QUANTITATIVE EASING AND OKUN'S LAW IN UNITED STATES

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FACULTY OF BUSINESS AND FINANCE
DEPARTMENT OF ECONOMICS

AUGUST 2017

OOI, CH’NG, DING, LEONG, & OOI QUANTITATIVE EASING BFE (HONS) AUGUST 2017

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

BACHELOR OF ECONOMICS (HONS)
FINANCIAL ECONOMICS

UNIVERSITI TUNKU ABDUL RAHMAN

FACULTY OF BUSINESS AND FINANCE
DEPARTMENT OF ECONOMICS

AUGUST 2017

DECLARATION

We hereby declare that:

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

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

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

(4) The word count of this research report is ____17218________.

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Date: 30th August 2017___

ACKNOWLEDGEMENT

We would like to express our heartfelt gratitude to various individuals that has helped us greatly in the midst of this research project, as we might not be able to complete this research project successfully without the help of these individuals.

First and foremost, we are grateful to our research supervisor, Dr. Wong Chin Yoong, as he has been very supportive and gave us guidance in the midst of preparing this research project. He has also been generous in teaching us economics knowledge which are helpful in our research project and providing valuable guidance when we faced obstacles and challenges in our research. We would not be able to complete this research without his valuable help.

We are also grateful to our research coordinator, Ms. Thavamalar a/p Ganapathy, for giving us information about the research project. Without her help, we are unable to submit the paperwork needed for the research project.

Next, we are grateful to our beloved family members and team members who have been supportive throughout this research. Their supports gave us motivation and strength in the progress of this research project.

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LIST OF ABBREVIATIONS

ADF	Augmented-Dickey Fuller
AIC	Akaike Information Criterion
ARCH	Autoregressive Conditional Heteroscedasticity
BOE	Bank of England
BOJ	Bank of Japan
CDO	Collateralized Debt Obligations
CE	Compensation of Employee
CLRM	Classical Linear Regression Model
CNLRM	Classical Normal Linear Regression Model
DF	Dickey-Fuller
ECB	European Central Bank
FDI	Foreign Direct Investment
FRED	Federal Reserve Economic Data
GARCH	Generalized Autoregressive Conditional Heteroscedasticity
GDP	Gross Domestic Product
GDS	Government Deficit Spending
GLS	Generalized Least Squares
HAC	Heteroscedasticity and Autocorrelation-consistent
INFEXP	Inflation Expectation
JB	Jarque-Bera
JJ Cointegration Test	Johansen-Juselius Cointegration Test
LSAP	Large Scale Asset Purchase
MBS	Mortgage-Backed Securities

OECD	Organization for Economic Cooperation and Development
OG	Output Gap
OLS	Ordinary Least Square
OMO	Open Market Operations
PP	Phillips Perron
QE	Quantitative Easing
RB	Reserve Balances
RESET	Regression Equation Specification Error Test
SIC	Schwartz Information Criterion
TED	TED Spread
TFP	Total Factor Productivity
TOL	Tolerance
TS	Treasury Security
U	Unemployment
VIF	Variance Inflation Factor
WLS	Weighted Least Squares

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PREFACE

The topic of our study is “Quantitative Easing and Okun’s Law in United States”. Quantitative Easing (QE) is a form of unconventional monetary policy implemented by Federal Reserve after 2008 Great Recession through Large Scale Asset Purchase program with the intention of bringing the U.S. economy out of liquidity trap; Okun’s Law can be defined as the relationship between unemployment rate and changes in real and potential Gross Domestic Product (GDP), where both of these depict a negative relationship.

However, the relationship between QE and Okun’s Law has never been studied by previously and thus we hope to make some contribution by filling in this gap. By doing so, we hope to have a better understanding regarding the effect of QE on the Okun’s Law multiplier and thus have a clearer picture about how QE affects the unemployment rate.

Unemployment (U) is the dependent variable of this study, while the independent variables are output gap (OG), reserve balance (LNRB), 10-year treasury spread (TS), government deficit spending (GDS) and inflation expectation (INFEXP). Among these variables, we use LNRB and TS as a proxy for QE.

This research is able to give insightful knowledge to various parties, which is to researcher who are interested in studying the macroeconomic impact of QE on unemployment rate through Okun’s Law as well as policymakers and government who is responsible for implementing and adopting new policies in terms of determining the optimal amount of QE needed for unemployment rate recover to pre-crisis level.

ABSTRACT

This paper explores the impact of Quantitative Easing on Okun’s Law in United States using Ordinary Least Square (OLS) model with quarterly time-series data from 1985 to 2015. We find that Okun’s Law multiplier does not diminish after 1990’s but declines whenever the economy is in a recession. Nevertheless, Quantitative Easing is effective in bringing back the negative relation of Okun’s Law in a wake of financial crisis but the amount of Quantitative Easing conducted by Federal Reserve is not sufficient for the economy and labour market condition to recover back to the pre-crisis level.

