchange rate in order to formulate proper policies to strengthen their economy. Given that the exchange rate fluctuations have important consequences for monetary policy, this research also offers insight to the central bank on the transmission between exchange rate and interest rate mechanism for them to stimulate proper inflation rate and growth in the country (Tsen, 2014; Andrieș, Căprarua, Ihnatova & Tiwaric, 2017).

Besides, this research also offers knowledge on the macroeconomic variables of exchange rate to assist exporters and importers in risk management decisions (Afzal & Hamid, 2013; Wong, 2015). By understanding the fundamentals of exchange rate, they can predict the movements of foreign exchange rate and avoid foreign exchange losses through appropriate hedging strategies, such as forward contract or futures, on foreign exchange market to mitigate the exchange rate fluctuations on their revenue.

Aside from that, individuals like investors and foreign exchange traders are very keen on a country's exchange rate movement because exchange rate can affect their investment portfolios. For investors, they prefer investment in a nation with stable exchange rate to decrease investment risk and avoid foreign exchange losses (Shaffer, 2016). Meanwhile, traders would like to forecast the movement of exchange rate to gain speculation and arbitrage profits (Hossfeld & Röthig, 2016). Therefore, this research would benefit these individuals to further improve their forecasting performance on exchange rate through the determinants.

Lastly, this research could be a platform for future researchers as reference. Since that there are limited studies on the role of crude palm oil in affecting the exchange rate in Malaysia, this research will offer more insight and understanding on their relationship and, thus, encourage further possible research in this area.

1.7 Chapter Layout

The research is made up of five chapters. Chapter 1 is an overview of the research background on Malaysia and its exchange rate, problem statement, research objectives, research questions, hypothesis and significance of the research. In chapter 2, a detailed literature review and theoretical models related to the real exchange rate determinants are provided. The theoretical framework and hypothesis development are also discussed in this chapter. Research design, data and methodology are explained in chapter 3 while chapter 4 will explain the results obtained from the processed data with graphs, tables and charts. Lastly, chapter 5 summarizes the major findings of the research and discusses implications, limitations and recommendations for this research topic.

1.8 Conclusion

This research is to investigate the macroeconomic determinants, such as CPO price, terms of trade, productivity differential and real interest rate differential on Malaysian real exchange rate. Further elaboration on the relationship between these variables will be discussed in chapter two.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

In this chapter, we are going to look at the literature review on the relationship between dependent variable (exchange rate) and independent variables, namely terms of trade, commodity prices, productivity differential and real interest rate differential. Initially, this chapter will present a layout of critical reviews on the past researcher's findings on these variables. After that, the relevant theoretical frameworks on the exchange rate will be discussed.

2.1 Review of Literature

2.1.1 Terms of Trade

Terms of trade could cause either income effect or substitution effect (Edwards & Wijnbergen, 1987). Changes in export price will trigger income effect. If export prices increases (decreases), local income will increase (decrease). Because of that, non-tradable's price will rise relatively to the exogenous price of tradable, leading to real exchange rate to appreciate because current account balance improves. Meanwhile, when the export price increases, this triggers substitution effect. Foreign demand starts to avoid local exports, resulting in a fall to the exports. Eventually, factors of productions from tradable shift to non-tradable. Consequently, the non-tradable price reduces and domestic currency weakens because of worsened trade. In short, the net effect of this variable with exchange rate is ambiguous, and thus, the empirical literature on explaining this variable on real exchange rate has remained mixed.

When Coudert, Couhard and Mignon (2015) looked at the commodity exporters, there is a positive long run relationship between the panel country's terms of trade and their real exchange rate, be they low-income, moderate or developed countries, but the positive relationship only last in the advanced economies in the short run. This is attributed by the pegged currency regime. Worry of floating regime, high intervention in foreign exchange and capital control are applied in developing countries, therefore mitigating the short run adjustments of their real exchange rates to fundamentals. They concluded that in high fluctuation regime, changes in the terms of trade become a positive factor of exchange rate variation.

Dauvin (2014), on the other hand, extended the study to include energy-exporting countries and also confirmed similar result as previous authors. He explained that the energy-dependent countries' currencies can be called as energy currencies because energy prices, reflected by the terms of trade, can explain largely on the real exchange rate. The author added that there is a point that the real effective exchange rate of the countries response to oil prices via terms of trade as evidenced by Tsen (2011) in Hong Kong and Japan. When oil market fluctuates highly, they become oil currencies because high movements in oil prices affects the terms of trade either through the imports' price or the exports' price. When the price of oil follows a downward trend, production and transportation costs are lowered for commodity producers, and improve terms of trade.

Similarly, Ricci, Milesi-Ferretti and Lee (2013) also found there is a strong positive long-run relationship between the real exchange rate and commodity terms of trade in advanced countries, but weaker in emerging markets. One unique of their studies is that they formulate it on the basis of the price of the main exported and imported commodities relative to a worldwide price index for manufactured goods because it is arguably less plagued by endogeneity problems and can reflect more on the commodity prices' role in driving real exchange rate.

However, Bouraoui and Phisuthtiwatcharavong (2015) and Bashir and Luqman (2014) disagreed because they found negative sign on the variable in Thailand and Pakistan respectively. The former argued that since terms of trade is a ratio between export price and import price for all commodity prices, it does not only contains trade between Thailand and the United States, but also trade with other countries too. Also, terms of trade's fluctuations normally show changes in the commodity prices rather than trade volume while Pakistan's result can be explained through substitution effect. When the price of exportable goods increases, the foreign demands on such goods decrease because it is being substituted by cheaper goods, thereby causing exports to decline and depreciation in real exchange rate.

In the context of three Asian countries, exchange rate in Hong Kong is found to be insignificantly affected by terms of trade whereas Japan and Korea show a positive relationship (Tsen, 2011). This can be explained through exchange rate regime. Since Hong Kong's exchange rate is closely monitored because of currency board arrangement, the terms of trade's impact on the real exchange rate is restricted in the fixed exchange regime, unlike the floating exchange regime which sees large impact of terms of trade in Japan and Korea.

2.1.2 Commodity Price

In commodity-dependent countries, fluctuations of world commodity price can affect the country's exports, income and inflation rates. Since commodity exports bring in foreign exchange, any fluctuation can directly impact exchange rate, which commonly dubbed as commodity currencies, for example, Chile (Hegerty, 2016) in the forex market. Generally, an increase of international commodity export price is always accompanied by appreciation of real exchange rate because more inflow of revenue into the country drives up the demand of domestic currency and then the exchange rate. Indeed, this phenomenon holds well in the past studies. Kohlscheen (2014) and Arezki, Dumitrescu, Freytag and Quintyn (2014) confirmed the importance of commodity prices in Brazil and South Africa respectively, while Kia (2013) and Choudhri and Schembri (2014) concluded that Canada, a producer of commodities, exhibits significant positive trend with commodity price index after 1990 because energy prices are an important component of the variable, likewise, to energy-exporting countries (Dauvin, 2014).

On the other hand, Bodart, Candelon and Carpantier (2015) added that with the effect of structural factors, i.e. flexible exchange rate regime, higher degree of financial openness and high trade openness; they can reduce the magnitude of the real exchange rate response (appreciation) toward a rise in commodity price in developing countries. When the exchange rate is flexible, the nominal exchange rate adjusts to offset the commodity price shocks, resulting in smaller response of real exchange rate toward the commodity price shock. When trade openness is high, this reflects lower non-tradable and more foreign-imported goods. Since non-tradable goods are very responsive to commodity price shock, smaller share of the non-tradable in the domestic market will have a smaller impact of commodity price shock, and eventually reduces the response of the real exchange rate. If the capital stock cannot increase in response to a positive commodity price shock, the domestic interest rate increases and the domestic wage rate increases by less than it would do if capital is freely mobile. This reduces the impact on the non-tradable good price and hence on the real exchange rate.

In Malaysia, oil industry and palm oil industry have been the main commodity industries in the country given their large share of commodity export volume among other commodities. In the empirical literature, oil price has been extensively studied as a factor in exchange rate determination. In line with result from Nusair and Kisswani (2014), Tsen (2014) also found positive co-integration between crude oil price with real exchange rate, but the former added that the relationship is more evident after incorporating structural breaks because of the dramatic crisis experienced. However, Basnet and Upadhyaya (2015) disagreed and argued that the sensitivity of exchange rate, inflation and economic growth are impacted by oil price fluctuations in short term only, and not in long run because in the impulse response function, much of the effect is absorbed within 5-6 quarters. This is because the effects are fully assimilated into the market and reach new equilibrium in long term, thereby signalling the macroeconomic stability. Hussain, Zebende, Bashir and Ding (2017) also confirmed that oil price affects the exchange rate in Malaysia, but the relationship is negative. When oil price increases, the cost of production also increases and this leads to non-competitive exports.

Despite the extensive studies on oil price variable, not much attention is focused on CPO price with exchange rate in Malaysia. In order to know how palm oil exports are affected by exchange rate risks, Sidek, Yusoff, Ghani and Duasa (2011) concluded that a good management of real exchange rate is needed to manage exports performance because Malaysia’s export will be bad when the real exchange rate appreciates. When the real exchange rate is overvalued, CPO exports decrease because they are now less competitive. At the same time, effect from global financial crisis is found to affect less on the commodity industry since food and agricultural commodities are just a small part of domestic expenditures.

In Malaysian stock market performance, Nordin et al. (2014) also agreed on the importance of CPO to the equity. They evidenced that an increase in the palm oil price will enhance the performance of the index in short run and long run, but Saiti, Ali, Abdullah and Sajilan (2014) could not find any presence of significant correlation and lead-lag relationship between the commodity price and exchange rate at all levels, suggesting that information of commodity returns is immediately absorbed into currency returns on day-to-day basis. Meanwhile, using simultaneous equation model on data from 1984 to 2011, Aprina (2014) managed to confirm that increase in CPO price brings appreciation of Rupiah's exchange rate, confirming positive impact of CPO price to Indonesia's exchange rate.

2.1.3 Productivity Differential

According to Balassa (1964) and Samuelson (1964), productivity differential in two economies can explain the deviation of real exchange rate. They explained that higher price of non-tradable is caused by higher productivity of tradable compared to non-tradable. As such, the real exchange rate appreciates. However, the empirical studies on the validity of Balassa-Samuelson (BS) hypothesis has provided mixed results.

Ricci et al. (2013) noticed that the relative productivity differential on real exchange rate in emerging and developed countries yield different results. They found no evidence of BS effect in advanced country, but significant evidence in emerging countries. This is because rapid-growth emerging countries have higher productivity of traded goods and their productivity growth has a greater variation than in advanced countries, thereby improving statistical testing ground. However, Camarero and Ordóñez (2012) disagreed. Using economy wide productivity measure to examine the $/£ exchange rate behaviour, there is significant confirmation of nonlinearity in the exchange rate adjustment to its productivity differential by ESTAR model, implying that the variable is enough to demonstrate the exchange rate's behaviour in a developed country, but, Tsen (2011) and Choudhri and Schembri (2014) found inconsistency of BS hypothesis in Hong Kong and Canada respectively.

Chowdhury (2012), on the other hand, supported that BS prediction is more pronounced among fast-growing economies. To fulfil BS hypothesis, there must be long run relationship and a positive impact. Among seven Asian countries (Bhutan, India, Pakistan, Sri Lanka, Maldives, Bangladesh and Pakistan), only Bangladesh showed sign of BS effect. This means that stage of development of a country is important in BS prediction because different country has different economy growth. In Malaysia, Tsen (2014) also evidenced that BS effect presents significantly just as Chowdhury's prediction on developing countries.

To clarify the mixed results on BS hypothesis, Choudhri and Schembri (2010) revisited the theory with a modified model which incorporates terms of trade mechanism. They show how the terms of trade's adjustment can alter the effect of productivity on real exchange rate. Finding implied that BS hypothesis is frail in that small changes in the elasticity within a plausible band can cause the productivity measurement on the real exchange rate be positive or negative as well as small or large. When there is productivity improvement in tradable sector, the supply of the goods increases, which then reduces the price of tradable goods, or export price. Consequently, terms of trade worsen and this negative effect offsets the positive BS effect, resulting in inconsistency of results.

Meanwhile, variation of trade costs over time also changes the impact of productivity on the real exchange rate (Bordo, Choudhri, Fazio & MacDonald, 2017). Since that their sample period includes major shifts in exchange rate regimes around four main sub-periods (classical gold standard, interwar, Bretton Woods and managed floating), the shift in the structural trade caused by changes in trade costs is found to account for the large variations of productivity differential effects across four different exchange regimes in 14 countries. When trade costs were high in the sub-sample period because of the implementation of trade restrictions, the sign contradicts with BS effect.

Another reason of the diverging results is because of the improper classification of sectors into tradable and non-tradable industries. Using GDP per capita as the productivity differential proxy can be misinformed because BS model studies on the long run real exchange rate movements in terms of traded-non-traded productivity growth, so the proxy used needs to have classification of industries into traded and non-traded to capture the country heterogeneity (Dumrongrittikul, 2012).

2.1.4 Real Interest Rate Differential

Interest rates are important to the exchange rate because any adjustments to the monetary policy can affect the exchange rate of a country. According to International Fisher Effect (IFE), interest rate affects exchange rate negatively. When the local interest rate increases, the domestic currency depreciates and exchange rate relative to another nation becomes bad. However, Byrne and Nagayasu (2008), Ozsoz and Akinkunmi (2012), Tsen (2014) and Adámek (2016) results are not consistent with IFE theory. Their findings revealed that increase in real interest rate differential leads to appreciation of real exchange rate. Because of high domestic interest rate, this would increase the attractiveness of domestic financial assets and enhance capital inflows (Wilson, 2014; Tafa, 2015). Despite that, Saraç and Karagöz (2016) cautioned that absence of evidence on higher short term interest rates worsening the exchange rate does not mean that high interest rates can defend the exchange rate because the perverse effect of higher interest rates on the exchange rate is still a theoretical matter.

In empirical literature, many authors have concluded that real interest rate differential have long run relationship with the real exchange rate (Beng & Ying, 2000; Alam Butt & Iqbal, 2001; Byrne and Nagayasu, 2008; Tang, 2011; Adámek, 2016). Byrne and Nagayasu (2008) and Tang (2011) suggested that structural break is very important in the real exchange-interest rate relationship because it can affect the co-integration test. Therefore, normal unit root and co-integration tests are not appropriate. To rectify this, Lanne, Lütkepohl & Saikkonen (2002) proposed approach of structural shifts in vector autoregressive (VAR) model to test long-run equilibrium. Also, presence of structural breaks is specific to country and uncommon across industrial countries (Byrne & Nagayasu, 2008). When Lanne et al. approach is applied, only did UK and Switzerland show co-integraton relationship compared to conventional co-integration test. This evidence confirms that structural shift may be uncommon across countries. While this condition holds in most industrial countries without consideration of structural breaks, they are important to certain countries such as Switzerland and UK.

Some authors also argued that countries cannot escape from the impossible holy trinity, meaning that the monetary authority fails to defend the exchange rate from the effect of domestic money supply because according to Isard's (1983), there appears to be a rope, in the form of interest rate differential, which connects the exchange rate to long-term current account position. This explains why there appears long run relationship between the variables in Malaysia and Cambodia (Beng & Ying, 2000; Tang 2011). In Romania, evidence of co-movement relationship between interest rates and exchange rates is also noted when using wavelet based analysis. In short term, the relationship between the variables is negative, confirming the sticky-price models, while in long term, the relationship is positive, indicating the PPP theory (Andries et al., 2015).

In contrast, Kohlscheen (2014) revealed that short or long term fluctuation in the Brazil's real exchange rate were not explained by the changes in the interest rate differential. The author explained that any attempt to include the variable in the model rendered counterintuitive signs because coincidentally, the long period of stable appreciation of the Real concurred with the unprecedented reduction of the interest rate differential. Similarly, Bouraoui & Phisuthtiwatcharavong (2015), who investigated on the determination of Thailand's exchange rate like Chow and Kim (2004) did, found that interest rate differential is not important to THB/USD exchange rate. This is because the economic conditions are difficult to predict and the central bank did not implement a suitable interest rate policy to manage the exchange rate.

2.2 Review of Relevant Theoretical Models

2.2.1 Neary (1988) Model

In commodity-exporting countries, terms of trade, which is reflected by commodity prices, usually explains the relationship between real exchange rates and commodity prices. The impact of terms of trade on the real exchange rate can be explained by two-sector (tradable and non-tradable sectors) models framework developed by Neary (1988) that demonstrates on how substitution and income effect to affect their relationship.

The real exchange rate is defined either externally by the relative price of the consumption basket between domestic country and abroad or internally as the relative price between the two sectors. In both situations, because of the law of one price on tradable, real exchange rate appreciates when the price of the non-traded goods increases relative to the tradable. In this model, an increase in the exported commodity price leads to appreciation of the real exchange rate through both substitution and income effect (Neary, 1988). Through substitution effect, supply of non-traded goods will reduce and then increases their price, pushing up the real exchange rate. Similarly, through income effect, the demand for non-traded goods increases which then contributes to the swelling of their relative prices as well. These effects, of course, assume that resources are used in the commodity sector and non-traded goods are normal goods, whose demand rises with income. However, if the tradable and non-tradable goods are complements, then, the indirect effect of improvement of terms of trade through the traded goods' price will lead to lower demand for non-traded goods and finally, a real exchange rate depreciation. Then, the net effect of terms of trade improvement is ambiguous unless the relative strength of the income effect and substitution effect are known.

2.2.2 Balassa-Samuelson Hypothesis

To examine the relationship between real exchange rate and its determinants, there is one popular and enduring explanation on how sectoral productivity changes affects the real exchange rate based on the well-known hypothesis of Balassa (1964) and Samuelson (1964). According to the basic version of the hypothesis, Balassa (1964) and Samuelson (1964) assumes that the purchasing power parity (PPP) holds for the traded goods. It predicts that the relative price of non-traded goods relative to traded goods. Price of non-traded goods will increase through the improvement in the relative productivity of traded to nontraded goods in a country with its trading partner, and thus, appreciate the local currency. Under the theory, it is assumed that there is technological progress in the home country's traded good sectors (especially manufactured goods and agricultural products) and no changes in foreign country. At the same time, labour is the only factor of production. The nominal wage, real wage and marginal product of labour will be raised in the home country's traded-goods sector when there is technical improvement in the home country. With unhindered labour mobility between sectors, the non-traded sector needs to increase the sector's nominal wage so that the labour force is maintained. As such, the prices would increase even if labour productivity in this sector remained relatively unchanged. Because of this, countries would experience a relative increase in their national price level and real exchange rate as countries experiencing higher rates of productivity growth in traded goods.

2.2.3 Real Interest Rate Differential models

Few models are available to explain the relationship between exchange rate and interest rate differential. The first model is flexible monetary exchange rate model by Frenkel (1976), who assumes that prices are perfectly flexible, which changes in expected inflation rate is reflected by changes in the nominal interest rate. When domestic interest rate increases relative to the foreign interest rate, demand for domestic currency drops, which causes it to depreciate instantly. Consequently, exchange rate worsens, thus there is negative relationship between nominal exchange rate and nominal interest rate differential (as cited in Frankel, 1979). Frenkel (1976) model is consistent with International Fisher Effect (IFE) theory as both indicate the same results.

The second model is introduced by Dornbusch (1976) that assumes that prices are sticky, at least in the short run. When there is an increase in the domestic money supply, domestic interest rate will fall and leads to capital outflow.

