

MACROECONOMIC VARIABLES THAT AFFECT  
THE EXCHANGE RATE VOLATILITY IN  
MALAYSIA

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A research project submitted in partial fulfillment of the  
requirement for the degree of

BACHELOR OF FINANCE (HONS)

UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF BUSINESS AND FINANCE  
DEPARTMENT OF FINANCE

APRIL 2018

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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.
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## ACKNOWLEDGEMENT

First and foremost, we would like to take this golden opportunity to express our deepest appreciation to our research project supervisor, Ms Nabihah Binti Aminaddin who are friendly and always being patient at listening to the problems we encountered while doing this final year project. This research project would not be completed well without her guidance, assistance and support.

In addition, we like to express our gratitude to our second examiner, Dr Nur Hafizah Binti Mohammad Ismail for her comments and suggestions on our project. Without her kind advice, we would not have rectified the errors that we made in project.

Besides, we would like to thanks and truly appreciate to the authorities of Universities Tunku Abdul Rahman (UTAR) for all the good facilities provided such as online library system and Bloomberg. These facilities are important and useful in the sense of extracting data and accessing to the journals needed to conduct our research project.

Last but not least, thousand thanks to all the group members for the contribution and cooperation given to have our research project done with a smooth sailing one. Each of the members has given their best in term of advices, ideas and suggestions which helped us to conduct the research project in a more progressive way. Lastly, thank you very much to all who had lent their helping hands to our research project.

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## LIST OF ABBREVIATIONS

ADF	Augmented Dickey-Fuller
AFC	Asian Financial Crisis
ANOVA	Analysis of Variance
ASEAN	Association of Southeast Asian
BG	Breusch and Godfrey
BLUE	Best Linear Unbiased Estimator
BNM	Bank Negara Malaysia
CLT	Central Limit Theorem
CLRM	Classical Linear Regression Model
CN	Conditioned Number
DW	Durbin Watson
GARCH	Generalized Autoregressive Conditional Heteroskedasticity
GDP	Gross Domestic Product
GLS	Generalized Least Square
JB	Jarque Bera
KLCI	Kuala Lumpur Composite Index
LM	Lagrange Multiplier
MAIC	Modified Akaike Information Criteria
OLS	Ordinary Least Square
PPP	Purchase Power Parity
RESET	Regression Equation Specification Error Test

SIC	Schwar Information Criterion
T-Bill	Treasury Bill
UAE	United Arab Emirates
UK	United Kingdom
US	United States
VAR	Vector Autoregression
VDP	Variance Decomposition Proportions
VECM	Vector Error Correction Model
VIF	Variance Inflation Factor
WLS	Weighted Least Square

## PREFACE

Final Year Project (FYP) is known as the research methodology and project. The students are required to conduct this research paper in the final year before they are qualify to get their degree. This research paper is conducted under the title of “Macroeconomic Variables that Affect the Exchange Rate Volatility in Malaysia”.

Many researches had been conducted on this topic. However, the results obtained by these researches are inconclusive. The results may be inconsistent due to different countries and different variables used.

This research is concerning on the determinants of foreign exchange rate in Malaysia. In order to manage foreign exchange rate efficiently, macroeconomic factors of foreign exchange rate should be deeply investigated. The students have reviewed quite a number of studies and research before conducting the research in order to have better understanding on the theory of the relationship between exchange rate volatility and macroeconomic variables. All in all, the study mainly focuses on testing the long term relationship between the exchange rate volatility and the four macroeconomic variables in Malaysia.

## ABSTRACT

This study is to determine the macroeconomic variables that affect the exchange rate volatility in Malaysia from year 1987 to year 2016. Independent variables which are export rate, inflation rate, lending interest rate and gross domestic product (GDP) were examined in this study. Annually data from the time period for each variable is adopted from Bloomberg data base. Several statistical tests were carried out by using E-Views 7 to study the relationship between the independent and dependent variables. Heteroscedasticity and autocorrelation problems were encountered and it was solved by using White Test and Newey-west Test respectively. The result shown only lending interest rate and gross domestic product is negative and statistically significant in affecting the exchange rate volatility in Malaysia while export rate and inflation is insignificant. This research obtained an inverse result with past researches where export rate should be the most significant variables in affecting the exchange rate volatility. However, there are also few researchers stated that the results might be ambiguous or different depending on the time period and country observed.



## **CHAPTER 1: RESEARCH OVERVIEW**

### **1.0 Introduction**

By going through research background and problem statement, the readers can briefly understand the scope and ideas of this research. The objectives of the research, questions of the research and hypotheses of the study are provided so that the readers can have better understanding and clear view towards our research. Besides, the significance of the study of this research is included in this chapter. The contents of chapter one are classified as the following: research background, problem statement, research questions, research objectives, hypotheses of the study, significance of the study, and lastly the chapter layout.

### **1.1 Research background**

Exchange rate is defined as the value of a country's currency in reference to currency of another country. In general, the exchange rate value of currency will fluctuate dependently according to market demand and supply for the respective currency even though bank may intervene the market to prevent other countries or people with bad intentions from manipulating the currency. In year 1997 to 1998, a serious financial crisis attacked various countries in Asia. This crisis was started from Thai and Malaysia is one of the victims of this Asian Financial Crisis (AFC). At that time, there were no changes on the Malaysia official exchange rate policy even though the ringgit devalued gradually. As a result, the Malaysian Ringgit depreciated to RM4.72 per US Dollar (USD). Besides, a major stock market index of Malaysia which is the Kuala Lumpur Composite Index (KLCI) was inevitably affected and turned into bearish which was proven by the performance of the GDP. In year 2008, a catastrophe global financial crisis had outburst in US was

famously known as The Great Depression. This had become a biggest challenge to the worldwide business environment including Malaysia.

On 1 September 1988, Malaysia appreciated its exchange rate to MYR3.80 per U.S which is the result of pegged to US currency by policy makers and it was 10 percent higher than the previous level. Thus, the central bank of Malaysia, Bank Negara Malaysia (BNM) had decided to implement ample governor over the national interest rates to shun from volatile short term capital flows of Malaysia Ringgit and large capital outflow (Seong, 2013). In the first quarter of year 2010, the increased of external surpluses, fast growing economic, low inflation, and increased in domestic interest rate had led to an appreciation about 7% in Ringgit against U.S. Dollar. Moreover, in year 2011 there was another Asia crisis attacked and Ringgit therefore depreciated as much as 6%. Although the Bank Negara Malaysia tried to recover the situation, the Ringgit still experienced a steady depreciation. This gradual depreciation had brought huge impact to the investors' confidence and these leads to a further depreciate of the Ringgit to a low rate of MYR4.46 per U.S. dollar on 29 September 2015.

The currency depreciation happened in the late 90s which lead to the Asian economic crisis and the subprime loan crisis which refers to the approval of loans to low creditworthiness individual with high interest rates in 2008 had wind-swept companies' market capitalization and also rigorously stressed the nation economies (Ramasamy & Abar, 2015). According to Chan, Lye and Hooy (2013), as Malaysia is having a small and open economy, the changes of the global economy situation will have a significant impact on it because of the export-oriented development strategy implemented. Global risk and volatilities will easily affect the stability of Malaysia foreign exchange rate, causing the real rate differ compared to predicted rate. To watch over this problem, various exchange rate regimes had been implemented by the country over the past 40 years. BNM had then announced a few exchange controls during that time in order to stabilize the country economic through restricting the fluctuation of exchange rate caused by currencies inflow or outflow (Seong, 2013). The currently used exchange rates

regimes include the Bretton Wood system, free floating, managed floating and currency floating (Chan, Lye & Hooy, 2013).

According to Zakaria (2013), Ringgit Malaysia had shown a wide range of fluctuation through the past twenty years due to the economic circumstances faced by the country throughout the time. Yet, the agreement on whether the exchange rate volatility is influencing the trade volumes in Malaysia, or whether it is positively influenced or negatively influenced is still absent, until today. This question thus has been the bull's eyes of debate involving the policymakers, business press and academic researchers regarding the current economic policy in Malaysia. Most of the time, the possibilities of negative effects of the „too much“ volatility in the exchange rates on the country's export will be the main concern of their discussion.

According to World Bank report published in 2012, the last report regarding goods and services exports in terms of percentage of GDP of Malaysia in 2010 was 97.30. This proved that Malaysia is a small and open economy. Hence, when Gross Domestic Product per capita (GDP) is low and a relatively small market size is able to contribute to the rapid economic growth of the country (Wong & Lee, 2016). International trade has become an important contributor to the Malaysian economic growth as Malaysia is having a relatively small domestic market. As the growth of the country is largely led by the export rate, one of the main focuses of Malaysia is that its export sector could be exposed to external shocks in a highly open economy.

## **1.2 Problem Statement**

As a developing country, Malaysia was lack of studies and researches compared to other developing and developed countries such as United State in terms of exchange rate volatility research area. Moreover, Malaysia is also facing exchange rate volatility risk as well. Therefore, this research is to study the exchange rate

volatility pattern against major macroeconomic variables. This research consists of four independent variables selected which are export rate, inflation rate, lending interest rate and gross domestic product (GDP). This research is mainly aims to study on how these variables give impact and affect the exchange rate volatility. Furthermore, to study whether the macroeconomic variables have a significant relationship and effect towards the exchange rate volatility is another purpose of this research.

Some researches may show different outcomes in their studies and research. For instance, different countries may show different results. According to Abdoh, Yusuf, Zulkifli, Bulot and Ibrahim (2016), the result presents that exchange rate is having a no relationship with inflation rate and interest rate in ASEAN countries after testing all the hypotheses. However, according to Khan (2014), inflation in Pakistan is the factor which influences the most on the exchange rate volatility in the recent years and followed by interest rates after conducting an analysis on the macroeconomic variables which affecting the exchange rate volatility in Pakistan. According to Cuiabano and Divino (2010), Gross Domestic Products (GDP) and exchange rate are negatively related. In conjunction with this, it can be said that the result of the studies may vary based on the country's economic performance and government policies. Therefore, this research is conducted to examine the relationship of exchange rate volatility with export rate, inflation rate, lending interest rate and Gross Domestic Products (GDP) in Malaysia.

According to the previous researches, the exchange rate fluctuation has critical global effects and is affected by a few macroeconomic determinants such as export rate, inflation rate, lending interest rate and Gross Domestic Products (GDP). Roubini (2000) stated that the changes in macroeconomic variables could affect the economic phenomenon. The movement in exchange rate at domestic level could be influenced by the changes in economic phenomenon. Above and beyond, the economists show their interests in studying the exchange rate volatility especially in developing countries such as Malaysia. There are quite less researches on the exchange rate volatility can be found in Malaysia. Most of the

researches are based in Pakistan, Nigeria, United State and others. Therefore, this research is interested to study how these macroeconomic variables give impacts and affect the exchange rate volatility in Malaysia.

According to Abdoh *et al.* (2016), the exchange rate is a crucial variable since it allows a national currency to convert into other country's currency. Hence, goods and services that are being traded internationally can be facilitated and thus fund transfer is being carried out between countries. Moreover, prices of goods can be compared at the same in different countries. However, due to the exchange rate volatility, the currencies may vary based on the economic conditions. It might be a risk for developing country to trade with developed country since the currencies movement is fluctuating. Generally, the goods traded are determined by the price difference between similar goods while one side may gain in the trade and one side may loss in the trade due to exchange rate volatility.

Last but not least, the findings found in the previous researches are inconsistent is the problem to be concerned. For instance, Cruz (2013) shows that interest rate is not related to exchange rate and is inversely related to exchange rate volatility. However, Utami and Inanga (2009) estimates interest rate could influence the movement of exchange rate. Based on the research's result, the only variable that shows a significant relationship with exchange rate movement is export. Meanwhile, interest rate and inflation rate show an insignificant relationship. The main reason for conducting a research on the similar topic is to get a more precise, consistent and accurate finding so that the unnecessary issues and inconsistent results can be avoided.

### **1.3 Research Questions**

- 1) What are the relationship between exports rate and exchange rate volatility in Malaysia?

- 2) What are the relationship between inflation rate and exchange rate volatility in Malaysia?
- 3) What are the relationship between lending interest rate and exchange rate volatility?
- 4) What are the relationship between Gross Domestic Product (GDP) and exchange rate volatility in Malaysia?

## **1.4 Research Objective**

In general, research objectives describe what the researches want to achieve after completing the research project. These objectives are linked to the research problem and used as statement of purpose for this study. In other words, a research objective will provide a general guideline to the research. The primary goal of this study is to examine the impact and the relationship between macroeconomic variables and exchange rate volatility in Malaysia.

### **1.4.1 General Objective**

This research is to study the effect of macroeconomic variables on exchange rate volatility in Malaysia. The macroeconomic variables are export rate, inflation rate, lending interest rate and Gross Domestic Products (GDP).

### **1.4.2 Specific Objective**

1. To identify the relationship between exports rate and exchange rate volatility in Malaysia.

2. To identify the relationship between inflation rate and exchange rate volatility in Malaysia.
3. To identify the relationship between lending interest rate and exchange rate volatility in Malaysia.
4. To identify the relationship between Gross Domestic Products and exchange rate volatility in Malaysia.

## **1.5 Hypotheses of the Study**

A hypothesis is an educated or specific prediction that can be tested. It describes the expectation of events to happen in a certain time and conditions. Hypothesis is to define the relationship between two variables which are dependent and independent variables by carrying out a research.

### **1.5.1 Exports Rate**

$H_0$  : There is no relationship between export rate and exchange rate volatility.