CHAPTER 1: INTRODUCTION

1.0 Introduction

U.S. subprime mortgage crisis which had led to the 2008 Great Recession, has been considered by many economists as the worst economic disaster since the Great Depression of 1929. According to Reinhart et al. (2008), subprime mortgage crisis has its roots in the declining U.S. housing prices, which consequently led to higher default levels particularly among less credit-worthy borrowers. The values of the derivatives collapsed, banks stopped lending to each other and the economy is in a liquidity trap where all forms for conventional monetary policies have proven to be ineffective.

In November 2008, the Federal Reserve of U.S. started their first round of QE, which is a form of unconventional monetary policy through large scale purchasing of long-term government securities and other financial assets from the market in order to pull the economy out of liquidity trap. In 12th December 2012, the FOMC statement of Federal Reserve's stated that its purchases of long term government bonds and agency-mortgage backed securities would not be terminated by the committee unless labour market conditions improve significantly.

After the Federal Reserve conducted a total of three rounds of QE, in 29thOctober 2014, it was mentioned in the FOMC statement the committee decided to bring QE to an end because of the substantial improvement in the labour market conditions which are moving towards full employment in a context of price stability. However, due to the complicated transmission process for QE to take effect on macroeconomic factors, thus by looking at the effect of QE on Okun's Law multiplier we can have a better understanding on how does QE impacts the labour market conditions in U.S..

1.1 Research Background

1.1.1 Okun's Law and Unemployment in United States (U.S.)

When it comes to studying the macroeconomic conditions of a nation, economic growth and employment has always been the two main factors that will be considered by economists. In fact, there has been a clear relationship between these two factors. In 1962, Okun's Law relationship was proposed by Arthur Melvin Okun. It is an empirically observed negative short-run relationship between unemployment and output gap. In the U.S., many economists proposed that 1 percent increase in the output gap will lead to an opposite change in unemployment by 0.5% percent. Since then, Okun's Law has received a broad support by studies and it has become a fixture that can be commonly found in the macroeconomic textbooks today. However, it was until recently that many questions have been raised by the economists regarding the accuracy of Okun's law.

According to studies conducted by Gordon (2010), they suggest that since 1980, the Okun's law procyclical productivity response is no longer up-to-date. Based on the previous 3 recessions that occurred in the U.S., observers suggested that those recessions were followed by a "jobless recovery" in which the economy experiences economy growth while still having a constant or increasing level of unemployment that does not follow what Okun's law prediction. It is also suggested that Okun's law is precarious in many countries, some economists even found that the Okun's law relationship has disintegrated during the subprime mortgage crisis of 2007 to 2009. Although it is rare to call a macroeconomic relationship as a "law", Okun's law is certainly stable and strong based on the standards of a macroeconomic variable. Therefore, Okun's law has earned its name. One suitable explanation for the precarious Okun's law relationship is the fact that the coefficient for Okun's law is no longer as high as the original Okun's law (Ball, Leigh & Loungani, 2013).