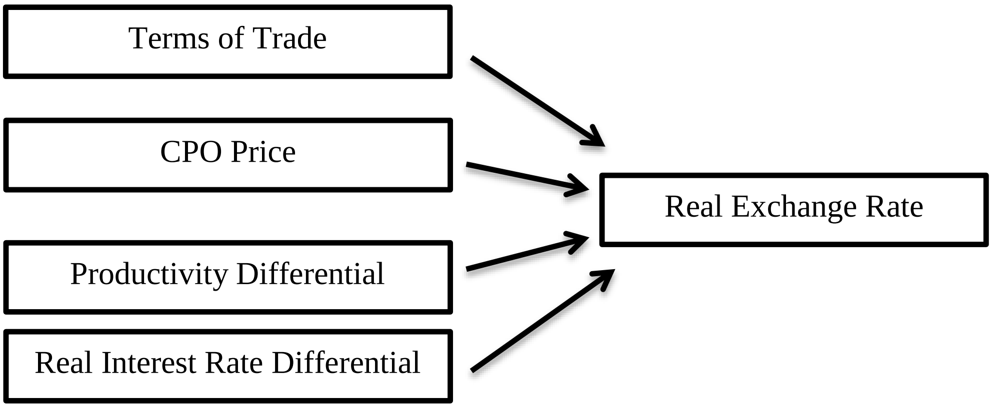
Consequently, domestic currency depreciates and overshoots its long run equilibrium level. Due to the depreciation of domestic currency, demand for domestic goods increases and this starts to drive up domestic prices, leading to appreciation of exchange rate. At the same time, an increase in the domestic price level leads to a rise in the domestic money demand and also domestic interest rate to maintain money market equilibrium. Moreover, excess money supply could lead to inflationary pressures. As a result, this will be reflected in a rise in interest rate and exchange rate would appreciate, thus there is a positive relationship between nominal exchange rate and nominal interest rate differential.

Frankel (1979) introduced real interest rate differential model that includes both flexible and sticky price model. It implies that exchange rate and nominal interest rate differential are negatively related while exchange rate and expected long run inflation rate differential are positively related. The exchange rate will differ from its equilibrium value by an amount which is same to the real interest rate differential, calculated by subtracting the expected inflation differential from nominal interest differential.

Three models above assume that Uncovered Interest Parity (UIP) and Purchasing Power Parity (PPP) are held constant. Firstly, UIP stated that the nominal interest differential between two countries should be equivalent to the expected spot exchange rate movement. Therefore, UIP implies that country with high interest rate should have depreciating currency thus leads to appreciation of exchange rate (Karahan & Çolak, 2012). Secondly, PPP is defined on the basis of law of one price, which indicates that the price of identical goods would be same in any given country. PPP holds when exchange rate adjusts to offset the inflation rate differential between two countries. Therefore, an increase in the relative price level of a country will lead to exchange rate depreciation relative to other country, keeping the relative price of similar goods the same across both countries (Madura, 2015).

2.3 Proposed Theoretical Framework

Figure 2.1: Proposed theoretical framework on the relationship between selected variables with real exchange rate.



Source: Developed for the research

Dauvin (2014) and Tsen (2011 found that energy prices and oil prices, reflected by terms of trade can explain largely on the real exchange rate. This shows that it is vital to include terms of trade as an independent variable especially in investigating the real exchange rate of export-dependent country, such as Malaysia (Tsen, 2014).

In Malaysia, the main commodity industries are oil industry and palm oil industry. According to Malaysia External Trade Development Corporation, both industries provide large share of commodity export volume among other commodities, so CPO price is included in our research. Besides, there are limited studies on the relationship between CPO price and real exchange rate in Malaysia.

According to Balassa-Samuelson (BS) effect, productivity differential is vital in explaining the relationship of real exchange rate (Chowdhury, 2012; Choudhri and Schembri, 2010). Ricci et al. (2013) found more evidence of BS effect on emerging countries compared to developed countries. The reason is because developing countries has higher productivity of traded goods and greater variation of productivity growth.

Real interest rate differential is one of the important variables in determining the relationship of real exchange rate in Malaysia as any changes in the monetary policy could affect the country's exchange rate (Tsen, 2014; Quadry, M. O., Mohamad, A., & Yusof, Y., 2017; Byrne and Nagayasu, 2008). Furthermore, domestic capital inflow and outflow is heavily determined by the domestic interest rate compared to foreign interest rate (Wilson, 2014; Tafa, 2015).

2.4 Hypothesis Development

Given that the real exchange rate used is a direct quote (RM/$), negative sign from the results refer to appreciation of exchange rate while positive sign refers to depreciation of exchange rate.

2.4.1 Terms of Trade

As mentioned in Neary (1988), terms of trade can bring either income effect or substitution effect. Income effect happens when there are changes in export price. When export prices increases, local income also increases, causing a rise in the non-tradable goods which then leads to real appreciation of exchange rate. At the same time, substitution effect can also come in when export prices increase. The higher export price will cause lower foreign demand on the local exports and shifts the factors of production from tradable sector to non-tradable sector. As a result, the non-tradable goods drop and domestic currency weakens because of worsened trade. Because of such offsetting effect, the relationship between terms of trade with real exchange rate can be ambiguous. Therefore, we expect that we could either obtain a positive or negative sign for this variable.

2.4.2 Crude Palm Oil Price

We expect to obtain a negative sign for CPO price with real exchange rate. This is because most of the empirical studies were able to evidence that commodity prices affect the real exchange rate positively. When the price of a commodity increases, there will be more inflow of currency to the home country from the export revenue, leading to appreciation of domestic currency (Kia, 2013; Aprina, 2014; Arezki et al., 2014; Choudhri & Schembri, 2014; Dauvin, 2014; Kohlscheen, 2014; Ashfahany & Priyatna, 2015; Hegerty, 2016).

2.4.3 Productivity Differential

Under Balassa-Samuelson hypothesis, labour is the only input in the production while technology is assumed to be constant (Balassa, 1964; Samuelson, 1964). When there is a wage hike in the home country's tradable sector, this effect will spill over to non-tradable sector too, causing the wage to rise to retain the workforce. As a result, the non-tradable goods experience an increase in price, leading to real exchange rate to appreciate. As such, the BS effect should bring appreciation to real exchange rate. Therefore, we expect to obtain a negative sign for this variable.

2.4.4 Real Interest Rate Differential

According to Frankel (1979) model, when the domestic money demand decreases due to tight money supply, domestic interest rate increases relative to foreign interest rate and causes inflation rate higher than expected. Thus, demand for domestic currency drop, leading to depreciation of domestic currency and exchange rate worsens. As a result, exchange rate and real interest rate differential is negatively related. This result also conforms to International Fisher Effect (IFE) theory. Therefore, we expect to get a positive sign for this variable.

2.5 Conclusion

This chapter highlights past empirical results on the relationship between independent variable (real exchange rate) with independent variables (terms of trade, crude palm oil price, productivity differential and real interest rate differential) and the relevant theoretical models that explain them. Then, the corresponding expected signs of the variables are determined before moving to next chapter on the data description and the methodology used.

CHAPTER 3: METHODOLOGY

3.0 Introduction

This chapter is about data collection method, research design, sample design which comprised of sampling technique and target population, data processing and data analysis. We selected crude palm oil, term of trade, productivity differential and real interest rate differential as independent variables while real exchange rate as dependent variable. Total data employed is 36 sample size from 2008Q1 to 2016Q4.

3.1 Research Design

This research paper is investigating the macroeconomic determinants of real exchange rate in Malaysia. This study covers the period from 2008Q1 to 2016Q4. Quantitative data is used in this research in which they are time series data and these secondary data is taken from Bloomberg, Department of Statistic Malaysia, Trading Economics and International Financial Statistics (IFS). These secondary data is used to investigate the relationship between the explanatory variable (real exchange rate) and response variables (CPO price, terms of trade, productivity differential and real interest rate differential), which is the objective of this research paper.

3.2 Data Collection Method

3.2.1 Data Source

This research study is using secondary data from 1st January 2008 to 31th December 2016 with quarterly basis. All variables which are real exchange rate, crude palm oil price, term of trade, productivity differential and real interest rate differential involves a total 36 observations. We are all using secondary data extracted out from different sources.

Table 3.1: Summary of variables used

Variable (s)	Proxy	Formula	Sources
(i) Dependent variable			
Real Exchange Rate	RER	$Nominal\ exchange\ rate \times \frac{CPI_{US,t}}{CPI_{M,t}}$	Bloomberg, IFS
(ii) Independent variables			
Terms of Trade	TOT	$\frac{\text{Malaysia export volume index}}{\text{Malaysia import volume index}}$	Department of Statistic Malaysia. Trading Economics
Crude Palm Oil	CPO	RM per metric tonne	Bloomberg
Productivity Differential (PD)	PD	$\log \frac{GDP_{M,t}}{Unemployment_{M,t}} - \log \frac{GDP_{US,t}}{Unemployment_{US,t}}$	IFS

Real Interest Rate Differential	RIRD	$(i_{M,t} - \pi_{M,t}) - (i_{US,t} - \pi_{US,t})$	IFS, Bloomberg

M = Malaysia , US = United Stated, t = time

Source: Developed for the research

Based on table 3.1, it shows all the sources used to extract the data. RER refers to a country's adjusted exchange rate to inflation rate. The nominal exchange rate of RM/$ is adjusted accordingly to inflation from Malaysia and United States to represent a country's price competitiveness. TOT is defined as amount of import goods an economy can purchase per unit of export goods and it is normally represented in index form (Tsen, 2011). CPO, one of the main commodities in Malaysia, is measured in domestic currency. PD refers to the productivity growth in a country, whether in tradable or non-tradable sectors. To represent this, Malaysia's productivity is compared with U.S.'s productivity differential in logarithm. Lastly, RIRD is the adjusted interest rate differential after taking inflation rate into account. Here, Malaysia uses money market rate while United States uses Federal fund rate to compare the interest rate differential between Malaysia and United States.

3.3 Sampling Design

3.3.1 Target Population

Purpose of this study is to investigate how macroeconomic factors affect Ringgit Malaysia against USD. All of the variables chosen are relevant to

Malaysia's economic conditions that are growing rapidly, i.e., term of trade, crude palm oil price, productivity differential and also real interest rate differential. Malaysia is the fastest growing economies among other neighbour countries because of good economic growth over the years. The expansion of manufactured exports and agriculture exports contributed much on the export growth (Bernama, 2017). In term of agriculture growth, Malaysia's main commodity, CPO, plays an important role for the expansion. It is one of the important components in determining the countries growth rate, thus, we include CPO as one of the independent variable in examining changes of exchange rate. Since Malaysia adopted managed float exchange regime, exchange rate has been fluctuating a lot, so every party is very concerned on such movement (Chen et al, 2010). Thus, our study is very important for those who expose to foreign exchange rate risk as we provide a clear study regarding exchange rate and factors affecting it. Moreover, this research will be useful to readers who are interested to know more about the performance of Ringgit after crisis since our research period is after 2007.

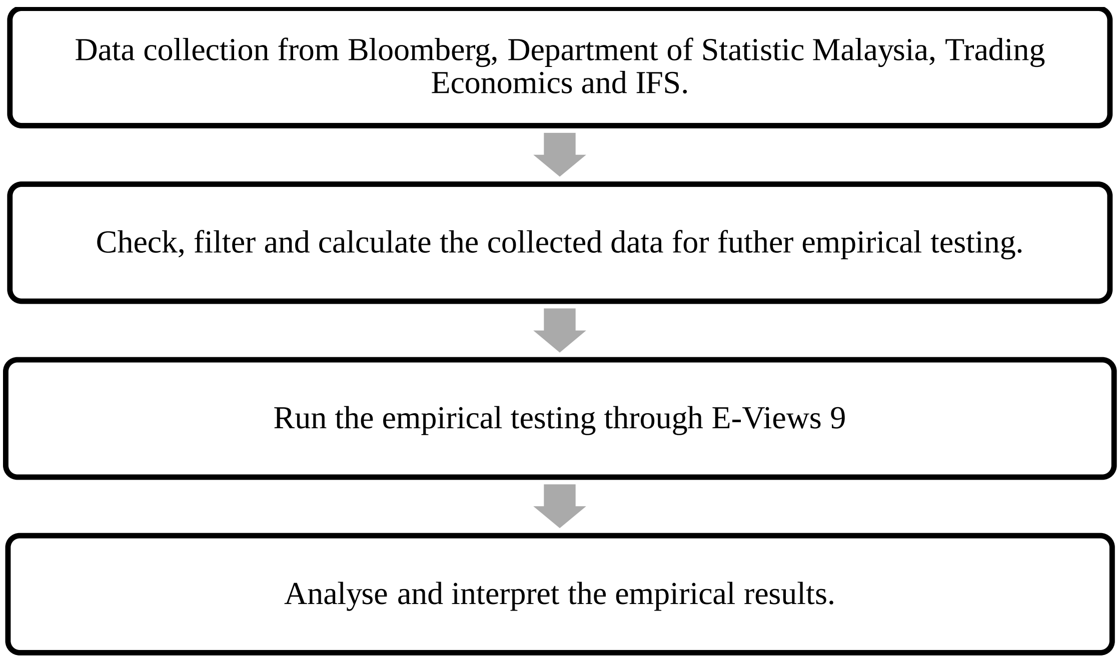
3.3.2 Sampling Technique

E-Views (Econometrics Views) is used for general statistical analysis and econometric analyses, such as cross-section and panel data analysis and time series estimation and forecasting. E-Views 9 is used in this research paper. E-Views 9 is a simple and powerful tool to be used for data analysis and evaluation, regression, forecasting, and simulation. E-Views 9 is able to perform data analysis (mean, median, standard deviation), diagnostic checking (autocorrelation, heteroscedasticity, multicollinearity, normality test), and co-integration testing (stability test, unit roots test, Johansen test and VECM) ("EViews 9 Overview", n.d.).

3.4 Data Processing

Data used in this research paper is collected from Bloomberg, Department of Statistic Malaysia, Trading Economics and IFS. The data collected are real exchange rate (nominal exchange rate of Malaysia, CPI of Malaysia and US), terms of trade of Malaysia, CPO price, productivity differential (GDP and unemployment for Malaysia and US), and real interest rate differential (interbank money market rate of Malaysia, federal fund rate of US and inflation rate of Malaysia and US). The data will be checked, filtered and calculated for further empirical analysis. The empirical testing will be conducted through E-Views 9.

Figure 3.1: Data Processing



Source: Developed for the research

3.5 Econometric Model

This research designs to examine the changes of exchange rate by using Ringgit Malaysia against United State Dollar (USD) as dependent variable (y_t) and involves four independent variables which are term of trade (x_1), crude palm oil price (x_2), productivity differential (x_3) and real interest rate differential (x_4).

The estimated regression model is given as below:

$$y_t = \alpha + \beta_1 x_{1t} + \beta_2 x_{2t} + \beta_3 x_{3t} + \beta_4 x_{4t} + \mu$$

$$\log RER_t = \alpha + \beta_1 \log TOT_t + \beta_2 \log CPO_t + \beta_3 \log PD_t + \beta_4 RIRD_t + \mu$$

N=36

Where,

$\log RER_t$ = *In* of real exchange rate of MYR against USD at period t

$\log TOT_t$ = *In* of term of trade at period t

$\log CPO_t$ = *In* of crude palm oil price at period t

$\log PD_t$ = *In* of productivity differential at period t

$RIRD_t$ = Real interest rate differential at period t

3.6 Data Analysis

3.6.1 Descriptive Statistics

Descriptive statistics show the summary of the measure and sample. The objective of the descriptive statistic is used to summarize data which contains kurtosis, skewness, standard deviation, minimum, maximum, median and mean for analysis. According to Gujarati (2004) mode, median and mean are the three measures of central tendency of a random variable. Maximum represents the largest number while minimum represents the smallest data in a dataset. Variance with square root will be standard deviation. Skewness measures about the symmetry in a distribution while kurtosis measures about the size of the tails.

3.6.2 Diagnostic Checking

3.6.2.1Multicollinearity

Multicollinearity may be defined as the situation where there is perfect or nearly perfect linear relationship between the explanatory variables. In other words, multicollinearity occurs when the explanatory variables are highly correlated. When the regressors are highly correlated, they are mostly conveying similar information.

Multicollinearity causes misleading of high individual p-value, even though the variable is important. In fact, a low p-value indicates that the independent variable significantly improves the fitness of the model. Multicollinearity causes wider confidence intervals on the regression coefficients. This will affect the confidence of independent variable in appreciating or depreciating dependant variable. The wide confidence intervals also will cause the action of excluding or adding a variable may alter the coefficients and their sign significantly (Paul, 2006).

Multicollinearity is the matter of degree, not about presence or absence. There is no certain tests for testing the multicollinearity, however variance inflation factor (VIF) and tolerance (TOL) are known as the indicator of multicollinearity. When VIF is close to 10, it indicates that the independent variables have perfect or nearly perfect multicollinearity. When TOL is close to zero, it means that there is perfect or nearly perfect multicollinearity. TOL is the inverse of the VIF (Gujarati, 2004).

$$\mathrm{VIF} = \frac{1}{1 - R_j^2}$$

$$\mathrm{TOL} = \frac{1}{\mathrm{VIF}_j} = 1 - R_j^2$$

3.6.2.2 Normality Test

Normality test is applied to test whether the data set follows a normal distribution and is in a bell-shaped curve or does not involve in normal distribution. This testing is important as normally distributed allows a precise distribution characteristic. OLS holds assumption that the error term is in normal distribution and the Classical Normal Linear Regression Model (CNLRM) assumes constant variance, independent and zero mean value of error term. Jarque-Bera (JB) test of normality is a method that based on OLS residuals. It requires a large sample size and also includes the kurtosis coefficient and skewness coefficient into Jarque-Bera formula. Skewness is used as a measurement in measuring the asymmetry of probability distribution while kurtosis is to measure the tallness of distribution in regard to a normally distribution data set (Gujarati, 2004). Test statistic of JB test:

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

N= sample size, S= skewness coefficient, K = kurtosis coefficient

3.6.2.3 Autocorrelation

$$\mathrm{cov}(\mu_i, \mu_j) = 0 \text{ or } \mathrm{E}(\mu_i\mu_j) = 0 \quad i \neq j$$

Autocorrelation or serial correlation may be defined as the disturbance of observation being correlated with other disturbance of observations ordered in times series data or cross sectional data (Gujarati, 2004). Autocorrelation is occurred mostly in times series but not cross sectional data. In the random sampling assumption, it assumes that there are different error terms for the observations in cross sectional data because of the independent conditional on the explanatory variables in the sample (Wooldridge, 2013). Presence of autocorrelation will lead to unbiased and consistent of the OLS estimators, inefficient and underestimated. The famous test used in detecting autocorrelation is Durbin-Watson test. Durbin-Watson test is used to detect the first order of autocorrelation problem of the regression equation. However, we will be using Breusch-Godfrey test instead of Durbin-Watson test in autocorrelation testing because it is difficult for time series model for assuming its regressors as non-stochastic, which means observations on explanatory variables are fixed in repeated samples. Breusch-Godfrey test (LM test) is based on Lagrange Multiplier principle. The test allows for (1) non-stochastic independent variables, such as the lagged values; (2) higher-order autoregressive models, such as AR(1), AR(2); and (3) simple or higher-order moving averages of white noise error terms.