$H_1$  : There is a relationship between export rate and exchange rate volatility.

### **1.5.2 Inflation Rate**

$H_0$  : There is no relationship between inflation rate and exchange rate volatility.

$H_1$  : There is a relationship between inflation rate and exchange rate volatility.

### **1.5.3 Lending Interest Rate**

$H_0$  : There is no relationship between lending interest rate and exchange rate volatility.

$H_1$  : There is a relationship between lending interest rate and exchange rate volatility.

### **1.5.4 Gross Domestic Products (GDP)**

$H_0$  : There is no relationship between Gross Domestic Products (GDP) and exchange rate volatility.

$H_1$  : There is a relationship between Gross Domestic Products (GDP) and exchange rate volatility.

## **1.6 Significance of Study**

This study examines the impact of the macroeconomics variables which are export rate, inflation rate, lending interest rate and Gross Domestic Products (GDP) towards the exchange rate volatility in Malaysia. This study is to identify the relationship between the independent variables and dependent variable. In other words, it determines what will happen to the dependent variable when there are changes in independent variables between the years 1987 to 2016. According to Ramasamy and Abar (2015), exchange rate volatility occurs when there are any unforeseeable exchange rate's movements. As said by Roubini (2000), the changes in macroeconomic variables could influence or affect the economic phenomenon. In addition, the exchange rate volatility's movement at domestic level is caused by the variations in the economic phenomenon.

By conducting this study, it will be beneficial for the policy makers such as government. In view of the fact that, the policy makers will have a clearer



understanding regarding the relationship between the macroeconomic variables and exchange rate volatility in Malaysia. It is also providing them a clearer and better understanding on the macroeconomic variables that affect the movement of the currency of Malaysia (Malaysian Ringgit). Moreover, the policy makers will be able to determine whether the macroeconomic variables would convey positively or negatively towards the exchange rate fluctuations and how the changes of the macroeconomic variables will bring effects on the exchange rate volatility in Malaysia. It acts as a benchmark and indicator to help the policy makers in their decision-making process by strengthening the decision making by off-putting the decision that may affect the depreciation in Malaysian Ringgit. Meanwhile, policy makers will be able to enhance their knowledge based on the study in decision-making on how to appreciate the Malaysian Ringgit.

This study also can provide a better insight for the researchers and academicians since it will provide a detailed economic analysis on the relationship between the macroeconomic variables and the exchange rate volatility in Malaysia. In conjunction with, it can act as a reference for the researchers and academicians who wish to conduct a further analysis and studies on the relationship between macroeconomic variables and exchange rate volatility.

In general, the exchange rate volatility levels are concerned by the investors who invest in currencies instead of only policy makers. One as a rational investor is always make their investment decisions by deep screening the risk associated and gaining or loss with their investment. Hence, they will choose to invest in an efficient market. Additionally, their investing decisions are basically depending on the returns by risk sensitivities. The exchange rate volatility will affect the investors' returns on the currencies. In such cases, as the stock market volatility increases, the risk taken by the investors will be higher if the exchange rate keep fluctuating, which will lead to an unstable return. Therefore, this study can help the investors to enhance their investment decision making to minimize their risk in investing in currencies.

## **1.7 Chapter Layout**

The research is made up of five chapters, which are introduction in chapter 1, literature review in chapter 2, methodology in chapter 3, data analysis in chapter 4 and discussion, conclusion and implication in chapter 5.

### **1.7.1 Chapter 1**

This chapter reviews on the overall of the research. It describes and discusses the research background, problem statement, objectives of the research, questions arise that motivate this research, hypotheses and significance of the research, and then followed by the conclusion. It will provide a better and clearer direction for the following chapters.

### **1.7.2 Chapter 2**

This chapter is to discuss the relevant characteristics of each macroeconomic variable that bring an impact on the volatility of exchange rate. It consists of the review on the literature based on studies that done by previous researches, details of the variables, analysis of the relevant theoretical models, proposed conceptual framework and hypotheses development. The journal articles regarding the independent variables (export rate, inflation rate, lending interest rate and Gross Domestic Products) that influence the dependent variable (exchange rate volatility) has been used as references for further understanding on this study.

### **1.7.3 Chapter 3**

Chapter three are mainly focusing on the research methodologies and data collection that is being used to conduct the research. A brief description on design and justification of the model, method of data collections, procedures of data processing, scales of measurement and description and interpretation of data analysis of the tests used. It has a connection with the following chapter based on the description and interpretation of the tests used.

### **1.7.4 Chapter 4**

This chapter is mainly focuses on the discussion of empirical results and analysis of the data. There are various types of tests have applied and use like unit root test, heteroscedasticity, autocorrelation, cointegration test, multicollinearity, normality and model specification error test for the diagnostic purpose. In addition, tables, graphs and charts will be used to illustrate the results for a clearer understanding of the results. To solve the problems for different test, there are some remedies to be discussed.

### **1.7.5 Chapter 5**

This chapter generally summarise the major finding, provides useful implications of the research and the discussion on the limitation of the research. It also provides the recommendations based on the obtained result from the research. The limitations and recommendations will be useful for future studies in same research area and topic.

## **1.8 Conclusion**

Generally, chapter one is discussing about the research background, problem statement, research objectives, research questions, hypotheses and the significance of study. These provide a clear guideline for doing researches that are investigating the impacts and relationship of the macroeconomics variables have on the volatility of exchange rate in Malaysia. By following the sequence, the reviews of the next chapter which discusses about the literature reviews is by referring to chapter one.

## **CHAPTER TWO: LITERATURE REVIEW**

### **2.0 Introduction**

The findings on how the macroeconomic variables are related to the exchange rate volatility will be discussed in detail in this chapter. The objective of doing the literature review is to enable the readers to understand better on how the macroeconomic variables are related to the exchange rate volatility. Moreover, literature review is used to determine and study the impact of macroeconomic variables toward exchange rate volatility. There are four macroeconomic variables which are export rate, inflation rate, lending interest rate and Gross Domestic Product (GDP) to be discussed. There are three parts that are classified under the contents of chapter two which include the literature review, relevant theoretical model's review, proposed conceptual framework and hypothesis development.

### **2.1 Literature Review**

#### **2.1.1 Exchange Rate Volatility**

Exchange rate volatility refers to the tendency of fluctuation of the currency of one country which will affect the profitability of foreign exchange. Volatility indicates to what degree the variable changes from time to time. The higher the spread of a variable change or the shorter time it takes to change from time to time, the higher the volatility of the variable is. The higher the volatility, the higher the risk is. In other words, the more volatile a currency, the more risk it has. According to Hussain and Farooq (2009), reserve money, exports of the country and exchange rate volatility and the growth of economy are moving in the same way in

the long run. Kashif (2000) stated that exchange rate which affect by the economic indicator's estimation indicates that inflation rate and exchange rate are negatively correlated. It indicates that the inflation rate will be decreased when there is an increased in the exchange rate. However, Simon (1997) indicates that inflation rate and exchange rate are moving in the same way. In addition, Khermiri and Ali (2012) found that inflation and exchange rate are significantly related by using Time Varying Probabilities Approach.

The exchange rate is a very significant macroeconomic variable that is use as a parameter to determine the competitiveness internationally and designates the position of economy globally of the country (Akhter & Faruqi, 2015). Since October 2015, the value of Malaysia's currency faced a serious declination. In 1997 where the Asian crises happened, the value of Malaysia Ringgit experienced a very hard knock that it depreciated to RM4.72 per US Dollar (USD). Then on October 2015, Malaysia Ringgit depreciated to a low of RM4.2460 per USD. It is a huge impact to many market participants such as policy makers, businesses like multinational firms, foreign students and also tourists because of the trade off on their respective sides (Quadry, Mohamad & Yusof, 2017). According to Ramasamy and Abar (2015), the quantum and direction of foreign trade and commerce is mainly determined by the exchange rate volatility or stability. Exchange rate volatility is defined as the risk when there is any unexpected movement in the exchange rate.

According to Abdol *et al.* (2016), the effect of export and exchange rate volatility has a significant correlation and it was investigated by previous researcher studies. Based on the investigation done by Moccero (2006), export rate and exchange rate volatility are negatively related. For further explanation, the fluctuations of export rate will be high when the exchange rate is low. In addition, findings showed that export rate and exchange rate volatility are having significant correlation. Khermiri and Ali (2012) stated

that export rate will reduce the uncertainty. Hence, high export rate will make the exchange rate volatility goes down as well as inflation also reduces.

### **2.1.2 Export Rate**

Zakaria (2013) has mentioned that the study of impact of exchange rate volatility to a country and trade flow has been heavily studied by researchers. However, trade surplus is also has an effect on exchange rate which is then exchange rate will affect trade too. Negative balance of payment of a country can be corrected by using exports as a source of income. Smith (2009) has stated that export is not directly affected by exchange rate but income of people is affected by exchange rate which directly influences exports even though their findings show that export and exchange rate are related to each other. The question of impact of export to exchange rate volatility is still remained a main concern to researchers on a country. It can be said that the exports and the exchange rate is negatively related (Moccerro, 2006; Abdoh *et al.*, 2016). The negative relationship means that the export increases, the exchange rate will decrease. From the findings by in Abdoh *et al.* (2016), exchange rate volatility and export are the most significant factors among others variables on exchange rate movement in ASEAN.

Cost of imports rise as the exchange rate depreciate which in return in demotivate imports and benefit exports thus creating a trade surplus and vice versa (Shafi, Hua, Idrees & Nazeer 2015). Based on the findings by Akhter and Faruqui (2015), it concluded that the exchange rate are positively affected the trend of increase export. Fahmida (2012) also further stated that the act of Bangladesh that has adopted floating exchange rate regime has a positive effect on the macroeconomic development in which export is included. From the result, the new exchange rate regime is

significantly in growing the macroeconomic variables. Akhter and Faruqui (2015) argued that a small country that trades a lot with others in open economies is suitable for flexible rates. Free market policy is almost unachievable for a small economies country like Bangladesh in which it relies on imports for consumption of goods.

Among most of the studies, Broda & Romalis (2011) has conducted a study of impact volume of trade on exchange rate volatility despite most of the other researchers ignored the situation of simultaneity problem that they assume volume of trade do not affect the exchange rate volatility. Empirically, the result shows that exchange rate volatility reduces for deeper bilateral trading relations and contributes to currency union. It also indicated that volatility was depressed by trade for their empirical model attributes most of the correlation between trade and volatility. Growth of trade can be affected by uncertainty in exchange rate and it will be tough for a country which heavily relies on trade with UAE, US and UK. Hassan (2013) mentioned in that exchange rate can be manipulated by increasing exports which then can decrease uncertainty in exchange rate.

### **2.1.3 Inflation Rate**

A sustained increase in a country's general prices of goods and services is known as the inflation rate. Inflation rate usually is measured based on annual percentage change. Inflation is one of the harmful economic phenomena and it happens when there is excess of money supply. During the time of inflation, the general prices of the things rise from time to time. The value of money or purchasing power falls accordingly when prices increase. Therefore, with every dollar you own, you only afford to buy lesser amount of goods or services, compare to the time before inflation.

One of the main factors that influence the affects the exchange rate volatility is the inflation rate. According to Ebiringa and Anyaogu (2014),



the impacts of inflation rate on exchange rate will be different based on different countries. However, majority of the results show that exchange rate is significantly and positively influenced by the inflation rate. By using the data from 35 countries for the period of 19 years, they also found that expansion on overall economic growth able to reduce inflation rates effectively. The researchers did a research to investigate the interdependencies between the inflation rates and exchange rate behaviour in Nigeria by using the autoregressive distributed lag analytical framework. The outcome shows that the inflation spiral and exchange rates movements are co-integrated in both long and short run.

Consumer Price Index is usually used to measure the inflation rate. The higher the home inflation rate, the lower the home currency value. Countries that are having lower inflation indicate a rising in the currency value. Vector Error Correction Model (VECM) shows the explanatory variable's relationship is in line with the prior expectation and satisfies the stability condition. According to the Adeniji (2013), the estimation shows that inflation rate and exchange rate volatility are having a significant and positive relationship.

Implication of monetary policy resulting in increasing in inflation volatility and also increase in exchange rate volatility, consequently lead to higher uncertainty. This may affect expectation about future inflation (Albuquerque & Portugal, 2005). Albuquerque and Portugal (2005) had done a Bivariate GARCH model to examine on how the inflation rate is related to the exchange rate volatility. As expected, inflation rate and exchange rate volatility show a significant and positive sign in the result.

To study the relationship between the inflation rate and exchange rate, the researcher had conducted a multiple regression analysis (Ng'ang'a, 2015). From the research, the rate of inflation tends to increase when the exchange rate volatility and T-bill rate increases. In the long run, financial

systems stability and fosters sustainable economic growth can be achieved by a low and stable inflation (Ng'ang'a, 2015). Therefore, the study made a conclusion on inflation and exchange rate volatility are positively related within a country.

### **2.1.4 Lending Interest Rate**

According to Keynes (1923), the cost of borrowing capital for a given time of period is known as the lending interest rates. Moreover, Ngumo (2012) stated that borrower will pay an additional price or expenses which is the lending interest rate in order to consume resources. According to Wilson and Sheefeni (2014), international economics mainly focus on how the exchange rate and interest rate are related to each other. Economic fundamentals like interest rate differential determined the exchange rates which predict by the most standard theoretical models of exchange rates. Based on Sargent and Wallace (1981), high interest rate policy will leads to a rise in the price level and a reduction in demand for money. The reason is when the interest rate goes up, the government debt will increase as well.