Figure 1.1 Unemployment Rate in United States

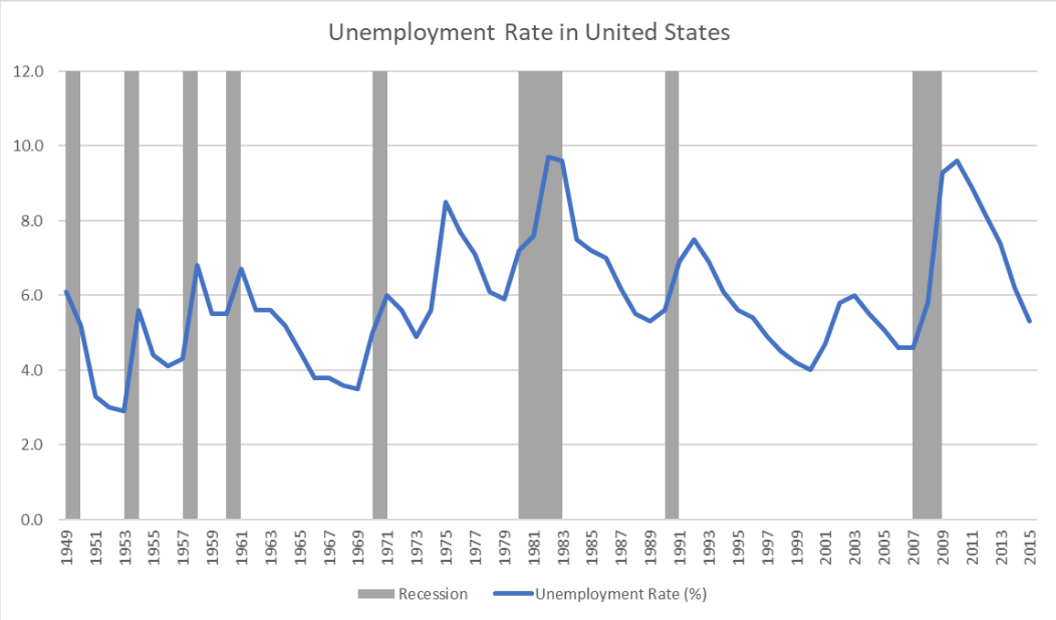


Figure 1.1 illustrates the relationship between unemployment rate in U.S. from the year 1949 until 2015, whereby the shaded region represents the period of recession. From the figure above, we can clearly see that whenever the economy is out of the recession period, unemployment declines. However, note that in the last two recessions, given that output had already recovers, but unemployment rate still remains high and this also known as a jobless recovery phenomenon. Therefore, people start to question the validity of Okun’s Law.

1.1.2 The Arrival of 2008 Subprime Mortgage Crisis

Prior the fall of the subprime mortgage crisis, housing prices in the U.S. rocketed for approximately 40% just from 2000 to 2006. According to Mah-Hui (2008), investment and mortgage bankers earned up to millions or even billions from trading the asset-backed securities. Many middle-class and even lower-class households were able to own a house with a minimal down payment. At the end, everyone felt rich. However, by early 2006, house prices started to decline after its peak and it became more difficult for house owners to refinance their loans. With a 20 trillion USD worth of house sector, every 10% decline in housing prices cuts off 2 trillion USD worth of household wealth. As a result, default and foreclosure rates began to increase as 1.2 million USD worth of household default loans started to increase in 2006 and it got even worse when 2.5 million adjustable rate mortgages were reset higher in 2008 (Schwartz, 2007).

It was not until 1990s that the rapid growth of the subprime mortgage market gained national attention (Chomsisengphet & Pennington-Cross, 2006). By definition, subprime mortgage is a type of mortgage that is lent to house borrowers with low credit ratings. Due to the borrowers' weak credit, the lending institution will not offer them a conventional mortgage because the risk of having them default the loan is relatively high. Therefore, house borrowers with low credit ratings, usually below 600, will be offered subprime mortgage, with a minimal down payment and a higher interest rate as a compensate for themselves for carrying a higher default risk. During the period from 2001 to 2006, the amount of subprime mortgage loan raised from 624,000 to 3,440,000, with a total increase of 451% (Demyanyk & Hermert, 2008). The conditions were still fine as long as the housing price continued to rise and the interest rate remained the same. However, when the housing price started to fall, the first to default the mortgage loans were the subprime borrowers. This led to the deterioration of mortgage-backed securities (MBS) and collateralized debt obligations (CDO) markets, which is what the mortgage debts was financed.

Mortgage-backed security (MBS) is a type of security that is secured by a collection of mortgages. It must be grouped in high ratings determined by the credit rating agencies and usually pay periodic payments which are similar to coupon payments. Mortgage-backed securities (MBS) had allowed financial institutions and mortgage companies to increase their liquidity because it enabled them to securitize and sell off the loans, which enhances the velocity and turnover of the loans. This also enables them to take on more loans because they moved the securitized loan off their books. As soon as the houses are built, the mortgage companies have aggressively pushed the mortgages to the borrowers, including the ones with the weak credit ratings, to increase their earning profit. Despite that, mortgage-based securities (MBS) have allowed the mortgage companies to transfer their risks to other investors (Mah-Hui, 2008).

On the other hand, collateralized debt obligations (CDO) refers to a structured financial product that pools a class of asset-backed securities and repackages these assets into discrete tranches with different credit ratings, interest rates, and order of payment (Mah-Hui, 2008). For instance, senior tranches pays the lowest interest, but they have the first priority to receive the debt payment; mezzanine tranches pays the moderate interest, and they have the moderate priority to receive the debt payment; equity tranches pays the highest interest, but they have the last priority to receive the payment. As long as the housing market is going through a typical inventory cycle, there will be a risk that the housing price could fall. A significant fall in housing price will speed up the risk of mortgage delinquencies and foreclosures and spell doom for the collateralized debt obligations (CDO) market (Sumerlin & Katzovitz, 2007).