3.6.2.4 Heteroscedasticity

When variances in a regression are not constant, there are either heteroscedasticity or homoscedasticity. Heteroscedasticity is possible to arise in both times series data and cross section data (Greene, 2002). However, according to Gujarati (2004), it is more likely to occur in cross sectional data compared to time series data. This condition could arise due to certain reason, for example, the presence of outliers and whenever assumption of CLRM doesn't hold. In addition, some other sources of heteroscedasticity such as incorrect data transformation and incorrect functional form are also factors for this problem. There are some test of heteroscedasticity such as Koenker-Bassett (KB) test, park, Breusch-Pagan-Godfrey and also White test. Each test based on certain assumption. For example, KB test is based on squared residuals. While for Breusch-Pagan-Godfrey test, left hand side of the regression will be placed with squared ordinary residuals as variable and the right hand side variables will be placed with those variables which need to be estimated (Breusch & Pagan. 1979).

3.6.2.5 Stability Test

Stability test applies to determine structural break and also the stability of error correction model. CUSUM of square test which stands for OLS method is very common nowadays as their calculation is easy (Ploberger & Kramer, 1992). Cumulative sum test used to show if coefficients of regression are changing systematically while cumulative sum of square test is applied to show if coefficients of regression changing suddenly. However, this testing is not perfect. If serial correlation problem occur in the data set, the result of CUSUM about model stability will be insufficient and misleading. Thus, there are different types of estimator to determine the stability of the model, for example, CUSUM and CUSUMQ. They are all function to determine the stability of model but in different condition. For instance, whenever a data set meets structural break or constant term, CUSUM test will be a good estimator compared to CUSUMQ test (Andrew, 1993).

3.6.3 Inferential Analysis

3.6.3.1 Unit Root Tests

The purpose of unit root test or so called stationary test is to test whether the time series variable is stationary or non-stationary. Inclusion of non-stationary data may lead to bias regression because when standard regression is used on non-stationary data, the result is valueless despite there is high R^2 and significant t ratio. Not only that, use of non-stationary data will make the standard assumptions for asymptotic analysis to be invalid, which means the t-ratios will not follow t-distribution, and F-statistic will not follow F-distribution (Brooks, 2008).

The common unit root tests will be Augmented Dickey-Fuller (ADF) unit root test and Phillips-Perron (PP) unit root test. ADF and PP test are to test whether the data are stationary in which level, or integrated in which level, such as first differences or second differences, i.e. I(0), I(1), I(2). The ADF test revises the DF test to overcome the possibility of serial correlation in the error terms by adding the lagged dependent terms, while PP test excludes the lagged difference terms. ADF test and PP test usually carry out the same conclusion; however, PP test is having a more complicated calculation of test statistic. Therefore, ADF test may be a better test as compared to PP test (Gujarati, 2004).

Hypothesis of the tests are as followed:

H_0: There is no serial correlation.

H_1: There is a problem of serial correlation.

3.6.3.2 Johansen & Juselius Test

After the stationary level or integrated order of independent variables have been classified, they are possible to build up a meaningful model that may lead to stationary relations among the variables, so that the model is predictable and forecastable. Co-integration testing is a necessary step to build an empirically meaningful relationship.

Johansen test is a superior test for co-integration. Johansen test is a VAR based test (Sjö, 2011). Johansen test needs an appropriate lag length in order to proceed. Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC) will be the most common use of lag length selection (Ozcicek & McMillin, 1999). Both AIC and SIC can be used to compare the in-sample and out-sample forecasting performance of a model (Gujarati, 2004). VAR model offers a very rich structure and able to capture more features of the data. VAR model can be further extended to include first difference terms and co-integrating relationships which is a vector error correction model (VECM) (Brooks, 2008). Johansen test can detect all co-integration relations existed in the system compared to older methods to determine the long run relationship between variables (Johansen & Juselius, 2009). In Johansen test, there is two testing statistic, which are trace statistics and maximum eigenvalue statistic (Johansen, 1991).

Hypothesis of trace statistics:

H_0: There are at most r cointegrating relations.

H_1: There are more than r cointegrating relations.

Hypothesis of maximum eigenvalue statistic

H_0: There are r coinegrating relations.

H_1: There are r+1 cointegrating relations

3.6.3.3 Vector Error Correction Model

Vector error correction model (VECM) is a testing instrument that reparameterized from VAR model with the objective to interpret co-integrating relationship about a data set. It is suitable to use in a set of variables with more than 1 cointegrating vectors. The concept of cointegration can be say is when a data set with linear combination of I (0) exists in a set of I (1) time series variables, the I(1) time series variables is then cointegrated (Killian & Lutkepohl, 2016).

ΔZt = Γ1 ΔZt-1 + …+ Γk- 1 ΔZt-k-1 + ΠZt-1 + μ + εt; t =1, …,T

Wald χ^2 , T and F test in VECM is performed to indicate econometric exogeneity of the dependent variables. VECM approach allows user to distinguish long run and short run Granger causality, for example, F test and Wald χ^2 in VEC model are mainly applied to examine short run causal effects of the data set, while T test of the lagged error-correction terms is used to indicate the long run causal relationship (Masih & Masih 1997). The reason researchers choose to apply VEC model is because of the efficiency gains and accuracy in estimating the reduced-form VAR model, when VECM is correctly specified. Moreover, one of the advantages of VECM is that VECM facilitates the imposition of restriction on the long run effects of structural shock in VAR model, which extends the range of identifying assumption used for the structural impulse response analysis (Killian & Lutkepohl, 2016). Error correction model is started with a not equilibrium and univariate quantity of x.

$$Z_t = \alpha' x_t$$

Supposedly, if x_t is a vector of economic variables, it is said to be equilibrium with equation $\alpha' x_t = 0$. However, in most of the time, x_t will not be equilibrium, it will form a equilibrium error with equation $Z_t = \alpha' x_t$. When equilibrium error occurred, error-correcting model will be used to correct the data by allowing long run components of variables to follow equilibrium constraints and perform a flexible dynamic specification in short run (Engle & Granger, 1987).

3.6.3.4 Granger Causality

Granger Causality is a test that applies to determine the relationship between variables. It is used to examine the causality between variables, but it cannot prove the direction of influence and causality towards the other variables. A unit root test must be performed to examine all the variables are stationary as to conform to the fulfilment of assumption of Granger causality test. Moreover, error term involved must be independent and uncorrelated to other variables to prevent bias. If the error term is correlated to other variables, transformation of the error term must be carried out (Gujarati, 2004). Block Exogeneity Wald tests is used to determine the causal relationship among all the variables. Under this system, an exogenous can be treated as endogenous and the test will let one knows which variables are exogenous and which variables are endogenous. In doing test statistic of Granger causality, Chi-square test is used. If Chi-square test > critical value, the null hypothesis will be rejected (Dasgupta, n.d).
Hypothesis of the test is as followed:

H_0: X does not Granger cause on Y
H_1: X does Granger cause on Y

And

H_0: Y does not Granger cause on X

H_1: Y does Granger cause on X

3.7 Conclusion

In summary, the research involves studying the terms of trade, CPO price, productivity differential and real interest rate differential against exchange rate of RM/$. All the data are obtained from Bloomberg, Department of Statistics Malaysia, IFS and Trading Economics. Overall, the sample size is 36 from 2008Q1 to 2016Q4 for the following tests: multicollinearity, normality, autocorrelation, heteroscedasticity, stability test, unit root test, Johansen test, VECM and Granger causality test. The tests will be carried out using E-Views 9 and the empirical results will be discussed in detail in Chapter 4.

CHAPTER 4: DATA ANALYSIS

4.0 Introduction

In this chapter, the description and interpretation of the empirical results will be carried out. All the results are computed through the software of E-views 9. Firstly, diagnostic checking, such as multicollinearity, normality (Jarque-Bera), autocorrelation (Breusch-Godfrey Serial Correlation LM Test), heteroscedasticity test (White Test) and stability test (CUSUM Test), will be reviewed before proceeding to co-integration test (Johansen & Juselius Test and Vector Error Correction Model). A precise and fully description on these tests will be presented.

4.1 Descriptive Analysis

In explaining the general pattern, trend and basic features of data collected, a descriptive statistics which included the mean, median, maximum, minimum, standard deviation, skewness and kurtosis is used in the analysis. The analysis included the dependent variable and independent variable from 2008Q1 to 2016Q4 as shown in Table 4.1.

Table 4.1 Descriptive Analysis of All Variables (2008Q1 – 2016Q4)

Variables	Obs	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis
LNRER	36	1.2174	1.1828	1.4504	1.1020	0.0956	0.9795	3.0647
LNTOT	36	4.6250	4.6255	4.7247	4.5444	0.0430	0.0083	2.3832
LNCPO	36	7.8526	7.8066	8.2318	7.3963	0.1830	0.2174	2.7949
LNPD	34	-1.8203	-1.7954	-1.7269	-2.0199	0.0802	-1.0339	2.9498
RIRD	36	1.8873	2.0750	4.7700	-2.6500	1.5353	-1.0635	4.1852

Notes: 1. No. of observation for eight years = 36. 2. LNRER = ln of exchange rate of MYR against USD; LNTOT = ln of terms of trade; LNCPO = ln of crude palm oil price per metric tonne in MYR; LNPD = ln of productivity differentials; RIRD = Real Interest Rates Differentials

Source: Developed for the research

According to the Table 4.1, crude palm oil price shows the highest value of the mean value (7.8526) while the lowest mean is productivity differential (-1.8203). This indicates that the crude palm oil price in Malaysia shows the highest level while productivity differential gives the lowest level among the variables. When it comes to median value, crude palm oil price still shows the highest value (7.8066) and productivity differential also shows the lowest level (-1.7954). As for minimum and maximum point of variables, crude palm oil again have the highest value at 7.3963 and 8.2318 respectively whereas the productivity differential has the lowest minimum (-2.0199) and maximum (-1.7269) point among the variables.

In standard deviation, real interest rate differential has the highest standard deviation value of 1.5353 while terms of trade has the lowest value at 0.0430. The skewness analysis indicates that most of the variables are positively skewed except for productivity differentials and real interest rate differentials which are negatively skewed, but for terms of trade, the distribution is approximately symmetric given the skewness value is very small at 0.00828. Besides, the kurtosis analysis shows that real interest rate differential has the highest kurtosis value (4.1852), which called leptokurtic, because the value exceeds 3. On the other hand, terms of trade shows the lowest kurtosis value (2.3832), or also known as platykurtic, as the value is less than 3.

4.2 Diagnostic Testing

4.2.1 Multicollinearity

Multicollinearity happens when the explanatory variables in a multiple regression model are highly correlated. There is no certain test to detect multicollinearity problem, but Variance Inflation Factor (VIF) can be used as an indicator to test multicollinearity. Variance Inflation Factor (VIF) is defined as:

$$\text{VIF} = \frac{1}{1-R^2}$$

Table 4.2: Summary table of Variance Inflation Factor (VIF)

(Refer to Appendix 4.1-4.4)

Variables	R^2	$(1-R^2)$	VIF	Result
LNCPO	0.3621	0.6379	1.5677	No serious multicollinearity problem
LNPD	0.1170	0.8830	1.1326	No serious multicollinearity problem
LNTOT	0.1793	0.8207	1.2185	No serious multicollinearity problem
RIRD	0.3234	0.6766	1.4779	No serious multicollinearity problem

Source: Developed for the research

Table 4.2 shows the result of Variance Inflation Factor (VIF) for LNCPO, LNPD, LNTOT and RIRD. The VIF figures for each independent variable are less than 10, which indicate that there is no serious multicollinearity problem occurred.

4.2.2 Normality Test

Normality test is used to determine whether the data set is normally distributed. The test would be unreliable if the error term is not normally distributed. We used Jarque-Bera test to detect whether the error term is normally or not normally distributed. The null and alternative hypothesis are as follow:

H_0: Error term is normally distributed

H_1: Error term is not normally distributed

This means that if p-value is less than 1%, 5% or 10% significance level, there is enough evidence to reject the null hypothesis. In other words, the error term is not normally distributed.

Table 4.3: Summary result of Normality test- Jarque-Bera

(Refer to Appendix 4.5)

Jarque-Bera Test	p-value	Decision
0.4449	0.8006	Normally distributed

Source: Developed for the research

From Table 4.3, the p-value is 0.8006 which is greater than 10% significance level. Therefore, we have not enough evidence to reject the null hypothesis, meaning that the error term is normally distributed.

4.2.3 Autocorrelation (Breusch-Godfrey Serial Correlation LM Test)

Autocorrelation happens when the error term of observations are correlated with other error term of observations and this problem mostly occurred in times series data. Therefore, it is imperative to conduct autocorrelation test to avoid spurious results. In this paper, Breusch-Godfrey Serial Correlation LM Test has been chosen to detect autocorrelation problem.

Table 4.4: Summary result of Breusch-Godfrey Serial Correlation LM Test (Refer to Appendix 4.6)

F-statistic	1.4287
Obs*R-squared	4.3840
Prob. Chi-Square(2)	0.1117

Source: Developed for the research

H_0: There is no autocorrelation problem.

H_1: There is autocorrelation problem.

In Table 4.4, the p-value obtained is 0.1117 which is greater than 10% significance levels. In the hypothesis for this test, the null hypothesis will not be rejected because p-value is more than 1%, 5% and 10% significance level. This means that there is autocorrelation problem. Thus, we do not have enough evidence to reject the null hypothesis. In short, our model has no autocorrelation problem.

4.2.4 Heteroscedasticity Test (White Test)

Heteroscedasticity occurs when the variance of a variable is not constant over time. This problem could occur due to the presence of outliers, or incorrect functional form or data transformation and lead to misleading result. As a result, the regression is no longer assumed to be best, efficient, unbiased and efficient. Hence, we choose to apply White Test to detect this problem in our model.

Table 4.5: Summary result of Heteroscedasticity White Test

(Refer to Appendix 4.7)

F-statistic	0.6677
Obs*R-squared	8.5951
Prob. Chi-Square(11)	0.6592

Source: Developed for the research

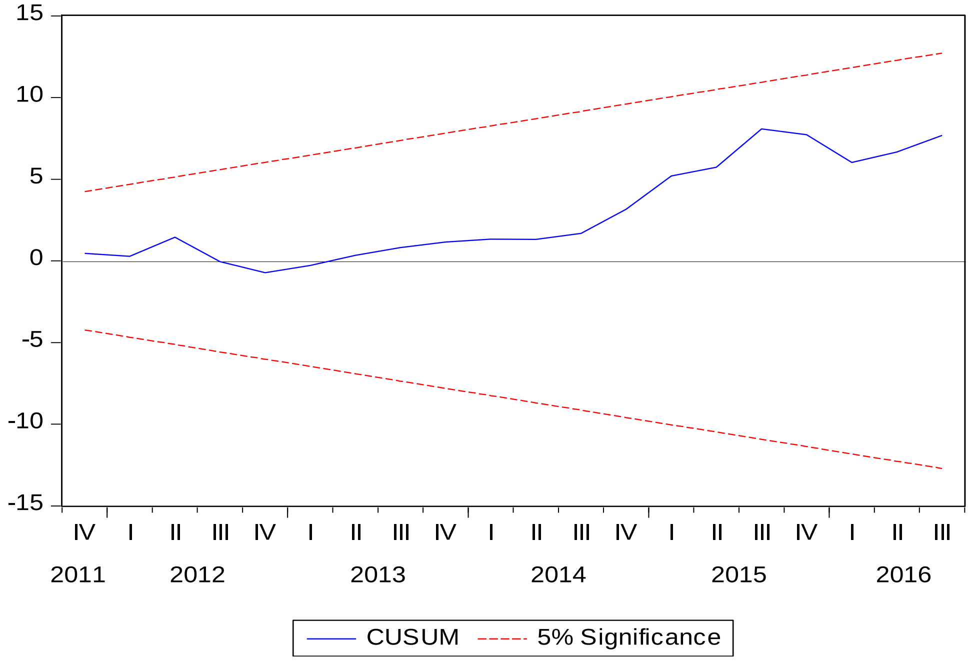
H_0: There is no heteroscedasticity problem.

H_1: There is heteroscedasticity problem.

In Table 4.5, our p-value (0.6592) is greater than 10% significance level. Hence, we do not have enough evidence to reject the null hypothesis. This means that the model has no heteroscedasticity problem.

4.2.5 Stability Test (CUSUM Test)

Figure 4.1: CUSUM Test



CUSUM test is used to ensure the stability of the coefficient. The figure 4.1 shows the cumulative sum of deviation of each sample value from the target value. A minor shift in the process mean will lead to gradually increasing or decreasing of the cumulative sum of deviation value. As shown in the figure above, CUSUM line does not cross either upper or lower 5% significance critical lines, thus the coefficients are considered as stable and this concludes that the model is stable.

4.3 Inferential Analyses

4.3.1 Unit Root Test

Before running the co-integration analysis, unit root test on all the variables are carried out to investigate the stationarity properties of the variables. Using Augmented Dickey Fuller (ADF) and Philips Perron (PP), they are conducted in levels and in first difference. The hypothesis of the unit root test is as follow:

H_0: There is presence of a unit root

H_1: There is no presence of a unit root

If p-value is less than the significance level, the null hypothesis will be rejected, concluding that the variable has a unit root in level form. Then, repetition of step will be conducted to the first difference.

Table 4.6: Results of Unit Root Test (ADF) (Refer to Appendix 4.8-4.27)

	LEVEL FORM		FIRST DIFFERENCE	
Variables	Intercept	Trend & Intercept	Intercept	Trend & Intercept
LNRER	-0.1510(0)	-0.8344(0)	-5.3474(0)***	-5.6880(0)***
LNTOT	-1.7619(0)	-1.8308(0)	-5.0798(0)***	-5.0325(0)***
LNCPO	-2.8042(0)*	-2.6199(0)	-5.1377(0)***	-5.2376(0)***
LNPD	-2.0087(0)	-2.4232(2)	-5.9907(0)***	-5.9052(0)***
RIRD	-2.3747(0)	-2.4176(0)	-4.7384(0)**	-4.6595(0)***

NOTE: *,**,*** indicates the rejection of null hypothesis at 10%, 5% and 1% of significance level. Number in parentheses is the number of lag length. The lag length is based on Schwarz Info Criterion. The null hypothesis under ADF test is the presence of a unit root.

Source: Developed for the research

Table 4.7: Results of Unit Root Test (Phillips-Perron)

(Refer to Appendix 4.28-4.47)

	LEVEL FORM		FIRST DIFFERENCE	
Variables	Intercept	Trend & Intercept	Intercept	Trend& Intercept
LNRER	-0.1887(1)	-0.8344(0)	-5.3474(0)***	-5.7648(4)***
LNTOT	-1.7619(0)	-1.9934(1)	-5.1404(2)***	-5.0930(2)***
LNCPO	-2.9395(1)*	-2.7596(1)	-5.0834(4)***	-5.2075(3)***
LNPD	-1.8888(4)	-2.7606(2)	-7.4773(11)***	-7.8348(12)***
RIRD	-2.6191(3)*	-2.6774(3)	-5.1340(11)***	-4.9308(11)***

NOTE: *,**,*** indicates the rejection of null hypothesis at 10%, 5% and 1% of significance level. Number in parentheses is the number of lag length and based on Newey-West Bandwith using Default (Barlett Kernel). The null hypothesis under PP test is the presence of a unit root.

Source: Developed for the research

From the table 4.6 and 4.7, both results from ADF and PP unit root test are unable to reject the null hypothesis of variables (LNRER, LNTOT and LNPD) having unit root at level form since their p-values are more than any of the significance level, i.e., 1%, 5% and 10%.. This concludes that these three variables are not stationary and contain unit root, except for LNCPO which can be rejected at 10% significance level. As for RIRD, ADF test does not reject the null hypothesis of having a unit root, but in PP test, it can reject the null hypothesis at 10% significance level.

