# CAN NATIONAL DEBT BE RESTRAINED? EVIDENCE FROM MALAYSIA

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## DECLARATION

We hereby declare that:

(1) This undergraduate research project is the end result of our own work and that due acknowledgement has been

(2) 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.

(3) 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.

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

(5) The word count of this research report is 16329.

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## ABSTRACT

The study examines whether primary fiscal balance, real interest rate and growth rate of GDP improve or deteriorate debt-to-GDP ratio by using Malaysia as a case study. Time series data from 1980 to 2013 were fitted into the regression equation using various types of econometric methodologies such as Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root test, Vector Autoregressive (VAR) model, Augmented Granger causality test, Impulse response functions and Variance Decomposition. The study finds that there is no co-integration relationship between fiscal balance, real interest rate and growth rate of GDP and debt-to-GDP ratio. Empirical results reveal that granger causality does not exist between GDP growth rate and debt-to-GDP ratio as reaction of debt ratio to GDP growth rate was also found to be weak and less significant in Malaysia. Further the research findings suggest that the response of the debt-to-GDP ratio to the primary fiscal balance is the most significant determinant of debt ratio in Malaysia. The real interest rate on government bonds remained a significant determinant of debt ratio in the short run as well as in medium run. In addition, we find little effectiveness of contribution of the debt-to-GDP ratio has a significant impact to variability of its own value in the short run. Looking ahead, we consider the use of VAR to forecast the debt-to-GDP ratio with the aid of data sheet and line graph.

# CHAPTER 1: RESEARCH OVERVIEW

## 1.1 Introduction

Background that in tend to accomplish the research which discussing the latest issues among the macroeconomic variables and debt-to-GDP ratio of Malaysia will be provided in this section. Empirical analyses are done by examining the dynamics, relationships and trend over the time for the selected macroeconomics variables that are important in this research. Furthermore, various issues from the research background will be emphasized to help us to form the problem statement for this research. After we identified and formulated the problem statements that relating to the several issues we discussed, the research objectives and also with the research questions will be laid down accordingly in respect to how the study can be conducted and formulated. Lastly, the significance of study and how it can contribute to the policymakers and investors will be stated.

## 1.2 Research Background

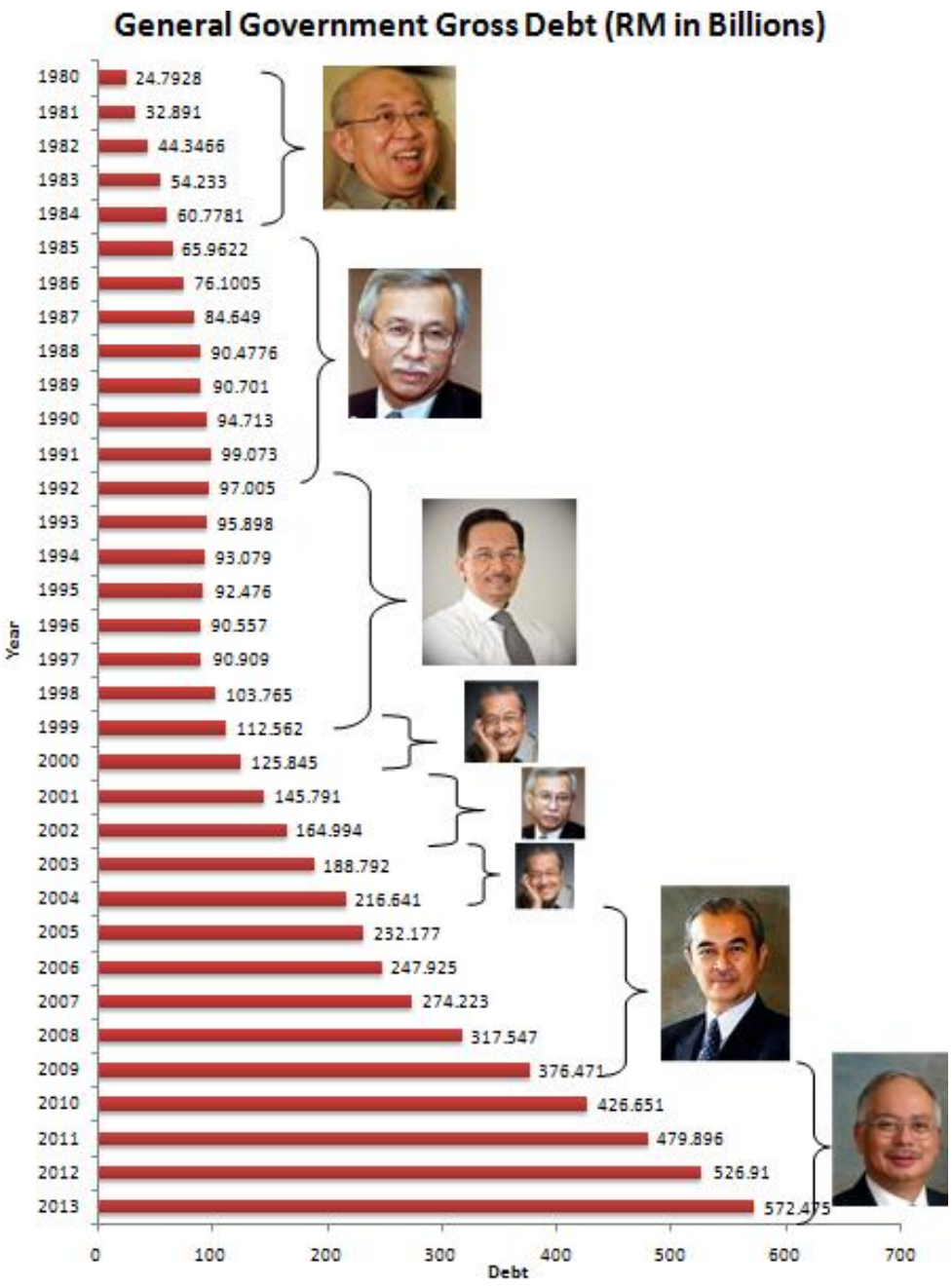
Malaysia is considered as an upper-middle income country according to Organization of Economy Cooperation and Development (OECD). Therefore, the level of government debt is an important factor for the growth of economics for a country. For example, those foreign direct investments (FDI) will take concern

about the government debt to make sure the country will bring profit to them when they intend to invest. Furthermore, the information of the national debt will be important for forecasting the future for a country. Besides that, some policies might be set up to deal with the serious level of the government debt due to this will greatly affect the future of Malaysia's economic growth.

When we discuss about the Government debt, people often associated into the case that happened in Europe which name Sovereign debt crisis. Europe country suffered Debt crisis during 2010 due to high government public debt. Then the economic system in Europe was totally corrupted and experienced negative impacts to their economic growth. It takes a long journey to recover their economic system and pay off their debt. On top of that, the reasons that this crisis happened is always concern by people. According to Steiner (n.d.), the main reason of Sovereign debt crisis occurs is due to the government is too indebted and unable to repay the interest on their bonds. Government will always go through debt financing instead of creation of money. By this, European Government had spent huge amount of money through issuing bond. With this imbalance spending, Europe Government becomes excessively indebted and incapable to issue more bond with preferable interest rate since investors will feel hesitation whether the Government able to repay the interest or not. In order to attract more investors to purchase the government bond, Europe Government had increased the rates of interest with the intention that investors will demand the government bond. As a consequence, Europe Government was having the difficulty to reduce the debt to a sustainable level. In year 2008, Global Financial Crisis happened due to the collapse of Lehman Brother, which caused many countries had used plenty of capital to save their banking systems as well as the economic performance, and Europe is not an exception to do so. Europe debt level had been driven up once again. In this recession, Europe no longer can rise up the interest rate to attract investors but it had been forced to reduce the interest rate in order to expand the economic. However, reduce interest rate is what bond

investors do not wish to be, hence investors start to withdraw their capital which invested before. At the same time, Europe government also forced to implement contractionary fiscal policy. This had worsened the current economy situation. As a result, Europe not only faced the high level of sovereign debt but also loss of credibility by the investors. Thus Europe economic was slowdown and their economic system had been seriously hurt as well as the fail to repay the interest payment. In that case, Malaysia government also too relies on debt financing which had driven up the debt level as well. This is why when we discuss about the government debt, people always associated into Sovereign debt crisis that happened in Europe.

Figure 1.1 General Government Gross Debt

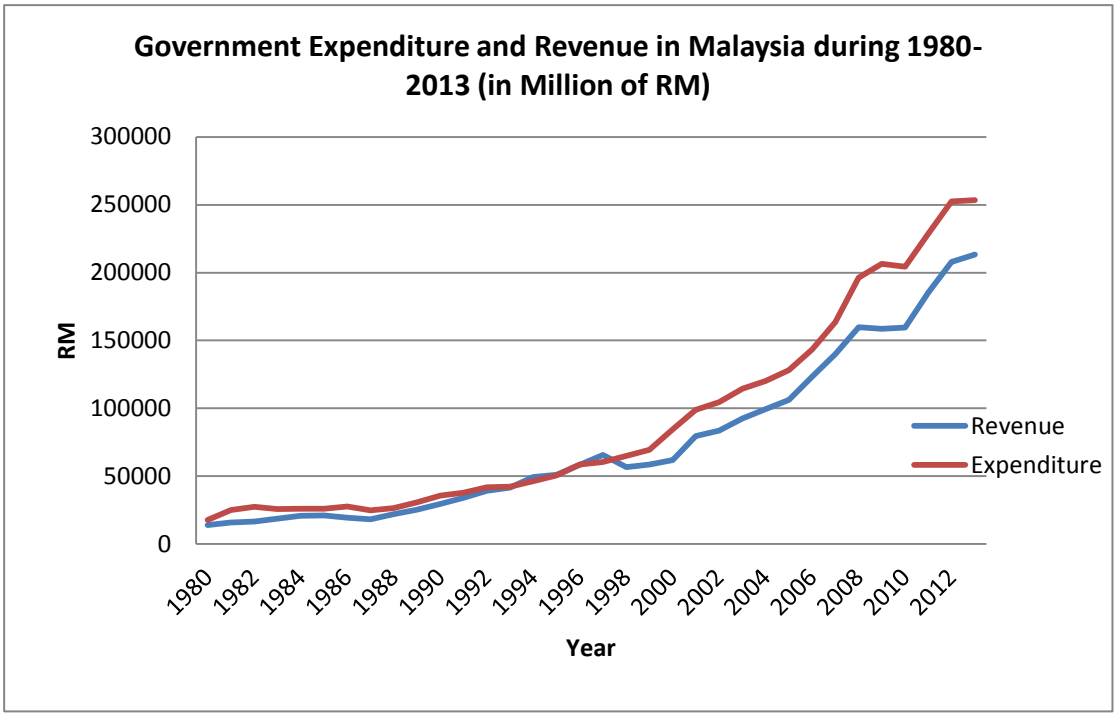



Sources: Bank Negara Malaysia

Back to the point, after review the Sovereign debt crisis in Europe, we are interested to observe the debt performance in Malaysia. From figure 1.1, Malaysia's debt was consider low and stable from 1980 until 1997 where the debt amount was below 100 billion. Unfortunately, the debt amount rose substantially

until RM274 billion in following 10 years. One of the reasons that causing the debt increase was due to the Asian Financial Crisis which originated from Thailand in year 1997. This crisis had bring negative impacts to Malaysia hence make the government of Malaysia having no choice but to solve it, that had tried to peg our local currency to US dollar. This crisis actually had given the largest financial shock and a huge damage which it had been affected the financial markets and institution at the core of the global financial system. Due to this reason, Malaysia be confronted with recession in year 1998 while this negative shock not only cause the economy growth for Malaysia slowing down and also devalued of Ringgit Malaysia. Thus, Malaysia is experiencing worst economic contraction during 1997. In order to solve this problem, Malaysia government had spent huge amount of money to boost up the GDP however it made the situation become worse that is, Malaysia was recorded budget deficit after the crisis. In year 2013, Government debt in Malaysia has driven up to about 23 times as compare to the year 1980. Besides, from the figure 1.1, it is hard to see that the debt in Malaysia is decreasing due to the pattern of Malaysia debt is keep on increasing without any decline. If truth be told, it was really crazy to know this, the debt is truly increases 23 times and never been reduced down from the past 30 years. In year 2013, it recorded the highest debts in the history of Malaysia and it is almost reached unsustainable debt level. According to Blanchard and Johnson (2013), when the debt of a country is too high, the policy makers will loss of the ability to control it. According to Blanchard and Johnson (2013) the debt will cause itself to increase due to the interest rate will accumulate the debt level and become higher and higher in long run. In short, the figure of debt have raise exaggeratedly and feel apprehensiveness by Malaysian. This is the big issue that Malaysia facing currently. There is a fact that, by divided the population, a Malaysian need to bear the cost of borrowing approximately RM 19115.89 in year 2013 (Debt= RM572, 475, 000,000, Population= 29947600) in order to pay off the debts.

Figure 1.2 Government Expenditure and Revenue in Malaysia




Sources: Ministry of Finance Malaysia

From the figure 1.2, Malaysia is confronted with budget deficit from the year 1980 to 2013 except in the year 1992 to 1997 which is surplus. Government expenditure is exceeding the government revenue throughout the year. With the gap in between, Government has to issue the bond to obtain the money for expenditure. This will be one of the reasons that Government debt in Malaysia raise intensively. Besides, after year 1998, the gap between government revenue and government expenditure become wider and wider. This indicate that, the speed of government revenue increase do not fast enough than government spending. It gives the impression that Malaysia is hard to achieve the budget surplus once again in the future. Moreover, in year 2007, financial crisis had crush into global financial market and caused enormous negative impacts to the whole world. Malaysia can't be spared from this global financial meltdown plus the Asian Financial Crisis before. As a result, Malaysia suffered in the high yield debt trouble. Malaysia Government implemented the expansionary Fiscal policy by

extremely spend money to rescue it banking system and economic system (Rasiah, 2011). This is the reason why the gap between Government expenditure and revenue in 2007 is the largest gap in the history of Malaysia. Therefore Malaysia's debt will be accumulated accordingly and become larger and larger. As a consequence, this has deteriorated the flexibility to respond to unpredictable challenges and it is likely to lose the creditworthiness of the investors to the government securities. As we learn from the past history of Sovereign debt crisis in Europe, this continuously rise in debt will consequences in Malaysia's government will lose the ability to manage its budget so that Malaysia government would be unable to borrow at the affordable rate if there is any unexpected challenge.

This situation will make people doubt that whether Malaysia government will suffer the Sovereign debt crisis as European and whether Malaysia government is going to bankrupt or not as well as whether government able to repay the debt or not. All these are worried by Malaysian. Not to mention, whether the speed of debt servicing fast enough than the new debt and whether our future generation need to bear those cost of this debt or not, all these questions are also obviously concerned by the Malaysian. Because of the debt is too high, we are poorly prepared to address future risks that require huge short term deficit spending.

On the other hand, according to Rasiah (2011), Malaysia has suffered a recession in 1980s which make worse by the reducing fiscal deficit policy given the privatization, at the same time, he declare that privatization has no significant contribution to driven the economic growth but it is more serious that cause the government debt to increase. This is reason why the selection of sample size should start from 1980 to the most recent year of 2013.