Occurred between 2007 and 2010, U.S. subprime mortgage crisis was a nationwide economic disaster. It was triggered by the large downfall of the U.S. housing price, leading to the delinquencies and foreclosures of mortgage loans, and the deterioration of mortgage-backed securities (MBS) and collateralized debt obligations (CDO) markets. According to Reinhart and Rogoff (2009), there are three broad characteristics that are shared on the impact of the subprime mortgage crisis. First and foremost, it is the intense and prolonged deterioration of the asset markets. The U.S. national home price index fell for an average of 35 percent over six years while households' equity in real estate deteriorates an average of 55 percent over three and a half years. Next, the impact of subprime mortgage crisis also led to the decline in the real GDP and employment. The real GDP has fell for approximately 4 percent over two years. The unemployment rate rose from 5 percent in 2007 before the financial crisis to 10 percent in 2010 after the financial crisis and last over four years, which is considerably longer than for real GDP. Lastly, subprime mortgage crisis also led to the expansion of the real government debt. As a matter of fact, the main reason that caused the explosion of real government debt is the unavoidable deterioration in the tax revenue suffered by government due to the rise of economic disaster, as well as the money spent for the government policies that is implemented to rescue the downturn of the economy.

1.1.3 Quantitative Easing (QE) the Unconventional Monetary Policy

When an economy is upon a crisis, the usual way for Central Banks to affect the short-term interest rates is through open market operations (OMO) by purchasing or selling securities that which is a type of conventional monetary. However, when a nation's economy is in a liquidity trap where short-term interest rate is already at its zero-lower bound, conventional monetary policy is no longer applicable in such situation. Therefore, when short-term interest rates are at or approaching zero, QE was introduced to the market as a type of unconventional monetary policy to signal a shift in focusing towards quantity variables in which a central bank purchases government securities or other securities from the market in order to boost the cash reserves in the system. QE increases the money supply by flooding financial institutions with capital in an effort to promote increased lending and liquidity. Eventually, this will hopefully increase the lending into the broader economy, help in driving the asset prices up and overcome the deflation pressure.

According to Joyce et al. (2012), QE has been the most well-known type of unconventional monetary policy. Japan was the first country that applied QE to deal with the collapse of the real estate market and the pressure of deflation in Japan. However, studies conducted by Schenkelberg and Watzka (2013) suggest that the effect of QE on inflation was not very significant, although it led to a significant but a short-term increase in output. This shows that while QE experiment in Japan has successfully stimulated the economy temporarily, it does not lead to any increase in inflation. Despite so, the central bank of the U.S., Europe, and the United Kingdom, have eventually followed the footsteps of Japan in implementing QE to their economy with some significant differences among them on how they implement QE compared to Japan.

In general, there were three QE stages, which are QE1, QE2, and QE3, at where these three are implemented at different time and through different channels in the U.S. Based on Krishnamurthy and Vissing (2011), first round of QE (QE1) was introduced in the late-2008 to 2009 by the Federal Reserve. It was implemented through the channel of purchasing mortgage-backed securities, treasury securities, and agency securities. In November 2008, the Federal Reserve has purchased 600 billion USD worth of agency mortgage-backed securities and agency debt. In March 2009, the Federal Reserve has expanded their QE1 by purchasing an additional worth of 750 billion USD of agency-backed securities and agency debt and 300 billion USD worth of treasury securities. In November 2010, the Federal Reserve announced that they would shift their second round of QE (QE2) towards purchasing 600 billion USD worth of longer-term treasuries at a rate of 75 billion USD every month, which is not agency mortgage-backed securities and agencies as in QE1. In September 2012, third round of QE (QE3) has been announced by the Federal Reserve. QE3 focuses on the purchase of agency mortgage-backed securities for 40 billion USD monthly until a substantial improvement has been observed on the labour market. In December 2012, the Federal Reserve continued to expand their purchases of agency mortgage-backed securities with the additional 45 billion USD worth of longer-term treasury securities monthly. In October 2014, the Federal Reserve ended their QE3.

In general, QE takes place by increasing the prices of mortgage backed securities and treasury bonds to stimulate the economy and reduce unemployment. However, the effect of QE on economy and unemployment seems to be very unnoticeable. The first mechanism behind QE is to stimulate the market by expanding the division of labour and enhance the productivity and decrease unemployment. Second mechanism behind QE is to affect the supply-side by reducing taxes to increase saving and investment. Even so, these 2 mechanisms are said to affect the income flow, whereas