Applying similar tests to the first differences, both tests are able to reject the null hypothesis of unit root at first differences since the p-value for all the variables are less than 1% significance level. Hence, this concludes that all variables are stationary and have no unit root at first differences.

In summary, ADF test and PP test conclude that LNRER, LNTOT, LNCPO, LNPD and RIRD are not stationary at level form. Instead, they are stationary at first difference, or known as I(1). Once the variables are confirmed to be I(1), we can proceed to Johansen co-integration test.

4.3.2 Johansen & Juselius (JJ) Cointegration Test

Before we conduct Johansen test, we need to choose the appropriate lag length because Johansen test is very sensitive to the lag length used. In order to do so, we run the VAR lag length selection criteria to choose the optimal lag length. To select a lag length, there are various lag length selection criteria such as Akaike information criteria (AIC), Schwarz information criteria (SIC), Hannan-Quinn criterion (HQC), final prediction error (FPE) and Bayesian information criterion (BIC) available. According to Liew (2004), AIC and FPE are found to be a better option for smaller sample sizes (60 observations and below) and they produce the least probability of under estimation among other criteria while HQC is more suitable for larger sample size (120 observations and above). Since our sample size is small, we choose to follow the recommended lag selections, AIC and FPE, in our study.

Table 4.8: VAR lag length selection criteria (Refer to Appendix 4.48)

Lag	LogL	LR	FPE	AIC	SC	HQ
0	101.8292	NA	1.33e-09	-6.2470	-6.0158	-6.1716
1	194.7202	149.8242*	1.71e-11*	-10.6271	-9.2394*	-10.1747*
2	212.7358	23.2460	3.08e-11	-10.1765	-7.6323	-9.3472
3	248.9505	35.0464	2.20e-11	-10.9000*	-7.1994	-9.6937

* 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: Hanna-Quinn information criterion.

Source: Developed for the research

From the table 4.8, we can see that FPE recommends one lag while AIC recommends three lags. Given that AIC is a more popular lag selection choice in previous empirical researches, we use three lags to run Johansen test.

In order to determine the number of co-integrating relations, there are two statistics, namely maximum eigenvalue statistic and trace statistic, that can be used to compare with critical values under 5% significance level to make decision on the hypothesis. The null hypothesis refers to no co-integration while the alternative hypothesis refers to co-integration. If p-value is less than the significance level, then the null hypothesis is rejected and this means that the variables are co-integrated, implying that there is long-run relationship between the variables.

Table 4.9: Johansen's cointegration tests results (Refer to Appendix 4.49)

Hypothesized no. of CE(s)	Eigenvalue	Trace Statistic	Critical Value	Max-Eigen Statistic	Critical Value
r=0	0.8713	157.4773	69.8189**	61.5181	33.8769**
r ≤ 1	0.8121	95.9592	47.8561**	50.1512	27.5843**
r ≤ 2	0.6172	45.8080	29.7971**	28.8044	21.1316**
r ≤ 3	0.3881	17.0035	15.4947**	14.7357	14.2646**
r ≤ 4	0.0728	2.2678	3.8415	2.2678	3.8415

Note: ** denotes significance level at 5%

Source: Developed for the research

From the table 4.9, the null hypothesis of no co-integration between the variables is rejected because the p-value from trace statistics and maximum eigenvalue statistic is less than 5% significance level. Hence, the variables are co-integrated and the test implies that there are 4 co-integrating vectors in the long-run relationship.

4.3.3 Vector Error Correction Model

Once cointegration is confirmed in Johansen test, we proceed to Vector Error Correction Model (VECM) to determine the long run and short run relationship in the model. From VECM, the long run coefficient of the variables in the model (Refer to Appendix 4.50) is constructed as below:

LNRER=15.1417-3.5321LNTOT+0.3512LNCPO+0.1732LNPD-0.0205RIRD

Se	(0.7161)	(0.1483)	(0.1952)	(0.0147)
t-stat	[4.9324]***	[-2.3683]**	[-0.8873]	[1.3979]

(Equation 4.1)

From the equation 4.1, when the terms of trade, crude palm oil price, productivity differential and real interest rate differential are zero, the real exchange rate is 15.14.

For terms of trade, the variable is significant at 1% significance level since the t-statistic is more than the critical value of 2.750. This means that when there is 1% increase in terms of trade, on average, the real exchange rate appreciates by 3.5321%, ceteris paribus.

Meanwhile, crude palm oil price is significant at 5% significance level since the t-statistic is less than the critical value of -2.042. This means that when there is 1% increase in crude palm oil price, on average, the real exchange rate depreciates by 0.3512%, ceteris paribus.

However, productivity differential and real interest rate differential are insignificant at 10% significance level. In the past, many empirical studies managed to find significance of productivity differential to their countries' exchange rate, especially those developing countries.

Besides, VECM is also able to show short run relationship between the variables through the lagged independent variables. Not only that, the error correction term (ECT) is able to capture the short dynamics of the four variables to long run equilibrium. The coefficient of ECT will tell the speed of adjustment of terms of trade, CPO price, productivity differential and real interest rate differential to reach long run equilibrium of real exchange rate. By referring to Appendix 4.50, the equation with ECT is illustrated as below:

$$\begin{aligned} DLNRER = {} & 0.00270 – 0.2966ECT_{t-1} + 0.2970DLNRER_{t-1} + 0.0933DLNRER_{t-2} – \\ & 0.1672DLNTOT_{t-1} + 0.1959DLNTOT_{t-2} – 0.1459DLNCPO_{t-1} – \\ & 0.1301DLNCPO_{t-2} - 0.3450DLNPD_{t-1} – 0.3517DLNPD_{t-2} – \\ & 0.0177DRIRD_{t-1} + 0.0102DRIRD_{t-2} + \varepsilon_t \end{aligned}$$

(Equation 4.2)

Where,

DLNRER = First difference of natural log of real exchange rate in Malaysia (RM/USD)

DLNTOT = First difference of natural log of terms of trade in Malaysia (unit)

DLNCPO = First difference of natural log of CPO price (RM per metric tonne)

DLNPD = First difference of natural log of productivity differential (GDP per capita)

DRIRD = First difference of real interest rate differential (%)

ECT = Error Correction Term

ε_t = Error term

From the equation 4.2, crude palm oil price, productivity differential and real interest rate differential have positive impact on the real exchange rate in the short run given that the t-value associated with the one lag value of the three variables are statistically significant at 10%, whereas the term of trade is not significant in the short run. Meanwhile, the ECT obtained is with a negative sign as expected and significant at 10%. The significance of ECT explains the validity of an equilibrium relationship among the variables used in the co-integration test. The adjustment coefficient indicates that there is 29.66% of short-run disequilibrium corrected in each quarter to achieve long run equilibrium. This shows that the VECM has fast speed of adjustment, approximately 3.37 quarters to reach the full adjustment to equilibrium.

Table 4.10: Overall fitness of the model (Refer to Appendix 4.51)

R^2 = 0.5152	Adjusted R^2 = 0.2485	F-test probability: 0.0967

Source: Developed for the research

In table 4.10, the significance of overall model represented by F test shows that the variables are able to explain the real exchange rate because the probability of F test (0.0967) is less than 10% significance level. Having low adjusted R^2 of 0.2485 does not mean that the model is necessarily bad because according to Gujarati & Porter (2009), as long as the regression coefficients are statistically significant and has logical relevance of the regressors with the dependent variable, the model is still good.

4.3.4 Granger Causality Test

VEC Granger Causality test is conducted to determine any short run causality running among the five variables. Under the test, the null hypothesis states that there is no granger causality among the variables and rejection of null hypothesis means there is causality exist between the variables. Table 4.11 provides the results of the existence of causality between real exchange rate and other four macroeconomic variables.

Table 4.11: Results of VEC Granger Causality (Refer to Appendix 4.52)

Dependent Variables	**Independent Variables**				
	ΔLNRER	ΔLNTOT	ΔLNCPO	ΔLNPD	ΔRIRD
ΔLNRER	-	0.4683	5.5207 *	8.6963 **	7.5331 **
ΔLNTOT	4.4478	-	0.0266	0.3206	9.2324 ***
ΔLNCPO	15.0260 ***	6.4130 **	-	1.9522	6.0113 **
ΔLNPD	0.9862	1.1436	1.5447	-	6.7112 **
ΔRIRD	1.7534	27.5090 ***	0.6645	1.4725	-

Note: ***, ** and * denotes significance level at 1%, 5% and 10% respectively.

Source: Developed for the research

Based on the results in table 4.11, real interest rate differential and crude palm oil price granger cause real exchange rate at 5% and 10% significance level respectively. On the same note, Kahyan, Bayat & Ugur (2013) also evidence uni-directional causality between real interest rate with exchange rate in China and India with causality running from real interest rate to exchange rate in the former and from exchange rate to real interest rate in the latter. Meanwhile, productivity differential also significantly exhibits short run causality to real exchange rate at 5% significance level; but only terms of trade do not have any short run causality with real exchange rate which contradicts with Tsen (2014) who found uni-directional causality from terms of trade to real exchange rate in Malaysia while Coudert et al. (2015) showed bi-directional between the two variables.

On the other hand, terms of trade has a causal effect on crude palm oil price at 5% significance level and the causality is uni-directional. Real interest rate differential also exhibits causal effect, a uni-directional one, to productivity differential and crude palm oil price both at 5% level of significance.

Lastly, real exchange rate also granger cause crude palm oil at 1% significance level, concluding that there exists bi-directional granger causality between crude palm oil price and real exchange rate which is similar as Hegerty (2014) that explained commodity prices caused exchange market pressure in Chile and Peru. Similarly, real interest rate differential and terms of trade also exhibit strong bi-directional granger causality.

4.4 Conclusion

In short, the descriptive analysis on the variables, diagnostic checking, and inferential analysis has been provided in this chapter which the empirical results generated from E-view 9. Following with the results, a well explained analysis and interpretation have also been presented in this chapter. The following chapter will step into the process of summarizing the whole research.

CHAPTER 5: DISCUSSION, CONCLUSION AND IMPLICATIONS

5.0 Introduction

Our research concentrates how crude palm oil price, terms of trade, real interest rate differential and productivity differential affects the real exchange rate in the long run and short run. This chapter will start from summary of statistical analysis, followed by justifications of major findings found by various econometric tests in Chapter 4. After that, policy implications, limitations and recommendations will be discussed in detailed in the last part of this chapter.

5.1 Summary of Statistical Analyses

Table 5.1 Summary table of Diagnostic Checking

Econometric Problems	**Results**
Multicollinearity	There is no serious multicollinearity problem.
Normally distribution	The error term is normally distributed.
Autocorrelation	There is no autocorrelation problem.
Heteroscedasticity	There is no heteroscedasticity problem.
Stability of coefficient	Stable coefficients and VECM model is stable.

Source: Developed for the research

Table 5.2: Summary of Vector Error Correction Model Test (Long run)

Vector Error Correction Model						
Dependent Variables	**Independent Variables**	**Expected Sign**	**Results**	**Consistency**	**Mixed Results**	**Inconsistency**
LNRER	**LNTOT**	+/-	Negative sign & significant	Tsen (2009), Ricci et. al. (2013), Dauvin (2014) and Coudert et al.,(2015)	-	-
LNRER	**LNCPO**	**-**	Positive sign & significant	-	-	Kia (2013) Aprina (2014), Arezki et al.(2014), Choudhri & Schembri (2014), Dauvin (2014) Kohlscheen (2014), Ashfahany and Priyatna (2015), and Hegerty (2016)
LNRER	**LNPD**	**-**	Positive sign & insignificant	Chowdhury(2012), Ricci et al.(2013), and Tsen (2014)	Choudhri & Schembri, (2010), Bordo et al. (2017)	-
LNRER	**RIRD**	+	Negative sign & insignificant	Byrne and Nagayasu (2008), Ozsoz and Akinkunmi (2012), Tsen (2014) and Adámek (2016)	-	Kohlscheen (2014), Bouraoui & Phisuthtiwatcharavong (2015) and Quadry, M. O., Mohamad, A., & Yusof, Y.(2017)

Source: Developed for the research

Table 5.3: Summary of Vector Error Correction Model Test (Short run)

Vector Error Correction Model				
Dependent Variables	**Independent Variables**	**Expected Sign**	**Results**	**Significance**
DLNRER	**DLNECT** $_{t-1}$	-	Negative	Significant
DLNRER	**DLNTOT** $_{t-1}$	+/-	Negative	Not Significant
DLNRER	**DLNCPO** $_{t-1}$	-	Negative	Significant
DLNRER	**DLNPD** $_{t-1}$	-	Negative	Significant
DLNRER	**DRIRD** $_{t-1}$	+	Negative	Significant

Source: Developed for the research

Table 5.4: VEC Granger Causality test

VEC Granger Causality test		
Variables	**Granger Cause**	**Results**
LNTOT → LNRER	No Granger Cause	-
LNCPO → LNRER	Granger cause	Bi-directional causality
LNPD → LNRER	Granger Cause	Uni-directional causality
RIRD → LNRER	Granger cause	Uni-directional causality
LNTOT → LNCPO	Granger cause	Uni-directional causality
LNTOT → RIRD	Granger cause	Bi-directional causality
RIRD → LNCPO	Granger cause	Uni-directional causality
RIRD → LNPD	Granger cause	Uni-directional causality

Source: Developed for the research

5.2 Discussions of Major Findings

5.2.1 Terms of Trade

In the research, we obtain a positive long run relationship between terms of trade and exchange rate from the co-integration tests, but it is insignificant in short run. In line with Coudert et al. (2015), they also noted similar result in a panel of commodity exporters, in which short run only lasts in advanced economies. This is because majority of the countries pegged their currencies. When pegged through intervention in foreign exchange and capital control in developing countries, these limit the short run responses of real exchange rate to fundamentals, including changes of terms of trade, because of the price rigidity and fixity of nominal parities in the short run. Similarly, Tsen (2011) also agreed that terms of trade's impact on the real exchange rate is restricted in the fixed exchange rate regime, unlike the floating exchange regime which sees large impact of terms of trade, especially in countries like Japan and Korea. Given Malaysia adopts a managed float exchange regime, this could mitigate any short run adjustment of its real exchange rate to terms of trade and explain the insignificance of the variable in short run.

Aside from that, Tsen (2009), Ricci et al (2013) and Dauvin (2014) also managed to prove that terms of trade affects real exchange rate positively in long run. Generally, export-oriented countries depend on the exports' activities to get their revenue and most of their wealth depends on the commodity exports which they contribute large part of the exports. When there is increase in export prices, local wages will increase, resulting in higher demand for non-traded goods. This in turn drives up the price of non-tradable in relative terms, thereby appreciating real exchange rate through improvement in current account balance, and this effect is known as income effect (Edwards & Wijnbergen, 1987; Neary, 1988).

In Granger causality test, we failed to exhibit any causality running from the terms of trade to the real exchange rate in Malaysia as opposed to Tsen (2009) and Coudert et al. (2015) who managed to find uni-directional and bi-directional causality between the variables respectively. In fact, many studies prove that commodity terms of trade are weakly exogenous. In other words, it is the real exchange rate that adjusts toward its equilibrium level. Since many commodity exporters are small nations, they have limited power over the international exports price and become price takers (Broda, 2004). In fact, this holds true for Malaysia as its main commodities, such as crude oil and crude palm oil, follow international pricing benchmark. Although Malaysia and Indonesia jointly produce about 85% of the world CPO production, their production magnitude are insufficient for them to influence the international price, causing disadvantage to them as major producers (Adnan, 2014).

5.2.2 Crude Palm Oil Price

In the co-integration test, we obtained a long run negative relationship between CPO price with real exchange rate in Malaysia which contradicts with authors' consensus that increase of price of commodity export has positive impact on real exchange rate (Kia, 2013; Aprina, 2014; Arezki et al., 2014; Choudhri & Schembri, 2014; Dauvin, 2014; Kohlscheen, 2014; Ashfahany & Priyatna, 2015; Hegerty, 2016). In fact, in Aprina (2014) and Ashfahany and Priyatna (2015) researches, they found that increase in CPO price appreciates Ringgit and Rupiah real exchange rate.

To clarify this surprising contradiction, it is important to determine the country's share of main exported commodity first. According to Bodart, Candelon and Carpantier (2012), in order for the domestic currency to appreciate, the dominant commodity needs to contribute for at least 20% of the total country's exports because the larger the share of the main exported commodity, the greater the price impact on the real exchange rate. Although Malaysia is the second largest world CPO producer and accounts for 40% of global demand of CPO, the share of CPO export in total export is just about 6.5% on average from 2008 to 2016 (Refer to Appendix 5.1.1 and Appendix 5.1.2.). In other words, the positive impact of CPO price on real exchange rate is not strong and could possibly be very small. Also, having higher CPO price lately does not guarantee much inflow of currency to the country because of the worsened export volume. Since 2012, the CPO export value (Refer to Appendix 5.2) has been decreasing because of weaker export demand from Malaysia's largest CPO importers and cheaper alternative vegetable oil, like soybean oil. Coupled with Indonesia's competitive pricing, Malaysia is losing competitive edge of CPO export to Indonesia (Ismail, 2017). In that case, the increase of CPO price lately does not translate much to the exchange rate appreciation since the effect is considerably small.

Besides, crude oil price and CPO price has been evidenced to be correlated and having dependence on each other. In long run, CPO price is highly elastic with crude oil price and there is a weak positive dependence between them as seen in Appendix 5.3 in which both move in similar trend (Arshad & Hameed, 2013; Kiatmanaroch, Puarattanaarunkorn, Autchariyapanitkul & Sriboonchitta, 2015). Given their dependence on each other, there could be a spill over effect among them toward exchange rate and thus, can explain why relationship between CPO price with exchange rate in Malaysia appears negative at a considerably small percentage (0.35%) in our research. In fact, from 2006 to 2016, Hussain et al. (2017) evidenced that there is strong negative cross-correlation between oil price and Malaysia exchange rate in long run. This means that when oil prices increase, the exchange rate depreciates. Coincidentally, Hussain et al. (2017)'s sample period also matches with ours

(2008-2016). In that case, the negative impact of crude oil price on exchange rate could spill over to CPO price and cause it to show negative long run relationship with real exchange rate. Since that the share of CPO export is not significant enough to exhibit strong positive impact of the commodity price on the real exchange rate, then the negative impact spill over from crude oil price will overlap the positive effect.

5.2.3 Productivity Differential

Surprisingly, we did not obtain the expected sign for our productivity differential in long run. Instead of negative sign, we obtained an insignificant positive sign, indicating that increase in productivity differential leads to depreciation of Ringgit, which is a violation from Balassa Samuelson hypothesis and different from Chowdhury (2012) and Tsen (2014) who confirmed presence of BS effect in Bangladesh and Malaysia respectively. According to Choudhri and Schembri (2010), many empirical results did not meet BS hypothesis because there is long run PPP deviations for traded goods, rendering the estimates to be insignificant and wrong sign. This can be explained through the demand-supply effects in Edwards (1987) model. If the growth in productivity has greater positive supply effects than demand effects, this causes the labour movement from traded sector to non-traded sector. When there is increase in labour force in non-traded sector, oversupply of non-traded goods happens and this decreases their prices, thereby depreciation of local currency.