According to Abdoh *et al.* (2016), changes in exchange rate movement will cause by the main macroeconomic variable such as interest rate. Cruz (2013) mentioned that the interest rate and exchange rate volatility is insignificantly and negatively related. However, Utami and Inanga (2009) carried a research based on the estimation of the exchange rate volatility that might be influenced by the interest rate. There are four foreign countries which are using the interest rate stated in year 2003 until year 2008 as their home like Japan, United States, United Kingdom and Singapore. The result of the estimation of the movement of exchange rate indicates that interest rate differentials and the exchange rate volatility are having a positive relationship but it is not significant.

Goldfajn and Baig (1998) studied the relationship between the real interest rate and real exchange rate for Asian countries from July 1997 until July 1998 using Vector Autoregression (VAR) based on the impulse response function from the daily exchange rates and interest rates. Based on the findings, no strong conclusion was found between the interest rate and the exchange rate volatility. According to Kwan and Kim (2004), the research has carried out an investigation on four Asian crisis countries concerning on how the interest rate and exchange rate volatility are related to each other such as Korea, Indonesia, Thailand and Philippines. The researchers examine the empirical relationship between interest rates and exchange rates by using bivariate VAR-GARCH model. In addition, Kwan and Kim (2004) also investigate the dynamics whether interest rates and exchange rates will change due to the post-Asia crisis. Based on the research, it suggests that the exchange rate able to stabilize after the crisis if the interest rate policy is not used actively by these countries. It is also provided the proof that the domestic currencies are more sensitive to the exchange rate post-crisis of their competitors. According to Kwan and Kim (2004), they made an argument that strong evidence does not exist between the interest rate volatility and exchange rate volatility.

### **2.1.5 Gross Domestic Products (GDP)**

Gross Domestic Products (GDP) is commonly used to evaluate a country's economy. GDP can be defined as everything that is produced within the country's boundaries, it does not matter if they are produced by local or foreign-owned companies. There are 4 components of GDP which are net export, government spending, business investment and personal consumption expenditures. Students sometimes might face difficulties in differentiating between economic growth and growth in GDP. Thus, Phua (2014) clarify that both economic growth and growth in GDP are having the same meaning.

According to Bristy (2014), GDP and exchange rate volatility are negatively related. The result is aligned with Cuiabano and Divino (2010) research, where GDP and exchange rate are having negative relationship. Moreover, the research also mentioned that an increased in GDP (Economic Growth) will leads to depreciation both the long and short run of the exchange rate. This is because monetary or consumption expansion might be happened due to GDP growth. While monetary or consumption expansion will lead to the excess of local currency. As a result, exchange rate depreciation occurs. Phua (2014) explained that depreciate in the currency will discourage a country's import. When there is a decline in a country's import, the foreign goods and services will become more expensive.

Based on Bristy (2014) OLS result, it shows a significant relationship between GDP and exchange rate. As mentioned earlier, GDP is influenced by few components. Bristy (2014) found that GDP is positively affected by an increase in government expenditure. In other words, when government expenditure goes up, GDP (economic growth) will go up as well. The same goes to the population, which is having a positive impact on GDP. When population goes up, overall consumption power will increase as well and therefore bring a positive impact towards the GDP. Lastly, trade openness also found that it is positively and significantly influence the GDP or economic growth. In conclusion, different researches will show different results regarding the relationship between GDP and exchange rate. This is because each research not necessarily using the same types of country and statistical method. However, Phua (2014) concluded that exchange rate could be influenced by economic growth by taking into account the channels of total industry and manufacturing industry.

## **2.2 Review of Relevant Theoretical Model**

### **2.2.1 Quantity Theory of Money**

One of the oldest economic theories in the world is known as the quantity theory of money. This theory basically discusses on how the changes in the quantity of money in circulation determine the changes in the general price level (inflation) (Ng'ang'a, 2015). Moreover, the researcher also mentioned that when the supply of money in the economy increases, inflation occurs. All in all, inflation occurs when the growth of money supply goes faster than the economic growth. To maintain growth and stability in the economy, Ng'ang'a (2015) suggested that monetary policy tends to stabilize both the exchange rates and prices, improve the level of employment, stable economic growth and interest rate.

### **2.2.2 Purchase Power Parity (PPP) Theory**

Purchase Power Parity (PPP) theory of exchange rate is determined by introduction about the behaviour of importers and exporters in response to difference in costs of national market. When the price of goods between two countries are differ, individuals tend to buy goods in the cheaper price market and resell in the greater price market in order to fulfil the incentive for profit seeking. The difference in the good's price will affect the exchange rate rather than the market price. However, there is one way to make an adjustment within the PPP theory which is arbitrage. The country with higher inflation rate will experience a depreciation in the currency against the other country's currency by approximately the inflation deferential (Ng'ang'a, 2015). There are two disadvantages discovered in this theory. Firstly, not every single goods and services are traded internationally such as building. The second disadvantage is transportation

cost sometimes being excluded. In fact, the transportation cost should be included in the good's worth.

According to Wilson and Sheefeni (2014), Purchase Power Parity (PPP) theory able to maintain the equality between foreign and domestic prices that measured in domestic currency term through commodity arbitrage. Different countries will be having different prices on the similar commodity after the exchange rate is adjusted if the condition of equilibrium is violated. The exchange rate will back to the equilibrium level when they keep purchasing commodity in the country that provide lower price and resell it in the country that provide higher price. Besides this, Kuttner and Posen (2006) assume that the normal equilibrium exchange rate between two inconvertible currencies determines the purchasing power ratio. Therefore, the equality point between the purchasing powers of the two currencies is called the exchange rate.

### **2.2.3 Vector Error Correction Model (VECM)**

An error correction model, also known as cointegration, used to estimate both short term and long term effects of one time series on another. In other words, how quick a dependent variable returns to the equilibrium after the variables have changed can be directly estimated by using ECMs (Adeniji, 2013). When cointegration is not found in a situation, VECM is no longer required. The number of cointegrating vectors is showed in the cointegration rank in a VECM. For example, any short term fluctuation between the independent and dependent variables will cause the stable long run relationship between the variables to rise. This situation indicates a negative and significant coefficient of the ECM. Yet, the longer term forecasts will be unreliable and data that contain any information regarding the long run adjustments are omitted (Adeniji, 2013).

### **2.2.4 Keynesian Theory**

Based on Keynesian theory, inflation can be caused by an increase in demand or increase in cost. Adeniji (2013) mentioned that rigidities in the economy usually happened in the labour market. Rigidity in this case means that workers not willing to reduce their nominal wages. The main cause of inflation is excess aggregate demand and so reduce the aggregate demand would be the best way to cure inflation. There are several reasons that caused aggregate demand to rise. For example, a cut in personal income tax, a reduction in interest rate, a rise in foreigner's income, expansion in government spending and so on. In conclusion, Keynesian theory of cost-push inflation concludes that supply side factors are the basic causes of inflation. This means that a rise in production costs will lead to inflation.

### **2.2.5 Interest Rate Parity Theory**

The interest rate parity is characterized as the relationship between the interest rate and exchange rate of two countries. The exchange rate of two countries is assumed to be affected by the interest rate differentials. Generally, the interest rate differential in two countries reflects the exchange value of the country's currency. Therefore, the exchange rate of domestic currency against the international currency will decrease when the interest rates are low. As a result, it caused a fluctuation in the exchange rate. According to Bergen (2018), country's interest rates goes up when relative interest rates levels exist and brings a depreciation to the currency and thus caused a movement in exchange rate. Changes in interest rates can cause a fluctuation in exchange rate, and hence increase the exchange rate volatility.

## 2.3 Proposed Theoretical Framework

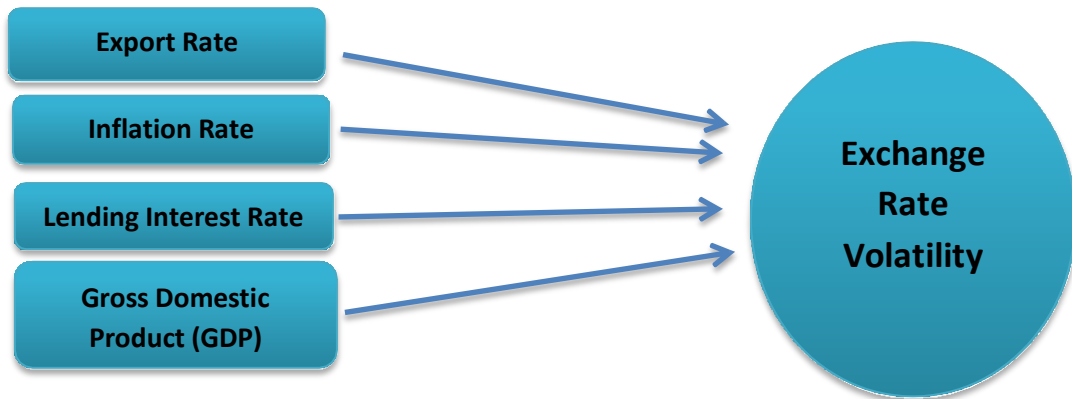


Figure 2.1: Relationship Between Selected Macroeconomic Variables And Exchange Rate Volatility

The proposed conceptual framework in Figure 2.1 provides a general image of our research. The framework consists of four independent variables: export rate, inflation rate, lending interest rate and gross domestic product (GDP) that will affect the exchange rate volatility which is the dependent variable. A lot of researchers study how the macroeconomic variables are related to the exchange rate volatility since these variables will lead to changes in exchange rate.

## 2.4 Hypotheses Development

### 2.4.1 Export Rate

How the exchange rate volatility will bring impact to the international trade is one of the important issues in the international economics. According to Wong and Lee (2016), the export rate and exchange rate volatility show a significant relationship. However, the way how the



exchange rate volatility brings impact to the export rate can be either positive or negative. This proposed the following hypothesis:

$H_0$  : There is no relationship between export rate and exchange rate volatility.

$H_1$  : There is a relationship between export rate and exchange rate volatility.

### **2.4.2 Inflation Rate**

According to Adeniji (2013), the inflation rate and exchange rate volatility show a positive and significant relationship. Exchange rate volatility is deduced to influence inflation. In order to reduce the burden of fiscal deficit and rate of inflation, government will increase the level of productivity and cut down the public sector expenditure. This proposed the following hypothesis:

$H_0$  : There is no relationship between inflation rate and exchange rate volatility.

$H_1$  : There is a relationship between inflation rate and exchange rate volatility.

### **2.4.3 Lending Interest Rate**

An insignificant relationship is expected on the interest rate and exchange rate volatility (Abdoh *et al.*, 2016; Mirchandani, 2013). It is said that countries with higher interest rate will have a competitive advantage as investors will be attracted to make investment into the currency thus affecting the exchange rate of the currency and vice versa. However, there is other researcher showed a result interest rate significantly affects the

exchange rate volatility (Grossmann, Love & Orlov, 2014). Thus, this proposed the following hypothesis:

$H_0$  : There is no relationship between lending interest rate and exchange rate volatility.

$H_1$  : There is a relationship between lending interest rate and exchange rate volatility.

#### **2.4.4 Gross Domestic Product (GDP)**

Based on Bristy (2014), GDP and exchange rate volatility are negatively related. The result is aligned with Cuiabano and Divino (2010) research, where GDP and exchange rate are having negative relationship. Thus, this proposed the following hypothesis:

$H_0$  : There is no relationship between Gross Domestic Product (GDP) and exchange rate volatility.

$H_1$  : There is a relationship between Gross Domestic Product (GDP) and exchange rate volatility.

### **2.5 Conclusion**

All in all, this chapter had further discussed and explained on the relationship between the macroeconomic variables and exchange rate volatility through the literature review of previous researchers. Export rate, inflation rate, lending interest rate, and Gross Domestic Product (GDP), which are the four independent variables, had been supported and identified with literature review. Lastly, readers will have better understanding on how these macroeconomic variables will bring impact to the exchange rate volatility.

## **CHAPTER THREE: METHODOLOGY**

### **3.0 Introduction**

Chapter three aims to provide an outline of the research methodologies applied and knowledge for better comprehension to readers. The main objective of Chapter 3 is to exhibit the methodology in well-organized form. In this chapter, it will mainly discuss on the design of the study, method in gathering data, econometric regression models, information processing as well as analysis of data.

### **3.1 Research Design**

This research is aim to study the association between macroeconomic variables and exchange rate volatility. The macroeconomic variables are export rate, inflation rate, lending interest rate, Gross Domestic Product (GDP). There are four macroeconomic variables as independent variables and exchange rate volatility as dependent variable. Quantitative data analysis is more suitable to be used in this research based on the independent variables" characteristics. A total of 30 observations used in this research which is from year 1987 to year 2016. Moreover, annually data is collected and used in this research.

Serial of empirical technique and sample data is applied which use to examine and measure the dynamic relationship between macroeconomic variables and exchange rate volatility. E-views 7 software has been applied and used to compute the variables data which had collected and transformed it into empirical result that use to analyse for the purpose of the research.

### 3.2 Data Collection

Process of collecting and evaluating data on selected factors systematically is known as data collection. The results produced could be used to answer the question of this research relevantly. Data can be collected in two ways which are primary and secondary data. The first method can be explained as the information gathered personally and explicitly for the use on research. The subsequent method is data that was formerly gathered by someone for their research purposes.

This research uses secondary data which consists of 30 observations from 1987 to 2016. The regress and is exchange rate volatility while the regressors are export rate, inflation rate, lending interest rate and Gross Domestic Product (GDP). All data are extracted from World Bank database with 30 years annually data from 1987 to 2016.