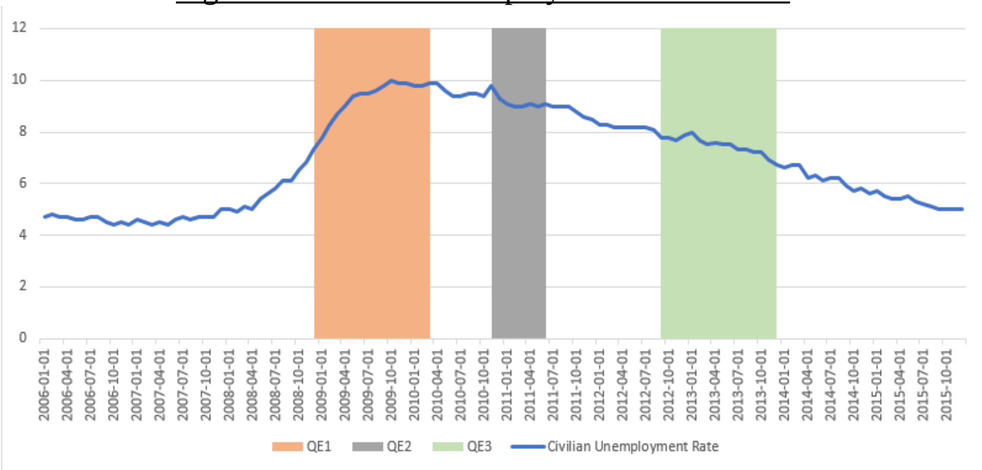
QE affects the asset prices, this obscurity between QE and real economy did raise a number of questions. This indicates that whether QE helps in reducing the unemployment still remains unknown (Watkins, 2014).

1.1.4 Unemployment after Quantitative Easing (QE)

According to Knotek II and Terry (2009), a similar significant increase in the unemployment rate can also be observed in other previous recession such as the recession in 1973 to 1975 and the recession in 1981 to 1982. However, unlike the slow recovery that occurred from the subprime mortgage crisis, the economy in the previous recessions had quickly recovered and unemployment rate had quickly reduced. Given the slow decline in the unemployment rate even after then implementation of QE, one would be hard pressed to conclude that quantitative easing had in fact helped in stimulating the economy and employment.

Figure 1.2 represents the unemployment rate in U.S from 2006 to 2015, whereby the shaded regions indicate QE period. Therefore, is QE effective in bringing back employment in U.S.? We have notice from the graph above that after the implementation of QE1, unemployment still remains high despite of the seemingly declining trend.

Figure 1.2 Civilian Unemployment Rate in U.S.



However, unemployment rate starts to drop after the QE2 is conducted and decrease significantly after the implementation of QE3.

1.2 Problem Statement

Rising unemployment is a serious matter of recessions. Every country aims to have low unemployment with improving employment as a part of recoveries. While during that period which is in the late of 2008, QE programme was implemented to support the labour market and also U.S. economy. U.S. civilian unemployment rate was persistently high since the recession, in a level that did not occur in any other previous recessions. Therefore, if there is repeat crisis in the future, is QE effective enough to minimize or even bring down the adverse effects like the high unemployment? If yes, how large will be the impacts against towards the U.S. economy. U.S. history did not provide the backing for linking high unemployment and low employment in the current recovery with the financial crisis during period 2007 to 2009. Previous researcher studies the impact of QE in different perspectives mainly on the overall economy performance such as gross domestic product (GDP). In addition, there is no study concerning on the relationship between QE and Okun's Law. Hence, this is the motive to study how QE can be employed to save the economy through its effects on the output and other economic indicators. Accordingly, we have to study the historical impacts of QE on a specific area such as unemployment. The construction of our model in this study is to determine the impact of QE on the unemployment in U.S. economy through the adoption of Okun's Law.

1.3 Research Objectives

Research objective explains the aim of conducting this paper. All the research objectives will be accomplished at the end of the research. There are two categories of research objectives, namely general and specific objectives.

1.3.1 General Objective

In this paper, our purpose is to investigate the effectiveness of QE on the recovery of unemployment rate in U.S. using quarter time series data from 1985 to 2015 by implementing the Okun's Law equation.

1.3.2 Specific Objectives

The main purposes of this study are specified to observe on how:

1) To investigate the Okun's law multiplier after 1990's.
2) To investigate the Okun's law multiplier after 2000's
3) To investigate the effect of financial crisis on Okun's law multiplier.
4) To investigate the effect of QE on Okun's law multiplier.
5) To investigate how the QE influence the role of financial crisis on Okun's law.
6) To investigate how government deficit spending (GDS) influence the role of QE on Okun's law.
7) To investigate how inflation expectation (INFEXP) influence the role of QE on Okun's law.

1.4 Research Questions

The purpose of conducting this study is to investigate the effectiveness of QE on the recovery of unemployment rate in U.S. using quarter time series data from 1985 to 2015 by implementing the Okun's Law equation. Therefore, it enables to answer the following research questions:

1) Does Okun's law multiplier decreases after 1990's?
2) Does Okun's law multiplier decreases after 2000's?
3) What is the effect of financial crisis on Okun's law multiplier?
4) What is the effect of QE on Okun's law?