Besides, Tsen (2011) and Choudhri and Schembri (2014) also confirm inconsistency of BS hypothesis in Hong Kong and Canada respectively. They found that increase in productivity differential leads to depreciation of exchange rate. This inconsistency can be answered through the role of terms of trade which can significantly changes the productivity differential effect on real exchange rate (Choudhri & Schembri, 2014; Gubler & Sax, 2017; Bordo et al., 2017). Tradable goods are differentiated and improvement in productivity in the local traded sector can deteriorate the terms of trade by increasing their supply. Although there is positive BS effect from the increase of price of non-tradable goods, the former tends to offset the latter, leading to depreciation of currency, for example, in Benigno and Thoenissen (2002) study on United Kingdom. When there is an increase in traded-goods productivity, this causes deterioration in the U.K. terms of trade, which is enough to offset the effect of the productivity-induced appreciation in the relative price of non-traded goods, resulting in a decrease in the real value of sterling.

Furthermore, the insignificance of productivity differential in our result could be attributed by the proxy problem. As mentioned by Dumrongrittikul (2012), using GDP per capita as proxy can be misleading because it does not represent the traded and non-traded productivity differential. Adámek (2016), who found insignificance and opposite BS effect in Czech Republic, also experienced similar problem like ours when ratio of domestic real GDP per capita to foreign’s is used as proxy. On the same note, Gubler and Sax (2017) concluded that different proxy can yield different result, for example, when total factor productivity and sectoral labour productivity are used, BS effect will be violated and produce opposite sign.

5.2.4 Real Interest Rate Differential

Although there are authors who managed to find positive and significance of the variable effect on real exchange rate (Byrne & Nagayasu, 2008; Ozsoz & Akinkunmi, 2012; Tsen, 2014; Adámek, 2016), our result failed to exhibit significant long run relationship between real interest rate differential with real exchange rate in Malaysia. This too is also reported by Kohlscheen (2014) in Brazil, Bouraoui and Phisuthtiwatcharavong (2015) in Thailand as well as Quadry, M. O., Mohamad, A., & Yusof, Y. (2017) in Malaysia. In Brazil, because of the long period of stable appreciation of Real coinciding with reduction of interest rate differential, it caused counterintuitive signs (Kohlscheen, 2014) while in Thailand, it is because of economic condition and inappropriate monetary policy (Bouraoui & Phisuthtiwatcharavong, 2015).

In the past, the failure of no co-integration between the variables has been associated with the issue of omission of important variables in the model (Campbell & Clarida, 1987; Meese & Rogoff, 1988). They agreed that the variance of the variable is not large enough to explain the fluctuation of the exchange rate and may need to include expected value of future real exchange rate, which may have a larger variance, to find co-integration.

Besides, Byrne and Nagayasu (2008) and Tang (2011) mentioned that structural break is very important in the real exchange-interest rate relationship. Using conventional unit root and co-integration tests can be biased because it exhibits absence of long run relationship, and thus, not suitable to use when structural break is present (Perron, 1988; Lanne et al., 2002). However, in our model, we assume there is no major structural break happened and this could possibly affect the result.

Meanwhile, likewise to Tsen (2014), we found positive relationship between real interest rate differential with exchange rate in short run. In Country Risk Report 2017, analysts also supports that the real interest rate differential between Malaysia and the United States remains in favour of Ringgit. This means that increase in the variable leads to appreciation of Ringgit. As mentioned by Wilson (2014) and Tafa (2015), because of higher domestic interest rate, investors will be attracted to local financial assets that offer better return. Eventually, this leads to capital inflows to the country. For example, when US Federal Reserve (Fed) increased the interest rate by 25 basis points, this triggers short-term capital outflows from Malaysia and adds pressure to Ringgit (Ee, 2017). This shows the positive relationship between these two variables.

5.3 Implications of Study

We would like to recommend various policy implications that are useful to different parties, such as government or central bank, firms, individual investors or traders and also academicians. The findings are helpful in assisting them to understand more regarding significant variables that influence real exchange rate and how these variables would benefit them.

5.3.1 Policy Makers

Real interest rate differential is important towards movement of real exchange rate and this research result implies that this variable brings positive impact to Ringgit in short run. Therefore, the central bank has to be more sensitive and closely monitor interest rate of both Malaysia and United States as real interest rate differential is determined by the gap between Malaysia money market rate and US federal funds rate real. As such, any movement by Fed to raise the interest rate can have adverse impact toward Ringgit. Recently, move of United States Federal Reserve (Fed) hikes on federal funds rate is still considered as major issue towards Malaysia because of possible capital outflow. When foreign interest rate is higher, this encourages investment away from home country, causing depreciation of domestic currency. Hence, this research highlights the importance of sensitivity of local interest rate relative to U.S. interest rate to central bank to incorporate appropriate short term monetary policy to mitigate possible capital outflow.

Given that the terms of trade exhibit the largest impact toward Ringgit in the result, policy makers need to be concern of Malaysia's external trade because the economy is tightly linked with export-oriented activities. When terms of trade improves, there will be more export revenue to the country and increases the demand for Ringgit. Therefore, trade policies especially those with major trading partners should be observed consistently and government needs to formulate policies to encourage more trading opportunities to Malaysia so that the country can still maintain competitiveness in the international trade.

The research also highlights the significance of CPO price to Ringgit in both short run and long run. Since CPO is the second main export commodity after crude oil in Malaysia, government may attempt to provide incentives to upstream and downstream CPO industries to increase the export share in the future.

5.3.2 Firm

In firm perspective, real exchange rate brings a meaningful impact towards the transaction of the company because it can affect cost and revenue of the firms, especially to importers and exporters. Hence, this research may help the firms to have better forecasting power on the future exchange rate movement through the variables incorporated in this study. In most of the countries (including Malaysia), US dollar is the most popular currency in trading

(Amadeo, 2017), therefore, fluctuation movement of US dollar towards home currency become relatively important as it will determine the cost of the raw materials. With this research, importers might be able to know the right timing to buy raw materials at cheaper cost when movement of exchange rate is predicted. Should the exchange rate is unfavourable, importers and exporters can enter into hedging contracts to overcome the probability of the foreign exchange losses. For example, crude palm oil plantation firms, such as Sime Darby, are recommended to put attention on the exchange rate movement because changes in the exchange rate can alter the revenue amount since the invoice billings are usually done in USD. Thus, CPO exporters could look into derivatives market, such as FCPO, in Bursa Malaysia to hedge against the FOREX losses.

5.3.3 Individuals

Individuals, such as investors and foreign exchange traders have interest in a country's exchange rate movement because any volatility in Ringgit can affect their investment portfolio and speculation. Thus, this research may provide them with important information for them to make a critical decision on their investment. Individual and institutional investors, as well as fund managers need to be aware of Malaysia's economic conditions, such as external trade, productivity growth, interest rate movement and commodity price, because fluctuations of Ringgit can affect their foreign investment greatly. With that, they can rely on these factors to forecast exchange rate movement so that they can, either to decide to invest locally, or to invest abroad to generate more return. As for foreign exchange traders, this research might aid them to earn better return from their foreign exchange speculation when they can have better forecasting power on the exchange rate market

5.3.4 Academician

In the past, not many empirical studies have been done on the relationship between crude palm oil price with real exchange rate in Malaysia, except for Ashfahany and Priyatna (2015) who obtained positive relationship between the variables. Yet, this research result shows that increase in CPO price depreciates Ringgit, which is surprisingly unexpected. As explained before, the unexpected result could be due to presence of external shocks, like crude oil. Considering such limited studies on this matter, this research can serve as a platform to bring more interest to future researchers to study more on relationship between CPO price with exchange rate and how these two variables interact in Malaysia.

5.4 Limitations of Study

Every research contains its own limitations that are unavoidable by the researcher. The following section is going to discuss several limitations that exist in our study and these limitations should be included in the future research in order to get more comprehensive results.

Structural break refers to unexpected sudden changes in time series that generally lead to serious forecasting error and occurrence of unreliability problem in the model. In our research, we assume that there is no structural break occurred in the sample period of 2008 to 2016. However, global financial crisis happens during 2008, which is the first year of our sample period. According to Byrne and Nagayasu (2008) and Tang (2011), structural break is important to detect real exchange rate and real interest rate differential relationship. Also, structural break is included to detect ringgit exchange rate misalignment (Sidek & Yusoff, 2009).

Without the inclusion of structural shift, this unexpected event might affect the behaviour of variables toward exchange rate.

Besides, we only include one pair of currency, that is RM/$ in our model. Although US dollar is the global currency that is commonly used by most of the countries, however, other currencies especially RMB is very important to Malaysia because China is the second largest major trading partner for Malaysia (Refer to Appendix 5.4) and recently Malaysia has many big projects with China which will significantly increase the flow of the traded funds between China and Malaysia. This indicates that RMB becomes relatively important to Malaysia; therefore, we cannot omit the influence of RMB towards Malaysia. If we only focus on one currency, it may not reflect other performance of the currency with Malaysia.

Lastly, our research is also limited because of the possibility of omission of important macroeconomic variables. In Malaysia, there is other main commodity, such as crude oil industry, that is very vital to the economy due to its high contribution of revenue to the government. Exclusion of this commodity might not be able to reflect how commodity sectors affect the real exchange rate. Also, inclusion of this variable could perhaps explain better on how CPO price affects the real exchange rate in our result.

5.5 Recommendations for Future Research

To overcome the limitations of the study, three recommendations are provided to future researchers to avoid similar problems happened in this research. These recommendations will be beneficial to future researchers to get better and valid results.

To enable better evidence on co-integration among the variables, it is recommended to pre-test any structural breaks in the model using LM unit root test before running any conventional co-integration tests. If there is presence of structural breaks detected, then it is highly recommended to apply breaks in Johansen et al. approach. In Byrne and Nagayasu (2008) study, the authors found the evidence that real interest rate differential is a vital variable to his research once structural shift is included. As a result, we recommend structural break should be taken into consideration in order to get significant co-integrating results.

In order to obtain more comparable and precise results, it is recommended to include more important currency such as RMB relatively to Malaysia. This is because when there are more choices of comparison, it provides higher quality of results to capture the effect of the determinants towards Malaysia exchange rate when we made the comparison with each of the currency.

In our research, we failed to exhibit positive relationship between CPO price with real exchange rate because of possibility of spillover effect from crude oil price. As such, for future research, it is recommended to incorporate crude oil price with CPO price as representative of commodities to reflect better relationship of them with the real exchange rate.

5.6 Conclusion

In summary, we are able to show the importance of crude palm oil, terms of trade, real interest rate differential and productivity differential towards real exchange rate in Malaysia. In long run, significant relationship is found between crude palm oil and terms of trade with real exchange rate while in the short run, only terms of trade shows insignificant relationship. Then, policy implications, limitations and recommendations are provided in the research.

REFERENCES

Abdulla, I., Arshad, F. M., Bala, B. K., Noh, K. M., & Tasrif, M. (2014). Impact of CPO export duties on Malaysian palm oil industry. *AmericanJjournal of Applied Sciences, 11*(8), 1301-1309.

Adámek, E. (2016). Factors influencing the development of the Czech Crown. *Procedia – Social and Behavioral, 220*, 3-11.

Adnan, H. (2014, August 16). CPO price war in the offing? *The Star Online.* Retrieved from http://www.thestar.com.my/business/business-news/2014/08/16/cpo-price-war-in-the-offing-malaysian-exporters-refiners-enter-danger-zone-if-indonesia-heeds-gapk/

Afzal, M., & Hamid, B. (2013). Factors influencing real exchange rate: International evidence. *International Journal of Finance, 25*(4), 7946-7965.

Alam, S., Butt, M. S., & Iqbal, A. (2001). The long-run relationship between real exchange rate and real interest rate in Asian countries: An application of panel cointegration. *The Pakistan Development Review, 40*(4), 577-602.

Amadeo, K. (2017, June 13). Why the Dollar is the global currency. Retrieved from https://www.thebalance.com/world-currency-3305931

Andrew, D. W. K. (1993). Test for parameter instability and structure change with unknown change point. Econometric, *61*(4), 821-856.

Andrieș, A. M., Ihnatov, I., Căpraru, B., & Tiwari, A. K. (2017).The relationship between exchange rates and interest rates in a small open emerging economy: The case of Romania. *Economic Modelling*, 1-14.

Aprina, H. (2014). The impact of crude palm oil price on Rupiah's rate. *Bulletin of Monetary, Economics and Banking, 16*(4), 296-312.

Arezki, R., Dumitrescu, E., Freytag, A., & Quintyn, M. (2014). Commodity prices and exchange rate volatility: Lessons from South Africa's capital account liberalization. *Emerging Markets Review, 19*, 96-105.

Arshad, F. M., & Hameed, A. A. A. (2013). Crude oil, palm oil stock and prices: How they link. *Review of Economics & Finance, 1*, 48-57.

Ashfahany, A. E., & Priyatna, M. F. (2015, May). *Analysis of world crude palm oil prices on the real exchange rate: A case study of Indonesia and Malaysia.* Paper presented at International Conference on Trends in Business and Economics, London.

Balassa, B. (1964). The Purchasing Power Parity doctrine: A reappraisal. *Journal of Political Economy*, *72*(6), 584-596.

Bashir, F., & Luqman, A. (2014). Long run determinants of real exchange rate: An econometric analysis from Pakistan. *Pakistan Journal of Commerce and Social Sciences, 8*(2), 471-484.

Basnet, H.C., & Upadhyaya, K. P. (2015). Impact of oil price shocks on output, inflation and the real exchange rate: Evidence from selected ASEAN countries. *Applied Economics*, *47*(29), 3078-3091.

Beng, G. W., & Ying, S. L. (2000). Exchange rate and interest rate differential: The case of the Malaysian Ringgit/US Dollar. *Applied Economics Letters, 7*(2), 95-97.

Benigno, G., & Thoenissen, C. (2002) Equilibrium exchange rates and supply side performance. *The Economic Journal*, (486), C103.

Bernama. (2016, December 31). Long, bumpy ride for ringgit in 2016. *New Straits Times*. Retrieved from https://www.nst.com.my/news/2016/12/200743/long-bumpy-ride-ringgit-2016

Bernama. (2017, February 22). Malaysia's total trade rises to RM1.49 trillion. *The Star*. Retrieved from http://www.thestar.com.my/business/business-news/2017/02/08/malaysias-total-trade-rises-to-rm1pt49-trillion/

Bodart, V., Candelon, B., & Carpantier, J-F. (2012). Real exchange rates in commodity producing countries: A reappraisal. *Journal of International Money and Finance*, *31*(6), 1482-1502.

Bodart, V., Candelon, B., & Carpantier, J. (2015). Real exchanges rates, commodity prices and structural factors in developing countries. *Journal of International Money and Finance*, *51*, 264-284.

Bordo, M. D., Choudhri, E. U., Fazio, G., & MacDonald, R. (2017). The real exchange rate in the long run: Balassa-Samuelson effects reconsidered. *Journal of International Money and Finance*, 75, 69-92.

Bouraoui, T., & Phisuthtiwatcharavong, A. (2015). On the determinants of the THB/USD exchange rate. *Procedia Economics and Finance*, *30*, 137-145.

Breusch, T. S., & Pagan. A. R. (1979). A simple test for heteroscedasticity and random coefficient variation Econometrics, *47*(5).

Broda, C. (2004). Terms of trade and exchange rate regimes in developing countries. *Journal International Economics*, *63*(1), 31-58.

Brooks, C. (2008). *Introductory Econometrics for Finance,* (2nd ed.). Cambridge University Press.

Byrne, J. P., & Nagayasu, J. (2008). Structural breaks in the real exchange rate and real interest rate relationship. *Global Finance Journal*, *21*(2), 138-151.

Camarero, M., & Ordóñez, J. (2012). Nonlinear adjustment in the real dollar-euro exchange rate: The role of the productivity differential as a fundamental. *Economic Modelling*, *29*(2), 444-449.

Campbell. J. Y., & Clarida, R. H. (1987). The dollar and real interest rates. *Carnegie-Rochester Conference Series on Public Policy 27*, 103-139.

Cashin, P., C*é*spedes, L. F., & Sahay, R. (2004). Commodity currencies and the real exchange rate. *Journal of Development Economics*, *75*(1), 239-268.

Chan, T.H., Lye, C.T., & Hooy, C.W. (2010, April 6). Forecasting Malaysian exchange rate: Do artificial neutral networks work? *Munich Personal RePEc Archive*. Retrieved from https://mpra.ub.uni-muenchen.de/id/eprint/26326

Choudhri, E. U., & Schembri, L. L. (2010). Productivity, the Terms of Trade, and the Real Exchange Rate: Balassa-Samuelson Hypothesis revisited. *Review of International Economics*, *18*(5), 924-936.

Choudhri, E. U., & Schembri, L. L. (2014). Productivity, commodity prices and the real exchange rate: The long-run behavior of the Canada-US exchange rate. *International Review of Economics and Finance*, 29, 537-551.

Chow, H. K., & Kim, Y. (2004). The empirical relationship between exchange rates and interest rates in post-crisis Asia, Research Collection School of Economics, 1-18.

Chowdhury, K. (2012). The real exchange rate and the Balassa-Samuelson hypothesis in SAARC countries: An appraisal. *Journal of the Asia Pacific Economy*, *17*(1), 52-73.

Coudert, V., Couharde, C., & Mignon, V. (2015). On the impact of volatility on the real exchange rate - terms of trade nexus: Revisiting commodity currencies. *Journal of International Money and Finance*, *58*, 110-127.

Dasgupta, N. (n.d*). Examining the long run effects of export, import and FDI inflows on the FDI outflow from India: A causality analysis.* Retrieved from http://gdex.dk/ofdi/64%20Dasgupta%20Nandita.pdf

Dauvin, M. (2014). Energy prices and the real exchange rate of commodity-exporting countries. *International Economics*, *137*, 52-72.

Dornbusch, R. (1976). Expectations and exchange rate dynamics. *Journal of political economy*, *84*(6), 1161-1076.

Dumrongrittikul, T. (2012). Real exchange rate movements in developed and developing economies: A reinterpretation of the Balassa-Samuelson Hypothesis. *Economic Record, 88*(283), 537-553.

Edwards, S., & Van Wijnbergen, S. (1987). Tariffs, the real exchange rate and the terms of trade: On Two Popular Propositions in international economics. *Oxford Economic Papers*, *39*, 458-464.

Ee, A. N. (2017, March 17). US rate hike to have little impact on Malaysian currency, stocks. *The Sun Daily*. Retrieved from http://www.thesundaily.my/news/2197155

Engle, R. F., & Granger, C. W. J. (1987). Cointegration and error correction: representation, estimation, and testing. *Econometrica*, *55*(2), 251-276.

EViews 9 Overview. (n.d.). Retrieved from http://www.eviews.com/EViews9/ev9overview.html

Frankel, J. A. (1979). On the mark: A theory of floating exchange rates based on real interest differentials. *The American Economic Review, 69*(4), 610-622.

Greene, W. H. (2002). *Econometric analysis,* (5th ed.). Prentice Hall, Upper Saddle River, New Jersey.

Gubler, M., & Sax, C. (2017). The Balassa-Samuelson Effect Reversed: New evidence from OECD Countries. *Swiss National Bank Working Papers,* (1), 3-34.

Gujarati, D. N. (2004). *Basic Econometric*, (4th ed.). Boston, MA: MCGraw-Hill.

Hegerty, S. W. (2014). Exchange market pressure, commodity prices, and contagion in Latin America. *The Journal of International Trade & Economic Dvelopment, 23*(1), 56-77.

Hegerty, S. W. (2016). Commodity-price volatility and macroeconomic spillovers: Evidence from nine emerging markets. *The North American Journal of Economics and Finance*, *35*, 23-37.