All in all, though the past experience, the Sovereign debt crisis that happen in Euro zone, we noticed that the impact of the crisis are obvious, economic system are corrupted, similar to Malaysia, if this crisis happen as well. Therefore, the government need to keep an eye on it seriously all the time before it is too late.

## 1.3 Problem Statement

First and foremost, since 1998 Malaysia's debt-to-GDP ratio has the upward trend, debt in Malaysia keep on increasing and the debt is beyond the GDP. This indicates that the market value of all final goods and services produced within Malaysia is not as much as the debt owed by a government. When there is widening amount of government debt, then there is bigger and bigger interest need to pay for the debt. Otherwise government needs to rise up the tax or print more money to monetize the debts this will result in hyperinflation similar to the debt crisis in European and the consequences may not be pleasant. What should we be concerned about is which factors may cause the government debt-to-GDP ratio to be increased and which of them will lead the government debt-to-GDP ratio to be decreased as well as the significance if its contribution in order to avoid the debt-to-GDP ratio overheat. Empirical testing will be conducted to investigate the relationships among the variables and it is important to examine the relationship between the debt-to-GDP ratio with other macroeconomics variables so that we can have a clear image and a certain understanding on how the macroeconomic variables actually affect the debt-to-GDP ratio in Malaysia.

Beside, rises in government debt become a major concern because it will

be a burden on the future generation. As we mention above, government can monetize the debt by either raise the taxes or print more money. Both methods will bring negative impact to the citizen and even the future generation if present of long run impact. It is important to the identify the short run dynamic impacts and long run impacts of the debt so that future generation of the country can avoid to bear the cost of borrowing by the government.

Lastly, according to International Monetary Fund (IMF) the debt-to-GDP ratio of Malaysia is forecast to be 54.8 percent in 2014 and it is more than half. This indicated that the debt ratio of the Malaysia is close to the legal debt limit which is 55 percent. If Malaysia's debt-to-GDP ratio is increase beyond the debt ceiling while there is any shock or crisis happen, Malaysia government is unable to borrow anymore debt, it is dangerous to the economy. Therefore it will lead to the credit rating of government bond to be decreased and loss of confidence to the foreign investors. In short, we should carry out the empirical testing to forecast the future debt-to-GDP ratio in Malaysia.

Based on the current issue above, we can simplify into three problem statements:

1. Discover often overlooked the impact of macroeconomics variables in Malaysia which will lead to the debt-to-GDP ratio in Malaysia to change.
2. Studies the impact of the macroeconomic variables which will affect the debt-to-GDP ratio to change in different time periods, whether it will have long run impact to the debt so that future generation no needs to bear those borrowing costs.
3. Predict future debt-to-GDP ratio so that investor and government can have the idea and clear image to minimize the default risk and improve the debt ratio as well as fiscal balance by modify the spending in future.

# 1.4 Research Objective

## 1.4.1 General Objective

Due to the problems of public debt of Malaysia, we are motivated to conduct empirical analysis to find the causal relationship among them. Hence, the general objective of this study is to determine the macroeconomics factors which significantly improving or deteriorating the debt-to-GDP ratio in Malaysia. An effort is to be made to establish the linkage of debt-to-GDP ratio among the macroeconomic variables.

## 1.4.2 Specific Objective

As we can see from the research background, debt-to-GDP ratio of Malaysia started to have an increasing trend after Asian financial crisis in year 1997 and global financial crisis in year 2008. Therefore, it is necessary to build the model to forecast the future of debt-to-GDP ratio of Malaysia. The forecasting is completed based on assumptions made. Furthermore, we also aim to evaluate the significance of the short run and long run effect between the variables and debt-to-GDP ratio.

Based on the outline of specific objective that stated on above, there are two specific objectives we aim to investigate in our research:

1. To determine the short run and long run relationship among macroeconomic variables and debt-to-GDP ratio.

2. To forecast the levels for debt-to-GDP ratio of Malaysia.

## 1.5 Research Question

With the general and specific objectives that clearly stated above, we aim to answer several research questions in respect to our problem statements stated above. There are three research questions which will serve as the guidance for the argument and inquiries of our research:

1. What is the impact of changes in macroeconomics variables on debt-to-GDP ratio of Malaysia, whether it shows positive or negative relationship?
2. Whether there is a short-run or long-run relationship among macroeconomics variables and debt-to-GDP ratio of Malaysia?
3. What is the level for debt-to-GDP ratio of Malaysia in the future period by using forecasting, whether it shows the increasing or decreasing trend?

## 1.6 Significance of Study

This study aims to contribute to the literature by investigating the linkage of debt-to-GDP ratio among the macroeconomic variables. This research is significant as we are able to identify the impact of these macroeconomic factors on the debt-to-GDP ratio. With the main objective, the finding of this study will help to determine whether the macroeconomics variables give a positive or negative impact to the debt-to-GDP ratio in Malaysia. Besides that, the

significance of empirical result may contribute to the Malaysia to reduce the national debt which may help to stimulate the economy growth.

Furthermore, the understanding of relationship between debt-to-GDP ratio and macroeconomic variables is crucial for policymakers in managing the national debt because an excessive debt most likely will influence the economic stability. Thus, this study will ensure the economic objectives are achieved which is to evaluate the significance of the short run and long run impact among the macroeconomic variables and debt-to-GDP ratio.

Moreover, this study aims to provide a more precise forecasting to the policymakers when they intend to implement or modified their fiscal policy. While bond investors may also take advantages from this which the forecasting can give them an idea on how the debt-to-GDP ratio affect the credit rating and hence they can predict a more accurate return.

## 1.7 Chapter Layout

**Chapter 1: Introduction**

The overview of this chapter presents the research background, problem statement, research objective and question, significance of study and chapter layout.

**Chapter 2: Literature Review**

This chapter presents the overview of literature that relevant to the field of the research. The hypothesis development and empirical testing procedure will be discussed in this chapter.

**Chapter 3: Methodology**

This chapter presents the research methodology, data sources, model structure, and data adjustment.

**Chapter 4: Data Analysis**

Estimation of the model and model simulation are reported in this chapter. Model evaluation and scenario forecasting are carried out by applying the model. E-view 7 is the analysis tool used in the data analysis in this research project.

**Chapter 5: Discussion, Conclusion and Implication**

The synopsis of statistical analysis is presented in this chapter. It further illustrates the major finding and implication of the study of the research. Recommendation for future researchers is recorded in this chapter.

## 1.8 Conclusion

For fear that the debts will give a threat to Malaysia, we are interested to investigate the macroeconomic variables against the debt-to-GDP ratio. This research is useful for policymakers when they intend to do forecasting on debt-to-GDP ratio. It may also give an idea to those citizens who intend to do investment in Malaysia. The literature contributed by previous researchers will be discussed in the following chapters.

# CHAPTER 2: LITERATURE REVIEW

## 2.1 Introduction

This chapter we have reviewed the factors that will affect the public debt in Malaysia that done by previous researchers. We found that there are few relevant factors that will affect the public debt such as real interest rate, growth rate of GDP, and primary fiscal balance. We would like to separate this chapter into three parts which are theoretical framework, hypothesis development and empirical testing procedure. In first part theoretical framework, we are going to review the studies of previous researchers that related to the relationship between independent variables and dependent variable that we stated earlier. In hypothesis development, we will slightly discuss about the theories that we review from previous studies and determine the expected sign for each independent variable. At the third part, we will review the methodologies that previous researchers used to estimate and interpret on the relationship between independent variables and debt-to-GDP ratio on their studies.

## 2.2 Theoretical Framework

### 2.2.1 Growth Rate of GDP

For growth rate of GDP, there was different result can be found from different research. According to Sinha, Arora and Bansal (2011), GDP growth rate

is the most important determinant of public debt which resulted in significant negative relationship. The total debt in case of middle income group countries is negatively correlated to the GDP growth rate which is under expectation, this means that GDP growth rate grows large while debt levels decline. Dube (2013) and Basu (2013), both results are suggesting that correlation of government debt-to-GDP ratio and growth rate of GDP are negative relationship, in another word, a higher growth rate of GDP will slow down the debt-to-GDP ratio. By the same token, in case of high income group countries the total debt is just dependent upon GDP growth rate. Pirtea, Nicolescu and Mota (n.d.) had found an increasing reaction of the public debt-to-GDP growth rate, this implies that a reduction in the GDP growth rate have given a rise in debt-to-GDP ratio. On the other hand, this can be prove by the study of Hall and Sargent (2010), which stated that rapidly growing of real GDP will reduce its debt-to-GDP ratio during the period of post-World War II in United State. According to Kuepper (n.d.), the common solution to a high debt-to-GDP ratio is enhancing the GDP growth rate in that country. Higher growth rate lead to increase the GDP at the end of the equation will lower down the overall debt-to-GDP ratio.

In the same way, Shah and Pervin (2012) stated that debt-to-GDP ratio will be affected by GDP growth, their result are same with most of other researchers, the economic growth will retards the debt-to-GDP ratio which is consistent with Cunningham (1993). However, Paudel and Perera (2009) argued that there is a positive relationship between GDP growth rate and public debt, which point out that economic growth, is not an effective way of reducing debt-to-GDP ratio. And also, Ogunmuyiwa (2002) stated that the relationship between growth rates of GDP with public debt was found to be weak and insignificant for different economic condition.

### 2.2.2 Real Interest Rate

Interest rate also play as a noteworthy variable in investigate the debt-to-GDP ratio for a country. In view of Pirtea, et al. (n.d.) explained that an increase in the real interest rate and a reduction of a GDP growth rate will give a positive significant impact on the variation of the debt-to-GDP ratio in the current period. In addition to this, in the case of middle income countries, real interest rate is found to be a positive significant impact on the borrowing cost of the government but not for the high income group countries due to the high variability (Sinha, et al., 2011). Hence, an increase in the borrowing cost may cause a rise of debt-to-GDP ratio. Furthermore, according to Boccia (2013), the higher the real interest rate will reduce the confidence of creditors or bondholders due to the probability of default is increasing while cost of borrowing increase. In order to make its bond more attractive, what the government can do is raise the interest rates further to compensate the creditors. A higher real interest rate will raise the cost of the debt and the government most probably will not increase the tax from their citizens in order to payback the debt which would affect the economic activity. In short, government has to take more and more debt for spending and for repayment which will lead to a debt spiral. In addition, Amadeo (n.d.) stated that, bondholders will demand for higher interest payments to compensate for the inflation, and it will force to an increase on interest payment expenses for the government bond, therefore it will push the government debt to a higher level. In addition, high debt loads will loss confident from a creditor and reduced the demand for government bonds end up this will lead to higher interest rates and higher payments on debt, thus, it may also lead to more borrowing and feeds back into higher interest rates. In short, it's a sort of snowball effect (Dye, 2013).

According to Ford and Laxton (1999), an increase in the real interest rate may reflect higher public debt which is crowding out private sector activity. The

results imply that the increase in government debt was a major factor in the rise in real interest rate. In addition, Marattin and Salotti (n.d.) indicated that an increase in long term real interest rate lead to positive and significant effect on public debt, with a stronger effect for high debt countries.

### 2.2.3 Primary Fiscal Balance

The relationship between the primary fiscal balance and debt-to-GDP ratio is as expected. Based on Sopek (2009), the primary fiscal balance has a significant role in the formation of the changes of the public debt, but it is not sufficient to quantify it completely. However, according to Clayton (2005), the primary fiscal deficit will generally increase the public debt, vice versa. As a matter of fact, due to there is a significant positive relationship between government expenditure with public debt therefore the increase of government expenditure causing the fiscal deficit increase and this will lead the government debt to increase as well. Moreover, there is a result to confirm that primary fiscal surplus or deficit has a significant impact to predict on public debt (Mah, Miruka and Petersen, 2013). According to Kuepper (n.d.), a country with a higher debt-to-GDP ratio, the government can cut down the spending to lower down the debt burden. The government also can choose to increase the taxes to pay off the debt. However, the government must make sure that the trick for the fiscal austerity in a way that does not affect GDP growth and underline the GDP portion of the equation. Another result confirmed the relevance of primary fiscal deficit with debt-to-GDP ratio (Izak, 2009) which he claimed that a government running a primary fiscal deficit will incur significantly higher borrowing costs due to the government need to issue more government bonds to keep financing their deficits and this will drive up the debt-to-GDP ratio absolutely even bond-financed deficit is not inflationary. The results for the debt-to-GDP ratio will have a bad sign for

the whole country if the government didn't take any action to cut down the deficits and increase the government expenditure by issue more bonds or create revenue besides tax revenue to purchase the government bonds by using newly printed money.

Other than that, Cogan, Taylor, Wieland and Wolters (2013) quantified the effects of fiscal austerity in United State in which reduce in government spending gradually over time with aimed to cut down budget deficits as well as the government debt. It showed that cut down the government expenditure leads to increase GDP in short run as well as long run. They mentioned that lower down the government spending in the future implies lower taxes, therefore resulting higher standard of living, which can boost up the consumption and productivity, hence rises in GDP will lower down the debt-to-GDP ratio. Besides that, Heylen, Stijn and Heylen (2013) found that decline in government spending and a raise in tax revenues can significantly reduce the public debt in the long run. Burger, Stuart, Jooste and Cuevas (2011), found that if government run a sustainable fiscal policy, by reducing the primary deficit or increasing the surplus will lead to a reduction in debt-to-GDP ratio.

## 2.3 Hypothesis Development

The empirical findings of Sinha et.al (2011), Dube (2013),Basu (2013), Pirtea, et al. (n.d.), are similar with the studies of Hall and Sargent (2010), Kuepper (n.d.), Shah and Pervin (2012) and Cunningham (1993) which GDP growth rate is negatively affects debt-to-GDP ratio. However, we also found that some of the article said that the debt-to-GDP ratio is positively affected by GDP growth rate (Paudel and Perera, 2009) and Ogunmuyiwa (2002) argued that there is no relationship between debt-to-GDP ratio and GDP growth. Based on the

majority result of previous studies that we reviewed earlier, it is enough evidence to conclude that there is a negative relationship between growth rate of GDP and debt-to-GDP ratio. Consequently, we hypothesize that the relationship between GDP growth rate and debt-to-GDP ratio for Malaysia in our study is negatively correlated.

Moreover, the empirical findings of Pirtea, et al. (n.d.), Dye (2013) and also Sinha, et al. (2011) said that is a positive relationship between interest rate and debt-to-GDP ratio. Together with Boccia (2013), Ford and Laxton (1999) Marattin and Salotti (n.d.) and Amadeo (n.d.) have the same view of this. An increase in interest rate will give a rise in the interest payment expenses for the government bond, therefore government debt will push to a higher level and this had been shown a positive relationship between debt-to-GDP ratio and the interest rate. Refer to the studies of previous researcher, we have sufficient evidence to conclude that there is a positive relationship between interest rate and debt-to-GDP ratio. Hence, we will hypothesize that the relationship among interest rate and debt-to-GDP ratio in our study on Malaysia is positively correlated.