5) How QE influence the role of financial crisis on Okun's law?
6) How government deficit spending (GDS) influence the role of QE on Okun's law?
7) How inflation expectation (INFEXP) influence the role of QE on Okun's law?

1.5 Hypotheses of the Study

1.5.1 Does Okun's Law multiplier decrease after 1990s?

H_0: Okun's Law multiplier does not decrease after 1990s.

H_1: Okun's Law multiplier decreases after 1990s.

1.5.2 Does Okun's Law multiplier decrease after 2000s?

H_0: Okun's Law multiplier does not decrease after 2000s.

H_1: Okun's Law multiplier decreases after 2000s.

1.5.3 Effect of Financial Crisis on Okun's Law

H_0: There is no effect of financial crisis on Okun's Law.

H_1: There is effect of financial crisis on Okun's Law.

1.5.4 Effect of Quantitative Easing (QE) on Okun's Law (TS)

H_0: There is no effect of QE on Okun's Law.

H_1: There is effect of QE on Okun's Law.

1.5.5 Effect of Quantitative Easing (QE) on Okun's Law (LNRB)

H_0: There is no effect of QE on Okun's Law.
H_1: There is effect of QE on Okun's Law.

1.5.6 How Quantitative Easing (QE) influence the role of financial crisis on Okun's Law

H_0: There is no effect of QE influencing the role of financial crisis on Okun's Law.
H_1: There is effect of QE influencing the role of financial crisis on Okun's Law.

1.5.7 How Government Deficit Spending (GDS) influences the role of Quantitative Easing (QE) on Okun's Law

H_0: GDS does not influence the role QE on Okun's Law.
H_1: GDS influence the role of QE on Okun's Law.

1.5.8 How INFEXP influence the role of Quantitative Easing (QE) on Okun's Law

H_0: INFEXP does not influence the role QE on Okun's Law.
H_1: INFEXP does influence the role of QE on Okun's Law.

1.6 Significance of Study

Previous researchers only focused on QE and stock price (Miyakoshi, et al., 2017), QE and interest rate (Angar et al., 2017), etc, but no one has done research on QE and Okun’s Law. Hence, this study is able to fill the research gap and it is able to provide more insightful knowledge about the macroeconomic impact of QE on unemployment through Okun’s Law.

Besides, by studying QE and Okun’s Law together, it is possible for us to find out the optimal amount of QE needed to bring back pre-crisis Okun’s relation. This is very crucial as it serves as a guideline for policymakers and government to create and implement an effective policy framework in terms of reducing unemployment rate to the pre-crisis level through QE and thus speeds up the recovery of the country’s economy.

Academicians and researchers are able to gain benefit as this might be helpful for them to conduct further research on QE and unemployment and they might be able to gain more discoveries. Researchers should study how other variables influence QE on Okun’s Law to gain more understanding on the macroeconomic impact of QE.

1.7 Chapter Layout

1.7.1 Chapter 1: Research Overview

Chapter 1 consist of introduction, which provides an overview and the background of QE and Okun’s Law. This chapter discusses about problem statement, research objectives, research questions, hypothesis of study, and significance of study, chapter outlay and conclusion.

1.7.2 Chapter 2: Literature Review

This chapter discusses the literature review of QE, Okun's Law and conclusion. It provides a clearer picture of QE and Okun's Law and further explanation about QE and Okun's Law will be shown in this chapter.

1.7.3 Chapter 3: Methodology

In this chapter, it includes the literature review about the relationship between independent variables and dependent variables. The framework used, data definition, data sources, data processing and data analysis in this study are further elaborated.

1.7.4 Chapter 4: Data Analysis

This chapter discusses about the results of descriptive statistics, empirical results and interpretation of the results obtained through data analysis and methodologies used in this study.

1.7.5 Chapter 5: Discussion, Conclusion, and Implications

This chapter provides a conclusion of this whole study together with the summary of major findings, policy implications, limitations and recommendations for future research.

1.8 Conclusion

In short, this study aims to examine QE and Okun's Law in U.S. and this chapter provides a brief picture about the research topic. It contains of introduction, research background, problem statement, research objectives, research questions, hypothesis, significance of study, chapter layout and conclusion. In the further chapters, we will further examine QE and Okun’s Law and the subsequent chapters will answer the objectives and questions of our study.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

In this chapter, we will discuss some of the previous studies done by previous researchers which are related to QE and Okun’s Law. Firstly, we will discuss on what people had studied about the impact of QE in general and then we will continue our discussion upon Okun’s Law in the second part of this chapter.