Hossfeld, O., & Röthig, A. (2016). Do speculative traders anticipate or follow USD/EUR exchange rate movements? New evidence on the efficiency of the EUR currency futures market. *Finance Research Letters*, *18*, 218-225.

Hussain, M., Zebende, G. F., Bashir, U., & Donghong, D. (2017). Oil price and exchange rate co-movements in Asian countries: Detrended cross-correlation of approach. *Physica A: Statistical Mechanics and its Application*, *465*, 338-346.

Intan, F. Z. (2017, March 24). Malaysian economy growth to be better this year than last. *The Star*. Retrieved from http://www.thestar.com.my/business/business-news/2017/03/24/growth-to-pick-up

Isard, P. (1983). An accounting framework and some issues for modelling how exchange rates respond to the news, *Exchange Rates and International Macroeconomics* (Ed.), J. A. Frankel, University of Chicago Press, Chicago, 19-55.

Ismail, N. (2017, July 3). *Malaysia's aim for more palm oil export to China may hit snag: Banker*. Malaysia Palm Oil Board. Retrieved from http://bepi.mpob.gov.my/news/detail.php?id=23590

Johansen, S. (1991) Estimation and hypothesis testing of cointegration vectors in Gaussian Vector Autoregressive Models. *Econometrica, 59*(6), 1551-1580.

Johansen, S., & Juselius, K. (2009). Maximum likelihood estimation and inference on cointegration- With applications to the demand for money. *Oxford Bulletin of Economics and statistic, 52*(2), 169-210.

Johari, A., Nyakuma, B. B., Mohd Nor, S. H., Mat, R., Hashim, H., Ahmad, A., Yamani Zakaria, Z., & Tuan Abdullah, T. A. (2015). The challenges and prospects of palm oil based biodiesel in Malaysia. *Energy, 81*, 255-261.

Kahyan, S., Bayat, T., & Ugur. A. (2013). Interest rates and exchange rate relationship in BRIC-T. *Ege Academic Review, 13*(2), 227-236.

Karahan, Ö., & Colak, O. (2012). Does uncovered interest rate parity hold in Turkey? *International Journal of Economics and Financial Issues, 2*(4), 389-394.

Khoo, D. (2015, June 13). Impact of weakening ringgit. *The Star Online*. Retrieved from http://www.thestar.com.my/business/business-news/2015/06/13/impact-of-weakening-ringgit/

Kia, A. (2013). Determinants of the real exchange rate in a small open economy: Evidence from Canada. *Journal of International Financial Markets, Institutions and Money*, *23*, 163-178.

Kiatmanaroch, T., Puarattanaarunkorn, O., Autochariyapanitkul, K., & Sriboonchitta,
S. (2015). Volatility linkages between price returns of crude oil and crude palm oil in the ASEAN region: A copula based GARCH approach. *IUKM* , 428-439

Killian, L., & Lutkepohl, H. (2016). *Structual Vector Autoregressive Analysis*, Cambridge University Press.

Kohlscheen, E. (2014). Long-run determinants of the Brazilian Real: A closer look at commodities. *International Journal of Finance & Economics*, *19*, 239-250.

Langner, C. (2016, November 20). Malaysia caught in currency ripples. *Bloomberg*. Retrieved from https://www.bloomberg.com/gadfly/articles/2016-11-21/malaysia-caught-in-ripples-of-its-own-currency-intervention

Lanne, M., Lütkepohl, H., & Saikkonen, P. (2002). Comparison of unit root tests for time series with level shifts. *Journal of Time Series Analysis, 23*(6), 667-685.

Liew, V. K. S. (2004). Which lag length selection criteria should we employ? *Economics Bulletin, 3(*33), 1-9.

Madura, F. (2015). *International financial management*, (9th ed.). Thomson South-Western.

Malaysia: Country Risk Report. (2017). (1), 1-45.

Malaysian Palm Oil Board. (2012, February 22). *Overview of the Malaysian oil palm industry 2011*. Retrieved from http://www.palmoilworld.org/PDFs/Overview-2011.pdf

Malaysian Palm Oil Council. (2013, October 4). *CPO Futures down on high inventories*. Retrieved from http://www.mpoc.org.my/CPO_futures_down_on_high_inventories.aspx

Masih, A. M. M., & Masih, R. (1997). On the temporal causal relationship between energy consumption, real income, and prices: Some new evidence from Asian-energy dependent NICs based on Multivariate Cointegration / Vector Error-Correction approach. *Journal of Policy Modelling, 19*(4), 417-440.

Meese, R., & Rogoff, K. (1988). Was it real? The exchange rate–interest rate differential relation over the modern-floating rate period. *The Journal of Finance*, *43*(4), 933-948.

Neary, P. (1988). Determinants of equilibrium real exchange rate. *The American Economic Review*, *78*(1), 210-215.

Nordin, S., Nordin, N., & Ismail, R. (2014). The impact of palm oil price on the Malaysian stock market performance. *Journal of Economics and Behavioral Studies*, *6*(1), 1-9.

Nusair, S. A., & Kisswani, K. M. (2014). Asian real exchange rates and oil prices: a cointegration analysis under structural breaks. *Bulletin of Economic Research*, *67*(S1), 1-25.

Ozcicek, O., & McMillin, W. D. (1999). Lag length selection in vector autoregressive models: symmetric and asymmetric lags. *Applied Economics*, *31*(4), 517-524.

Ozsoz, E., & Akinkunmi, M. (2012). Real exchange rate assessment for Nigeria: An evaluation of determinants, strategies for identification and correction of misalignments. *OPEC Energy Review*, *36*(1), 104-123.

Paul, R. K. (2006). *Multicollinearity: Causes, effects and remedies*, *IASRI*, *New Delhi*. Retrieved from http://www.iasri.res.in/seminar/AS-299/ebooks%5C2005-2006%5CMsc%5Ctrim2%5C3.%20Multicollinearity-%20Causes,Effects%20and%20Remedies-Ranjit.pdf

Perron, P. (1988). The great crash, the oil price shock and the unit root hypothesis. *Econometrica*, *57*(6), 1361.

Ploberger, W., & Kramer, W. (1992). The CUSUM test with OLS residuals. *Econometrica*, *60*(2), 271-285.

Puspadevi, S. (2017, March 7). Global palm oil output forecast to increase by 6 million tonnes. *The Star Online*. Retrieved from http://www.thestar.com.my/business/business-news/2017/03/09/global-palm-oil-output-forecast-to-increase-by-6-million-tonnes/

Quadry, M. O., Mohamad, A., & Yusof, Y. (2017). On the Malaysian Ringgit exchange rate determination and recent depreciation. *International Journal of Economics, Management and Accounting*, *25*(1), 1-26.

Ricci, L. A., Milesi-Ferretti, G. M., & Lee, J. (2013). Real exchange rates and fundamentals: A cross-country perspective. *Journal of Money, Credit and Banking*, *45*(5), 845-864.

Saiti, B., Ali, A., Abdullah, N., & Sajilan, S. (2014). Palm oil price, exchange rate and stock market: A wavelet analysis on the Malaysian market. *Eurasian Journal of Economics and Finance*, *2*(1), 13-27.

Samuelson, P. A. (1964). Theoretical notes on trade problems. *Review of Economics and Statistics*, *46*(2), 145-154.

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

Shaffer, L. (2016, November 21). Malaysia’s ringgit may keep tumbling amid the market's Trump tantrum. *CNBC*. Retrieved from http://www.cnbc.com/2016/11/21/why-malaysias-ringgit-may-keep-tumbling-amid-the-markets-trump-tantrum.html

Sidek, N. Z. M., & Yusoff, M. B. (2009). An empirical analysis of Malaysian Ringgit equilibrium exchange rate and misalignment. *Global Economy & Finance Journal, 2*(2), 104-126.

Sidek, N. Z. M., Yusoff, M., Ghani, G., & Duasa, J. (2011). Malaysia's palm oil exports: Does exchange rate overvaluation and undervaluation matter? *African Journal of Business Management*, *5*(27), 11219-11230.

Sjö, B. (2011). *Testing for unit roots and cointegration – guide.* Retrieved from https://www.iei.liu.se/nek/730A16/filarkiv/1.307105/Dfdistab8.pdf

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

Tang, T. C. (2011). Real exchange rates and real interest differentials: The case of a transitional economy – Cambodia. *International Journal of Business and Society*, *12*(2), 101-108.

Tsen, W. H. (2009). Real exchange rate and terms of trade: Some empirical evidence in Malaysia, Singapore, and Thailand, *16*(1), 229-259.

Tsen, W. H. (2011). The real exchange rate determination: An empirical investigation. *International Review of Economics and Finance*, *20*(4), 800-811.

Tsen, W. H. (2014). The real exchange rate determination: Empirical evidence from Malaysia. *The Singapore Economic Review*, *59*(2), 1-19.

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.

Wong, K. P. (2015). Export and hedging decisions under correlated revenue and exchange rate risk. *Bulletin of Economic Research, 67*(4), 371-381.

Wooldridge, J. M. (2013). *Introduction to econometrics: A modern approach.* (5th ed.). Mason, Ohio: Thomson/South-Western.

APPENDICES

Appendix 4.1: Multicollinearity for LNCPO

Dependent Variable: LNCPO
Method: Least Squares
Date: 06/29/17 Time: 16:57
Sample (adjusted): 2008Q1 2016Q2
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNPD	-0.187166	0.354828	-0.527484	0.6017
LNTOT	1.614728	0.637449	2.533110	0.0168
RIRD	0.055976	0.018234	3.069883	0.0045
C	-0.071928	2.998476	-0.023988	0.9810

R-squared	0.362142	Mean dependent var	7.844379
Adjusted R-squared	0.298356	S.D. dependent var	0.184135
S.E. of regression	0.154239	Akaike info criterion	-0.790492
Sum squared resid	0.713693	Schwarz criterion	-0.610920
Log likelihood	17.43836	Hannan-Quinn criter.	-0.729252
F-statistic	5.677471	Durbin-Watson stat	1.053245
Prob(F-statistic)	0.003339		

Appendix 4.2: Multicollinearity for LNPD

Dependent Variable: LNPD
Method: Least Squares
Date: 06/29/17 Time: 16:59
Sample (adjusted): 2008Q1 2016Q2
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCPO	-0.049098	0.093079	-0.527484	0.6017
LNTOT	0.016488	0.359696	0.045839	0.9637
RIRD	0.019527	0.010095	1.934423	0.0625
C	-1.547192	1.509550	-1.024936	0.3136

R-squared	0.117043	Mean dependent var	-1.820291
Adjusted R-squared	0.028747	S.D. dependent var	0.080158
S.E. of regression	0.078997	Akaike info criterion	-2.128678
Sum squared resid	0.187217	Schwarz criterion	-1.949107
Log likelihood	40.18753	Hannan-Quinn criter.	-2.067439
F-statistic	1.325578	Durbin-Watson stat	0.534994
Prob(F-statistic)	0.284456		

Appendix 4.3: Multicollinearity for LNTOT

Dependent Variable: LNTOT
Method: Least Squares
Date: 06/29/17 Time: 16:59
Sample (adjusted): 2008Q1 2016Q2
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCPO	0.109121	0.043078	2.533110	0.0168
LNPD	0.004248	0.092664	0.045839	0.9637
RIRD	-0.004722	0.005365	-0.880059	0.3858
C	3.788522	0.359404	10.54112	0.0000

R-squared	0.179287	Mean dependent var	4.628139
Adjusted R-squared	0.097215	S.D. dependent var	0.042200
S.E. of regression	0.040096	Akaike info criterion	-3.484955
Sum squared resid	0.048230	Schwarz criterion	-3.305383
Log likelihood	63.24424	Hannan-Quinn criter.	-3.423716
F-statistic	2.184523	Durbin-Watson stat	0.529550
Prob(F-statistic)	0.110484		

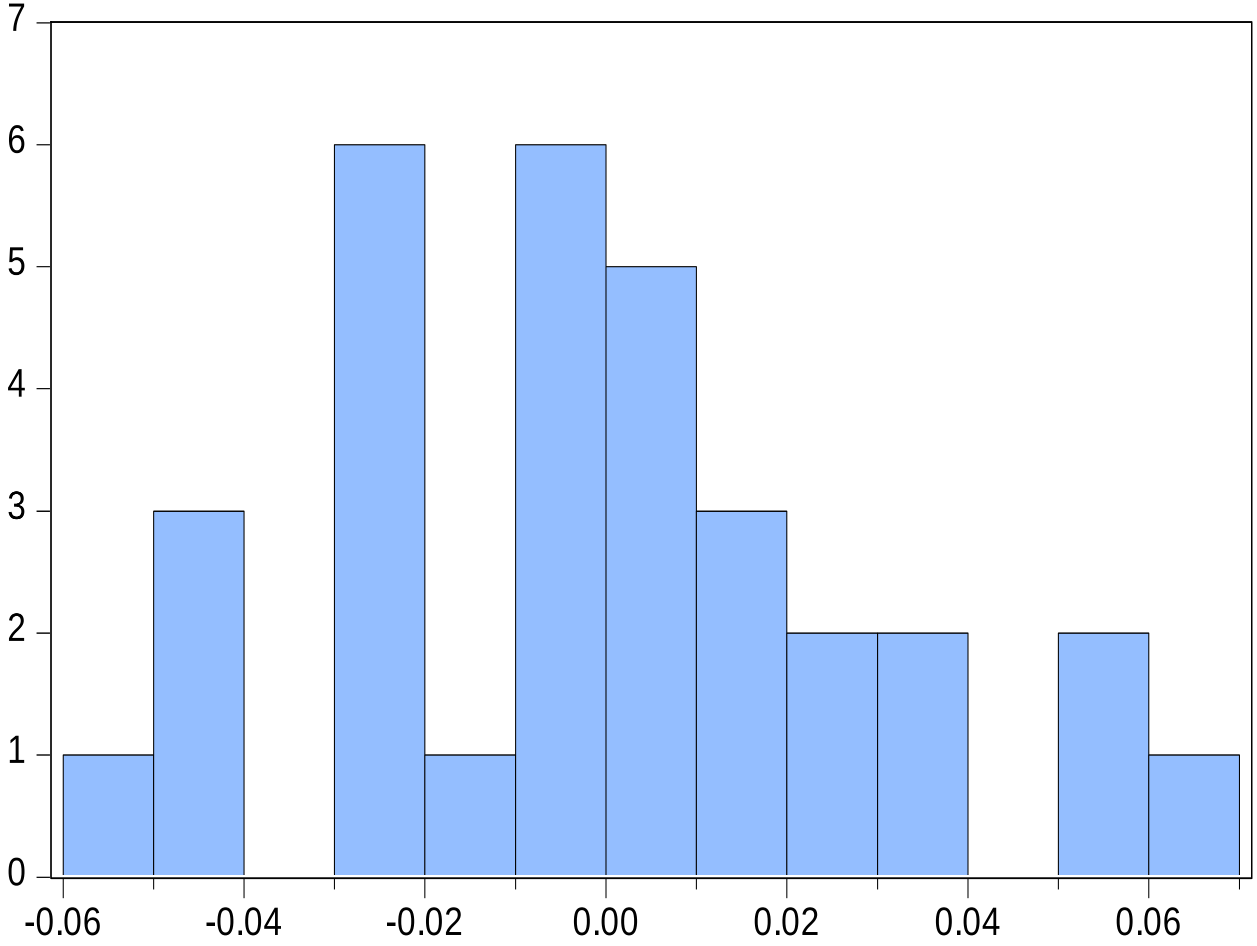
Appendix 4.4: Multicollinearity for RIRD

Dependent Variable: RIRD
Method: Least Squares
Date: 06/29/17 Time: 17:00
Sample (adjusted): 2008Q1 2016Q2
Included observations: 34 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNTOT	-5.330247	6.056694	-0.880059	0.3858
LNPD	5.679180	2.935852	1.934423	0.0625
LNCPO	4.270477	1.391088	3.069883	0.0045
C	3.337419	26.18322	0.127464	0.8994

R-squared	0.323385	Mean dependent var	1.829779
Adjusted R-squared	0.255723	S.D. dependent var	1.561578
S.E. of regression	1.347197	Akaike info criterion	3.544060
Sum squared resid	54.44817	Schwarz criterion	3.723632
Log likelihood	-56.24902	Hannan-Quinn criter.	3.605299
F-statistic	4.779444	Durbin-Watson stat	0.957466
Prob(F-statistic)	0.007713		

Appendix 4.5: Normality test- Jarque-Bera



Series: Residuals
Sample 2008Q4 2016Q3
Observations 32

Mean	-4.33e-16
Median	-0.001752
Maximum	0.065801
Minimum	-0.057401
Std. Dev.	0.029822
Skewness	0.241525
Kurtosis	2.683243
Jarque-Bera	0.444896
Probability	0.800557

Appendix 4.6: Autocorrelation- Breusch-Godfrey Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.428721	Prob. F(2,18)	0.2655
Obs*R-squared	4.383959	Prob. Chi-Square(2)	0.1117

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/29/17 Time: 22:59
Sample: 2008Q4 2016Q3
Included observations: 32
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	0.013731	0.158200	0.086797	0.9318
C(2)	-0.016806	0.313458	-0.053615	0.9578
C(3)	-0.284583	0.282498	-1.007380	0.3271
C(4)	0.003056	0.079811	0.038296	0.9699
C(5)	-0.009192	0.062015	-0.148221	0.8838
C(6)	-0.046688	0.162120	-0.287983	0.7766
C(7)	0.038067	0.161578	0.235597	0.8164
C(8)	-0.079970	0.412392	-0.193918	0.8484
C(9)	0.033641	0.319944	0.105146	0.9174
C(10)	0.003118	0.006797	0.458670	0.6520
C(11)	0.002480	0.008046	0.308237	0.7614
C(12)	0.001916	0.007319	0.261812	0.7964
RESID(-1)	0.030024	0.361739	0.083000	0.9348
RESID(-2)	0.580197	0.348431	1.665169	0.1132

R-squared	0.136999	Mean dependent var	-4.32E-16
Adjusted R-squared	-0.486280	S.D. dependent var	0.029822
S.E. of regression	0.036357	Akaike info criterion	-3.491210
Sum squared resid	0.023793	Schwarz criterion	-2.849950
Log likelihood	69.85935	Hannan-Quinn criter.	-3.278650
F-statistic	0.219803	Durbin-Watson stat	1.960800
Prob(F-statistic)	0.996011		

Appendix 4.7: Heteroscedasticity Test: White Test

F-statistic	0.667697	Prob. F(11,20)	0.7518
Obs*R-squared	8.595069	Prob. Chi-Square(11)	0.6592
Scaled explained SS	2.825701	Prob. Chi-Square(11)	0.9928

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/29/17 Time: 15:02
Sample: 2008Q4 2016Q3
Included observations: 32

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000926	0.000408	2.269321	0.0345
(-15.141729473600003-0.35121036770600003*LCPO(-1)-0.17323426306999999*LPD(-1)+LRER(-1)+3.5321059434799999*LTOT(-1)+0.020500572327000001*RIRD(-1))^2	0.010481	0.022141	0.473385	0.6411
(LRER(-1)-LRER(-2))^2	-0.049950	0.066016	-0.756644	0.4581
(LRER(-2)-LRER(-3))^2	0.003926	0.058478	0.067144	0.9471
(LPD(-1)-LPD(-2))^2	-0.080194	0.058601	-1.368469	0.1863
(LPD(-2)-LPD(-3))^2	-0.009956	0.060833	-0.163656	0.8716
(LCPO(-1)-LCPO(-2))^2	-0.010807	0.009332	-1.158058	0.2605
(LCPO(-2)-LCPO(-3))^2	-0.004197	0.005867	-0.715321	0.4827
(RIRD(-1)-RIRD(-2))^2	4.47E-05	8.59E-05	0.520238	0.6086
(RIRD(-2)-RIRD(-3))^2	4.33E-05	8.00E-05	0.540842	0.5946
(LTOT(-1)-LTOT(-2))^2	0.752246	0.349291	2.153637	0.0436
(LTOT(-2)-LTOT(-3))^2	-0.178675	0.329904	-0.541595	0.5941