Table 3.1 Explanation on variables

<b>Variable</b>	<b>Proxy</b>	<b>Unit Measurement</b>	<b>Description</b>	<b>Sources</b>
Exchange Rate Volatility	EXC	LCU per USD	Exchange rate of Malaysia Ringgit Per USD	World Bank Database
Export Rate	NX	Export Value Index (2000=100)	Change in price level of exported and imported goods	World Bank Database
Inflation Rate	INT	Percentage (%)	Percentage (%) per annum	World Bank Database

Interest Rate	i	Percentage (%)	Percentage (%) per annum	World Bank Database
Gross Domestic Product (GDP)	%	Percentage (%)	Economic output of a nation	World Bank Database

### 3.3 Data Processing Procedures

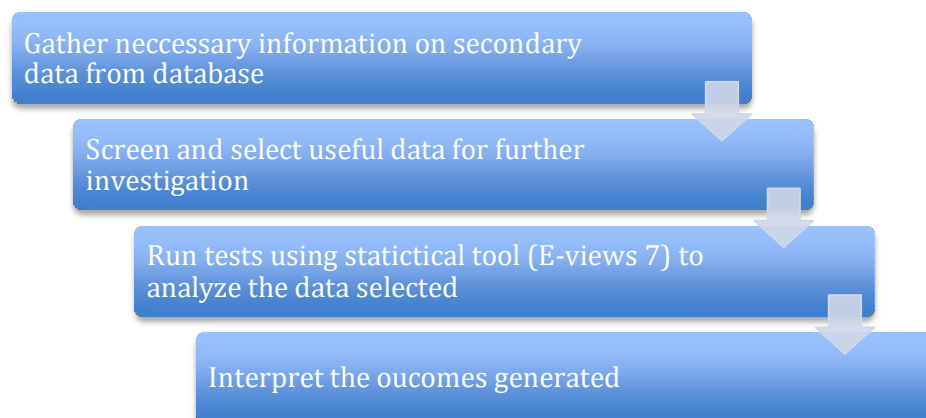


Figure 3.1 Illustration of Data Processing

Generally, data processing procedure comprises the four steps shown in the figure above. Firstly, this research collect the secondary data needed from reliable database which is World Bank. Secondly, the collected data is being screen and relevant data is selected and rearranged for further study. Next, the data is transformed into meaningful analysable information by running tests using E-views 7. Lastly, the results from the statistical tool are interpreted.

### 3.4 Econometric Regression Model

#### Econometric Function

Exchange Rate Index = f (Export Rate, Inflation Rate, Lending Interest Rate,  
Gross Domestic Product)

#### Expected sign for the selected independent variables

Export Rate : negative

Inflation rate : positive

Lending interest rate : negative

Gross Domestic Product (GDP) : negative

#### Econometric Model

$$\text{Log}(Y) = \hat{\beta}_0 + \hat{\beta}_1 \text{LOG}X_1 + \hat{\beta}_2 X_2 + \hat{\beta}_3 X_3 + \hat{\beta}_4 X_4$$

$$\text{Log}(Y) = 1.8513 - 0.000865X_1 + 0.034559X_2 - 0.061543X_3 - 0.026185X_4$$

Dependent variable, : Exchange rate volatility

Independent variable, :  $X_1 = \text{Export rate}$

$X_2 = \text{Inflation Rate}$

$X_3 = \text{Lending Interest Rate}$

$X_4 = \text{Gross Domestic Product (GDP)}$

## 3.5 Methodology

### 3.5.1 Heteroscedasticity

The presence of the heteroscedasticity is one of the key concerns in the application of regression analysis. In statistics, heteroscedasticity occurs when the standard deviations of the variables are not persistent. Heteroscedasticity usually arises in 2 forms which are conditional and unconditional. Conditional heteroscedasticity is used when future volatility cannot be identified (not predictable by nature), for example the prices of stocks and bonds. Unconditional heteroscedasticity is used when the future volatility can be identified (predictable by nature) such as electricity usage.

Heteroscedasticity problem can be detected via two ways: formal and informal methods. The informal way to detect heteroscedasticity problem is known as graphical method. In other words, is to detect heteroscedasticity problem by using graph of the hypothetical patterns of estimated square residuals. The formal way to detect heteroscedasticity is through the hypothesis testing. There are quite a lot of hypothesis testing which are commonly used to detect heteroscedasticity problem such as Breusch-Pagan test, Glejser test, White test and so on. White test is conducted to detect the presence of heteroscedasticity in this research.

White test:

$H_0$  : There is no heteroscedasticity problem in the model.

$H_1$  : There is heteroscedasticity problem in the model..

Decision Making: Reject  $H_0$  if p-value is less than the significance level, otherwise do not reject  $H_0$ .

P-value < $\alpha$	Reject $H_0$
P-value > $\alpha$	Do not reject $H_0$

Classical linear regression model (CLRM) assumed that there is no heteroscedasticity. This is because heteroscedasticity will cause the variances of a model to rise. When the variance increases, the OLS estimator will be inefficient. Heteroscedasticity also indicates that the variance is different between the true and estimated model. This might be caused by model misspecification, skewness of regressor, error learning model and inadequate data transformation.

One of the severe consequences caused by heteroscedasticity is that the OLS estimator will remain unbiased and consistent but become inefficient. Due to these factors, BLUE (Best Linear Unbiased Estimator) will not exist in the model anymore as the variance is inaccurate. Therefore, the results of the hypothesis testing will become invalid. However, the heteroscedasticity problem can be reduced by:

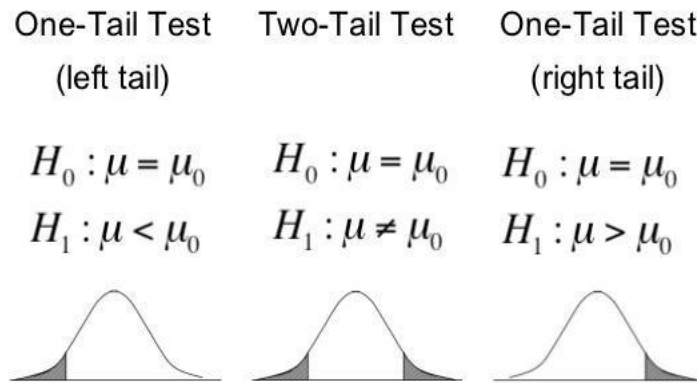
- (i) using a different specification for the model (different x variables)
- (ii) apply weighted least squares (WLS) and generalized least squares (GLS)
- (iii) improve the OLS residual estimates
- (iv) increase the sample size and variability of the regressors (larger sample size able to lessen the impact of missing value and outlier)

### **3.5.2 Hypothesis Testing**

Hypothesis testing can be described as an analysis on the means of two populations through usage of statistical test. When testing the difference between the samples, a t-test with two samples are commonly used with small sample sizes. It shows an indication on the differences between the two samples, which likely reflect a “real” difference in the populations based on the samples selected. T-test



statistical significance plays a major role as it determines whether the variation between the averages of the selected sampled is close to the real variation between the populations.



### **Decision rule**

#### **Positive one-tailed test (Right-tailed test)**

- The rule is opposed the null hypothesis as long as T-statistic value is greater than the upper critical value at significance level,  $\alpha$  (assume significance level is 0.05). Otherwise, do not reject null hypothesis.

#### **Negative one-tailed test (Left-tailed test)**

- The rule is opposed the null hypothesis as long as T-statistic value is lower than the lower critical value at significance level,  $\alpha$  (assume  $\alpha$  equal to 0.05). Otherwise, do not reject null hypothesis.

#### **Two tailed test**

- The rule is opposed the null hypothesis as long as T-statistic value is greater than the upper critical value or smaller than the lower critical value at a specific  $\alpha$ , significance level (assume  $\alpha$  equal to 0.05). Otherwise, do not reject null hypothesis.

### 3.5.3 F-test

F-test shows an indication whether there is a similarity on the variances or standard deviation between two selected populations. It can be further described as the results or outcomes of F-test will indicate whether the model is significant or not significant. Besides, F-test plays an important part in Analysis of Variance (ANOVA). It is required to indicate the level of significance and determine the critical value by taking account into degrees of freedom.

#### **Decision Rule**

If  $F_{\text{calculated}} > F_{\text{critical}}$  , then reject null hypothesis.

- The rule is opposed the null hypothesis as long as the F-statistic is greater than the critical value at significance level,  $\alpha$  (assume  $\alpha$  equal to 0.05). Otherwise, do not reject null hypothesis.

If  $F_{\text{calculated}} < F_{\text{critical}}$  , then do not reject null hypothesis.

- The rule is opposed the null hypothesis as long as the F-statistic is lower than the critical value at a specific  $\alpha$ , significance level (assume  $\alpha$  equal to 0.05). Otherwise, do not reject null hypothesis.

### 3.5.4 Multicollinearity

The situations of various independent variables in OLS estimators which are collinear are first taken into consideration by Frisch (1934). The reliability of estimation methods of multiple linear regression models depends on several vital assumptions in which the model is expected to be free from multicollinearity in independent variables. By using ordinary least squares (OLS) to estimate a linear regression model with multicollinearity problem, it will result in unreliable parameter and high variance. The chance of occurrence of type II error and greater confidence

interval rises in a regression model that has multicollinearity (Sinan & Alkan, 2015; Locking, Månsson, & Shukur, 2014).

There are several methods to detect multicollinearity in which it includes VIF, CN and VDP. In this research we will focus on using VIF to diagnostic multicollinearity since it is the most commonly used diagnostic method. According to Marquardt (1970), variance inflation factor (VIF) is a guideline in measuring the increment of variance of a regression coefficient that has collinearity.  $R_j^2$  is taken into consideration of the formula of VIF which is  $VIF = 1 / (1 - R_j^2)$ .  $R_j^2$  can determine  $j$ th independent variable base on other independent variable regarding the multiple coefficient of determination in a regression. Unless the value of VIF is larger than 10, otherwise it indicates that there is no existence of multicollinearity problem in the regression (Sinan & Alkan, 2015).

### **3.5.5 Autocorrelation**

Autocorrelation is defined as the correlation between error terms. It is also referred as serial correlation or lagged correlation, a measure of the degree of correspondence between the variables across different points of time which is time series data or different section of classes which is cross sectional data. Generally, autocorrelation happens in time series data, where the errors in the previous time period will affect the next time period. It usually occurs when the data is taken from the same source of data instead of being selected randomly.

The result of autocorrelation is ranging between positive 1 and negative 1. A perfect positive result of 1 indicates a time series increment will cause another time series to escalate proportionally. On the other hand, a perfect negative result of -1 indicates that a decrease on a time series will lead to a decrease in another time series proportionally.

According to DeCarlo and Tryon (1993), problems arise in estimating autocorrelation when the sample size of the variables use is small, for instance, lesser than 30 observations. Thus, the outcome of the estimation may be considered biased, leading to a non-reliable result.

The most commonly used test to check for autocorrelation for first order regression analysis is the Durbin-Watson (DW) test. A statistical regression analysis can be tested with error terms to detect autocorrelation. The Durbin-Watson statistic ranges from 0 to 4. When the results of the test fall under region of value 2, it means that there is no autocorrelation between the variables. Values fall under region 0 to  $D_l$  means there is positive autocorrelation while values fall under region  $4 - D_l$  to 4 indicates that there is negative autocorrelation. At times, DW test statistic values will fall under inconclusive region. However, Durbin-Watson test is only applicable for large sample size and is not applicable for small samples. For small samples, bootstrap procedure might be able to solve this problem. Besides, this test is only applicable to first order autocorrelation (Akter, 2014).

Hypothesis of autocorrelation test:

$H_0$  : The model does not suffer from autocorrelation problem.

$H_1$  : The model suffer from autocorrelation problem.

Decision Rule: Reject  $H_0$  if test statistic value falls in the rejection area, otherwise do not reject.

Or using p-value approach

Decision:

If P-value  $< \alpha$ , reject  $H_0$  at significance level  $\alpha$ .

If P-value  $> \alpha$ , do not reject  $H_0$  at significance level  $\alpha$ .

As Durbin-Watson test only solve for first order autocorrelation, Breusch-Godfrey (BG) test is suggested to use. This test is implemented by Breusch

and Godfrey. This test is applicable for testing the serial correlation hypotheses which is beyond first order, and is also applicable if there are lagged dependent variables in the model. This test is also asymptotically comparable to the Lagrange Multiplier (LM) test (Mantalos, 2003).

### **3.5.6 Jarque-Bera Test**

Jarque-Bera Test is the most well-known and easily adopted test statistic for testing normality of the model. This is according to the measure of skewness and kurtosis of the sample data (Bai & Ng, 2005; Thadewald & Büning, 2007). According to Bai and Ng (2005), with the combination of skewness and kurtosis, Jarque-Bera test is useful in generating time series data after possibilities of serial correlation in the data had been considered.

According to Ghasemi & Zahediasl (2012), most of the statistical test such as regression, T-test, correlation, and variance analysis are affected by the normality assumption of the statistic. Normal distribution of data collected is also one of the assumptions of this test. In addition, the Central Limit Theorem (CLT) stated that sample size need to be at least 30 and above to assure the normality of sampling distribution. Besides, the sampling distribution is normally distributed without considering the shape of the data as long as the sample size is sufficient. Therefore, in order to ensure normal distribution of data and accurate results, it is important to acquire big sample size to avoid this problem.

#### Hypothesis of Jarque-Bera test:

$H_0$  : Error terms are normally distributed.

$H_1$  : Error terms are not normally distributed.

Decision Rule: Reject  $H_0$  if P-value is less than significance level.