2.1 Effectiveness of Unconventional Monetary Policy

Bernanke and Reinhart (2004) proposed three strategies in conducting unconventional monetary policy: (i) communicate with investors to form public expectations that the short-term rates will remain low in future, (ii) changing the composition of central bank’s balance sheet so that relative supplies of securities could be altered, (iii) expand the size of central bank’s balance sheet by conducting Large Scale Asset Purchasing programme (LSAP).
In the aftermath of 2008 Great Recession, in order to prevent the history of 1930’s Great Depression to repeat itself again, U.S. Federal Reserve had conducted three rounds of unconventional expansionary monetary policy, through Large Scale Asset Purchasing programme (LSAP) from year 2008 until year 2014, where interest rate is at zero lower bound and it’s widely known as Quantitative Easing. Ben Bernanke, former chairman of U.S. Federal Reserve commented that QE doesn’t work in theory but in practice and the main purpose for Federal Reserves to implement QE is to lower the long-term yields so that the demand can be stimulated by a lower long term interest rates.

Eggertsson (2003) argued that when short-term nominal interest rates reached zero lower bound, the effectiveness of conducting monetary policy under this constrain is all depends on the skillful management of expectations regarding the future course of interest rate. This means that in order for unconventional monetary policy to be effective, central banks should communicate with the market regarding their firm commitment in conducting unconventional monetary policy and would not reverse their action in near future. By doing so, the market will form expectations which is in favor of central bank's policy and thus boost effectiveness of the unconventional monetary policy.

2.2 Quantitative Easing (QE) and Unemployment

Based on the FOMC statement of Federal Reserve's in 12th December 2012, it was stated that the committee would not terminate its purchases of long term government bonds and agency-mortgage backed securities unless the labour market conditions improve substantially. Nonetheless, under Federal Reserve issues FOMC statement in 29thOctober 2014, it was mentioned that the labour market conditions had improved substantially and are moving towards full employment in a context of price stability under the effects of QE and thus the committee decided to bring the LSAP to an end.

Many had said that the fast recovery of U.S. economy from Great Recession is due to effectiveness of QE and according to Engen, Laubach, and Reifschneider (2015) upon the study of effects of Federal Reserve's unconventional monetary policies on macroeconomics, they have found that QE had increased the rate of recovery from 2011 on because the private sector believed that QE will be conducted over a longer period. Besides, they also mentioned that the peak unemployment and inflation effect did not occur until early 2015 and 2016.

However, while reviewing the statistical data regarding civilian unemployment rate and financial crisis from FRED Economic Data, we've noticed that in the recent three recessions that occurs after 1990's, unemployment rate did not recovered even though economy had recover from recession. Joyce, Miles, Scott, and Vayanos (2012) stated that it is either due to the ineffectiveness of QE or extremely strong recessionary forces that causes the recovery of Western economies to be weak and sluggish.

Shea, Sheng, and Varner (2017) studied the effects of QE on real economy and found that QE had leads to a decline in price level and increased in unemployment rate which are contrary to many related literatures. Wen (2014) found that even if QE had anchored inflation and lowered real interest rate, aggregate output and employment will still remain low unless LSAP is extremely large and is very persistent.

Nonetheless, we noticed that although the civilian unemployment rate did not decreased right after the economy is out from 2008 Great Recession, yet the trend of high unemployment is not that obvious compared to the previous two recessions. Chung, Laforte, Reifschneider, and Williams (2012) found that unemployment rate had reduced by 1½ percentage points in the presence of QE.

2.3 Other Studies Regarding Quantitative Easing

Meinusch and Tillmann (2016) stated that QE shocks causes interest rates to fall, a rise in stock price and an increase in real economic activity and inflation. QE was conducted by Federal Reserve's which intend to better develop firm's refinancing cost in long term and the domestic interest rates usually decreased after implementation of QE was being announced. As a result, QE may assist economic recovery and long term interest rate should reduce, at the same time, asset prices should increase after the shock.

Rahal (2016) studied how housing markets responded to QE shocks in terms of total assets innovations and monetary base. QE decreased the real interest rates and cost of housing and therefore the demand for (and price of) houses increase. This also means that QE have identical effects with policy rate shocks, a weaker impact on the price level and the impact on output is less persistent. The empirical results prudent strong evidence in favor of the intuitive economic theory that QE shock not only has effects on house prices but the residential supply and mortgage markets is also affected.

Neely (2015) found that the international long-term yields can be reduced by unconventional monetary policy at the zero bound. Implementation of QE not only will affect U.S. yields but also will influence international asset prices through signaling channel. QE had significantly decreased the 10-year nominal yields of Australia, Canada, Germany, Japan, and the United Kingdom and have depreciated the USD against the currencies of Australia, Canada, Germany, Japan, and the United Kingdom. Besides, QE announcements also decreased expected long-term U.S. bond real and nominal yields, long-term foreign bond yields in dollars, and dollar value.