R-squared	0.268596	Mean dependent var	0.000862
Adjusted R-squared	-0.133676	S.D. dependent var	0.001136
S.E. of regression	0.001209	Akaike info criterion	-10.31768
Sum squared resid	2.92E-05	Schwarz criterion	-9.768034
Log likelihood	177.0830	Hannan-Quinn criter.	-10.13549
F-statistic	0.667697	Durbin-Watson stat	1.365846
Prob(F-statistic)	0.751762		

Appendix 4.8: ADF Test for LNRER include intercept in level form

Null Hypothesis: LNRER has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.151003	0.9356
Test critical values:	1% level	-3.632900	
	5% level	-2.948404	
	10% level	-2.612874	

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

Appendix 4.9: ADF Test for LNRER include intercept and linear trend in level form

Null Hypothesis: LNRER has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.834438	0.9524
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

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

Appendix 4.10: ADF Test for LNRER include intercept in first difference form

Null Hypothesis: D(LNRER) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.347362	0.0001
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

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

Appendix 4.11: ADF Test for LNRER include intercept and linear trend in first difference form

Null Hypothesis: D(LNRER) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.688015	0.0002
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

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

Appendix 4.12: ADF Test for LNTOT include intercept in level form

Null Hypothesis: LNTOT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.761856	0.3925
Test critical values:	1% level	-3.632900	
	5% level	-2.948404	
	10% level	-2.612874	

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

Appendix 4.13: ADF Test for LNTOT include intercept and linear trend in level form

Null Hypothesis: LNTOT has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.830754	0.6681
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

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

Appendix 4.14: ADF Test for LNTOT include intercept in first difference form

Null Hypothesis: D(LNTOT) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.079838	0.0002
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

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

Appendix 4.15: ADF Test for LNTOT include intercept and linear trend in first difference form

Null Hypothesis: D(LNTOT) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.032453	0.0014
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

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

Appendix 4.16: ADF Test for LNCPO include intercept in level form

Null Hypothesis: LNCPO has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.804243	0.0679
Test critical values:	1% level	-3.632900	
	5% level	-2.948404	
	10% level	-2.612874	

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

Appendix 4.17: ADF Test for LNCPO include intercept and linear trend in level form

Null Hypothesis: LNCPO has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.619884	0.2744
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

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

Appendix 4.18: ADF Test for LNCPO include intercept in first difference form

Null Hypothesis: D(LNCPO) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.137731	0.0002
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

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

Appendix 4.19: ADF Test for LNCPO include intercept and linear trend in first difference form

Null Hypothesis: D(LNCPO) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.237578	0.0008
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

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

Appendix 4.20: ADF Test for LNPD include intercept in level form

Null Hypothesis: LNPD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.008650	0.2819
Test critical values:	1% level	-3.646342	
	5% level	-2.954021	
	10% level	-2.615817	

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

Appendix 4.21: ADF Test for LNPD include intercept and linear trend in level form

Null Hypothesis: LNPD has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.423192	0.3613
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

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

Appendix 4.22: ADF Test for LNPD include intercept in first difference form

Null Hypothesis: D(LNPD) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.990727	0.0000
Test critical values:	1% level	-3.653730	
	5% level	-2.957110	
	10% level	-2.617434	

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

Appendix 4.23: ADF Test for LNPD include intercept and linear trend in first difference form

Null Hypothesis: D(LNPD) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.905194	0.0002
Test critical values:	1% level	-4.273277	
	5% level	-3.557759	
	10% level	-3.212361	

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

Appendix 4.24: ADF Test for RIRD include intercept in level form

Null Hypothesis: RIRD has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.374677	0.1559
Test critical values:	1% level	-3.632900	
	5% level	-2.948404	
	10% level	-2.612874	

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

Appendix 4.25: ADF Test for RIRD include intercept and linear trend in level form

Null Hypothesis: RIRD has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.417553	0.3647
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

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

Appendix 4.26: ADF Test for RIRD include intercept in first difference form

Null Hypothesis: D(RIRD) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.738355	0.0005
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

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

Appendix 4.27: ADF Test for RIRD include intercept and linear trend in first difference form

Null Hypothesis: D(RIRD) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.659458	0.0036
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

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

Appendix 4.28: PP Test for LNRER include intercept in level form

Null Hypothesis: LNRER has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.188652	0.9308
Test critical values:	1% level	-3.632900	
	5% level	-2.948404	
	10% level	-2.612874	

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

Residual variance (no correction)	0.001766
HAC corrected variance (Bartlett kernel)	0.001816

Appendix 4.29: PP Test for LNRER include intercept and linear trend in level form

Null Hypothesis: LNRER has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.834438	0.9524
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

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

Residual variance (no correction)	0.001621
HAC corrected variance (Bartlett kernel)	0.001621

Appendix 4.30: PP Test for LNRER include intercept first difference form

Null Hypothesis: D(LNRER) has a unit root
Exogenous: Constant
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.347362	0.0001
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

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

Residual variance (no correction)	0.001813
HAC corrected variance (Bartlett kernel)	0.001813

Appendix 4.31: PP Test for LNRER include intercept and linear trend in first difference form

Null Hypothesis: D(LNRER) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.764774	0.0002
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

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

Residual variance (no correction)	0.001672
HAC corrected variance (Bartlett kernel)	0.001105

Appendix 4.32: PP Test for LNTOT include intercept in level form

Null Hypothesis: LNTOT has a unit root
Exogenous: Constant
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.761856	0.3925
Test critical values:	1% level	-3.632900	
	5% level	-2.948404	
	10% level	-2.612874	

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

Residual variance (no correction)	0.000526
HAC corrected variance (Bartlett kernel)	0.000526

Appendix 4.33: PP Test for LNTOT include intercept and linear trend in level form

Null Hypothesis: LNTOT has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.993440	0.5845
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

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

Residual variance (no correction)	0.000520
HAC corrected variance (Bartlett kernel)	0.000632

Appendix 4.34: PP Test for LNTOT include intercept in first difference form

Null Hypothesis: D(LNTOT) has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.140390	0.0002
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

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

Residual variance (no correction)	0.000508
HAC corrected variance (Bartlett kernel)	0.000622

Appendix 4.35: PP Test for LNTOT include intercept and linear trend in first difference form

Null Hypothesis: D(LNTOT) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.092960	0.0012
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

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

Residual variance (no correction)	0.000499
HAC corrected variance (Bartlett kernel)	0.000612

Appendix 4.36: PP Test for LNCPO include intercept in level form

Null Hypothesis: LNCPO has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.939516	0.0510
Test critical values:	1% level	-3.632900	
	5% level	-2.948404	
	10% level	-2.612874	

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

Residual variance (no correction)	0.018580
HAC corrected variance (Bartlett kernel)	0.021588

Appendix 4.37: PP Test for LNCPO include intercept and linear trend in level form

Null Hypothesis: LNCPO has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.759565	0.2208
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

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

Residual variance (no correction)	0.018425
HAC corrected variance (Bartlett kernel)	0.021129

Appendix 4.38: PP Test for LNCPO include intercept in first difference form

Null Hypothesis: D(LNCPO) has a unit root
Exogenous: Constant
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.083424	0.0002
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

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

Residual variance (no correction)	0.023414
HAC corrected variance (Bartlett kernel)	0.018258

Appendix 4.39: PP Test for LNCPO include intercept and linear trend in first difference form

Null Hypothesis: D(LNCPO) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.207461	0.0009
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

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

Residual variance (no correction)	0.022598
HAC corrected variance (Bartlett kernel)	0.019400

Appendix 4.40: PP Test for LNPD include intercept in level form

Null Hypothesis: LNPD has a unit root
Exogenous: Constant
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.888767	0.3333
Test critical values:	1% level	-3.646342	
	5% level	-2.954021	
	10% level	-2.615817	

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

Residual variance (no correction)	0.002094
HAC corrected variance (Bartlett kernel)	0.001720

Appendix 4.41: PP Test for LNPD include intercept and linear trend in level form

Null Hypothesis: LNPD has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.760626	0.2209
Test critical values:	1% level	-4.262735	
	5% level	-3.552973	
	10% level	-3.209642	

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

Residual variance (no correction)	0.001903
HAC corrected variance (Bartlett kernel)	0.002050

Appendix 4.42: PP Test for LNPD include intercept in first difference form

Null Hypothesis: D(LNPD) has a unit root
Exogenous: Constant
Bandwidth: 11 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.477341	0.0000
Test critical values:	1% level	-3.653730	
	5% level	-2.957110	
	10% level	-2.617434	

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

Residual variance (no correction)	0.002419
HAC corrected variance (Bartlett kernel)	0.000677

Appendix 4.43: PP Test for LNPD include intercept and linear trend in first difference form

Null Hypothesis: D(LNPD) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 12 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.834766	0.0000
Test critical values:	1% level	-4.273277	
	5% level	-3.557759	
	10% level	-3.212361	

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

Residual variance (no correction)	0.002412
HAC corrected variance (Bartlett kernel)	0.000541

Appendix 4.44: PP Test for RIRD include intercept in level form

Null Hypothesis: RIRD has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.619136	0.0988
Test critical values:	1% level	-3.632900	
	5% level	-2.948404	
	10% level	-2.612874	

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

Residual variance (no correction)	1.199608
HAC corrected variance (Bartlett kernel)	1.527682

Appendix 4.45: PP Test for RIRD include intercept and linear trend in level form

Null Hypothesis: RIRD has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.677399	0.2514
Test critical values:	1% level	-4.243644	
	5% level	-3.544284	
	10% level	-3.204699	

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

Residual variance (no correction)	1.182441
HAC corrected variance (Bartlett kernel)	1.535034

Appendix 4.46: PP Test for RIRD include intercept in first difference form

Null Hypothesis: D(RIRD) has a unit root
Exogenous: Constant
Bandwidth: 11 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.134007	0.0002
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

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

Residual variance (no correction)	1.366066
HAC corrected variance (Bartlett kernel)	0.369975

Appendix 4.47: PP Test for RIRD include intercept and linear trend in first difference form

Null Hypothesis: D(RIRD) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 11 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.930791	0.0018
Test critical values:	1% level	-4.252879	
	5% level	-3.548490	
	10% level	-3.207094	

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

Residual variance (no correction)	1.365788
HAC corrected variance (Bartlett kernel)	0.386677

Appendix 4.48: Var lag order selection criteria

VAR Lag Order Selection Criteria
Endogenous variables: LNRER LNTOT LNCPO LNPD RIRD
Exogenous variables: C
Date: 06/29/17 Time: 17:46
Sample: 2008Q1 2016Q4
Included observations: 31

Lag	LogL	LR	FPE	AIC	SC	HQ
0	101.8292	NA	1.33e-09	-6.247043	-6.015754	-6.171648
1	194.7202	149.8242*	1.71e-11*	-10.62711	-9.239379*	-10.17474*
2	212.7358	23.24603	3.08e-11	-10.17651	-7.632336	-9.347170
3	248.9505	35.04640	2.20e-11	-10.90003*	-7.199417	-9.693722

* 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 4.49: Johansen & Jusellius Co-integration Test

Date: 06/29/17 Time: 16:50
Sample (adjusted): 2009Q1 2016Q2
Included observations: 30 after adjustments
Trend assumption: Linear deterministic trend
Series: LNRER LNTOT LNCPO LNPD
RIRD
Lags interval (in first differences): 1 to 3

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.871343	157.4773	69.81889	0.0000
At most 1 *	0.812074	95.95920	47.85613	0.0000
At most 2 *	0.617164	45.80796	29.79707	0.0003
At most 3 *	0.388102	17.00353	15.49471	0.0294
At most 4	0.072808	2.267840	3.841466	0.1321

Trace test indicates 4 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 *	0.871343	61.51810	33.87687	0.0000
At most 1 *	0.812074	50.15124	27.58434	0.0000
At most 2 *	0.617164	28.80443	21.13162	0.0034
At most 3 *	0.388102	14.73569	14.26460	0.0421
At most 4	0.072808	2.267840	3.841466	0.1321

Max-eigenvalue test indicates 4 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 Cointegrating Coefficients (normalized by b'*S11*b=I):

LNRER	LNTOT	LNCPO	LNPD	RIRD
31.47764	54.22220	-11.64913	-11.09975	0.835809
46.95080	105.4280	-4.113760	6.189955	0.885320
-15.86332	-96.12033	17.03685	-22.20731	1.188712

-5.697479	-11.91192	9.799678	-2.933631	-1.314402
14.30297	-38.29776	3.176179	14.28533	-0.037360

Unrestricted Adjustment Coefficients (alpha):

D(LNRER)	-0.013296	-0.009619	-0.010477	-0.006095	0.000839
D(LNTOT)	-0.006346	-0.003871	0.004260	-0.004721	0.000646
D(LNCPO)	0.022840	-0.059077	0.026477	-0.008899	0.000196
D(LNPD)	0.028243	0.009956	0.001695	-0.003232	0.004047
D(RIRD)	-0.112480	-0.016907	-0.006063	0.348924	0.076119

1 Cointegrating Equation(s):	Log likelihood	266.9708

Normalized cointegrating coefficients (standard error in parentheses)

LNRER	LNTOT	LNCPO	LNPD	RIRD
1.000000	1.722563	-0.370076	-0.352623	0.026552
	(0.31764)	(0.06399)	(0.09549)	(0.00658)

Adjustment coefficients (standard error in parentheses)

D(LNRER)	-0.418519
	(0.17962)
D(LNTOT)	-0.199743
	(0.09441)
D(LNCPO)	0.718934
	(0.66001)
D(LNPD)	0.889013
	(0.19450)
D(RIRD)	-3.540597
	(5.49081)

2 Cointegrating Equation(s):	Log likelihood	292.0464

Normalized cointegrating coefficients (standard error in parentheses)

LNRER	LNTOT	LNCPO	LNPD	RIRD
1.000000	0.000000	-1.300497	-1.948451	0.051904
		(0.24326)	(0.47509)	(0.03057)
0.000000	1.000000	0.540138	0.926426	-0.014717
		(0.11892)	(0.23225)	(0.01494)

Adjustment coefficients (standard error in parentheses)

D(LNRER)	-0.870136	-1.735032
	(0.28512)	(0.59800)

D(LNTOT)	-0.381494	-0.752192
	(0.15831)	(0.33203)
D(LNCPO)	-2.054792	-4.989992
	(0.73953)	(1.55104)
D(LNPD)	1.356447	2.581002
	(0.31246)	(0.65532)
D(RIRD)	-4.334400	-7.881385
	(9.85661)	(20.6726)

3 Cointegrating Equation(s): Log likelihood 306.4486

Normalized cointegrating coefficients (standard error in parentheses)

LNRER	LNTOT	LNCPO	LNPD	RIRD
1.000000	0.000000	0.000000	-0.981459	0.067982
			(0.19388)	(0.01250)
0.000000	1.000000	0.000000	0.524804	-0.021395
			(0.09376)	(0.00605)
0.000000	0.000000	1.000000	0.743555	0.012363
			(0.32793)	(0.02115)

Adjustment coefficients (standard error in parentheses)

D(LNRER)	-0.703935	-0.727970	0.015957
	(0.24206)	(0.62927)	(0.08677)
D(LNTOT)	-0.449066	-1.161629	0.162416
	(0.14908)	(0.38756)	(0.05344)
D(LNCPO)	-2.474800	-7.534940	0.428049
	(0.63570)	(1.65258)	(0.22787)
D(LNPD)	1.329559	2.418082	-0.341082
	(0.32335)	(0.84060)	(0.11591)
D(RIRD)	-4.238215	-7.298570	1.276542
	(10.2369)	(26.6122)	(3.66944)

4 Cointegrating Equation(s): Log likelihood 313.8165

Normalized cointegrating coefficients (standard error in parentheses)

LNRER	LNTOT	LNCPO	LNPD	RIRD
1.000000	0.000000	0.000000	0.000000	0.201752
				(0.05069)
0.000000	1.000000	0.000000	0.000000	-0.092924
				(0.02659)
0.000000	0.000000	1.000000	0.000000	-0.088981
				(0.03666)
0.000000	0.000000	0.000000	1.000000	0.136297
				(0.05085)

Adjustment coefficients (standard error in parentheses)

D(LNRER)	-0.669211	-0.655372	-0.043767	0.338586
	(0.22182)	(0.57570)	(0.08730)	(0.09685)
D(LNTOT)	-0.422169	-1.105394	0.116153	-0.034273
	(0.12833)	(0.33307)	(0.05051)	(0.05603)
D(LNCPO)	-2.424098	-7.428934	0.340840	-1.181068
	(0.62187)	(1.61397)	(0.24474)	(0.27152)
D(LNPD)	1.347972	2.456579	-0.372752	-0.280021
	(0.32054)	(0.83191)	(0.12615)	(0.13995)
D(RIRD)	-6.226200	-11.45492	4.695882	0.254881
	(8.55551)	(22.2045)	(3.36711)	(3.73551)

Appendix 4.50: Vector Error Correction Model

Vector Error Correction Estimates
Date: 06/29/17 Time: 17:47
Sample (adjusted): 2008Q4 2016Q2
Included observations: 31 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LNRER(-1)	1.000000
LNTOT(-1)	3.532106 (0.71611) [4.93238]
LNCPO(-1)	-0.351210 (0.14830) [-2.36827]
LNPD(-1)	-0.173234 (0.19525) [-0.88726]
RIRD(-1)	0.020501 (0.01467) [1.39786]
C	-15.14173

Error Correction:	D(LNRER)	D(LNTOT)	D(LNCPO)	D(LNPD)	D(RIRD)
CointEq1	-0.296611 (0.16114) [-1.84070]	-0.130464 (0.06412) [-2.03479]	-1.098232 (0.41506) [-2.64595]	0.090911 (0.21660) [0.41972]	-4.758582 (3.69792) [-1.28683]
D(LNRER(-1))	0.296972 (0.25724) [1.15447]	0.179917 (0.10235) [1.75781]	0.341509 (0.66258) [0.51542]	0.176210 (0.34577) [0.50962]	-5.527463 (5.90319) [-0.93635]
D(LNRER(-2))	0.093263 (0.24651) [0.37833]	-0.032585 (0.09809) [-0.33222]	2.355812 (0.63496) [3.71018]	-0.187082 (0.33135) [-0.56461]	2.625945 (5.65705) [0.46419]
D(LNTOT(-1))	-0.167179 (0.40428) [-0.41352]	-0.039482 (0.16086) [-0.24544]	2.468582 (1.04133) [2.37060]	-0.365633 (0.54341) [-0.67285]	10.36045 (9.27757) [1.11672]
D(LNTOT(-2))	0.195930 (0.31680) [0.61847]	0.339043 (0.12605) [2.68974]	-1.107857 (0.81599) [-1.35768]	0.405154 (0.42582) [0.95147]	-38.12897 (7.26995) [-5.24473]