Otherwise, do not reject.

However, for sample size greater than 2,000 the test statistic is compared with chi-squared distribution denoted in  $\chi^2$  with 2 degrees of freedom. To get an accurate chi-squared statistic, the sample size needs to be large. Normal distribution does not appear in sample statistic with the test statistic result bigger than chi-squared.

### **3.5.7 Model Specification Error**

In econometric model, there are a few assumptions need follow to decide whether empirical analysis is correct by using Classical Linear Regression Model (CLRM). One of the assumptions is the econometric must be free from model specification errors. A model that suffers from specification error is sometimes the developer overlooked the interaction among the regressors (Thursby & Schmidt, 1977; Gujarati & Porter, 2009). There are six consequences that caused misspecification error which are important variables not included, presence of not important variables, wrong functional form are applied, measurement errors, stochastic error term is not properly stated, as well as the assumption of normal distribution of error term. The first situation will lead to the empirical result biased and inconsistent. In addition to that, hypothesis testing will have an incorrect conclusion since the variances and standard errors of coefficients are wrong. In the other situation in which empirical model has included unnecessary variables, it is less serious than the first situation. The empirical result will still remain unbiased and consistent. However, the variances or confidence intervals are greater than it normally should be which it will result in the parameters are not precisely estimated.

The proposal by Ramsey (1969) of Regression Equation Specification Error Test (RESET) which is general test of specification error can be applied.

The hypothesis of this test is stated as below:

$H_0$  : The model is correctly specified.

$H_1$  : The model is not correctly specified.

Decision rule: Reject  $H_0$  if P-value is less significant level,  
otherwise do not reject  $H_0$ .

Based on the hypothesis, the null hypothesis should not be rejected in this research if P-value is more than significant level. Therefore, the result model should be accurately identified, vice versa.

### **3.5.8 Unit Root Test**

In time series analysis, it is important to identify the stochastic trend or “random walk” of variables. When variables follow a non-stationary pattern, it indicates the time series has a unit root. Generally, econometric model should have an insistent result or stationary trend of mean, variance, covariance throughout the time (Gujarati & Porter, 2009). Therefore, the presence of unit roots will affect empirical results seriously. For instance, the regression can be said as false with high r-squared, but with uncorrelated data. There are a few tests can be used to detect unit root. One of them is Augmented Dickey-Fuller (ADF) test which is proposed by Dickey and Fuller (1979). It can be used to identify serial correlation problem in which this test will have a high probability of finding Type 1 error. According to Ng and Perron (2001), they have suggested that Modified Akaike Information Criteria (MAIC) should be applied in determining amount of lags. However, according to Cheung and Lai (1997) and Asghar and Abid (2007), the mostly used method of lag length selection is Schwarz Information Criterion (SIC).

Hypothesis of Augmented Dickey-Fuller Test:

$H_0$  : There is a unit root (Non-stationary).

$H_1$  : There is no unit root (Stationary).

Decision rule: Reject  $H_0$  if P-value is lower than significant level, otherwise do not reject  $H_0$ .

In this study, Modified Akaike Information Criteria (MAIC) is selected in choosing lag length for Augmented Dickey-Fuller Test with two model of constant without trend but with level and first difference comparatively.

### **3.5.9 Johansen & Juselius Cointegration Test**

First of all, co-integration refers to time series variables are cointegrated but with lower order of integration in linear combination which is, in example, first-order integrated  $I(1)$ . It enables incorporation of long run expectations (correction to equilibrium) and short term dynamics (deviations from equilibrium) according to Low and Chan (2017). The reason that resulting in wrong suggestion of relationships in spurious regressions is because of non-stationary variables that standard regression analysis is wrong. Therefore, econometric theories are unable to use on such regressions (Granger & Newbold, 1974).

In order to counter this problem, Johansen-Juselius Co-integration tests are applied to identify multivariate (system-based) long run relationship between economic variables within different models. There are two tests which are trace test and maximum eigenvalue test.



Hypothesis for both of the test are stated in below:

$H_0$  : There is no co-integration vector.

$H_1$  : There is co-integration vector.

Decision rule: Reject  $H_0$  if P-value is lower than significant level, (T-statistic value is higher than upper critical value) otherwise do not reject  $H_0$ .

### **3.6 Conclusion**

In conclusion, chapter 3, Methodology has provided a clear description and explanation on the research design, method of data collection and methods of data processing as well as the analysis of data. Besides of that, this chapter also vividly describe the econometric model that is used during this study. Last but not least, there are some explanations for all econometric methods and statistical test applied are clearly provided and stated in this research.

## **CHAPTER 4 : DATA ANALYSIS**

### **4.0 Introduction**

Ordinary Least Square (OLS) and multiple linear regression models are used to present the data analysis of the research. The test results will show the relationships between the exchange rate volatility and export rate, inflation, lending interest rate and Gross Domestic Product (GDP). The data analysis conducted using E-views 7.

### **4.1 Ordinary Least Square (OLS)**

Ordinary Least Square (OLS) is widely applied to estimate the model. According to Łukawska-Matuszewska & Urbański (2014), a global model of the variables analysis is provided by Ordinary Least Square (OLS). A regression equation is the output of the analysis that examines the relationship between exchange rate volatility and independent variables like export rate, inflation rate, lending interest rate and Gross Domestic Product (GDP). Unknown parameter can be forecasted by using OLS.

The following represents the multiple linear regressions.

$$Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \epsilon$$

$$\text{LOGER} = \beta_0 + \beta_1 \text{EXPT} + \beta_2 \text{LOGIF} + \beta_3 \text{IR} + \beta_4 \text{GDP} + \epsilon$$

Where,

Y = ER = Exchange Rate Volatility (LCU per USD)

X<sub>1</sub> = EXPT = Export Rate Index (2000=100)

$X_2 = IF =$  Inflation Rate (Consumer Prices, Percentage per annum)

$X_3 = IR =$  Lending Interest Rate in Malaysia (Percentage per annum)

$X_4 = GDP =$  Gross Domestic Product Growth (Percentage per annum)

### **The Relationship between Export Rate (EXPT) and Exchange Rate Volatility (ER)**

According to Abdoh *et al.* (2016), export rate plays an important role in determining volatility of exchange rate and it is significant. The researchers found that export rate is the most influential factor in determining the exchange rate volatility of ASEAN countries. Besides, the correlation between export rate and exchange rate is shown to be positively related, which indicates that the two variables are moving in the same direction. Another study by Akhter and Faruqui (2015) also found that export rate and exchange rate is having a positively significant relationship. An appreciation in export rate will bring a positive effect on the exchange rate.

However, Zakaria (2013) research results shown that the impact of export rate on exchange rate is ambiguous. The export rate is found to be significant in Malaysia's exports to United States (U.S.) and Japan while exports to United Kingdom (U.K.) and Singapore is found to be insignificant.

### **The relationship between Inflation Rate (IF) and Exchange Rate Volatility (ER)**

The relationship between inflation and exchange rate volatility is expected to has a positive coefficient in the research, where indicates exchange rate volatility increase is caused by an increase in inflation. According to Abdoh *et al.* (2016), inflation and real exchange rate is positive related for Asia. Moreover, Inflation and real exchange rate is having a causal relationship.

### **The relationship between Lending Interest Rate (IR) and Exchange Rate (ER)**

Interest rate caused exchange rate to change as it is one of the main macroeconomic variables. According to Abdoh *et al.* (2016), interest rate is positively related with the exchange rate. Moreover, the study also mentioned that interest rate's changes could lead to appreciation or depreciation of the currency. For example, when the change of interest rate is positive, it will make the currency appreciate and vice versa. The hypotheses of the study also show that interest rate has an insignificant relationship with the exchange rate. While Wilson and Sheefeni (2014) indicate that interest rate could lead to monetary expansion or tightening, which will affect the prices and output in an economy. However, Wilson and Sheefeni (2014) also dictate that lending interest rates and exchange rates volatility are negatively related.

### **The relationship between Gross Domestic Product (GDP) and Exchange Rate Volatility (ER)**

Cuiabano and Divino (2010) have shown that the relationship is negative but significant between economic growth and exchange rate in short and long run in the case of Brazil. In other words, currency will depreciate as economic growth increase. However, according to Parveen, Khan and Ismail (2012), their empirical study indicates that it is significant and positive relationship between the GDP and exchange rate volatility in the case of Pakistan. In the case of India, the research that is conducted by Mirchandani (2013) stated that GDP and exchange rate volatility is moderate significant and positive related at significant level of 0.05. However, both of the variables do not have very significant relationship according to their results. However, other variables such as imports of goods and services provide road for both of the variables to be linked indirectly. Therefore, it can be concluded that each country would yield a different result.

**Original Econometric Model** : (Please refer to Appendix 4.1)

$$\widehat{\text{LOGER}} = 1.851993 - 0.000865 \text{ EXPT} + 0.034559 \text{ LOGIF} - 0.061543 \text{ IR} \\ - 0.026185 \text{ GDP}$$

SE	= 0.26300	0.000741	0.041734	0.024014
	0.006557			
t-stat	= 7.041790	-1.166897	0.828066	-2.562864
	-3.993452			
Prob.	= 0.0000	0.2543	0.4155	0.0168
	0.0005			

$$\text{F stat} = 8.331918$$

$$\text{Prob.} = 0.0002$$

$$R^2 = 0.571387$$

$$\bar{R}^2 = 0.502809$$

Where,

$Y = \text{ER} = \text{Exchange Rate Volatility (LCU per USD)}$

$X_1 = \text{EXPT} = \text{Export Value Index (2000=100)}$

$X_2 = \text{IF} = \text{Inflation Rate (Consumer Prices, Percentage per annum)}$

$X_3 = \text{IR} = \text{Lending Interest Rate in Malaysia (Percentage per annum)}$

$X_4 = \text{GDP} = \text{Gross Domestic Product Growth (Percentage per annum)}$

Time period,  $t = 1987 - 2016$

**Econometric Model with Best Linear Unbiased Estimator (BLUE) :**

(Please refer to Appendix 4.6)

$$\widehat{\text{LOGER}} = 1.851993 - 0.000865 \text{ EXPT} + 0.034559 \text{ LOGIF} - 0.061543 \text{ IR} - 0.026185 \text{ GDP}$$

SE	= 0.272747	0.000788	0.032572	0.022931
	0.006849			

t-stat	= 6.790139	-1.097761	1.060990	-2.683807
	-3.823065			

Prob.	= 0.0000	0.2828	0.2988	0.0127
	0.0008			

F stat = 8.331918

Prob. = 0.0002

R<sup>2</sup> = 0.571387

$\bar{R}^2$  = 0.502809

Where,

Y = ER = Exchange Rate Volatility (LCU per USD)

X<sub>1</sub> = EXPT = Export Value Index (2000=100)

X<sub>2</sub> = IF = Inflation (Consumer Prices, Percentage per annum)

X<sub>3</sub> = IR = Lending Interest Rate in Malaysia (Percentage per annum)

X<sub>4</sub> = GDP = Gross Domestic Product Growth (Percentage per annum)

Time period, *t* = 1987 – 2016

**Interpretation:**

$\hat{\beta}_0 = 1.851993$  indicates that if there is no export rate, no lending interest rate, no inflation rate, no gross domestic products, the estimated exchange rate volatility increase by 1.85%.

$\hat{\beta}_1 = -0.000865$ . Export rate was found to be insignificant, therefore interpretation is inappropriate for this coefficient.

$\hat{\beta}_2 = 0.034559$ . Inflation was found to be insignificant, therefore interpretation is inappropriate for this coefficient.

$\hat{\beta}_3 = -0.061543$  indicates that when lending interest rate rises by 1%, the estimated exchange rate volatility in Malaysia will decrease by 0.060235%, ceteris paribus.

$\hat{\beta}_4 = -0.026185$  indicates that when gross domestic product rises by 1%, the estimated exchange rate volatility in Malaysia will decrease by 0.025762%, ceteris paribus.

$R^2 = 0.571387$  indicates that approximately 57.14% of the exchange rate in Malaysia is explained by export rate, inflation rate, lending interest rate, and gross domestic products and in Malaysia.

$\bar{R}^2 = 0.502809$  indicates that approximately 50.28% of the exchange rate volatility in Malaysia is explained by export rate, inflation rate, lending interest rate, and Gross Domestic Products (GDP) in Malaysia, after taking the degree of freedom into account.

**Correlation Analysis:****Correlation Coefficient**

Coefficient of correlation measures the relationship between two variables. A positive sign means that the variables are moving in same direction and a negative sign means the variables move in opposite direction.

The correlation coefficient values range from +1 to -1. Correlation coefficient closer to +1 indicates the two variables are having stronger positive relationship, while closer to -1 indicating stronger negative relationship. Meanwhile, zero correlation coefficient indicates there is no relationship between the two variables (Gogtay & Thatte, 2017).

Table 4.1 Correlation analysis

	<b>EXPT</b>	<b>LOGIF</b>	<b>IR</b>	<b>GDP</b>
<b>EXPT</b>	1.000000	-0.019605	-0.869705	-0.286979
<b>LOGIF</b>	-0.019605	1.000000	0.233687	0.181435
<b>IR</b>	-0.869705	0.233687	1.000000	0.143365
<b>GDP</b>	-0.286979	0.181435	0.143365	1.000000

**i) Correlation between Export Rate (EXPT) and Inflation Rate (IE)**

The correlation coefficient between export rate and inflation rate is -0.019605. This indicates that the two variables have very weak negative relationship. They move in opposite direction where export rate increase, inflation rate will decrease and vice versa but in a very low fluctuation.