On the other hand, the empirical findings of Sopek (2009), Clayton (2005), Mah, et al. (2013), Kuepper (n.d.) and (Izak, 2009) on primary fiscal balance and debt-to-GDP ratio show a negative relationship between primary fiscal surplus and debt-to-GDP ratio. Besides that, Cogan, et al. (2013), Heylen, et al. (2013) and Burger, et al. (2011) found that a drop in government spending and a grow in tax revenues can significantly reduce the public debt in the long run. Based on the previous studies from the literature review, thus, we will hypothesize that the primary fiscal balance positively influence debt-to-GDP ratio for Malaysia.

## 2.4 Empirical Testing Procedure

### 2.4.1 Unit Root Test

According to Sinha, et al. (2011), the test that had been carried out to test for the stationary of the model were Levin Lin and Chu Shin test (2003) and also Harris and Tzavalistest test (1999). According to Shah and Pervin (2012) and Mah, et al. (2013), the unit root test that had been carried out were Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) test for both research paper. For the Ogunmuyiwa (2002) only had been carried out the Augmented Dickey-Fuller test for the unit root test in the research paper. Augmented Dickey-Fuller and Phillips-Perron test had been conducted for the unit root stationary test by Paudel and Perera (2009). Generally, all of them obtained the same results which the variables have the same order of integration.

### 2.4.2 Vector Autoregressive (VAR), Granger Causality, Impulse Response Function (IRF), Variance Decomposition

According to Izak (2009), Mah, et al. (2013),Basu (2013), Ogunmuyiwa (2002), Burger, et al. (2011) and Marattin and Salotti (n.d.), all of them have conducted the vector autoregressive (VAR) analysis to study the dynamic interaction among a group of macroeconomic variables. In order to overcome the limitation of the VAR, the authors also come out with the granger causality to ascertain the direction of causality between the variables. In addition, Impulse Response had been used by the authors to show the effects of shock on the adjustment path of the variables. They found the results able to confirm the

relevance of primary fiscal deficit to implicit costs. For a raise in primary deficit is associated with an increase in debt ratio. Besides, results showed GDP growth rate is a significant determinant to reduce debt ratio. In addition, the results show a significant negative relationship between primary fiscal surplus and debt ratio. For Granger causality, the past value of primary fiscal balance has a predictive ability in determining the present value of debt ratio. Also, economic growth in the past can use to predict the debt ratio in future. However, Marattin and Salotti (n.d.) are using the Panel Vector Autoregressive (PVAR) with annual data as their estimated model which is flexible and capable to dealing with the endogeneity problem and allows for unobserved individual heterogeneity also using panels consists in an grow in the number of observation. They found that an increase in real interest rate led to positive and significant effect on debt ratio.

### 2.4.3 Vector Error Correction Model (VECM), Johansen-Juselius (JJ) Co-integration Test

Based on Paudel and Perera (2009), Ogunmuyiwa (2002) and Mah, et al. (2013) and Burger, et al. (2011), the time series data is identified to be integrated of order one. As all the selected series have follow I(1), the Johansen co-integration approach is used to detect the co-integration between the series with the trace test and one with the maximum Eigen value test. After make sure the number of co-integrating vector which is number of long run relationship for the model. The authors present of both the short run and long run equation of the macroeconomic variables by using Vector error correction model (VECM). To summarize their results, it is found that there is a co-integration relationship between debt ratio, GDP growth, real interest rate and primary fiscal balance.

### 2.4.4 Other Methods

In order to estimated that the average duration of the crisis. Sopek (2009) was using ESA (Engage, Study and Activate) methodology with the intention to know how much the total revenues and expenditure changed from the year before the beginning of the crisis up to the end of the crisis. Besides, he also use a polynomial of the fifth degree since it appears that it almost perfectly describes the data in the period in question and proves to be much better when adjusting to the Croatian figures. Polynomial regression is actually a special case of multiple linear regressions. Furthermore, Kolmogorov- Smirnov test (KS) use to verify whether the residuals satisfy the characteristic of normality and it can use to further supports the quality of the estimated model. Based on the result, he found that primary deficit has a significant role in the formation of the changes of the public debt, and a negative correlation was found with the primary deficit.

For the pooled ordinary least square (OLS) method, Burger, et al. (2011), Ford and Laxton (1999), Izak (2009) and Sinha, et al. (2011) apply this test to check whether fixed effects should in the model. The pooled OLS method implies that there are no differences between the estimated cross sections. The null hypothesis is that all the constants are the same, and that therefore the common constant method is applicable.

Moreover, There are two research paper which are Pirtea, et al. (n.d.) applied the Ordinary least square to estimate the unknown parameter while the Newey-West procedure in order to correct the problems of heteroscedasticity and the autocorrelation in the model. Furthermore, they presented evidence that primary fiscal deficit, real interest rate and GDP growth has had a substantial effect on debt ratio.

According to Pirtea, et al. (n.d.), the Quandt-Andrews Unknown Breakpoint test been carried out in order to indicate the structural break which exist in the regression. For Pirtea, et al. (n.d.), the Panel EGlS been conducted in order to capture the cross sectional random effects which exist in the model. The research findings suggest that the reaction of the debt ratio to the growth rate of GDP and real interest rate are significant to determine the debt ratio. Lastly, Burger, et al. (2011) presents their studies which estimated with Gaussian mixture model (GMM); they also consider the use of fiscal reaction functions to forecast the debt-to-GDP ratio and gauging the likelihood of achieving policy goals with the aid of probabilistic simulations and fan charts. They observed that the median forecast for debt ratio in South Africa is increase from year 2009/10 to 2014/15. However, the forecasted result suggests that the probability that debt ratio will stay below the 50 percent. In other words, it suggests that there is a fairly low chance that debt will breach 50 percent of GDP by fiscal year 2014/15.

## 2.5 Conclusion

As has been mentioned, most of our expectations of the relation for most of the independent variable were matched with those researchers' studies such as growth rate of GDP, interest rate and also primary fiscal balance. For GDP growth rate and debt-to-GDP ratio was proved by those previous researchers which were negative relationship. By way of contrast, interest rate and primary fiscal deficit have significant positive relation with debt-to-GDP ratio as well. Even though some previous researchers already stated that relationship between those variables, whereas we still will conduct our own data analysis to determine the relationships among dependent and independent variables whether it significantly affect the debt ratio for Malaysia. Lastly, the methodologies that we are going to conduct in our data analysis will be discussed in the following chapter.

# CHAPTER 3: METHODOLOGY

## 3.1 Introduction

In this chapter we will discuss about the theoretical background of the macroeconomic variables and the methodologies will be applied to answer the research question that stated in Chapter 1. The sources of the data treated and employed in the analysis will be carried out. The objective of our study is to determine which macroeconomic factors are improving or deteriorating the debt-to-GDP ratio in Malaysia by using several types of methodologies for example Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) test to determine unit root and stationarity of macroeconomic variables. But first, the diagnostic checking should put in the first place in order to make sure the series have no any econometric problems. Besides, Johansen-Joselius (JJ) co-integration test will be employed to examine the long run relationship between the variables before proceed to Vector Autoregressive (VAR) model. After that, Toda and Yamamoto (1995) and Dolado and Luetkepohl (1996) procedure will be proceed where the test is Augmented Granger Causality test, Impulse Response and Variance Decomposition in model. Moreover, VAR forecasting approach is to forecast the future level for the debt-to-GDP ratio of the Malaysia.

## 3.2 Data Collection

The time series data that used for this research is starting from year 1980

to 2013, which having total 34 observations. We choose to use annually data in our employed methodology. For debt-to-GDP ratio are extracted from Bank Negara Malaysia (2013) and World Bank's online database (2013). The data series for GDP growth are extracted from World Bank's online database (2013) as well. For the data of controlling variable primary fiscal balance are extracted from Ministry of Finance Malaysia (2013) and World Bank's online database (2013). While for data series of real interest rate was obtained by using the formula $real\ interest\ rate = base\ lending\ rate - inflation$ whereby the data series of base lending rate are extracted from Bank Negara Malaysia (2013) while inflation rate was obtained from World Bank's online database (2013). All of the empirical testing is run by the E-views 7 software to capture dynamics of the movement of the series.

## 3.3 Conceptual Framework

Debt-to-GDP ratio is defined as a ratio of a country's national debt to its gross domestic product (GDP). It indicates the country's ability to repay the debt and it also can be interpreted as the number of years needed to pay back debt if GDP is dedicated entirely to debt repayment. Although the economists have no identified a specific debt-to-GDP ratio as being hazardous, and instead focus on the sustainability of the debt levels. Even though a country has a slightly higher of the debt-to-GDP ratio, if it can continue to repay debt without harming economic growth, it is still considered to be stable. In other words, GDP growth rate play an important role in debt-to-GDP ratio. However, a higher level of the debt-to-GDP ratio may make it more difficult for a country to repay the debts due to creditors seek for higher interest rate to compensate the risk of default. If a country was unable to repay its debt due to high interest payment, it might default, which will cause a negative impact to the economy and also will harm to the taxpayers today

as well as the future generations. In addition to this, the public debt that government owed in the past will be accumulated as well. This will worsen the debt-to-GDP ratio in the current year. The government will face a resistance to reduce to public debt if the accumulation of debt is too high. Besides, primary fiscal deficit occurs when the government expenses exceed its revenue. However, this is often because of the disproportionate balance between the revenue and expenditure of a government. The fiscal deficits will finance by either issue government bond or increase tax rate in the future period. Nevertheless, policymakers normally will not choose to raise the tax rate because it most probably will lose their reputation among the voters, therefore the deficit will normally finance by government bond and it might lead to a raise in debt-to-GDP ratio. Hence, all of these have motivate us to choose GDP growth rate, real interest rate and primary fiscal balance as independent variables into our data analysis in order to determine the relationship and whether or not it actually improve or deteriorate to debt-to-GDP ratio of Malaysia.

In order to determine the relationship between them, we have formulated an empirical function to conduct our estimation:

$$D\_GDP_t = f\ (G_t\ , RIR_t\ , PFB_t, \mathcal{E}_t)$$

$D\_GDP_t$ denotes per annum debt-to-GDP ratio, $G_t$ denotes per annum growth rate of GDP, $RIR_t$ denotes per annum real interest rate, $PFB_t$ denotes per annum primary fiscal balance and $\mathcal{E}_t$ denotes error term.

## 3.4 Unit Root Test

### 3.4.1 Augmented Dickey-Fuller (ADF) Test

This test was further developed by Dickey and Fuller (1981). ADF unit

root test is used to difference the time series data to make it stationary. Initial DF unit root test assumed the first differences in the series are serially uncorrelated when under the unit root null hypothesis, but practically most of them will serially correlated when first difference the series. Therefore DF has been developed to become ADF unit root test. It relies on a parametric transformation of the model that removes the serial correlation in the error term, leaving the asymptotic distributions of the various tau-statistics. Below is the equation for the ADF test:

$$\Delta Y_t = \mu + \delta Y_{t-1} + \sum_{i=1}^{k} \alpha_i \Delta Y_{t-i} + \varepsilon_t$$

In the equation, $Y_t$ is our variable of interest, $\Delta$ is the differencing operator. The optimal lag length for the unit root test model is based on the minimum AIC or SC, where the autocorrelation problem does not exist in the model. $\varepsilon_t$ is the white noise residual which is follow mean zero error of disturbance and constant variance. $\delta$ and $\alpha_i$ is the set of parameters to be estimated. The null hypothesis of this unit root test is:

$H_0$: $Y_t$ has a unit root / non- stationary

We reject $H_0$ if test statistic is less than lower critical value, otherwise do not reject $H_0$. In other words, a unit root does not exist in the series if we reject the null hypothesis. The critical value can be obtained from the tau-statistical table that has been modified by Dickey and Fuller. Later, the distribution of modified t is expanded by Mackinnon (1996).

### 3.4.2 Phillips-Perron (PP) Test

PP unit root test was developed by Phillips and Perron (1988). This unit root test is also can deal with the autocorrelation problem in Dickey-Fuller test and this unit root test is only for small sample size. Besides, it is a non-parametric test (ranking) with no assumptions is required. However, we will waste some

information (sample size) by conducting this unit root test.

$$\Delta Y_t = \mu + \beta\left(t - \frac{n}{2}\right) + \delta Y_{t-1} + \varepsilon_t$$

The null hypothesis of this unit root test is:

$H_0$: $Y_t$ has a unit root / non- stationary

We reject $H_0$ if test statistic is less than lower critical value, otherwise do not reject $H_0$. In other words, a unit root does not exist in the series if we reject the null hypothesis. The critical value can be obtained from the tau-statistical table that has been modified by Dickey and Fuller. Later, the distribution of modified t is expanded by Mackinnon (1996).

## 3.5 Diagnostic Checking

### 3.5.1 Inverse Roots of AR Characteristic Polynomial

Generally, stationarity is an assumption about explanatory variable in linear regression model. The model will provide spurious result if use non-stationary variable into the model even based on large sample theory. Therefore it is important to fulfill the assumption of the linear regression model. Otherwise, consistency of the model will break down if series have a unit root. However, we can verify whether the variables have a unit root in estimated linear regression model based on inverse roots of AR characteristic polynomial. The model is dynamic stable if all the characteristic roots are within the unit root circle which is $|Z| < 1$, then the series will be stationary in this estimated model.

### 3.5.2 Jarque-Bera (JB) Test

The Jarque- Bera test of normality is an asymptotic or large sample test based on the Ordinary Least Square (OLS) residuals which is proposed by Jarque and Bera (1980). The test computes the skewness and kurtosis measures of the OLS residuals and uses the following test statistic:

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

The p-value of the test statistic is then used to decide whether or not to reject the null hypothesis. If p-value for JB-test statistic is greater than level of significance means we do not reject the null hypothesis that the residuals of the equation are normally distributed.

### 3.5.3 White Test

This test is proposed by White (1980) to detect whether the error variance is constant in regression model which is homoscedasticity. Homoscedasticity means that the variance of each disturbance term μ as constant movement, that is, equal variance. Symbolically it means:

$$E(\mu_i^2) = \sigma^2 \quad \text{where } i = 1, 2, 3\ldots, n$$

Heteroscedasticity happens when the conditional variance of $Y_i$ increase as X increase and the variance of $Y_i$ are not the same:

$$E(\mu_i^2) = \sigma_i^2 \quad \text{where } i = 1, 2, 3\ldots, n$$

The White test for heteroscedasticity can be used to detect this problem. By comparing p- value with significance level (α- value), we refer to the p- value of test statistic and if p-value is more than level of significance, do not reject null

hypothesis and there is no heteroscedasticity problem with no specification errors. In other words, the White test can be a test of heteroscedasticity or specification error or both. If there is no cross term are introduced in this White test procedure, then it will become a pure heteroscedasticity test. Otherwise, it is a test of both heteroscedasticity and specification error.

### 3.5.4 Breusch-Godfrey LM Test

Due to the Durbin Watson test provides inconclusive results and can't take into account higher orders of series correlation and also the lagged dependent variable in Durbin's h test is not applicable to use. Therefore, Breusch and Godfrey (1978) have developed LM test that can accommodate all the cases. The null hypothesis to be tested is that:

$H_0$: There is no autocorrelation problem

We can reject null hypothesis if the p-value of the LM-statistic less than level of significance and there is an autocorrelation problem. Otherwise, we do not reject null hypothesis.