D(LNCPO(-1))	-0.145875	0.002625	-0.291115	0.031994	-1.214115
	(0.07934)	(0.03157)	(0.20437)	(0.10665)	(1.82078)
	[-1.83855]	[0.08314]	[-1.42447]	[0.30000]	[-0.66681]
D(LNCPO(-2))	-0.130117	0.004044	-0.669109	0.103437	0.238188
	(0.06277)	(0.02497)	(0.16167)	(0.08437)	(1.44039)
	[-2.07303]	[0.16192]	[-4.13868]	[1.22603]	[0.16536]
D(LNPD(-1))	-0.344971	0.036982	0.096932	-0.205740	0.143826
	(0.16414)	(0.06531)	(0.42280)	(0.22063)	(3.76686)
	[-2.10163]	[0.56623]	[0.22926]	[-0.93249]	[0.03818]
D(LNPD(-2))	-0.351655	0.001515	0.584633	0.004023	-4.549217
	(0.16376)	(0.06516)	(0.42181)	(0.22012)	(3.75805)
	[-2.14737]	[0.02325]	[1.38601]	[0.01828]	[-1.21053]
D(RIRD(-1))	-0.017665	-0.000637	0.013558	0.008384	-0.046617
	(0.00689)	(0.00274)	(0.01774)	(0.00926)	(0.15801)
	[-2.56549]	[-0.23240]	[0.76444]	[0.90583]	[-0.29502]
D(RIRD(-2))	0.010207	0.008993	-0.046539	0.022610	-0.561902
	(0.00746)	(0.00297)	(0.01922)	(0.01003)	(0.17127)
	[1.36768]	[3.02833]	[-2.42097]	[2.25388]	[-3.28084]
C	0.002679	-0.003238	-0.023751	0.009028	0.003576
	(0.00761)	(0.00303)	(0.01960)	(0.01023)	(0.17461)
	[0.35202]	[-1.06955]	[-1.21186]	[0.88271]	[0.02048]
R-squared	0.535135	0.748679	0.675514	0.387132	0.693543
Adj. R-squared	0.266002	0.603177	0.487654	0.032313	0.516120
Sum sq. resids	0.026261	0.004158	0.174233	0.047447	13.82994
S.E. equation	0.037178	0.014793	0.095761	0.049972	0.853166
F-statistic	1.988368	5.145500	3.595838	1.091070	3.908985
Log likelihood	65.65444	94.22323	36.32383	56.48585	-31.47625
Akaike AIC	-3.461577	-5.304725	-1.569279	-2.870055	2.804920
Schwarz SC	-2.906485	-4.749633	-1.014188	-2.314963	3.360011
Mean dependent	0.003845	-0.003911	0.002161	0.005006	0.065887
S.D. dependent	0.043394	0.023483	0.133785	0.050800	1.226492

Determinant resid covariance (dof adj.)	2.74E-12
Determinant resid covariance	2.37E-13
Log likelihood	230.6516
Akaike information criterion	-10.68720
Schwarz criterion	-7.680451

Appendix 4.51: Proxy system of LNRER equation in VECM model into OLS

Dependent Variable: D(LRER)
Method: Least Squares
Date: 07/15/17 Time: 15:24
Sample (adjusted): 2008Q4 2016Q3
Included observations: 32 after adjustments
D(LRER) = C(1)*(LRER(-1) + 3.53210594348*LTOT(-1) - 0.351210367706
*LCPO(-1) - 0.17323426307*LPD(-1) + 0.020500572327*RIRD(-1) -
15.1417294736) + C(2)*D(LRER(-1)) + C(3)*D(LRER(-2)) + C(4)
*D(LTOT(-1)) + C(5)*D(LTOT(-2)) + C(6)*D(LCPO(-1)) + C(7)*D(LCPO(
-2)) + C(8)*D(LPD(-1)) + C(9)*D(LPD(-2)) + C(10)*D(RIRD(-1)) + C(11)
*D(RIRD(-2)) + C(12)

	Coefficient	Std. Error	t-Statistic	Prob.
C(1)	-0.270573	0.158694	-1.704995	0.1037
C(2)	0.272701	0.255687	1.066540	0.2989
C(3)	-0.009780	0.222323	-0.043990	0.9653
C(4)	-0.159270	0.403664	-0.394562	0.6973
C(5)	0.139136	0.310963	0.447436	0.6594
C(6)	-0.144229	0.079219	-1.820625	0.0837
C(7)	-0.117611	0.061356	-1.916864	0.0697
C(8)	-0.311599	0.160311	-1.943717	0.0661
C(9)	-0.384055	0.160129	-2.398403	0.0263
C(10)	-0.015914	0.006638	-2.397571	0.0264
C(11)	0.008460	0.007235	1.169451	0.2560
C(12)	0.004465	0.007374	0.605514	0.5516

R-squared	0.515178	Mean dependent var	0.004460
Adjusted R-squared	0.248526	S.D. dependent var	0.042830
S.E. of regression	0.037128	Akaike info criterion	-3.468870
Sum squared resid	0.027570	Schwarz criterion	-2.919219
Log likelihood	67.50193	Hannan-Quinn criter.	-3.286677
F-statistic	1.932021	Durbin-Watson stat	1.879277
Prob(F-statistic)	0.096679		

Appendix 4.52: VEC Granger Causality

VEC Granger Causality/Block Exogeneity Wald Tests
Date: 06/30/17 Time: 10:25
Sample: 2008Q1 2016Q4
Included observations: 31

Dependent variable: D(LNRER)

Excluded	Chi-sq	Df	Prob.
D(LNTOT)	0.468335	2	0.7912
D(LNCPO)	5.520679	2	0.0633
D(LNPD)	8.696324	2	0.0129
D(RIRD)	7.533056	2	0.0231
All	21.61400	8	0.0057

Dependent variable: D(LNTOT)

Excluded	Chi-sq	Df	Prob.
D(LNRER)	4.447765	2	0.1082
D(LNCPO)	0.026639	2	0.9868
D(LNPD)	0.320621	2	0.8519
D(RIRD)	9.232372	2	0.0099
All	15.29398	8	0.0537

Dependent variable: D(LNCPO)

Excluded	Chi-sq	Df	Prob.
D(LNRER)	15.02604	2	0.0005
D(LNTOT)	6.412956	2	0.0405
D(LNPD)	1.952177	2	0.3768
D(RIRD)	6.011309	2	0.0495
All	24.82261	8	0.0017

Dependent variable: D(LNPD)

Excluded	Chi-sq	Df	Prob.
D(LNRER)	0.986249	2	0.6107
D(LNTOT)	1.143593	2	0.5645
D(LNCPO)	1.544704	2	0.4619
D(RIRD)	6.711202	2	0.0349

All	9.751451	8	0.2829

Dependent variable: D(RIRD)

Excluded	Chi-sq	Df	Prob.
D(LNRER)	1.753423	2	0.4161
D(LNTOT)	27.50904	2	0.0000
D(LNCPO)	0.664473	2	0.7173
D(LNPD)	1.472500	2	0.4789
All	31.49493	8	0.0001

Appendix 5.1.1 Malaysia's major export from 2008 to 2012

Export Products	2008		2009		2010		2011		2012	
	RM billion	%	RM billion	%	RM billion	%	RM billion	%	RM billion	%
Electrical & Electronic Products	253.81	38.25	227.78	41.02	249.9	39.12	236.53	34.06	231.16	32.9
Palm Oil	49.69	7.49	38.48	6.93	47.7	7.47	64.82	9.33	56	8
LNG (Liquified natrual gas)	40.73	6.14	31.2	5.62	38.74	6.06	49.96	7.19	56.13	8
Refined Petroleum Products	32.21	4.85	22.06	3.97	28.71	4.49	36.53	5.26	51.49	7.3
Chemicals & Chemical Products	40.55	6.11	32.98	5.94	40.69	6.37	47.19	6.79	46.3	6.6
Crude Petroleum	44.09	6.64	25.57	4.60	31.02	4.86	32.92	4.74	31.95	4.5
Machinery, Appliances & Parts	21.93	3.31	19.12	3.44	21.23	3.32	23.59	3.40	25.31	3.6
Optical & Scientific Equipment					18.31	2.87	18.75	2.70	22.93	3.3
Manufactures of Metal	19.65	2.96	14.53	2.62	18.37	2.88	21.46	3.09	20.24	2.9
Rubber Products					16.02	2.51%	18.14	2.61%	20.14	209
Textiles & Clothing										
Wood products			14.15	2.55						
Iron & steel products										
Other Products									140.99	20.1

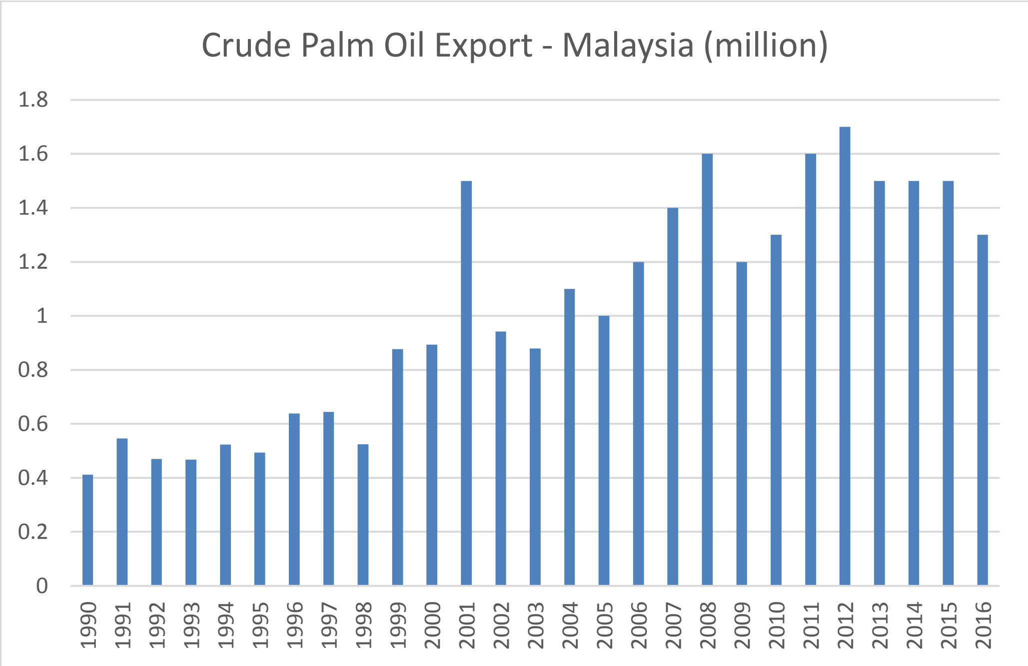
Adapted from: MATRADE

Appendix 5.1.2 Malaysia’s major export from 2013 to 2016

Export Products	2013		2014		2015		2016	
	RM billion	%	RM billion	%	RM billion	%	RM billion	%
Electrical & Electronic Products	236.98	32.91	256.15	33.43	277.92	35.75	287.72	36.61
Palm Oil	45.92	6.38	46.95	6.13	40.12	5.16	41.44	5.27
LNG (Liquified natrual gas)	59.57	8.27	64.29	8.39	44.6	5.74	32.02	4.07
Refined Petroleum Products	68.37	9.50	70.36	9.18	54.53	7.01	54.5	6.93
Chemicals & Chemical Products	47.47	6.59	51.51	6.72	55.13	7.09	58.99	7.51
Crude Petroleum	31.64	4.39	33.79	4.41	26.08	3.35	22.27	2.83
Machinery, Appliances & Parts	27.07	3.76	30.01	3.92	36.16	4.65	37.69	4.80
Optical & Scientific Equipment	20.84	2.89	23.64	3.09	26.09	3.36	28.75	3.66
Manufactures of Metal	28.16	3.91	26.45	3.45	34.9	4.49	33.39	4.25
Rubber Products	18.94	2.63	18	2.35	20.18	2.60	20.25	2.58
Textiles & Clothing								
Wood products								
Iron & steel products								
Other Products	135.03	18.75	144.98	18.92	161.64	20.79	168.92	21.49

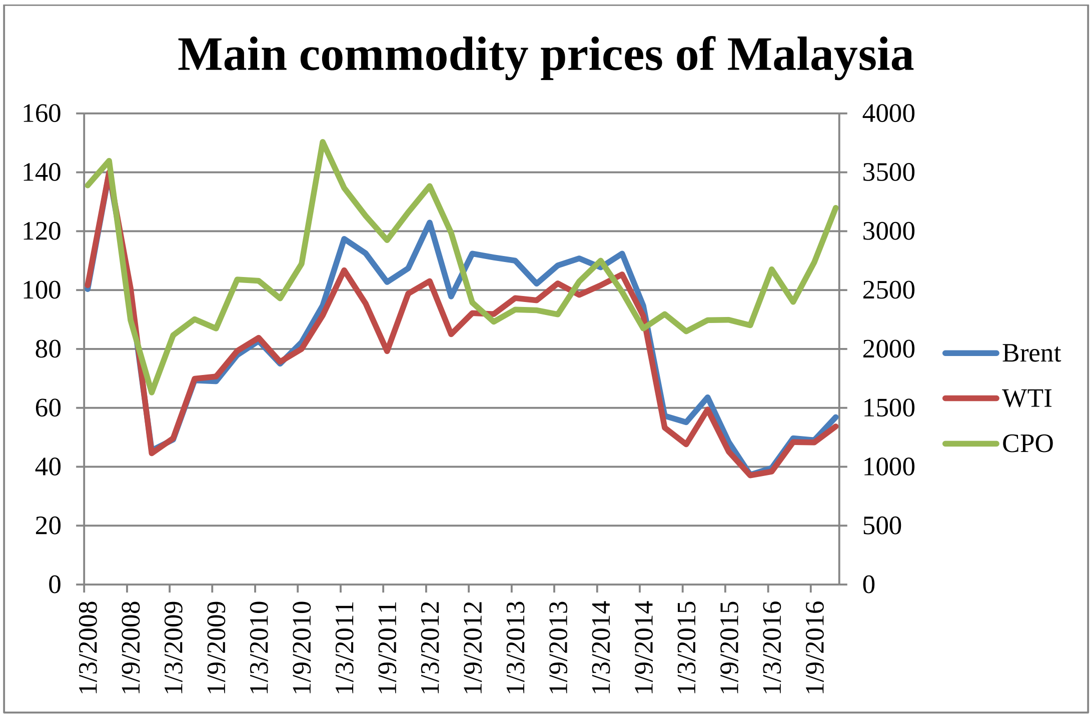
Adapted from: MATRADE

Appendix 5.2: Crude Palm Oil Export from 1990-2016 in Malaysia



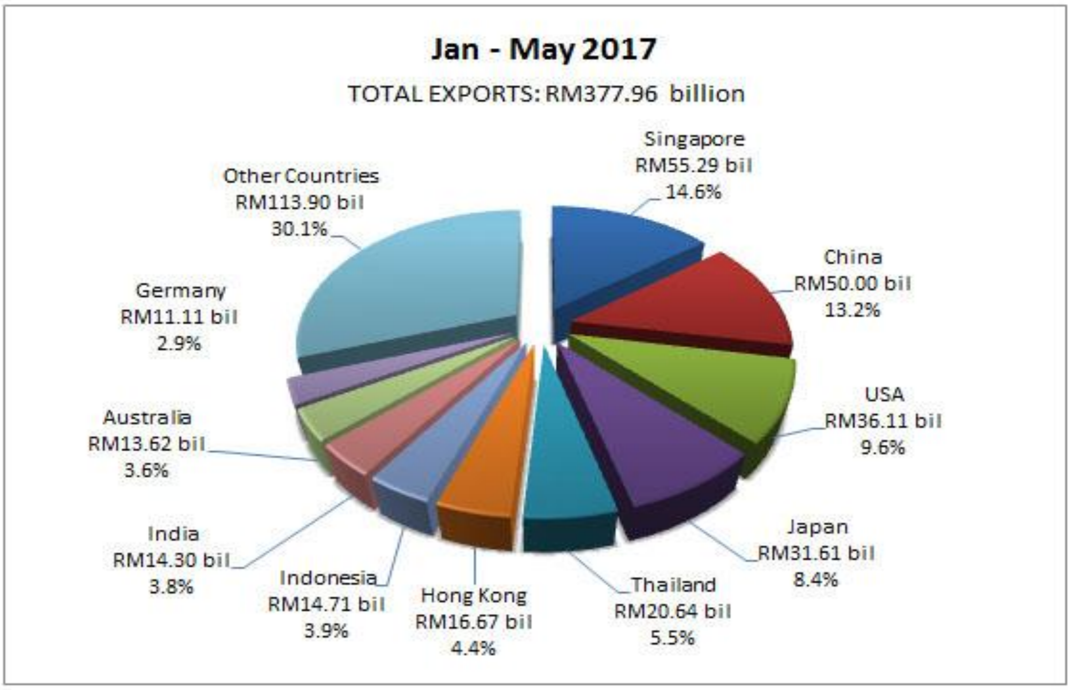
Adapted from: Palm Oil Analytics

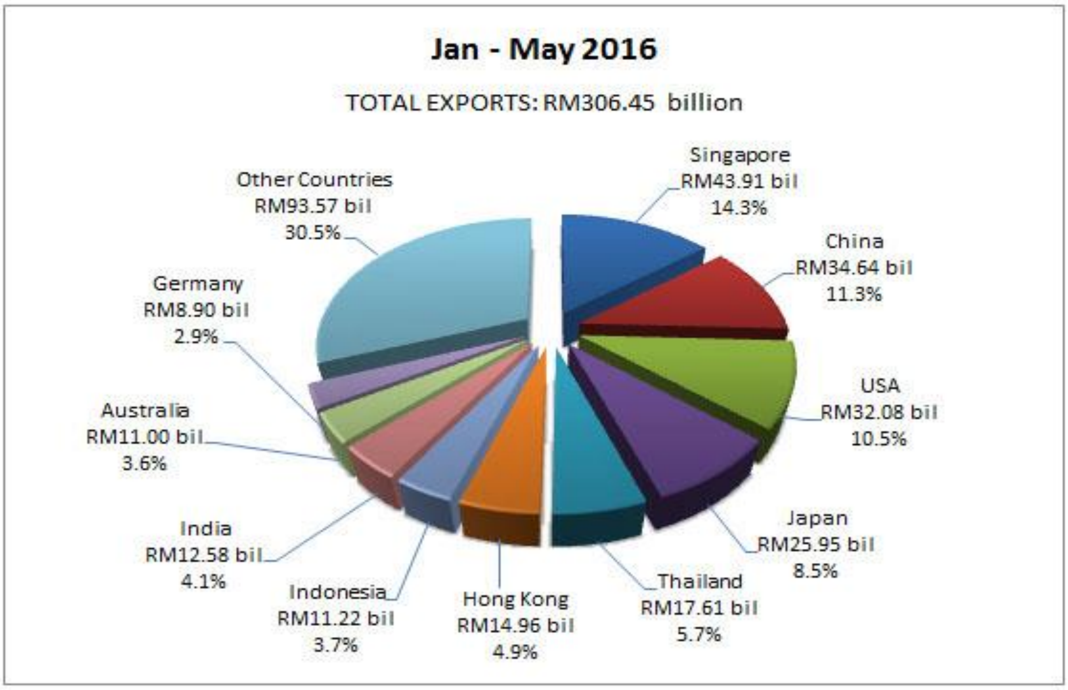
Appendix 5.3: Crude oil prices ($/barrel) and crude palm oil prices (RM/tonne)



Adapted from: Bloomberg

Appendix 5.4: Malaysia's trading partners





Adapted from: MATRADE