**ii) Correlation between Export Rate (EXPT) and Lending Interest Rate (IR)**

The correlation coefficient between export rate and lending interest rate is -0.869705, indicating strong negative relationship between the two variables. When EXPT increase, IR will decrease.

**iii) Correlation between Export Rate (EXPT) and Gross Domestic Product (GDP)**

The coefficient of correlation between export rate and Gross Domestic Product (GDP) is -0.286979 which indicates that it has weak negative relationship. EXPT and GDP move in opposite direction.

**iv) Correlation between Inflation Rate (IF) and Lending Interest Rate (IR)**

The correlation coefficient between inflation and lending interest rate is 0.233687. This indicates that the two variables have weak positive relationship. They move in same direction where an increase in IF will lead to an increase in IR, vice versa.

**v) Correlation between Inflation Rate (IF) and Gross Domestic Product (GDP)**

The correlation between IR and GDP is 0.181435, indicating the two variables are weakly related in a positive manner. When IR increases, GDP increases as well and when IR decreases, GDP decreases as well.

**vi) Correlation between Lending Interest Rate (IR) and Gross Domestic Product (GDP)**

The coefficient of correlation of interest rate and gross domestic product is 0.143365. it determines a weak positive relationship between the two variables. The variables move in same direction where IR increases, GDP increases too.

### 4.1.1 F-test

*(Please refer to Appendix 4.6)*

<b>H<sub>0</sub></b>	: $\beta_1 \beta_2 \beta_3 \beta_4 = 0$
<b>H<sub>1</sub></b>	: At least one of the variables is different from zero, where $i = 1, 2, 3, 4$
<b>Significance Level</b>	: $\alpha = 0.05$
<b>Decision Rule</b>	: Reject H <sub>0</sub> , if P-value less than significant level at 0.05. Otherwise, do not reject H <sub>0</sub> .
<b>P-Value</b>	: 0.0002
<b>Decision Making</b>	: Reject H <sub>0</sub> , since P-value is 0.0002 which is less than significant level at 0.05.
<b>Conclusion</b>	: It has sufficient evidence to conclude that the whole model is significant.

### 4.1.2 T-test

*(Please refer to Appendix 4.6)*

#### **Relationship between Exchange Rate Volatility (ER) and Export Rate (EXPT):**

<b>H<sub>0</sub></b>	: $\beta_1 = 0$
<b>H<sub>1</sub></b>	: $\beta_1 \neq 0$
<b>Significant Level</b>	: $\alpha = 0.05$
<b>Decision Rule</b>	: Reject H <sub>0</sub> if P-value less than significant level at 0.05. Otherwise, do not reject H <sub>0</sub> .
<b>P-value</b>	: 0.2828
<b>Decision Making</b>	: Do not reject H <sub>0</sub> , since P-value (0.2543) is greater than significant level at 0.05.
<b>Conclusion</b>	: It has insufficient evidence to conclude that export rate has a significant relationship with export rate.

**Relationship between Exchange Rate Volatility (ER) and Inflation****Rate (IF):**

<b>H<sub>0</sub></b>	: $\beta_3 = 0$
<b>H<sub>1</sub></b>	: $\beta_3 \neq 0$
<b>Significant Level</b>	: $\alpha 0.05$
<b>Decision Rule</b>	: Reject H <sub>0</sub> if P-value less than significant level at 0.05. Otherwise, do not reject H <sub>0</sub> .
<b>P-value</b>	: 0.2988
<b>Decision Making</b>	: Do not reject H <sub>0</sub> , since P-value (0.4155) is greater than significant level at 0.05.
<b>Conclusion</b>	: It has insufficient evidence to conclude that exchange rate volatility has a significant relationship with inflation rate.

**Relationship between Exchange Rate Volatility (ER) and Lending****Interest Rate (IR):**

<b>H<sub>0</sub></b>	: $\beta_2 = 0$
<b>H<sub>1</sub></b>	: $\beta_2 \neq 0$
<b>Significant Level</b>	: $\alpha 0.05$
<b>Decision Rule</b>	: Reject H <sub>0</sub> if P-value less than significant level at 0.05. Otherwise, do not reject H <sub>0</sub> .
<b>P-value</b>	: 0.0127
<b>Decision Making</b>	: Reject H <sub>0</sub> , since P-value (0.0168) is less than significant level at 0.05.
<b>Conclusion</b>	: It has sufficient evidence to conclude that exchange rate volatility has a significant relationship with lending interest rate.

**Relationship between Exchange Rate Volatility (ER) and Gross Domestic Product (GDP)**

<b>H<sub>0</sub></b>	: $\beta_4 = 0$
<b>H<sub>1</sub></b>	: $\beta_4 \neq 0$
<b>Significant Level</b>	: $\alpha$ 0.05
<b>Decision Rule</b>	: Reject H <sub>0</sub> if P-value less than significant level at 0.05. Otherwise, do not reject H <sub>0</sub> .
<b>P-value</b>	: 0.0008
<b>Decision Making</b>	: Reject H <sub>0</sub> , since P-value (0.0005) is which less than significant level at 0.05.
<b>Conclusion</b>	: It has sufficient evidence to conclude that exchange rate volatility has a significant relationship with Gross Domestic Product (GDP).

### 4.1.3 Normality Test

*(Please refer to appendix 4.2)*

<b>H<sub>0</sub></b>	: Error terms are normally distributed.
<b>H<sub>1</sub></b>	: Error terms are not normally distributed.
<b>Decision Rule</b>	: Reject H <sub>0</sub> if P-value is less than significance level. Otherwise, do not reject H <sub>0</sub> .
<b>Significance Level</b>	: $\alpha$ 0.05
<b>P-Value</b>	: 0.411983
<b>Decision Making</b>	: Do not reject H <sub>0</sub> . P-value (0.411983) is greater than significance level at 0.05.
<b>Conclusion</b>	: It has sufficient evidence to conclude that the model is normally distributed at 5% significance level.

In order to the normality of the error term of the model, Jarque-Bera (JB) Test is used. From the result, the error term of the model is normally distributed since the p-value obtained is greater than the significance level ( $\alpha$ ) at 5% which is 0.05.

#### 4.1.4 Multicollinearity

*(Please refer to Appendix 4.3)*

From the result of the OLS model, the coefficient of determination ( $R^2$ ) shown is 0.571387.  $R^2$  determine how well the model fits the data thus, this shows that the overall regression model fitted the data by 57.14%. This also explained that 57.14% of changes in the exchange rate of Malaysia is determined by the changes in export rate, inflation rate, lending interest rate and GDP in Malaysia.

Variance Inflation Factor (VIF) is being used to test for multicollinearity between the independent variables. It determined how much the variance of the coefficients are inflated due to collinearity of variables in the model. Multicollinearity problem exist when VIF is greater than 10.

**VIF =** —

<b>Dependent variable</b>	<b>VIF</b>
Export Rate (EXPT)	$VIF_{EXPT} = \text{—————} = 3.218093$
Inflation Rate (IF)	$VIF_{IF} = \text{—————} = 1.083017$
Lending Interest Rate (IR)	$VIF_{IR} = \text{—————} = 3.160968$

Gross Domestic Product (GDP)	$VIF_{GDP} = \text{—————} = 1.050469$
---------------------------------	---------------------------------------

Table 4.2 Result of Variance Inflation Factor

Based on the result above, each VIF of the variables are below 10. Therefore, the regression model does not have serious multicollinearity between each independent variable.

#### 4.1.5 Heteroscedasticity

*(Please refer to appendix 4.4)*

Prob. Chi Square	0.8439
------------------	--------

- H<sub>0</sub>** : There is no heteroscedasticity problem in the model
- H<sub>1</sub>** : There is heteroscedasticity problem in the model
- Significant Level** : 0.05
- Decision Rule** : Reject H<sub>0</sub> if the P-value is less than significant level of 0.05. Otherwise, do not reject H<sub>0</sub>.
- Test Statistics** : P-value = 0.8439
- Decision Making** : Do not reject H<sub>0</sub> since the P-value (0.8439) is more than significant level at 0.05.
- Conclusion** : It has insufficient evidence to conclude that the model suffered from heteroscedasticity problem at significant level of 0.05.

White test has been used to determine heteroscedasticity problem of financial time series. According to the table above, the P-value is greater than the significant level at 0.05. Hence, Heteroscedasticity problem does not exist in the model.

### 4.1.6 Autocorrelation

(Please refer to Appendix 4.5)

Prob Chi Square	0.0008
-----------------	--------

**H<sub>0</sub>** : The model does not suffers from autocorrelation problem.

**H<sub>1</sub>** : The model suffers from autocorrelation problem.

**Significance Level** :  $\alpha$  0.05

**Decision Rule** : Reject H<sub>0</sub> if P-value lesser than significant level at 0.05. Otherwise, do not reject H<sub>0</sub>.

**P-value** : 0.0008

**Decision Making** : Reject H<sub>0</sub>, since P-value (0.0002) which is lesser than significant level at 0.05.

**Conclusion** : It has sufficient evidence to conclude that the model suffer from autocorrelation problem.

Newey-west (HAC) Test is used in the research in order to solve autocorrelation problem. Table below shows the comparison of coefficient and standard error for the variables after using Newey-west (HAC) Test. The results show that there are differences in standard errors whereas there is no change in the coefficient estimates after using Newey-west Test. There is no autocorrelation since there are consistent variances based on the results. Moreover, changes in the standard error will increase the significance of the variable. Thus, the autocorrelation problem was solved in this model.

Variables	Original OLS		Newey-west (HAC) Test	
	Coefficient	Standard Error	Coefficient	Standard Error
EXPT	-0.000865	0.000741	-0.000865	0.000788
LNIF	0.034559	0.041734	0.034559	0.032572
IR	-0.061543	0.024014	-0.061543	0.022931
GDP	-0.26185	0.006557	-0.026185	0.006849
C	1.851993	0.263000	1.851993	0.272747

#### 4.1.7 Model Specification Bias

*(Please refer to Appendix 4.7)*

- H<sub>0</sub>** : The model is correctly specified.
- H<sub>1</sub>** : The model is not correctly specified.
- Significance Level** :  $\alpha$  0.05
- Decision Rule** : Reject H<sub>0</sub> if P-value less than significant level at 0.05. Otherwise, do not reject H<sub>0</sub>.
- P-value** : 0.1199
- Decision making** : Do not reject since the P-value is greater than significant level at 0.05.
- Conclusion** : It has insufficient evidence to conclude that the model is not correctly specified at 5% significance level. Therefore, the model is correctly specified.



### 4.1.8 Unit Root Test

(Please refer to Appendix 4.8)

ADF Unit Root Test

Variables	Level Constant without trend	Lag	First Difference Constant without Trend	Lag
Log(ER)	-1.498991(0.5194)	1	-4.108402*(0.0036)	0
Log(INF)	-5.990513*(0.0000)	0	-6.488326*(0.0000)	1
EXPT	-0.990894(0.7430)	0	-5.424316*(0.0001)	0
INT(IR)	-1.109068(0.6984)	0	-4.953379*(0.0004)	0
GDP	-4.386508*(0.0017)	0	-7.607007*(0.0000)	1

Note: P-value are presented in the parentheses ( ). \* denotes significant at 5% level

According to this table, the result shows that Log(ER), EXPT and INT cannot reject null hypothesis in the form of Level and constant without trend whereas Log(INF) and GDP shows that null hypothesis should be rejected at the significant level of 5%. Following that, the first difference of Augmented Dickey-Fuller test displays that all variables reject null hypothesis since the P-value is greater than significance level at 5%. In other words, stationary occurs in all of the variables.

Since some of the variables do not reject null hypothesis in level form in the first places, fruitful long-term information cannot be obtained. Moreover, the result also becomes stationary only after first difference for unit root test. Therefore, co-integration test can be used to find out the long run equilibrium interrelationship of the variables since it has fulfilled the criteria integrated of order 1.

## 4.1.9 Cointegration Test

### Johansen & Juselius Cointegration Test

*(Please refer to Appendix 4.9)*

Test Statistic	86.26104
Critical Value	69.81889

Consequently, Johansen and Juselius (1990) Co-integration tests are applied to study the existence of long term balance interrelationship of the variables. From the table, the null hypothesis is rejected based on trace test statistic of 86.26104 which is greater than critical value 69.81889 at 5% significance level. In other words, there is a minimum of 1 co-integrating vector. Beside of that, Maximum Eigenvalue test also have shown a result of rejecting null hypothesis since the max-eigen t-statistic is greater than critical value at 33.87687 at significance level of 5%. Since both of the tests also rejected null hypothesis, it can conclude that long run equilibrium relationship does exist among the four variables (Low & Chan, 2017).

## 4.2 Conclusion

The explanations of Ordinary Least Square (OLS) are presented in the beginning of this chapter. Moreover, the approaching relationship between exchange rate volatility and independent variables like export rate, inflation rate, lending interest rate and Gross Domestic Product (GDP) presented in this chapter. E-views 7 is used to compute and analyse the relationship between the dependent variable and independent variables. The results shown are consistent with the past research. However, some of the independent variables like export rate are not consistent with the expected relationship and the significance. Thus, explanation of results will be further discussed in chapter five.

## **CHAPTER 5 : DISCUSSION, CONCLUSION AND IMPLICATIONS**

### **5.0 Introduction**

The outline of this chapter is about the test statistic results as well as analyses which discussed in previous chapter. Besides, the objectives and hypothesis of this study will be certified and discussed in detail under major findings. Moreover, discussion for the implication of this study is also included under this chapter. Limitations faced while doing this research and recommendations to improve future research are being discussed as well.