## 3.6 Johansen-Juselius (JJ) Co-integration Test

This co-integration test was developed by Johansen and Juselius (1990). The test for co-integration among the non-stationary variables is calculated by looking at the rank of the $\pi$ matrix via its Eigen values. However, it required some technical intermediate steps to prove this. Firstly, determine the order of integration of the variables to make sure those stationarity tests indicate that all series have same number of integrated order. Second of all, determine the appropriate lag length of the model by using minimum information criterion.

Third step, choose the appropriate model regarding the deterministic components in the multivariate system. Lastly, conduct hypothesis testing based on Trace statistic and maximum Eigen value statistic:

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

and

$$\lambda_{max(r)} = -T \ln(1 - \hat{\lambda}_{r+1})$$

The first one is Trace statistic, it is based on all Eigen values together at a same time to conduct hypothesis testing (joint test). The following is Maximum Eigen value statistic, it is based on one Eigen value at a time (from the largest to smallest Eigen value) to conduct hypothesis testing. When the p-value is more than level of significance, we should reject the null hypothesis that there are r co-integrating vectors in favor of the alternative that there is r+ 1 for $\lambda_{trace}$ or more than r for $\lambda_{max}$.

## 3.7 Multi-equation Time Series Model

### 3.7.1 Vector Autoregressive Models

VAR was developed by Sims (1972; 1980), we can generalized the univariate autoregressive model to the multivariate case. The usefulness of VAR is there is no different about the choice of dependent variable as it treated all variables symmetrically variable in the system. It treated all variables as endogenous variables in a same VAR system instead of exogenous variables. VAR model estimates the variable over the time period as a linear function of only their

past information. Thus, we can use Ordinary Least Square to estimate the model separately instead of Two Stage Least Square (2SLS) or Indirect Least Square (ILS). Furthermore, VAR can estimate the dynamic interrelation between variables by consists of the history dependent variable as well as the history of all the independent variables. Assume all variable have the same integrated order at I(1). VAR Model can be shown as below:

$$\Delta D\_GDP_t = \beta_{0,1} + \beta_{1,1}\Delta D\_GDP_{t-p} + \beta_{2,1}\Delta G_{t-p} + \beta_{3,1}\Delta PFB_{t-p} + \beta_{4,1}\Delta RIR_{t-p} + \varepsilon_{1,t}$$

$$\Delta G_t = \beta_{0,2} + \beta_{1,2}\Delta D\_GDP_{t-p} + \beta_{2,2}\Delta G_{t-p} + \beta_{3,2}\Delta PFB_{t-p} + \beta_{4,2}\Delta RIR_{t-p} + \varepsilon_{2,t}$$

$$\Delta PFB_t = \beta_{0,3} + \beta_{1,3}\Delta D\_GDP_{t-p} + \beta_{2,3}\Delta G_{t-p} + \beta_{3,3}\Delta PFB_{t-p} + \beta_{4,3}\Delta RIR_{t-p} + \varepsilon_{3,t}$$

$$\Delta RIR_t = \beta_{0,4} + \beta_{1,4}\Delta D\_GDP_{t-p} + \beta_{2,4}\Delta G_{t-p} + \beta_{3,4}\Delta PFB_{t-p} + \beta_{4,4}\Delta RIR_{t-p} + \varepsilon_{4,t}$$

Where,D_GDP is debt-to-GDP ratio

G is growth rate

PFB is primary fiscal balance

RIR is real interest rate

$\varepsilon_t$ is error term

Number of variable (m) is 4

Lag length of variables is p

Beside, VAR can be written in vector form or matrix form as below:

$$\begin{bmatrix} \Delta D\_GDP_t \\ \Delta G_t \\ \Delta PFB_t \\ \Delta RIR_t \end{bmatrix} = \begin{bmatrix} \beta_{0,1} \\ \beta_{0,2} \\ \beta_{0,3} \\ \beta_{0,4} \end{bmatrix} + \begin{bmatrix} \beta_{1,1} & \beta_{2,1} & \beta_{3,1} & \beta_{4,1} \\ \beta_{1,2} & \beta_{2,2} & \beta_{3,2} & \beta_{4,2} \\ \beta_{1,3} & \beta_{2,3} & \beta_{3,3} & \beta_{4,3} \\ \beta_{1,4} & \beta_{2,4} & \beta_{3,4} & \beta_{4,4} \end{bmatrix} \begin{bmatrix} \Delta D\_GDP_{t-p} \\ \Delta G_{t-p} \\ \Delta PFB_{t-p} \\ \Delta RIR_{t-p} \end{bmatrix} + \begin{bmatrix} \varepsilon_{1,t} \\ \varepsilon_{2,t} \\ \varepsilon_{3,t} \\ \varepsilon_{4,t} \end{bmatrix}$$

Before we explore the dynamic relationship between the variables, we must ensure that the variables are stationary exclusive of any trend or pattern to stay away from spurious result. While the optimal lag length of the variable can confirm by the minimum information criterion where using lowest value of any Akaike Information Criterion (AIC), Schwarz Information Criterion (SC), and

Hannan-Quinn Information Criterion (HQ) and so forth.

### 3.7.2 Granger Causality Test

As we know that, changes in a variable will causes another variable to changes, sometime it won't. Sometime the variable will have the same movement but no any causality, the empirical result will only provide us the correlation among the variables, but it does not mean the movement of one variable will cause the movement of other variable to change. Besides, we know that one variable will cause another one variable to change however sometime it wills feedback the initial variable to change as well. This is known as bidirectional effect. In order to find out this phenomenon more accurately, we should carry out the Granger causality test. Granger (1969) developed a relatively simple test that defined causality. Granger causality test will provide us the information such as the relationship among independent variable (x) and dependent variable (y) is in unidirectional causality, bidirectional causality, or X and Y are independently which is no any causality.

In order to know the short run relationship between debt-to-GDP ratio and other macroeconomic variables in Malaysia we apply F test or Wald test. If the result show that X causes Y to changed, mean the past value of X is significant in the equation of Y, vice versa.

$H_0$: X does not Granger cause Y.

$H_1$: X Ganger cause Y

The test statistic and critical value is given as below:

Critical Value: $F_{\alpha, (Kfull-Kreduced), (n-Kfull-1)}$

Test Statistic (Wald F Test): $F = \frac{(SSE_{reduced} - SSE_{Full})/(K_{Full} - K_{reduced})}{SSE_{Full}/(N - K_{full} - 1)}$

In the Granger causality test we reject $H_0$ in favor of greater value of test statistic than critical value. If the result shows that the test statistic is more than

critical value, we will reject $H_0$ and we can conclude that X cause Y in the short run and continue to conduct hypothesis testing on:

$H_0$: Y does not Granger cause X.

$H_1$: Y Ganger cause X.

Decision rule and decision making is same as Granger causality test at above.

### 3.7.3 Augmented Granger Causality Test

First of all, Toda and Yamamoto (1995) and Dolado and Luetkepohl (1996) procedure is said to be a methodology of statistical inference that allow parameter estimation valid even when the VAR is not cointegrated with the objective to overcome the problem of invalid asymptotic critical values when causality tests are performed in the presence of non-stationary series. Following is the procedure of TYDL methodology and let $y_t$ sequence be generated by the following linear function:

$$y_t = \beta_0 + \beta_1 t + \cdots + \beta_q t^q + \eta_t$$

Assume $n_t$ sequence is a vector autoregressive with k lag length and it can be presented as:

$$\eta_t = J_1 \eta_{t-1} + \cdots + J_k \eta_{t-k} + \varepsilon_t$$

It is assumed that k is the lag length that optimal and Ɛt is random vector. TYDL augmented Granger causality test is a simple procedure requiring the estimation of an augmented or over fitted VAR that is applicable irrespective of the degree of integration or co-integration present in the system. It uses a modified Wald test to test for restriction on the parameters of the VAR (p) model (Gharana and Adhikari, 2011). As an illustration, there are all together four steps involved in

this procedure. To start with the procedure, determination of non-stationary properties and the maximal order of integration ($d_{max}$) need to be included. Subsequently, determination of the true lag length (k) of the VAR system has to be conducted by using some suitable minimum information criteria. Next, third step is to estimate the unrestricted level of VARL ($k+d_{max}$) which using the Seemingly Unrelated Regressions (SUR) technique (Rambaldi and Doran, 1996).

Last but not least, last step is to apply standard Wald test to the first k of VAR coefficient matrix only in order to conduct inference on Granger causality. According to Toda and Yamamoto (1995), Dolado and Luetkephol (1996) and Rambaldi and Doran (1996), it is enough to add extra and redundant lags in estimating the parameters of the structure to ensure the standard asymptotic properties of the Wald statistic which maintains its usual limiting chi-squared distribution. Thus, TYDL enables the proposed modified Wald statistic to test linear or nonlinear restriction on these coefficients matrix by using the standard asymptotic theory. Moreover, TYDL procedure can avoids the need for preliminary tests for co-integration and the augmented lags method performs consistently well over wide range of systems including near-integrated, stationary and mixed integrated and stationary system.

### 3.7.4 Impulse Response Functions (IRF)

In general, a shock to one variable not only gives the effect its own but also will give impact to all other variables through the dynamic structure of the VAR. Impulse Response Functions (IRF) show the effects of shock on the adjustment path of the variables, that is, the response of variable to shock (Luetkepohl, 2008). In other words, an Impulse Response Function traces the effect of a one-time shock to one of the innovations on current and future values

of the endogenous variables. In details, IRF can offer us the consequences of one-unit increase on one variable's shock will lead to how much the coefficient value of other variables will change, holding other variable constant. By conducting IRF through E-views 7, we will obtain the IRF plot. From the plot we can know the shock that will affect the other variable whether in positive way or negative way.

### 3.7.5 Variance Decomposition (VD)

While Impulse Response Functions are used to capture the effects of a shock to one variable on the other variables in the same VAR system, Variance Decomposition separates the variation in an endogenous variable into the component shocks. Thus, the Variance Decomposition provides information about the contribution of each random innovation in affecting the variables. The shock not necessary affects other variables in the system, but it also affects the other shocks in the same system due to the shocks of the equations in the VAR model will be correlated (Luetkepohl, 2007). Therefore, Variance Decomposition (VD) provide us the information of the response to the shock of other variable if there is raising the shock in one variable. Besides, it can used to capture how much of the forecast error variance for any variable in the system is explained by innovations to each explanatory variable including its own in the system over a series of time horizons.

## 3.8 VAR Forecasting Approach

Multivariate simultaneous equations models were used extensively for

macro econometric analysis when Sims (1980) advocated VAR model as alternatives. As a matter of fact, VAR model described the dynamic structure of the variables and VAR model are natural tools for forecasting which their setup is such that current values of a set of variables are partly explained by past values of the variables involved and they also can be used for economic analysis (Luetkepohl, 2011). Additionally, Luetkepohl (2011) also claims that the VAR model will only approximates the true value if the data generation process (DGP) is unknown. Let $\hat{y}_{T+h|T}$ denote a forecast based on a VAR model which is specified and estimated based on the available data. Then the forecast error is:

$$y_{T+h} - \hat{y}_{T+h|T} = (y_{T+h} - y_{T+h|T}) + (y_{T+h|T} - \hat{y}_{T+h|T}).$$

By using VAR model to forecast the debt-to-GDP ratio and macroeconomics variables, the debt-to-GDP ratio has taken into account as the exogenous variable (Cherif and Hasanov, 2012). They also claim that if one uses the VAR methodology in debt and fiscal policy empirical analysis, VAR with debt feedback is recommended approach to take. Furthermore, Favero and Giavazzi (2007; 2009) stated the importance of using the debt feedback equation since excluding debt in the VAR could result in an omitted variable bias.

## 3.9 Cholesky Ordering

The only limitation of the Variance Decomposition is, its results is depend on the Cholesky factor that we can change dramatically if we alter the ordering of the variables in the VAR model. That is, it is very important to arrange the ordering due to the zero restrictions we imposed in the model.

Blanchard and Johnson (2013) indicated that the first way in which a

country can reduce its debt ratio is through the high primary fiscal surpluses. Suppose that the debt ratio of a country was equal to zero. Then the increase in the debt ratio over some period would just be the sum of the ratios of primary fiscal deficit over the period. The second way is through real interest rate with the growth rate of GDP, these will valid only if a country was running a fiscal deficit over the period and given the debt ratio is higher than zero. As we know that real interest rate is the borrowing cost of government to issue bonds, growth rate of GDP is a measure of the rate of change that a nation's GDP experiences from one year to another. Suppose the country was run a primary fiscal balance in this period, debt will then increase at a rate equal to the real interest rate. But if GDP is growing as well, the debt ratio will grow more slowly. In other words, it will grow at a rate equal to the real interest rate minus the growth rate of GDP. This claim or assumption perhaps, might probably argue that real interest rate and GDP growth rate are taken into account only after the fiscal deficit is determined. Although this is an untestable hypothesis but it seems logical and makes sense.

## 3.10 Conclusion

Overall, few types of tests will be applied in this research. For unit root test, Augmented Dickey Fuller (ADF) test and Phillips and Perron (PP) will be used to confirm for the stationary of the model. Since there are few types of stationary stochastic processes, therefore the integrated order of the model will be find out to confirm for it due to different processes having different role. For the co-integration among those non-stationary variables will be tested by using Johansen-Joselius (JJ) Co-integration Test, given all variable have the same integrated order. We will proceed to VAR-in-difference and Toda-Yamamoto-Dolado-Luetkepohl procedure as an alternative model if the integrated order of variables is not same. Not to mentioned, diagnostic checking

will check for the model whether having any econometric problems in the estimated regression model. In Multi-equation time series model, Granger Causality test, Impulse Response Function and Variance Decomposition will be applied due to the limitation of Vector Autoregressive Model. For the confirmation of bidirectional effect in the model, Granger Causality test will be used in this research. Impulse Response Function will be used to find out the consequences of one-unit increase on one variable's error term will lead to how much the coefficient value of other variables will change, ceteris paribus. Variance Decomposition provide us the information of the response to the shock of other variable if there is raising the shock in one variable. Besides, the method to forecast the macroeconomic variables will be applied by VAR forecasting approach.

# CHAPTER 4: DATA ANALYSIS

## 4.1 Introduction

All the methodologies that we discussed in Chapter 3 will be used to conduct the data analysis and the following results will be explain and interpret accordingly in this chapter. Firstly, the integrated order of the variables will be first determined by several unit root tests such as Augmented Dickey-Fuller (ADF) and Philips-Perron (PP). After that, we will conduct the Johansen co-integration test to examine whether there is a long run relationship between the macroeconomic variables. Furthermore, we conducted Vector Autoregressive model (VAR) to investigate the short run relationship between the variables when the series are not co-integrated, we will proceed to diagnostic checking to ensure there is no any econometric problem. In order to overcome the disadvantages of VAR, we apply these three approaches to capture the dynamic information which is Augmented Granger Causality test, Impulse Response Functions and Variance Decompositions. Last but not least, we do the forecasting for the debt-to-GDP ratio by using the information from VAR model. On the other hand, the optimal lag length of all the method we estimated is based on the minimum SC, given that the autocorrelation problem does not exist in the models.

## 4.2 Unit Root Test

First and foremost, stationary test is the most important test in every time

series model. The results of ADF (Augmented Dickey-Fuller) test statistic and PP (Pillips-Perrron) test statistic for stationary are shown in the table 4.1 and 4.2. The difference between table 4.1 and 4.2 is table 4.1 shown the result of Unit Root tests for ADF and PP include constant but exclude trend while table 4.2 shown the result of Unit Root tests for ADF and PP include constant and include trend.