### **5.1 Statistical Analyses**

Table 5.1 : Expected and actual statistic result

<b>Variables</b>	<b>Actual Result</b>	<b>Expected Relation</b>
EXPT and ER	Insignificance	Negative
IF and ER	Insignificance	Positive
IR and ER	Negative Significance	Negative
GDP and ER	Negative Significance	Negative

Table 5.2 : The Summary of Results

Test	Result
F-test	The model is significant
T-test	Only lending interest rate (IR) and gross domestic product (GDP) are significant related with exchange rate volatility (ER)
Normality Test	The model is normally distributed
Multicollinearity	No multicollinearity
Heteroscedasticity	The model does not has heteroscedasticity
Autocorrelation	The model has autocorrelation, but solved using Newey-west Test
Model Specification Bias	The model is correctly specified
Unit Root Test	Stationary occurs in all variables
Cointegration	The four variables do not have long run equilibrium relationship

## 5.2 Discussion of Major Findings

### 5.2.1 Export Rate

Based on result obtained, export rate is having an insignificant effect on the exchange rate of Malaysia at 5% significant level ( $\alpha$ ). This result is in line with Zakaria (2013) research in which it shown that export rate and exchange rate is having an ambiguous relationship. It could be insignificantly or significantly related depending on the trading countries. The regression analysis result shown Malaysia's export to the U.S. and Japan is significant related while Malaysia's export to the U.K. and Singapore is insignificantly related to the exchange rate volatility.

Malaysia is a country with comparatively smaller domestic market; therefore, international trade plays a crucial role affecting its economic growth. One of the main concerns for an export-leading growth country like Malaysia is that its export sector could be easily exposed to the harmful effect from external shocks, in a highly open economy. Hence, the findings from this research evidently shown the significance of export rate towards exchange rate volatility is uncertain (Zakaria, 2013).

In contrast, Abdoh *et al.* (2016) found that export rate and exchange rate volatility is significantly related. The research results shown that export rate is the most significant variable in affecting the volatility of exchange rate, indicating export rate is crucial in determining the movements of exchange rate in ASEAN countries which includes Malaysia. In addition, according to Akhter and Faruqui (2015), the export rate is having a positive relationship with exchange rate. The researchers' result shown that when export rate increase, the exchange rate will appreciate too.

### **5.2.2 Inflation**

The study showed that the inflation rate is insignificant in affecting the exchange rate. The outcome obtained is corresponded with the result found by Abdoh *et al.* (2016) which states that the two variables is insignificantly related. However, inflation rate shows a quite weak relationship with exchange rate volatility. According to Ebiringa and Anyaogu (2014), the impacts of inflation rate on exchange rate will be different based on different countries. Therefore, the findings for the research would be different according to different countries. On the other hand, Ali, Mahmood and Bashir (2015) stated that inflation rate and exchange rate is positively related. Moreover, in distant future and short term period the influence of inflation rate on the exchange rate volatility also vary from time to time.

Ramasamy and Abar (2015) mentioned that based on the theory, the inflation should have affecting the exchange rate positively, however, the results from their research shown is negatively affecting the exchange rate. Domestic currency value falls when the inflation is high. The main reason of causing the difference is the value of currency is strong. In addition, the strength of the currency is determined by the public and investors' confidence. It is not from the dominant economic variable in the particular country.

### **5.2.3 Lending Interest Rate**

Based on this research, it clearly shown the lending interest rate and exchange rate is negative and statistically significant. Ali, Mahmood and Bashir (2015) mentioned that high interest rate significantly reduces the exchange rate volatility. Moreover, the researchers also discovered that interest rate and exchange rate is negatively related. An appreciation in interest rate will result in depreciation in exchange rate. Therefore, the result of this study is reliable since it is in line with the researchers' result.

The result shows that lending interest rate is significantly related to exchange rate volatility. This indicates that the lending interest rate is an important determinant that significantly affecting the exchange rate. The volatility of interest rate and exchange rate is higher compare to other variables such as inflation rate and money supply (Ali, Mahmood, & Bashir, 2015). Dash (2012) also believed that high interest rate will result to a lesser borrowing from the public because the cost of borrowing becomes higher. Moreover, Dash (2012) also mentioned that the repayment probabilities of domestic firms and banks will fall causing by a high interest rate. They are not able to repay their external debt. This is because high interest rate will reduce domestic firms' profitability and increase borrowing costs which negatively affect the economic activity

domestically. Consequently, an increase in interest rate will lead to an outflow of capital and this, eventually causes depreciation in the exchange rate.

Wilson and Sheefeni (2014) found that interest rate and exchange rate is insignificantly related. Prices in an economy are affected by the interest rate changes from monetary expansion or tightening. Thus, interest rate should be adjusted and controlled from time to time as it is an important factor that affects macroeconomic policy decision.

However, Abdoh *et al.* (2016) stated that different researchers might found different results regarding to relationship of interest rate and exchange rate, which indicating inconsistency of result is possible. This is because different time period and different countries were studied by different researches where these differences will provide different outcomes.

#### **5.2.4 Gross Domestic Product (GDP)**

As refer to the empirical result of this research, there is a negatively significant relationship between GDP and exchange rate in the case of Malaysia at 5% significant level. It means that that exchange rate of currency of Malaysia will depreciate by the increase in economic growth, vice versa. In fact, it can be viewed as the country has adopted policy of monetary expansion to promote economic growth in which local currency is being spent excessively inside the country (Cuiabano & Divino, 2010).

However, the effect of economic growth on exchange rate volatility might not be the same for different country. In the perspective of underdeveloped countries, they are striving to increase their economic growth. Therefore, appreciation of the value of currency may not be wise for underdeveloped countries as it will reduce their exports to other countries and it will

decrease economic growth and earning. In contrast, depreciation in currency may lead to debt accumulation. Thus, it is advised to set the exchange rate at a sustainable level (Bashir & Luqman, 2014).

When a country falls into recession, it can be predictable that the country will most probably lowers down the interest rate compared to other countries in future to promote competitiveness or to boost economic growth. Theoretically, it will make domestic currency less attractive compared with foreign currency, causing investors to save less in home country and seek for foreign countries with higher interest rates and invest in it. Therefore, the flow of money out of the country will cause the domestic currency value to decrease (Cuiabano & Divino, 2010). This theory is also in line with the empirical result of this study.

### **5.3 Implication of Study**

As mention in the earlier part of this research, it can impact Malaysia in various ways. Through the result of this study, policymakers can make better decision by understanding and balancing the effect of each macroeconomic factor on exchange rate volatility and able to be more flexible in formulating economic policies according to needs of the country when exchange rate can be control (Chong & Tan, 2007). The balance between fiscal policy and monetary policy can be effectively linked as well as trade policy. By using these policies effectively, the economy of a country will keep growing while maintaining inflation at a conducive level (Parveen, Khan & Ismail, 2012). Beside of that, the result also can act as a motivation or strength in decision making to policymakers as they can refer to the fact or relationship of the independent variables of this study with exchange rate volatility of Malaysia. In addition to that, policymakers also can predict the impact of the policies to country if they have implemented them.



Moreover, this study also contributes to researchers and academicians who have interest in this topic. It can be used to make comparison with other study of the similar topic on the macroeconomic factors and act as an enhancement for future research. As example, every researcher uses different approaches to carry out statistical tests in their studies. Different approaches can provide the answer as to why some of the methods can be applied successfully whereas some methods failed to do so. Therefore, continuous innovation and research is needed in order to have better understanding about the interaction between macroeconomic variables and exchange rate volatility as any new findings can be beneficial in modifying the model.

As exchange rate changes will affect the profit and loss of a foreign or local investor, this empirical result can act as a benchmark for investors to predict the changes on exchange rate. A good investor will not only look at the fundamental analysis of a company, but also the macroeconomic variables outlook of the country as any changes in the variables will affect their investment, which includes exchange rate too. The strengthening and weakening in local currency against other currencies will influence the purchasing power of investors and also investors' gain from investment. Therefore, the risk evaluation should include exchange rate volatility as it will affect an investor's foreign investment return. Lastly, it will enhance decision making of investors in investment which helps them to reduce losses as much as possible and maximize their gain.

## **5.4 Limitation**

Throughout this research, there are several limitations that will influence the outcome of the research. First of all, the availability of the data is limited. Quarterly data from the year 1995 to 2016 for each of the variables was initially planned to be adopted. However, the data for one of the variables is only available in annually form. Therefore, annual data from the year 1987 to 2016 is decided to be used in this study. As a result, the amount of data and the sample size has

decreased. When the number of observations decreases, the information in the regression model are less sufficient. Insufficient of information will then leads to inaccurate and misleading results in the diagnostic checking.

Moreover, the previous model suffers from heteroscedasticity and autocorrelation problem. These might be due to annually data was being used in this study. The application of annual data will increase the probability for the models to suffer from autocorrelation problem. When heteroscedasticity and autocorrelation problem are detected, several methods have been tried out in order to solve the problems. Finally, the researchers decided to remove a variable initially used which is money supply from the model and replaced with gross domestic product (GDP). Another problem occurs which is the secondary information for the newly added variable GDP is limited. Most of the journals are discussing on how exchange rate will affect GDP while this research is studying on how GDP will affect exchange rate volatility. Thus, lacks of reliable and supportive findings occur since not all the findings from the journal are applicable to this research.

In addition, limited variables are also one of the limitation encounters in this research. The aim of this research is to study on how inflation rate, lending interest rate, gross domestic product and export rate will affect exchange rate volatility. However, there are still a lot of macroeconomic determinants that can bring an impact to the exchange rate volatility other than the four variables included. It is proven that researches might have bias result due to omitted important variables. Hence, researchers need to choose the most significant variables in order to conduct a better research.

Lastly, certain variables can hardly find the similar journal to support the result in this research. For example, most of the journals showed that export rate should be the most significant variable but the result from this research showed that export rate is insignificant. Furthermore, the dependent and independent variables is having an ambiguous relationship by referring to the result from different journals. Some journals mentioned that lending interest rate is negatively related to the

exchange rate while some journals indicate that they should be positively related. Each research is not necessarily using the same types of country and statistical method. Therefore, different researches might have different result regarding the relationship between the variables.

## **5.5 Recommendations**

As a few limitations have been confronted while doing this study, several recommendations are being proposed in order to help to improve future researches on the macroeconomics variables that affect exchange rate.

First and foremost, the availability of data from various databases is limited in which the time period of the data for different variables are inconsistent. Thus, in order to ensure the consistency of data and to ensure a normal sample size, researchers are recommended to study on the variables which the data is available is semi-annually or quarterly. Researchers are also recommended to study on the variables in which the data is available from the earlier year like 1980-an to ensure there is sufficient data for normal sample size in running various statistical tests. Larger sample size of at least 30 is important to minimize the possibilities of outlier in the statistical test and to obtain a more accurate result.

The methodology used to test for heteroscedasticity and autocorrelation in this research are White Test and Neway-west Test respectively. This eventually solved the heteroscedasticity problem which could not be solved when using ARCH Test and autocorrelation problem when using Breusch-Godfrey Serial Correlation LM Test. As autocorrelation problem often occurs in time series data, Neway-west Test does not consider the assumptions of regression analysis. Moreover, White Test is easy to apply in solving heteroscedasticity problem and it is not affected by the assumption of normality test. Hence, researchers are recommended to use White Test and Neway-west Test instead as these tests provide a better and more reliable result compare to the latter tests mentioned.

It is recommended to study more variables that determined the exchange rate volatility in addition to export rate, inflation rate, lending interest rate and GDP. Important variables such as money supply, import rate and foreign direct investment which are omitted in this research might be greatly influencing the results of the study. The R-squared which indicates how much the model fits for the data might be improves, enhancing the reliability of the model as well.

Last but not least, journal articles which are important to act as supporting evidence are difficult to find on online platforms like Google Scholars and UTAR online Library E-Resources. Many of the journals found might need reader to purchase in order to access it. Thus, it is recommended that future researchers can find the supporting evidence from more sources such as textbooks or any other reference books which are available in library in addition to journals found online. This could greatly improve the empirical evidence and research results of the study.

## **5.6 Conclusion**

In a nut shell, the study on the impact of macroeconomic variables like export rate, inflation, lending interest rate and Gross Domestic Product (GDP) on exchange rate volatility in Malaysia has done in this research. The identification and look into the macroeconomic variables that bring an effect to the exchange rate volatility are objective of this research. The macroeconomics variables are export rate, inflation rate, lending interest rate and gross domestic product (GDP). According to the major findings, the results obtained shows that gross domestic product (GDP) and lending interest rate is negatively related to the exchange rate volatility. Furthermore, the export rate and inflation rate show insignificant relationship with the exchange rate volatility.

Useful information regarding the impact of macroeconomic variables on the exchange rate volatility could be provided by this research to government,

investors and policy makers. Besides, the limitation which has been encountered during the research's progress was also discussed in this chapter. In conjunction with the limitations, recommendations are provided and suggested to help to improve future researches.