Table 4.1 Results of Unit root Tests (Constant without Trend)

| Variable | Augmented Dickey-Fuller(ADF) Test Statistic | | Pillips-Perron(PP) Test Statistic | |
|---|---|---|---|---|
| | Level Form | First Differences | Level Form | First Differences |
| D_GDP | -1.110356 | -3.422458** | -1.525803 | -3.422458** |
| PFB | -1.917589 | -5.885165*** | -1.774759 | -5.932301*** |
| G | -4.611406*** | -7.006974*** | -4.619851*** | -17.75972*** |
| RIR | -2.906744* | -4.162259*** | -2.937552* | -6.036155*** |

Table 4.2 Results of Unit root Tests (Constant with Trend)

| Variable | Augmented Dickey-Fuller(ADF) Test Statistic | | Pillips-Perron(PP) Test Statistic | |
|---|---|---|---|---|
| | Level Form | First Differences | Level Form | First Differences |
| D_GDP | -1.977539 | -3.324431* | -2.361159 | -3.324431* |
| PFB | -1.947658 | -6.065114*** | -2.001870 | -7.594163*** |
| G | -4.651657*** | -6.879804*** | -4.662065*** | -17.26671*** |
| RIR | -3.029902 | -4.121276** | -2.981530 | -6.108278*** |

Note: If null hypothesis is rejected, this indicates that the series is stationary or do not contain of unit root, vice versa. The rejection is based on the Mackinnon (1996) left hand sided p-values which refer to the Tau-Statistic table.

***, ** and * denotes that rejection of null hypothesis if p-value less than significant level at 1%, 5%, and 10% respectively.

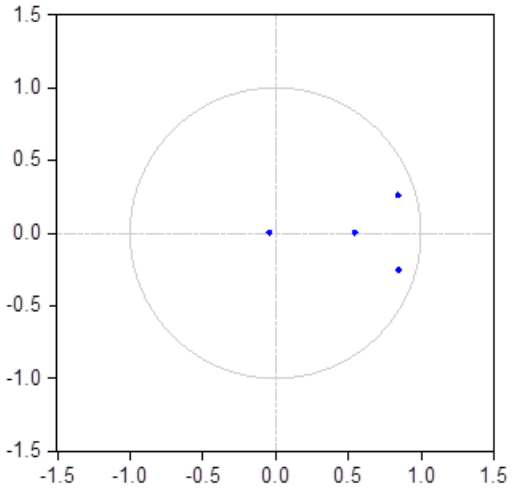
Based on the result of table 4.1, we can clearly see that most of the variables are significant in first difference for both ADF and PP tests at significant level 1%, 5% and 10% respectively, except for the G and RIR. Where, G have already significant in level form and having the zero integration order at significant level 1%, 5% and 10%. While RIR is statistically significant at 10% significant level in level form for both ADF and PP test.

Nonetheless, the results in table 4.2 shown similar result as in table 4.1, yet the only different is, RIR is not significant in level form at significance level 1%, 5% and 10% but significant at first difference. However, through the ADF and PP Test Equation, the p-value of trend variable is 0.3167 (level form) and 0.6030 (first difference) for ADF test while 0.3167 (level form) and 0.2865 (first difference) for PP test. All of this indicates that the trend variable is not significant in this case, thus we should not lie on the result in table 4.2 for the variable RIR.

In short, the variables of D_GDP and PFB are stationary and contain no unit root in first difference whereas G and RIR are stationary and contain no unit root in level form. In other word, D_GDP and PFB are first order-integrated I(1) whilst G and RIR are follows I(0) at 10% significant level thus the maximum integration order will be I(1).

## 4.3 Diagnostic Checking

Figure 4.1 Inverse Roots of AR Characteristic Polynomial




Based on figure 4.1, it shows that the inverse characteristic roots of the model which is debt-to-GDP ratio, primary fiscal balance, real interest rate and GDP growth rate are dynamic stable as the inverse characteristic roots are all below than 1. That is, the series are stationary since all of the roots are lie inside the unit root circle.

Table 4.3 Jarque-Bera Normality Test

| Jarque-Bera stat. | Prob. |
|---|---|
| 2.289077 | 0.318371 |

From table 4.3, the result of normality test was showed that the residuals have followed normal distribution in this estimated model. As we can see, we fail to reject null hypothesis since the p-value of Jarque-Bera test statistic is 0.318371 which is more than level of significance at 1%, 5% and also 10%. We can

conclude that the error terms are normally distributed in this model.

Table 4.4 White Heteroscedastisity Tests

| | Chi-square stat. | Prob. |
|---|---|---|
| No cross terms | 91.49234 | 0.1787 |
| Includes cross terms | 168.5134 | 0.0505 |

Based on table 4.4, it shows that the result of White heteroscedasticity test indicated that there is no heteroscedasticity problem in this model since the probability of Chi-square statistic value are larger than 1%, 5% and 10% which is 0.1787. Therefore, we can make sure that our estimated model has no suffer heteroscedasticity problem. On the other hand, the White test can be a test of heteroscedasticity and specification error if cross terms are introduced in this White test procedure. At table 4.4, we observed that our model has no heteroscedasticity problem and model specification is correct at $\alpha = 5\%$ and 1%.

Table 4.5 Breusch Godfrey Serial Correlation LM Test

| Lags | LM-stat. | Prob. |
|---|---|---|
| 1 | 21.01634 | 0.1779 |
| 2 | 17.42807 | 0.3584 |

From table 4.5, the results of residual serial correlation LM test showed that the model has no autocorrelation problem. Based on lag order selection criteria, the Schwarz information criterion (SC) indicated that the lag length suggested is 1 in this model. The p-value of LM-statistic in lag 1 is 0.1779, therefore we do not reject null hypothesis since the p-value is greater than level of

significance at 1%, 5% and 10%, and thereby we can conclude that there is no autocorrelation problem at lag order 1 in this model. On the other hand, the serial correlation problem does not exist at lag order 2 as we include an additional lag based on the requirement of augmented granger causality test.

## 4.4 Johansen Co-integration Test

As mention in Chapter 3, Johansen co-integration test is to figure out whether the variables are co-integrated or not, if they are co-integrated this indicate that the series might contain one or more long run relationship, vice versa. Meanwhile, one of the assumptions of JJ test is all the variables must consist of same order of integration otherwise we can straight away conclude the variables have no co-integration. However, from the result of stationary, the integration orders of the variables are difference which means the movements of the variables are diverse. In no doubt, we can conclude that the variables have no contained any long-run relationship, even without using JJ co-integration test.

## 4.5 Lag Length Selection

Table 4.6: Lag Length Criterion

| The criterion to select lag order | Suggested lag length |
|---|---|
| LR | 3 |
| FPE | 5 |
| AIC | 5 |
| SC | 1 |
| HQ | 5 |

LR = sequential modified LD test statistic

FPE = Final Prediction error

AIC = Akaike Information Criterion

SC = Schwarz Information Criterion

HQ = Hannan-Quinn Information Criterion

In order to avoid the problem of autocorrelation, where the error terms are not correlated over the period, we should choose the best lag length based on the criterions as in table 4.6. Most of the lag-length selection criterions (FPE, AIC and HQ) suggest that the best lag length should be 5. While, LR suggests the lag 3 will be the best lag length and SC proposes that the lag 1 is the most excellent lag length of the model. According Gayawan and Ipinyomi (2009), SC is most preferable criterion compare to others for lag length selection. Beside, SC recommends the lag 1 as the best lag length also is the smallest amount of lag length compare to others criterion is more preferable as we will not lose too many degree of freedom when goes to the VAR model.

## 4.6 Augmented Granger Causality Test

Based on the result of unit root test, the variables have different level of integration order, some of the variables are stationary in level form whilst some have to go through the first different only will contain no unit root. If we simply run the Wald test as usual way without go through TYDL procedure, the result will be spurious and the test statistic's asymptotic distribution will provide the 'nuisance parameters' which will deteriorate the robustness of the results (Giles, 2011). Subsequently, Augmented Granger causality should be carrying out to replace the Granger causality test. In view of the fact that our maximum integration order is one I(1), p=1 and the optimal lag length is one, m=1, when

applying the TYDL procedure, we have to include (p+m) additional lag length in the model as the exogenous variable. The purpose of this "exogenous" variable is when this variable included in the model, all the coefficients are counted to perform Granger Causality subsequently and it would be incorrect, as a consequent the test statistic will not follow the general asymptotic chi square null distribution (Giles, 2011). After all, through the E-Views we obtain the result of Modified Wald Test as shown in the table 4.7.

Table 4.7 Augmented Granger Causality

| Dependent Variable | Independent Variable | Chi-sq |
|---|---|---|
| D_GDP | PFB | 13.90068*** |
| D_GDP | RIR | 5.515247** |
| D_GDP | G | 0.028426 |
| PFB | D_GDP | 0.163687 |
| RIR | D_GDP | 0.054617 |
| G | D_GDP | 0.147357 |

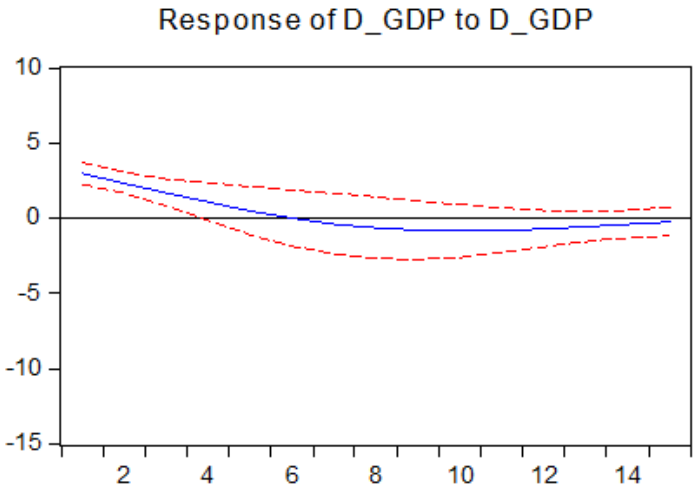
Note: ***, ** and * denotes that rejection of null hypothesis if p-value less than significant level at 1%, 5%, and 10% respectively. If null hypothesis is failed to reject implies a rejection of Granger Causality. The rejection of null hypothesis holds the .presence of Granger Causality.

In this M-Wald test, the main concern is about the dependent variables, D_GDP. Based on the table 4.7, the result of M-Wald test shows that the PFB is granger cause the D_GDP at all three significant levels 1%, 5%, and 10%. Besides, the result of M-Wald test also shows that RIR is granger cause the D_GDP at significant level 10% and 5%. On the other hand, based in the table 4.7, we also discover that the G will not granger cause D_GDP hence D_GDP will not granger cause the others three variables (G, RIR, and PFB). As we mention is chapter 3, Granger causality test is just provide the base guidance for researcher, in other word, if X said to granger cause Y implies that, by using both X and Y past

historical data to predict Y is better than simply using the past historical data of Y.

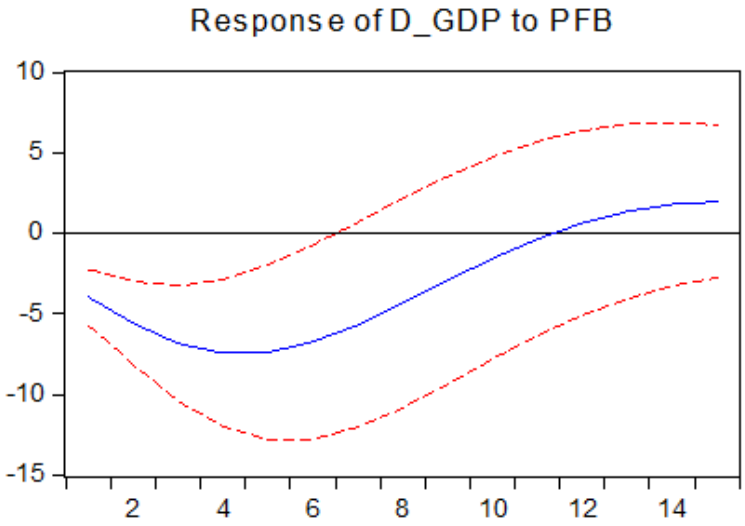
## 4.7 Impulse Response Function

Figure 4.2



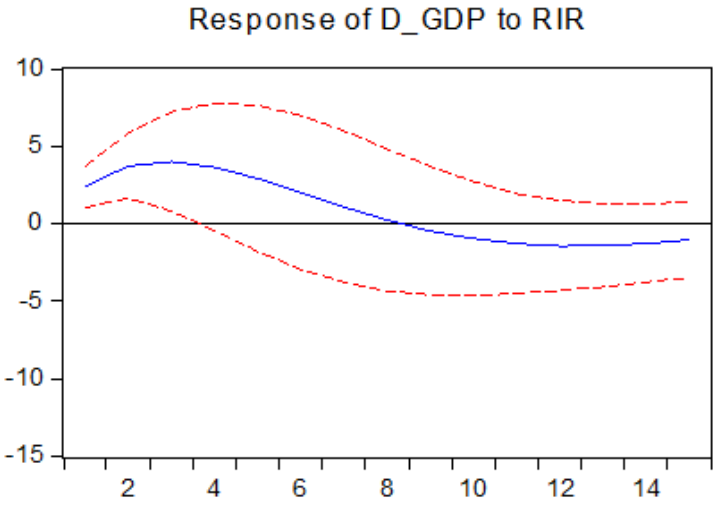

From the figure 4.2 above, the result showed that the shock of debt-to-GDP ratio causing debt-to-GDP ratio to increase from time to time. Positive impact was showed in the graph from 1st period to 5th period. However, the effect is started to diminish. At 6th period, the graph is showed the shock of debt-to-GDP ratio will bring negative impact to its own until the 15th period. It means an increase in shock of debt ratio will reduce the debt ratio after 6th period. Nevertheless, we can see that the Impulse Response values of debt-to-GDP ratio are close to zero after 6th period until 15th period. It is indicated that the shock of debt ratio are less significant on affecting the debt ratio after 6th period.

Figure 4.3



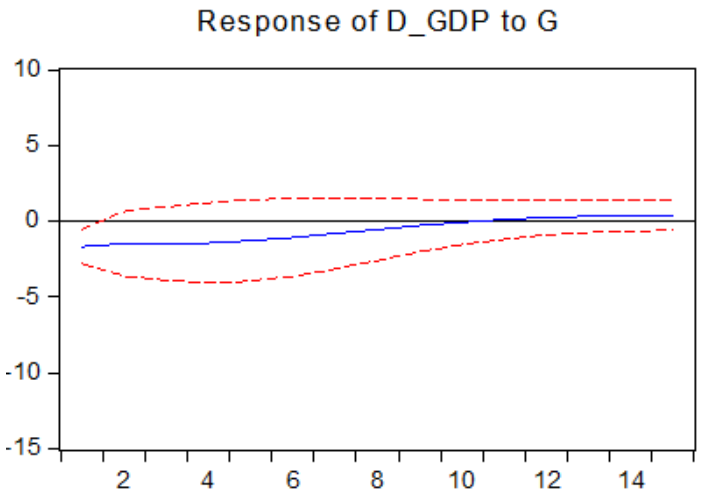

In figure 4.3, the effect of primary fiscal balance shock was having a negative impact on influencing debt ratio from 1st period until 10th period. It indicates an increase in primary fiscal surplus will lead debt ratio to decrease. However, the impact become weaker started from 4th period until 11th period. After 12th period, the response of debt-to-GDP ratio was become positive until 15th period. Which means that debt ratio will increase even when primary fiscal surplus was implemented.