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**APPENDIX**
**Appendix 4.1 : Original OLS Model**

Dependent Variable: LOGER

Method: Least Squares

Date: 03/09/18 Time: 01:05

Sample: 1 30

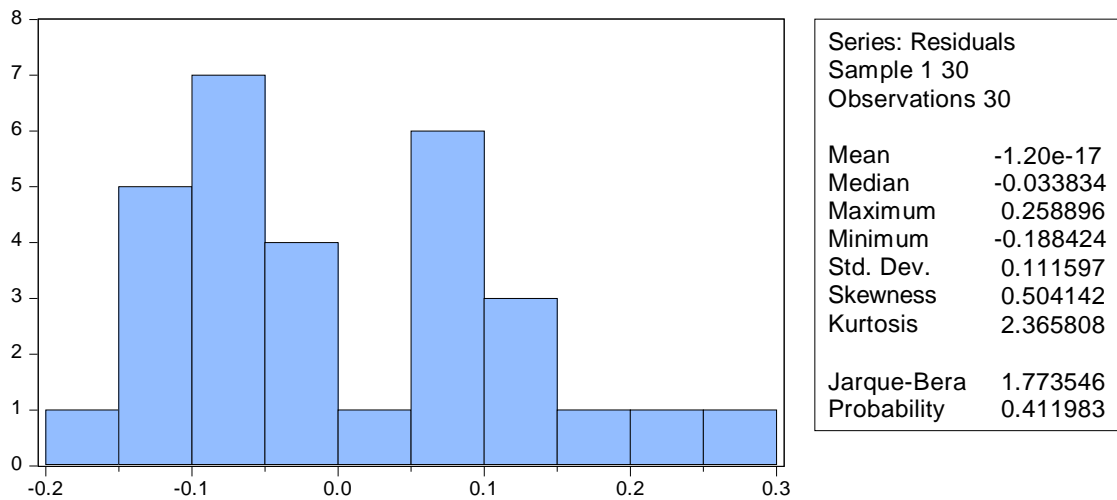
Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXPT	-0.000865	0.000741	-1.166897	0.2543
LOGIF	0.034559	0.041734	0.828066	0.4155
IR	-0.061543	0.024014	-2.562864	0.0168
GDP	-0.026185	0.006557	-3.993452	0.0005
C	1.851993	0.263000	7.041790	0.0000
R-squared	0.571387	Mean dependent var	1.161750	
Adjusted R-squared	0.502809	S.D. dependent var	0.170459	
S.E. of regression	0.120193	Akaike info criterion	-1.248416	
Sum squared resid	0.361162	Schwarz criterion	-1.014883	
Log likelihood	23.72624	Hannan-Quinn criter.	-1.173707	
F-statistic	8.331918	Durbin-Watson stat	0.699497	
Prob(F-statistic)	0.000205			

---

Correlation analysis

	<b>EXPT</b>	<b>LOGIF</b>	<b>IR</b>	<b>GDP</b>
<b>EXPT</b>	1.000000	-0.019605	-0.869705	-0.286979
<b>LOGIF</b>	-0.019605	1.000000	0.233687	0.181435
<b>IR</b>	-0.869705	0.233687	1.000000	0.143365
<b>GDP</b>	-0.286979	0.181435	0.143365	1.000000

Appendix 4.2 : Normality Test



**Appendix 4.3 : Multicollinearity****1. Dependent variable: Export Rate (EXPT)**

Dependent Variable: EXPT

Method: Least Squares

Date: 02/24/18 Time: 11:33

Sample: 1 30

Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	337.3105	21.61442	15.60581	0.0000
LOGIF	26.20601	9.774773	2.680984	0.0126
IR	-29.24622	2.734887	-10.69376	0.0000
GDP	-3.789868	1.567785	-2.417339	0.0229
R-squared	0.830215	Mean dependent var		119.2848
Adjusted R-squared	0.810625	S.D. dependent var		73.08573
S.E. of regression	31.80491	Akaike info criterion		9.880684
Sum squared resid	26300.37	Schwarz criterion		10.06751
Log likelihood	-144.2103	Hannan-Quinn criter.		9.940452
F-statistic	42.37837	Durbin-Watson stat		0.895850
Prob(F-statistic)	0.000000			

**2. Dependent variable: Inflation Rate (LOGIF)**

Dependent Variable: LOGIF

Method: Least Squares

Date: 02/24/18 Time: 11:43

Sample: 1 30

Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2.598280	1.125935	-2.307664	0.0292

EXPT	0.008264	0.003083	2.680984	0.0126
IR	0.288475	0.097636	2.954591	0.0066
GDP	0.050638	0.029167	1.736121	0.0944
R-squared	0.276863	Mean dependent var		0.834709
Adjusted R-squared	0.193424	S.D. dependent var		0.628893
S.E. of regression	0.564806	Akaike info criterion		1.818896
Sum squared resid	8.294143	Schwarz criterion		2.005722
Log likelihood	-23.28344	Hannan-Quinn criter.		1.878663
F-statistic	3.318158	Durbin-Watson stat		1.608735
Prob(F-statistic)	0.035377			

### 3. Dependent variable: Lending Interest rate (IR)

Dependent Variable: IR

Method: Least Squares

Date: 02/24/18 Time: 11:44

Sample: 1 30

Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	10.58368	0.552472	19.15694	0.0000
EXPT	-0.027859	0.002605	-10.69376	0.0000
LOGIF	0.871339	0.294910	2.954591	0.0066
GDP	-0.094367	0.050250	-1.877962	0.0716
R-squared	0.826826	Mean dependent var		7.412134
Adjusted R-squared	0.806845	S.D. dependent var		2.233496
S.E. of regression	0.981609	Akaike info criterion		2.924319
Sum squared resid	25.05247	Schwarz criterion		3.111145
Log likelihood	-39.86478	Hannan-Quinn criter.		2.984086
F-statistic	41.37938	Durbin-Watson stat		0.903143
Prob(F-statistic)	0.000000			

#### 4. Dependent variable: Gross Domestic Product (GDP)

Dependent Variable: GDP

Method: Least Squares

Date: 02/24/18 Time: 11:51

Sample: 1 30

Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	19.54641	6.869097	2.845558	0.0085
EXPT	-0.048421	0.020031	-2.417339	0.0229
LOGIF	2.051508	1.181662	1.736121	0.0944
IR	-1.265719	0.673986	-1.877962	0.0716
R-squared	0.219190	Mean dependent var		6.101310
Adjusted R-squared	0.129096	S.D. dependent var		3.852228
S.E. of regression	3.594985	Akaike info criterion		5.520522
Sum squared resid	336.0218	Schwarz criterion		5.707349
Log likelihood	-78.80784	Hannan-Quinn criter.		5.580290
F-statistic	2.432912	Durbin-Watson stat		2.013417
Prob(F-statistic)	0.087626			

**Appendix 4.4 : Heteroscedasticity**

## Heteroskedasticity Test: White

F-statistic	1.734898	Prob. F(14,15)	0.1507
Obs*R-squared	18.54629	Prob. Chi-Square(14)	0.1830
Scaled explained SS	8.795373	Prob. Chi-Square(14)	0.8439

Test Equation:

Dependent Variable: RESID^2

Method: Least Squares

Date: 02/24/18 Time: 11:53

Sample: 1 30

Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-1.398514	0.458540	-3.049929	0.0081
EXPT	0.006742	0.002472	2.727147	0.0156
EXPT^2	-8.81E-06	3.52E-06	-2.505093	0.0243
EXPT*GDP	-0.000140	5.63E-05	-2.480655	0.0255
EXPT*IR	-0.000487	0.000224	-2.168720	0.0466
EXPT*LOGIF	0.000283	0.000355	0.797060	0.4379
GDP	0.040462	0.020201	2.002953	0.0636
GDP^2	-0.000142	0.000331	-0.430102	0.6732
GDP*IR	-0.003547	0.001955	-1.814949	0.0896
GDP*LOGIF	0.004108	0.004755	0.863934	0.4012
IR	0.240452	0.082331	2.920569	0.0105
IR^2	-0.010178	0.003642	-2.794735	0.0136
IR*LOGIF	0.006605	0.010157	0.650275	0.5253
LOGIF	-0.105306	0.119041	-0.884619	0.3903
LOGIF^2	-0.021431	0.011751	-1.823858	0.0882
R-squared	0.618210	Mean dependent var		0.012039
Adjusted R-squared	0.261872	S.D. dependent var		0.014310
S.E. of regression	0.012294	Akaike info criterion		-5.652513
Sum squared resid	0.002267	Schwarz criterion		-4.951914
Log likelihood	99.78769	Hannan-Quinn criter.		-5.428385
F-statistic	1.734898	Durbin-Watson stat		2.377721
Prob(F-statistic)	0.150704			

**Appendix 4.5 : Autocorrelation**

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	10.35691	Prob. F(2,23)	0.0006
Obs*R-squared	14.21552	Prob. Chi-Square(2)	0.0008

Test Equation:

Dependent Variable: RESID

Method: Least Squares

Date: 03/09/18 Time: 01:06

Sample: 1 30

Included observations: 30

Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXPT	0.000702	0.000624	1.125427	0.2720
LOGIF	-0.008607	0.031762	-0.270990	0.7888
IR	0.019947	0.019984	0.998150	0.3286
GDP	0.009434	0.005536	1.704200	0.1018
C	-0.278957	0.226454	-1.231848	0.2305
RESID(-1)	0.696598	0.202281	3.443718	0.0022
RESID(-2)	0.106595	0.228632	0.466228	0.6454
R-squared	0.473851	Mean dependent var		3.05E-17
Adjusted R-squared	0.336594	S.D. dependent var		0.111597
S.E. of regression	0.090895	Akaike info criterion		-1.757253
Sum squared resid	0.190025	Schwarz criterion		-1.430307
Log likelihood	33.35879	Hannan-Quinn criter.		-1.652660
F-statistic	3.452304	Durbin-Watson stat		1.520733
Prob(F-statistic)	0.014016			

Newey-West (HAC) test is used to fixed bandwidth test since there is an autocorrelation problem. Therefore, the overall model is adjusted without autocorrelation problem.

**Appendix 4.6 : Newey-West (HAC) Test**

Dependent Variable: LOGER

Method: Least Squares

Date: 03/09/18 Time: 01:07

Sample: 1 30

Included observations: 30

HAC standard errors & covariance (Bartlett kernel, Newey-West fixed  
bandwidth = 4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
EXPT	-0.000865	0.000788	-1.097761	0.2828
LOGIF	0.034559	0.032572	1.060990	0.2988
IR	-0.061543	0.022931	-2.683807	0.0127
GDP	-0.026185	0.006849	-3.823065	0.0008
C	1.851993	0.272747	6.790139	0.0000
R-squared	0.571387	Mean dependent var		1.161750
Adjusted R-squared	0.502809	S.D. dependent var		0.170459
S.E. of regression	0.120193	Akaike info criterion		-1.248416
Sum squared resid	0.361162	Schwarz criterion		-1.014883
Log likelihood	23.72624	Hannan-Quinn criter.		-1.173707
F-statistic	8.331918	Durbin-Watson stat		0.699497
Prob(F-statistic)	0.000205	Wald F-statistic		5.932822
Prob(Wald F-statistic)	0.001687			

**Appendix 4.7 : Model Specification Diagnostic Testing**

Ramsey RESET Test

Equation: UNTITLED

Specification: LOGER LOGIF IR GDP EXPT C

Omitted Variables: Powers of fitted values from 2 to 3

	Value	df	Probability
F-statistic	2.329465	(2, 23)	0.1199
Likelihood ratio	5.533633	2	0.0629

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.060835	2	0.030417
Restricted SSR	0.361162	25	0.014446
Unrestricted SSR	0.300327	23	0.013058
Unrestricted SSR	0.300327	23	0.013058

LR test summary:

	Value	df
Restricted LogL	23.72624	25
Unrestricted LogL	26.49306	23

Unrestricted Test Equation:

Dependent Variable: LOGER

Method: Least Squares

Date: 02/24/18 Time: 12:04

Sample: 1 30

Included observations: 30

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGIF	-0.734838	1.406240	-0.522555	0.6063
IR	1.265582	2.488008	0.508673	0.6158
GDP	0.534179	1.062054	0.502968	0.6198
EXPT	0.017597	0.034783	0.505914	0.6177
C	-30.76071	59.04438	-0.520976	0.6074
FITTED^2	20.91547	34.04720	0.614308	0.5450
FITTED^3	-6.629938	9.462353	-0.700665	0.4905

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R-squared	0.643583	Mean dependent var	1.161750
Adjusted R-squared	0.550605	S.D. dependent var	0.170459
S.E. of regression	0.114270	Akaike info criterion	-1.299537
Sum squared resid	0.300327	Schwarz criterion	-0.972591
Log likelihood	26.49306	Hannan-Quinn criter.	-1.194944
F-statistic	6.921874	Durbin-Watson stat	0.862045
Prob(F-statistic)	0.000269		

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**Appendix 4.8 Johansen & Juselius Cointegration Test**

Date: 02/26/18 Time: 01:46

Sample (adjusted): 3 30

Included observations: 28 after adjustments

Trend assumption: Linear deterministic trend

Series: LOGIF LOGER IR GDP EXPT

Lags interval (in first differences): 1 to 1

## Unrestricted Cointegration Rank Test (Trace)

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.758208	86.26104	69.81889	0.0014
At most 1	0.569091	46.51004	47.85613	0.0665
At most 2	0.436735	22.93798	29.79707	0.2491
At most 3	0.152433	6.865824	15.49471	0.5933
At most 4	0.076720	2.235029	3.841466	0.1349

Trace test indicates 1 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		Max-Eigen	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.758208	39.75100	33.87687	0.0089
At most 1	0.569091	23.57206	27.58434	0.1504
At most 2	0.436735	16.07216	21.13162	0.2207
At most 3	0.152433	4.630795	14.26460	0.7875
At most 4	0.076720	2.235029	3.841466	0.1349

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level

\* denotes rejection of the hypothesis at the 0.05 level

\*\*MacKinnon-Haug-Michelis (1999) p-values