Figure 4.4



Based on figure 4.4, the shock of real interest rate showed it has a positive effect on influencing debt ratio from 1st period until 8th period. That is, an increase in real interest rate lead debt ratio to increase. However, the effect is diminishing from 3rd period to 8th period. When it came to 9th period, the effect of real interest rate shock on affecting the debt ratio started to become negative until 15thperiod. Which means that debt ratio will reduce when increase in real interest rate, but its impact will become less significant due to the responses value are close to zero.

Figure 4.5




Lastly, from figure 4.5, as we can see, the shock of GDP growth rate was showed as negative on influencing the debt ratio from 1st period to 15th period. However, the effect is not strong as other variables and it is diminishing start from the beginning of the period. It still can imply that increase in shock of the GDP growth rate can help to reduce the debt ratio. After 10th period, we can see that the Impulse Response values of debt-to-GDP ratios all are very close to zero. It indicated that the shock of GDP growth rate is almost insignificant on influencing the debt ratio after 10th period.

## 4.8 Variance Decomposition

Table 4.8 Variance Decomposition of D_GDP

| Period | PFB | RIR | G | D_GDP |
|---|---|---|---|---|
| 1 | 47.61523 | 17.21306 | 8.496046 | 26.67566 |
| 2 | 54.53060 | 22.94622 | 5.863100 | 16.66009 |
| 3 | 60.84111 | 23.26406 | 4.728258 | 11.16657 |
| 4 | 66.02017 | 21.74441 | 4.121834 | 8.113589 |
| 5 | 70.03660 | 19.81428 | 3.762285 | 6.386829 |
| 6 | 72.96048 | 18.06222 | 3.535701 | 5.441604 |
| 7 | 74.88770 | 16.73499 | 3.389513 | 4.987794 |
| 8 | 75.93631 | 15.91969 | 3.296523 | 4.847473 |
| 9 | 76.26727 | 15.60065 | 3.240396 | 4.891688 |
| 10 | 76.09623 | 15.67761 | 3.209274 | 5.016888 |
| 11 | 75.67204 | 15.99085 | 3.193352 | 5.143751 |
| 12 | 75.22235 | 16.36844 | 3.184704 | 5.224503 |
| 13 | 74.89799 | 16.67866 | 3.177918 | 5.245434 |
| 14 | 74.75170 | 16.85919 | 3.170348 | 5.218761 |
| 15 | 74.75819 | 16.91203 | 3.161577 | 5.168209 |

According to the table 4.8, we can notice that the percentage of contribution of the debt-to-GDP to variability of its own value is relatively high in the 1st period which is 26.67566%. However, the role of debt-to-GDP ratio in explaining variability of its own value is decreasing from 1st until 8th period which having the lowest percentage of 4.847473% at 8th period. After that, the rebound was started from 9th period and the percentage of contribution was ended up with

5.168209% in 15th period.

For primary deficit balance, the percentage of contribution to the variability of debt-to-GDP ratio is the highest among the variables and it increased significantly from the beginning until 10th period which ended up at 76.09623% and it only slightly decrease and persists from 10th period until 15th period ended up with the percentage of contribution of 74.75819%. It implies that primary fiscal deficit or surplus is the most important factor on influencing the debt ratio among the other variables.

Moreover, the percentage of contribution of real interest rate to the variability of debt ratio is 17.21306% in the 1st period and it showed an increasing trend but only from the 1st period until 3rd period which having 23.26406% of contribution which is the highest point among these fifteen period. After that, it started to drop form 4th period until 9th period and reaches its nadir point at 15.60065%. However, the real interest rate is still continues to play an important role in explaining the variability of debt-to-GDP ratio from the 1st until to 15th period.

Lastly, the percentage of contribution of the GDP growth rate toward the variability of debt ratio is only 8.496046% in the 1st period. It decreased gradually over the period and reaches its lowest point at 3.161577% in 15th period. In other words, the highest percentage of contribution to the variability of debt ratio is only 8.496046% in the 1st period while the lowest is 3.161577% in 15th period. This indicated that the percentage of contribution of the GDP growth rate to the variability of debt-GDP ratio is relatively low either in short or medium run, as well it stand no important role in explaining the variability of the debt ratio in medium run.

# 4.9 VAR Forecasting Approach

Figure 4.6

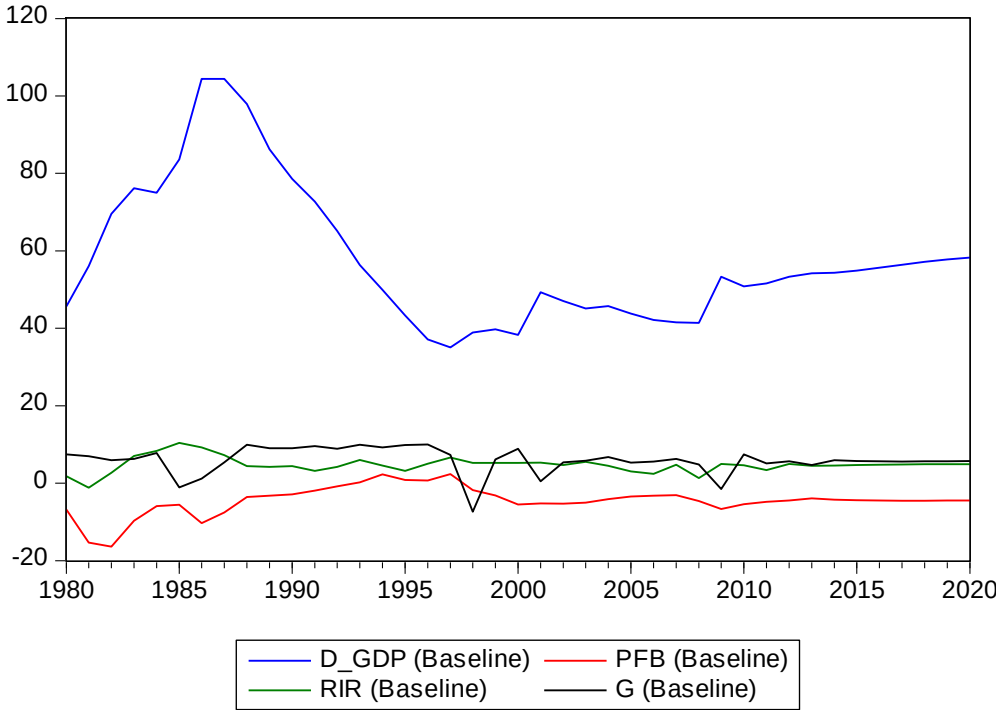



Table 4.9

| Year | D_GDP | PFB | RIR | G |
|---|---|---|---|---|
| 2014 | 54.35210 | -4.280556 | 4.553446 | 5.898127 |
| 2015 | 54.91379 | -4.391914 | 4.678888 | 5.696096 |
| 2016 | 55.64114 | -4.476796 | 4.767730 | 5.628261 |
| 2017 | 56.41925 | -4.521062 | 4.832223 | 5.612475 |
| 2018 | 57.15829 | -4.526889 | 4.876573 | 5.633083 |
| 2019 | 57.79555 | -4.500433 | 4.903818 | 5.676226 |
| 2020 | 58.29320 | -4.450117 | 4.916658 | 5.730947 |

Generally, debt-to-GDP ratio is used by investors to measure a country's

ability to make future payments on its debt, which will influence the cost of borrowing and the yields of government bond. Furthermore, our forecasting also aims to provide a guideline to the policy maker on how to restrain the debt ratio if any changes in fiscal policy or any other macroeconomic component.

Figure 4.6 provided by VAR forecasting approach show that the actual value of debt-to-GDP ratio (D_GDP), primary fiscal balance (PFB), real interest rate (RIR) and GDP growth rate (G) from year 1980 to 2013 and its own forecast value from year 2014 to 2020. Based on the diagram, we can observe there is a flat upward trend of D_GDP from year 2014 to 2020, this is an unhealthy trend and if left unchecked which will have a negative impact on credit rating of the government bond and also create the problem of economic uncertainty due to debt ratio will most likely to achieve and surpass the legal debt limit at the future period based on the result from forecasting which the debt ceiling is tied at 55% GDP that currently agreed by parliament (Investment Frontier, 2013). However, the moving trend of PFB, RIR and G are relatively stable.

D_GDP, which is affected by its own past value and primary fiscal surplus or deficit, followed by real interest rate and growth rate of GDP. Refer to table 4.9, the forecasting results show that the government will continue to implement the fiscal deficit until year 2020 as we can see all the figures of PFB are in negative value. In details, the forecasted PFB seem will be worsening from year 2014 to 2018, nevertheless, the fiscal deficit will reduce from year 2018 until year 2020. Moreover, forecasted RIR show an increasing trend from year 2014 to 2020 even though we do not know the real interest rate will increase is because whether there is increase in base lending rate or reduce in inflation rate or both. By referring to the moving trend of PFB and RIR, we can explain the reason for upward trend of the debt-to-GDP ratio.

From the empirical result of the Impulse Response Function and Variance

Decomposition, PFB and RIR play the important roles to affect the debt ratio. From year 2014 to 2018, primary fiscal deficit become worsen year by year with the annually increase of real interest rate which significantly deteriorating the debt ratio in Malaysia. On the other hand, we don't omit the effect of G as well as the past D_GDP although there is less influence than the other two variables. In overall, the forecasted D_GDP will have an increasing trend until year 2020 is because of rising trend in real interest rate and the accumulation of past debt ratio throughout the forecast period. Of course, the expansion of primary fiscal deficit and reduction of GDP growth will deteriorate the D_GDP. However, based on the result of VAR forecasting the PFB and G will have an upward trend in year 2019 onward and 2018 until year 2020 respectively. However, forecasted D_GDP from year 2018 to 2020 is still having an upward slopping trend instead of downward trend, the one of the reason behind is because the assumption of "ceteris paribus" does not hold in VAR forecasting. That is, we may conclude that the impact of a small percentage change of the reduction of primary fiscal deficit with increase in GDP growth rate are hard to improve the overall D_GDP due to large accumulation of the government debt in the past with the increasing real interest rate which indicate higher interest payment and also a higher financial burden for government, same explanation with Berger and Tyson (2013) and Bohn (1998).

## 4.10 Conclusion

On the whole after we have gone through all the related tests, we obtain a result which shown that there is no co-integrated between debt-to-GDP ratio and those macroeconomics variables. In other word, there is no any long run relationship between them because their orders of integration are different. To illustrate, we found that the growth rate and real interest rate are stationary in level

form which are differ to debt-to-GDP ratio and primary deficit balance whereby they stationary in first difference form. Therefore, all of these have given us an intention to use Augmented Granger Causality test as our methodology. Through the Granger Causality test, we know that PFB and RIR might granger cause debt-to-GDP ratio to have changes. On top of that, the lag length criterion shown that the first lag length will be the best lag length where there is no any autocorrelation problem between the error terms over the period. To prove all of these, LM test is needed and the result has matched the result of SC where the lag one has no contain any autocorrelation problem. The result of both Impulse Response diagram and Variance Decomposition table have matched the theory provided in Chapter 2, thus we can conclude that our empirical analysis for debt-to-GDP is applicable in Malaysia as well. Besides that, through VAR forecasting it has brought an idea of increasing debt to us. Eventually, all of these had helped us to meet our objectives which stated earlier.

# CHAPTER 5: DISCUSSION, CONCLUSION AND IMPLICATIONS

## 5.1 Introduction

Recently, there are many issues about the increases of national debt in Malaysia until some of the Malaysian might start to worry about the future of Malaysia. In this research paper, we would like to examine which macroeconomic factors will be the main problem that will cause the increases of the national debt. This will bring convenience to those policymakers when they try to make some decisions in order to improve the economy. Even though there are various studies had been carried out to investigate about the relationship between macroeconomic variables and national debt for some others countries. Therefore this research paper is to study the relationship of debt ratio, primary fiscal deficit, real interest rate and GDP growth rate for Malaysia.

## 5.2 Summary of Statistical Analyses

Based on the previous tests that we have conducted in Chapter 4, the empirical study has managed to answer the entire research question and provide a linkage to the research objective which we have set in Chapter 1. First of all, we had conducted unit root tests which is Augmented Dickey Fuller (ADF) and Philips and Perron (PP) stationary test, we observed that our series are at least stationary at I(1). Second of all, from the result of APF and PP tests, our variables

have no same order of integration which means the movements of the variables are diverse. We conclude that our variables have no any long run relationship, even without using JJ co integration test. Therefore, we extend the VAR model in-difference due to some of the variables has a unit root and they are not cointegrated. The optimal lag length for VAR model is based on the minimum SC, where the serial correlation problem does not exist in model based on the result of Breusch Godfrey LM test. Besides, we had applied Augmented Granger Causality test in our data analyses. From the result of unit root tests, our variables have a maximum integration order of I(1). That is, when applying Augmented Granger Causality test, we add in an additional lag length for each of the variables into each of the VAR equations. Furthermore, Granger Causality test, Impulse Response Function and Variance Decomposition have been conducted to examine the relationship between varies of variables and debt-to-GDP ratio. Hence, the results for relationship between each variable and debt ratio are explained as below.

By looking at the result, we found that growth rate of GDP does not granger cause debt-to-GDP ratio. This is quite consistent that shock of GDP growth rate tend to reduce the debt ratio but its effect is very weak in affecting debt-to-GDP ratio which shown in Impulse Response Function and Variance Decomposition. In other words, we can say that growth rate of GDP does not play an important role in reducing the debt ratio. In addition to this, we had observed that real interest rate does granger cause debt-to-GDP ratio and the result of Impulse Response Function and Variance Decomposition also show that real interest rate shock is significant in affecting the debt-to-GDP ratio. In other words, an increase in real interest rate will lead to increase in the debt ratio in the short run. Regarding to primary fiscal balance, we found that its past information is significant to predict the future movement of the debt ratio. And primary fiscal balance plays the most important role in affecting the debt-to-GDP ratio based on the information of Impulse Response Function and Variance Decomposition. A

reduction of the debt ratio will occur if primary fiscal surplus was implemented in the short run. As additional information from Impulse Response Function and Variance Decomposition, we found that there is a positive and significant response of debt-to-GDP ratio by an increase in its own past shock in the short run. As we have categorized the impact of various variables to the debt ratio, we have also obtained the result of increasing trend in debt-to-GDP ratio from VAR forecasting approach and we had interpreted the result of impact of each forecasted variable on the debt ratio respectively.

## 5.3 Discussions of Major Findings

To begin with, we have hypothesize there is a negative relationship between primary fiscal balance and debt-to-GDP ratio. That is, the debt ratio may decline when there is a surplus. This hypothesis is consistent with the result we found in Chapter 4. However, when the periods have been longer for a decade, it ends up may conflict with our results. To illustrate, the results shown by Impulse Response is that primary fiscal balance bring a negative impact from first period to the tenth period but when the period getting longer until fifteenth, it turns out to be positive relationship. From this, it have been given us an idea to suggest those policymakers reduce debt by using primary fiscal surplus in the short run but not implement it for a decade due to it may bring a negative impact to economic. Eventually, policymakers can control the debt level through primary fiscal balance (G=T) in the medium run.

By the same token, the relationship of real interest rate to debt-to-GDP ratio we emphasized in previous chapter is consistent to the result we obtain in Chapter 4. The result given shown by Impulse Response is that a positively correlated between them from the first period to the eighth period. However it

turns out to be negatively correlated after the period nine. The reason we found that the real interest rate increase and cause a decline on the debt ratio in medium run is because when the real interest rate increase, it brings a means that borrowing cost also increase. Therefore, government may try to borrow less from public in the medium run. In view of short run debt increase is due to the bond had been issued by government thus the interest payments should be pay to those bondholder.

Most of the previous researchers found that GDP growth rate are playing an important role to influence the debt-to-GDP ratio. However what we found in the result shown by Impulse Response is in the other way round. The result given show that GDP growth rate is less significant to influence the debt ratio even though it is having a negative relationship between them which consistent to our hypothesis in Chapter 2. From this, we can suspect that the bond issued by government with an intention to stimulate economic growth was in large amount, but at the end due to the growth is not faster enough and thus it can't slow down the speed of debt which is increasing. Hence, the result given show that growth rate is less significant to debt ratio.

Based on the additional information we observed from Impulse Response Function and Variance Decomposition, the debt-to-GDP ratio will also been affected by its own past shock. It will worsen the current debt ratio if the accumulated debt ratio in previous year increased. At first, due to the debt had been accumulated to a high level thus the coupon payment became higher in the short run. It created a short run fever with a reason more bonds means more coupon payment need to made by government to public due to the bond had reached its maturity date. Hence, borrowers will start to control the new issue of bond and this have cause the impact of past debt-to-GDP ratio less significant to influence current debt ratio. In medium run, the relationship between them will become negative may because of the government has aware on how to maintain

and manage the bonds which have not mature yet.

## 5.4 Implications of Study

Most importantly, the policymakers should take attention on primary fiscal balance (PFB) and real interest rate (RIR). Primary fiscal balance is playing an important role to influence debt-to-GDP ratio due to when there is a negative value shown in PFB, then it may bring a means that spending is more than government revenue. Thus, it may raise the national debt. For instance, a rise in spending also may give an impact which the speed of increase in debt is much faster than the speed of increase in GDP. With a large portion of government expenditure, government should revise its subsidy policy and reducing it so that excess resources can be reallocated for others productive and efficient uses. Furthermore, government can reduce some corruption, rent seeking case through a transparency of its procurement system. Not to mention, policymakers should suggest government reduce the spending through implementation of contractionary fiscal policy. Incidentally, policymakers can implement contractionary fiscal policy without any worry about the effect of growth rate due to growth rate is less significant to influence debt-to-GDP ratio which the result had been shown by the Impulse Response and Variance Decomposition.

Moreover, the real interest rate and the debt-to-GDP ratio move in same direction. That is as real interest rate increases, the debt-to-GDP ratio may increases and vice versa. A positive relationship had been shown by the result in Chapter 4. The real interest rate is said to have a snowball effect as the debt will getting larger and larger due to the compound interest. Hence, this should serve as warnings to government to control the real interest rate in order to prevent it

worsen the debt level. Not to mention, the behavioral patterns of interest rate and inflation rates have had some influence on GDP, thus when inflation increase may cause an increase on nominal interest rate and a decline of real interest rate. So if inflation grow faster than base lending rate then real interest rate will drop and hence the bond payment reduced. From this, the burden of debt may reduce also. Eventually, policymakers should take into account of the effect of interest rate and the effect of inflation when giving suggestion to government or implementation of monetary policy because the impact given by real interest rate might be huge to the debt ratio.

## 5.5 Limitations of Study

Generally, all studies comprise it owns limitations. In no doubt, this study also consists of several limitations. First of all, lack of available data is basically the main limitation for this analysis. Our sample size is not large enough due to the missing data problem from World Bank, Central bank of Malaysia and ministry of finance. Missing data also is the common restriction faced by the researcher who desire to carry out the analysis in Malaysia. A small sample size is basically the possible methodological limitations for the researcher who desire to perform the research of debt-to-GDP in Malaysia. This restriction is likely to reduce the degree of freedom for empirical analysis. If the degree of freedom does not large enough, it will simply make the wrong decision making for the entire test statistic. Besides, a small sample size of the series is probably limiting the scope of the empirical analysis, and small sample size is more likely to provide spurious result compare to large sample size. This is due to reason of when the sample size is large enough, it is more close to the population and the error term is likely to become normally distributed. In this study, VAR is the main model where it have to use extensively of lagged variable, thus the degree of freedom in this

study is particularly small. Moreover, lack of trustworthy data. We found out that through different online resources, the data provided will be different. It is very hard to determine which data is more reliable. This study is using annual data from the year of 1980 to 2013 where it is the maximum period that we able to found out. The sample size is merely about 34 and it might influence the accuracy of the result in our empirical analysis.

According to Schlegel (n.d.), VAR model do also have some limitations for forecasting whereby most of the macroeconomic variables are highly correlated with its own past values and with current and past values of other series, and this will cause a serious multicollinearity problem when additional lagged values of series are introduced into the model. When the system expands, it can become very difficult to separate the effects of the explanatory variables, and the estimated parameter will become extremely sensitive to the combination of variables used in the model. As consequences, we are hard to determine which variables are significant in affecting the dependent variable. Hence the estimated model will become inefficient. Thus, the result of VAR forecasting will be not precise in forecast the future value of unknown series as the serious multicollinearlity problem existed.

## 5.6 Recommendation for Future Research

As mention above, the lack of available data is basically our main limitation for this analysis. Future researchers are advised to figure out the ways to obtain quarterly data. Quarterly data is statistically proven that will enhance the robustness of the results as compare to annually data. Moreover, using panel data to analyse the test statistic also is one of the methods which able to improve

sample size. To overcome the limitation of lack of trustworthy data, future researchers are recommended to find the data from the authority website and high credibility sources which can improve the accuracy of the result.

Besides that, future researchers are suggested to use Bayesian Vector Autoregressive (BVAR) model instead of VAR to do the forecasting. According to Felix and Nunes (n.d.), BVAR model have a main advantage which the possibility of mixing sample information with prior information in a fully transparent ways the possibility of mixing different pieces of information enables the researcher to build a model that accounts not only for the stochastic behavior of economic variables but also the uncertainty surrounding economic relationships behind the economic system under analysis. These enable those future researchers to have a better model in terms of economic forecasting as compare to VAR model. According to Todd (n.d.), Bayesian Vector Autoregressive (BVAR) model can improve the forecasting of macroeconomic data by given the modellers more flexibility by take into the account of the true nature of their beliefs and the historical data. BVAR can improve the accuracy of the result for forecasting, according to Altar (n.d.), BVAR model able to overcome the problems of overs implication which happens when using ARIMA model to forecast and over fitting which occurs when using VAR to forecast. In view of Altar (n.d.), univariate models failure to take into the account of interaction between variables while multivariate model is likely to incorporate useless or misleading relationships among the variables. In general, BVAR methodology is consider the prior beliefs and the probabilities about which of the possible models will be the best forecasting approach. As stated above, BVAR is said to have better performance than VAR. As the matter of fact, future researchers should able to acquire E-views 8 and have expertise to provide the guidance in order to do well for forecasting by using BVAR approach.

## 5.7 Conclusion

This research has examined the relationship of debt-to-GDP ratio to those macroeconomic factors in Malaysia, both retrospectively and prospectively. The retrospective assessment differs from previous research in the way that it decomposes the effects of macroeconomic variables toward debt-to-GDP ratio. The prospective approach to debt restrained has at least two advantages which are an econometric framework like our uses data to inform the policy process in a more sophisticated way than accounting framework. While the other advantage is that we believe our framework communicates a clearer menu of options for policymakers. Not to mention, stimulating growth in the short run and reducing debt would be the best policy response. If policymakers respond to debt buildup and their economic environment as in the past, we should expect a lower deficit and higher growth and eventually a decreasing debt ratio. Thus, in general the previous chapters have discussed the important of the relationship between debt-to-GDP ratio, primary fiscal balance, real interest rate and GDP growth rate in Malaysia and those empirical analysis also been carried out in order to confirm what we can get according to the theories and the prediction that we made. At the same time, we believe this research can bring contributions for those who intend to do investment in Malaysia with some valuable information and of course for some policymakers who intend to apply policy in order to improve the Malaysia's national debt and use it as reference. Finally, we had argued that it is important to include the debt feedback for the future research and hence we did forecast the future debt path by using VAR model. Summing up, the debt-to-GDP ratio will increase continuously in the future. This have given us an idea which suggest policymakers should to come out some ways of precautionary before it is happened in real because prevention is better than cure.

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# APPENDIX

## Appendix 1: Augmented Dickey-Fuller unit root tests results

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

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.110356 | 0.6999 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

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

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -3.422458 | 0.0175 |
| Test critical values: | 1% level | -3.653730 | |
| | 5% level | -2.957110 | |
| | 10% level | -2.617434 | |

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

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.977539 | 0.5917 |
| Test critical values: | 1% level | -4.262735 | |
| | 5% level | -3.552973 | |
| | 10% level | -3.209642 | |

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

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -3.324431 | 0.0804 |
| Test critical values: | 1% level | -4.273277 | |
| | 5% level | -3.557759 | |
| | 10% level | -3.212361 | |

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

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.917589 | 0.3205 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

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

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -5.885165 | 0.0000 |
| Test critical values: | 1% level | -3.653730 | |
| | 5% level | -2.957110 | |
| | 10% level | -2.617434 | |

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

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.947658 | 0.6073 |
| Test critical values: | 1% level | -4.262735 | |
| | 5% level | -3.552973 | |
| | 10% level | -3.209642 | |

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

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -6.065114 | 0.0001 |
| Test critical values: | 1% level | -4.273277 | |
| | 5% level | -3.557759 | |
| | 10% level | -3.212361 | |

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

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -2.906744 | 0.0553 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

Null Hypothesis: D(RIR) has a unit root

Exogenous: Constant

Lag Length: 1 (Automatic - based on SIC, maxlag=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -4.162259 | 0.0028 |
| Test critical values: | 1% level | -3.661661 | |
| | 5% level | -2.960411 | |
| | 10% level | -2.619160 | |

Null Hypothesis: RIR has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -3.029902 | 0.1397 |
| Test critical values: | 1% level | -4.262735 | |
| | 5% level | -3.552973 | |
| | 10% level | -3.209642 | |

Null Hypothesis: D(RIR) has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 1 (Automatic - based on SIC, maxlag=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -4.121276 | 0.0146 |
| Test critical values: | 1% level | -4.284580 | |
| | 5% level | -3.562882 | |
| | 10% level | -3.215267 | |

Null Hypothesis: G has a unit root

Exogenous: Constant

Lag Length: 0 (Automatic - based on SIC, maxlag=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -4.611406 | 0.0008 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

Null Hypothesis: D(G) has a unit root

Exogenous: Constant

Lag Length: 1 (Automatic - based on SIC, maxlag=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -7.006974 | 0.0000 |
| Test critical values: | 1% level | -3.661661 | |
| | 5% level | -2.960411 | |
| | 10% level | -2.619160 | |

Null Hypothesis: G has a unit root

Exogenous: Constant, Linear Trend

Lag Length: 0 (Automatic - based on SIC, maxlag=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -4.651657 | 0.0038 |
| Test critical values: | 1% level | -4.262735 | |
| | 5% level | -3.552973 | |
| | 10% level | -3.209642 | |

Null Hypothesis: D(G) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -6.879804 | 0.0000 |
| Test critical values: | 1% level | -4.284580 | |
| | 5% level | -3.562882 | |
| | 10% level | -3.215267 | |

## Appendix 2: Phillips-Perron unit root tests results

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

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | -1.525803 | 0.5083 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

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

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | -3.422458 | 0.0175 |
| Test critical values: | 1% level | -3.653730 | |
| | 5% level | -2.957110 | |
| | 10% level | -2.617434 | |

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

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | -2.361159 | 0.3917 |
| Test critical values: | 1% level | -4.262735 | |
| | 5% level | -3.552973 | |
| | 10% level | -3.209642 | |

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

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | -3.324431 | 0.0804 |
| Test critical values: | 1% level | -4.273277 | |
| | 5% level | -3.557759 | |
| | 10% level | -3.212361 | |

Null Hypothesis: PFB has a unit root
Exogenous: Constant
Bandwidth: 9 (Newey-West automatic) using Bartlett kernel

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | -1.774759 | 0.3859 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

Null Hypothesis: D(PFB) has a unit root

Exogenous: Constant

Bandwidth: 6 (Newey-West automatic) using Bartlett kernel

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | -5.932301 | 0.0000 |
| Test critical values: | 1% level | -3.653730 | |
| | 5% level | -2.957110 | |
| | 10% level | -2.617434 | |

Null Hypothesis: PFB has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 6 (Newey-West automatic) using Bartlett kernel

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | -2.001870 | 0.5789 |
| Test critical values: | 1% level | -4.262735 | |
| | 5% level | -3.552973 | |
| | 10% level | -3.209642 | |

Null Hypothesis: D(PFB) has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 17 (Newey-West automatic) using Bartlett kernel

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | -7.594163 | 0.0000 |
| Test critical values: | 1% level | -4.273277 | |
| | 5% level | -3.557759 | |
| | 10% level | -3.212361 | |

Null Hypothesis: RIR has a unit root

Exogenous: Constant

Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | -2.937552 | 0.0518 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

Null Hypothesis: D(RIR) has a unit root

Exogenous: Constant

Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | -6.036155 | 0.0000 |
| Test critical values: | 1% level | -3.653730 | |
| | 5% level | -2.957110 | |
| | 10% level | -2.617434 | |

Null Hypothesis: RIR has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | -2.981530 | 0.1522 |
| Test critical values: | 1% level | -4.262735 | |
| | 5% level | -3.552973 | |
| | 10% level | -3.209642 | |

Null Hypothesis: D(RIR) has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | -6.108278 | 0.0001 |
| Test critical values: | 1% level | -4.273277 | |
| | 5% level | -3.557759 | |
| | 10% level | -3.212361 | |

Null Hypothesis: G has a unit root

Exogenous: Constant

Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | -4.619851 | 0.0008 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

Null Hypothesis: D(G) has a unit root

Exogenous: Constant

Bandwidth: 15 (Newey-West automatic) using Bartlett kernel

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | -17.75972 | 0.0001 |
| Test critical values: | 1% level | -3.653730 | |
| | 5% level | -2.957110 | |
| | 10% level | -2.617434 | |

Null Hypothesis: G has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | -4.662065 | 0.0037 |
| Test critical values: | 1% level | -4.262735 | |
| | 5% level | -3.552973 | |
| | 10% level | -3.209642 | |

Null Hypothesis: D(G) has a unit root

Exogenous: Constant, Linear Trend

Bandwidth: 15 (Newey-West automatic) using Bartlett kernel

| | | Adj. t-Stat | Prob.* |
|---|---|---|---|
| Phillips-Perron test statistic | | -17.26671 | 0.0000 |
| Test critical values: | 1% level | -4.273277 | |
| | 5% level | -3.557759 | |
| | 10% level | -3.212361 | |

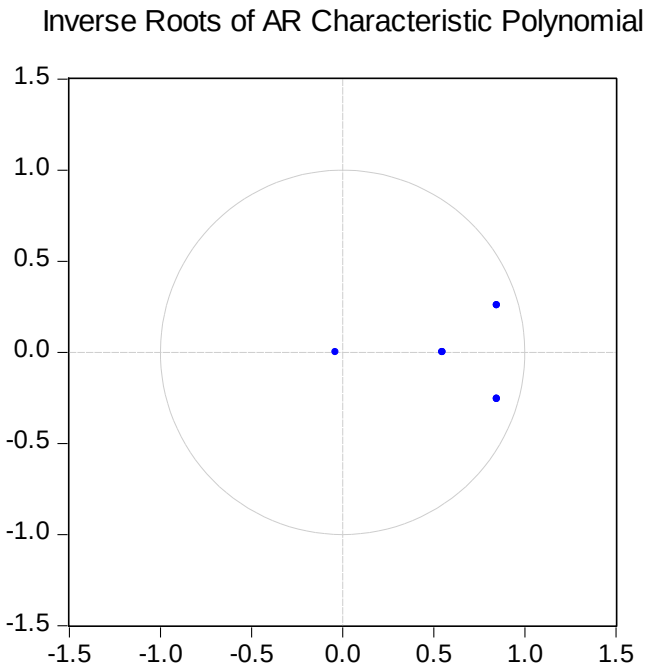
## Appendix 3: Lag Order Selection Criteria

VAR Lag Order Selection Criteria
Endogenous variables: D_GDP PFB RIR G
Exogenous variables: C
Date: 07/19/14 Time: 15:46
Sample: 1980 2013
Included observations: 29

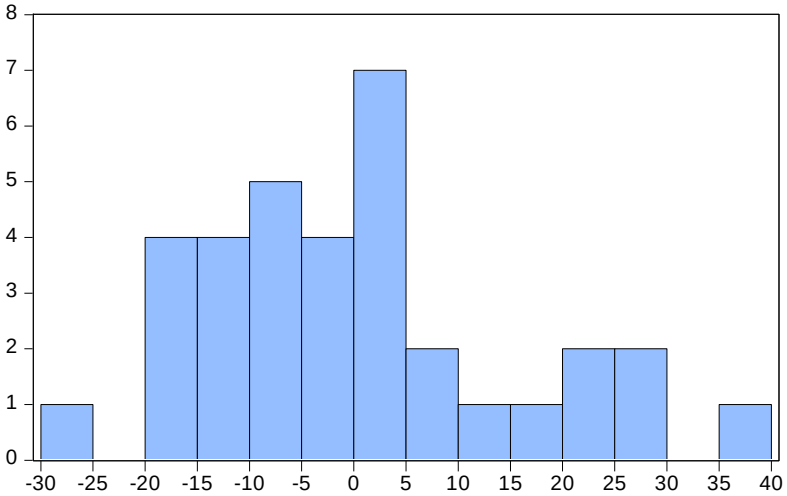
| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -325.5572 | NA | 87263.04 | 22.72808 | 22.91667 | 22.78715 |
| 1 | -243.2643 | 136.2089* | 914.6721 | 18.15616 | 19.09912* | 18.45148 |
| 2 | -231.0368 | 16.86547 | 1273.445 | 18.41633 | 20.11366 | 18.94792 |
| 3 | -212.7845 | 20.14051 | 1317.652 | 18.26100 | 20.71270 | 19.02884 |
| 4 | -182.4462 | 25.10757 | 739.4633 | 17.27215 | 20.47822 | 18.27625 |
| 5 | -147.2031 | 19.44446 | 459.7828* | 15.94504* | 19.90548 | 17.18540* |

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

## Appendix 4: Stability test results




## Appendix 5: Diagnostic Checking results




| | |
|---|---|
| Series: Residuals | |
| Sample 1980 2013 | |
| Observations 34 | |
| Mean | 4.37e-15 |
| Median | -1.107483 |
| Maximum | 37.20944 |
| Minimum | -29.44045 |
| Std. Dev. | 15.02156 |
| Skewness | 0.634676 |
| Kurtosis | 3.067560 |
| Jarque-Bera | 2.289077 |
| Probability | 0.318371 |

VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)

Date: 07/19/14 Time: 15:58

Sample: 1980 2013

Included observations: 33

Joint test:

| Chi-sq | df | Prob. |
|---|---|---|

| | | |
|---|---|---|
| 91.49234 | 80 | 0.1787 |

VAR Residual Heteroskedasticity Tests: Includes Cross Terms
Date: 07/19/14 Time: 15:59
Sample: 1980 2013
Included observations: 33

Joint test:

| Chi-sq | df | Prob. |
|---|---|---|
| 168.5134 | 140 | 0.0505 |

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 07/19/14 Time: 15:59
Sample: 1980 2013
Included observations: 33

| Lags | LM-Stat | Prob |
|---|---|---|
| 1 | 21.01634 | 0.1779 |
| 2 | 17.42807 | 0.3584 |
| 3 | 24.51679 | 0.0788 |
| 4 | 10.37787 | 0.8462 |
| 5 | 16.48470 | 0.4197 |
| 6 | 7.200374 | 0.9692 |
| 7 | 9.850808 | 0.8743 |
| 8 | 5.330854 | 0.9938 |
| 9 | 12.56032 | 0.7046 |
| 10 | 11.16933 | 0.7989 |

## Appendix 6: Augmented Granger causality tests results

VAR Granger Causality/Block Exogeneity Wald Tests
Date: 07/19/14 Time: 16:02
Sample: 1980 2013
Included observations: 32

Dependent variable: D_GDP

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| PFB | 13.90068 | 1 | 0.0002 |
| RIR | 5.515247 | 1 | 0.0189 |
| G | 0.028426 | 1 | 0.8661 |
| All | 14.07686 | 3 | 0.0028 |

Dependent variable: PFB

| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| D_GDP | 0.163687 | 1 | 0.6858 |
| RIR | 0.027208 | 1 | 0.8690 |
| G | 0.338826 | 1 | 0.5605 |
| All | 0.420575 | 3 | 0.9360 |

Dependent variable: RIR

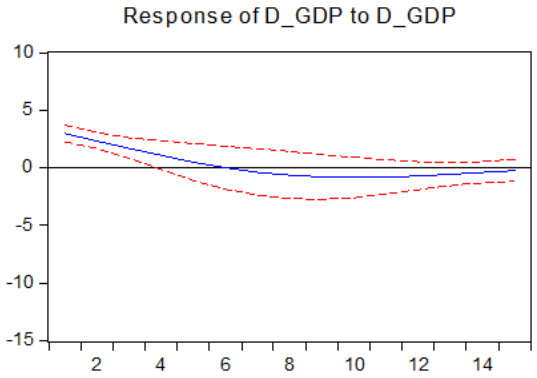
| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| D_GDP | 0.054617 | 1 | 0.8152 |
| PFB | 0.667857 | 1 | 0.4138 |
| G | 0.045878 | 1 | 0.8304 |
| All | 0.960385 | 3 | 0.8108 |

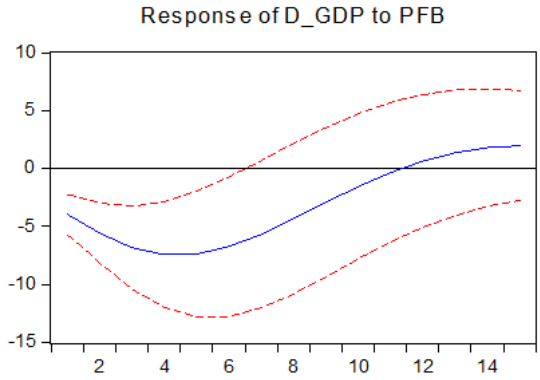
Dependent variable: G

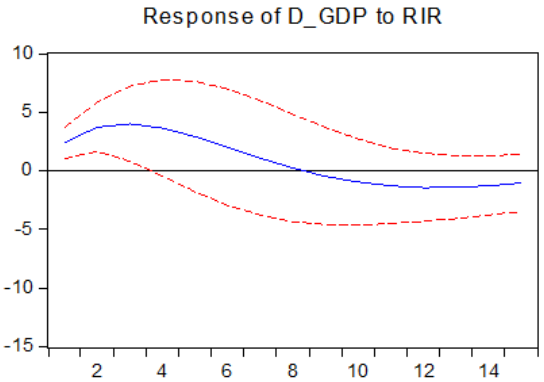
| Excluded | Chi-sq | df | Prob. |
|---|---|---|---|
| D_GDP | 0.147357 | 1 | 0.7011 |
| PFB | 0.665755 | 1 | 0.4145 |

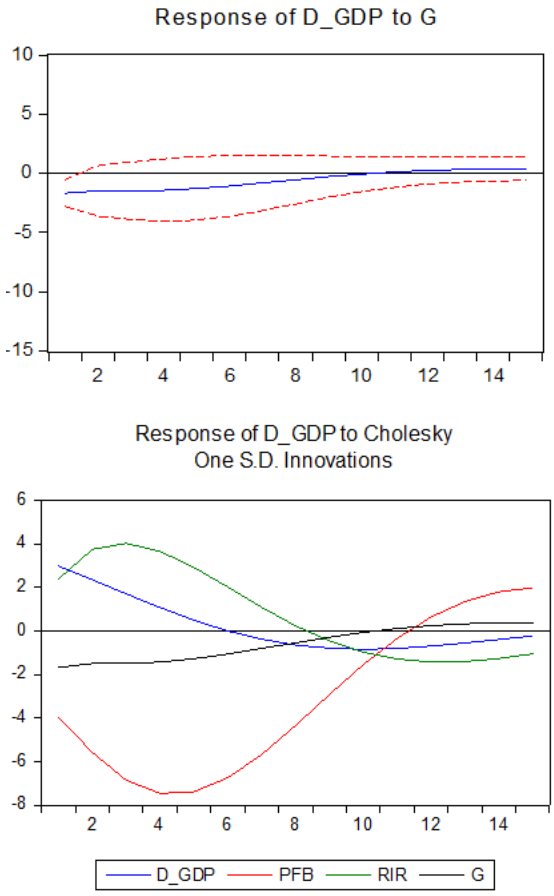
| | | | |
|---|---|---|---|
| RIR | 1.643101 | 1 | 0.1999 |
| All | 1.751192 | 3 | 0.6256 |

**Appendix 7: Responses of debt-to-GDP ratio to macroeconomic variables shock**





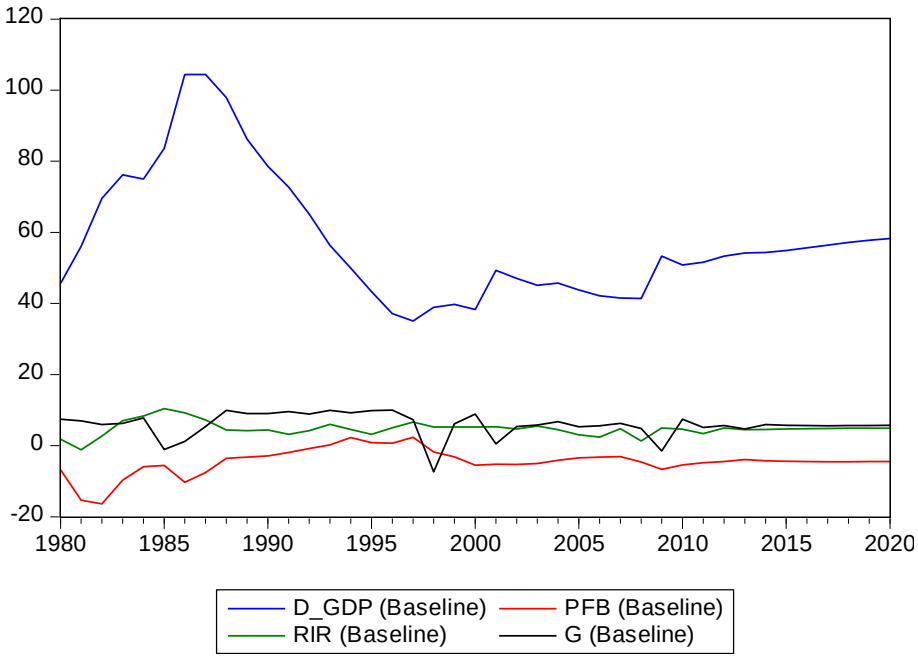

## Appendix 8: Variance Decomposition of debt-to-GDP ratio

| Variance Decomposition of D_GDP: Period | S.E. | D_GDP | PFB | RIR | G |
|---|---|---|---|---|---|
| 1 | 5.757548 | 26.67566 | 47.61523 | 17.21306 | 8.496046 |
| 2 | 9.278534 | 16.66009 | 54.53060 | 22.94622 | 5.863100 |
| 3 | 12.42732 | 11.16657 | 60.84111 | 23.26406 | 4.728258 |
| 4 | 15.05538 | 8.113589 | 66.02017 | 21.74441 | 4.121834 |
| 5 | 17.07923 | 6.386829 | 70.03660 | 19.81428 | 3.762285 |
| 6 | 18.50323 | 5.441604 | 72.96048 | 18.06222 | 3.535701 |
| 7 | 19.40384 | 4.987794 | 74.88770 | 16.73499 | 3.389513 |
| 8 | 19.90320 | 4.847473 | 75.93631 | 15.91969 | 3.296523 |
| 9 | 20.13975 | 4.891688 | 76.26727 | 15.60065 | 3.240396 |

| | | | | | |
|---|---|---|---|---|---|
| 10 | 20.24062 | 5.016888 | 76.09623 | 15.67761 | 3.209274 |
| 11 | 20.30103 | 5.143751 | 75.67204 | 15.99085 | 3.193352 |
| 12 | 20.37501 | 5.224503 | 75.22235 | 16.36844 | 3.184704 |
| 13 | 20.47882 | 5.245434 | 74.89799 | 16.67866 | 3.177918 |
| 14 | 20.60323 | 5.218761 | 74.75170 | 16.85919 | 3.170348 |
| 15 | 20.72860 | 5.168209 | 74.75819 | 16.91203 | 3.161577 |

Cholesky Ordering: PFB RIR G D_GDP

## Appendix 9: VAR forecasting results




| Year | D_GDP | PFB | RIR | G |
|---|---|---|---|---|
| 2014 | 54.35210 | -4.280556 | 4.553446 | 5.898127 |
| 2015 | 54.91379 | -4.391914 | 4.678888 | 5.696096 |
| 2016 | 55.64114 | -4.476796 | 4.767730 | 5.628261 |
| 2017 | 56.41925 | -4.521062 | 4.832223 | 5.612475 |
| 2018 | 57.15829 | -4.526889 | 4.876573 | 5.633083 |
| 2019 | 57.79555 | -4.500433 | 4.903818 | 5.676226 |
| 2020 | 58.29320 | -4.450117 | 4.916658 | 5.730947 |