2.4 Okun’s Law: Unemployment and Output Gap

Based on the Valadkhani and Smyth (2015), for every percentage point increase in the unemployment rate is associated with closely 2 to 3-percentage-point decline in real GDP, which means an extra 2–3% grow in real output will accompany by 1 percentage point decline in unemployment if two variables have bi-directional causality. Guisinger and Sinclair (2015) stated that Okun’s Law can be described as ‘‘a negative short-run correlation between unemployment and output’’ and because Okun’s Law is often consistent with both forecasts and forecast revision, thus Okun’s Law is highly regarded by forecasters.

According to Tombolo and Hasegawa (2014), the inverse of the Okun relationship is estimated in which the decrease in unemployment rate will cause increase in output growth. The effect of output growth (unemployment) on unemployment (output growth) was discovered by Valadkhani and Smyth (2015) at where there was less asymmetric behaviour in expansions than recessions where the Okun relationship is weak and occur jobless recoveries in U.S. during the recession in early 1980s. The issue indicates that higher output growth is needed when employment situation is worst in order to improve the overall economy during the recession period.

When the late recession come to the end since June 2009, Higgins (2011) stated that only 0.4 percentage point decrease in unemployment rate which is from 9.5 percent to 9.1 percent. After two-year period, an annual rate of 2.4 percent increase in real gross domestic product (GDP). According to the economist Arthur Okun in 1962, he determined that an immediate increase in GDP will lead to a decline in unemployment. In contrary, if output growth declines then the unemployment rate will increase, whereas if growth rate is equal to the production capability, unemployment rate remains constant.

In the study of Egypt, Okun's law was explained in way when GDP grow by 3% will cause 1% decrease in unemployment (Elshamy, 2013). Okun's law stated an inverse relationship between cyclical fluctuations in the output gap and the unemployment gap (Elshamy, 2013). Elshamy (2013) stated that there is a long run relationship between the GDP growth and unemployment which is similar with Okun's findings. In the long run, the relationship between the output gap and unemployment gap is statistically significant and the negative sign was found to be constant with the theoretical rational when Okun's law is estimated for Egypt. The objective for unemployment to reduce would cause an output growth rate significantly higher than the productivity growth rate. These show that the Egyptian government should encourage private and public investment to reduce the unemployment rate and increase the growth rate of GDP.

Furthermore, Okun's law also exist in Malaysia which explains that any effort to decrease the unemployment will lead to an increase in the output growth. This negative relationship between output and unemployment was supported by the empirical results (Mohd Noor, Mohamed Nor & Abdul Ghani, 2007). Mohd Noor et.al (2007) show that decline in output will cause increase in unemployment. Studies from German also show relationship between output and unemployment rate is negative (Malley & Monala, 2007). Moreover, Villaverde and Maza (2009) examined Okun's law in Spanish indicated that there is inverse relationship between unemployment rate and output growth as well.

There are several reasons why we focus on U.S. First, majority focus of study on Okun's Law is primarily from U.S. Second, unemployment and output relationship in U.S. have impacts on other countries as U.S. is the largest economy in the world. Third, there exists real contemporary policy in the aftermath of global financial crisis (GFC) between unemployment and output. The relationship between output and unemployment has been stable over time but the relationship seem to collapse after GFC as a result of an increase in structural unemployment which then led to a phenomenon called “ jobless recovery” (Valadkhani & Smyth, 2015). However, Ball, Leigh, and Loungani (2013) stated that Okun’s Law relationship still remain stable and strong among most of the countries even during the Great Recession period and “jobless recoveries” is flawed to be accounts of breakdowns in Okun’s Law.

The situation of jobless recovery appears when there is decline in output growth rate. Jobless recovery period appeared during the recession of 1990-1991 and 2001 as well as the recession of 1970s and 1980s. According to Katz (2010), during the period of greater depth of great recession, there was a symptom where the employers intended to hire more workers. However, there are three circumstances that show jobs recovered slowly than the great recession during the period of middle of 1970s and early in 1980s. This mentioned by Gordon and Robert (2010) at where (i) the firms are not willing to hire more employees when economy is recovered slowly in order to maintain their operation and productive in the organization, (ii) higher in permanent layoffs than temporary layoffs during the economy downturns, (iii) employers increase working hours for the existing part-timer instead of hiring more new employees to boost the output.

Furthermore, slow in jobless recovery in the aftermath of great recession in U.S. show possibility of nonlinearities in Okun’s law. For example, Virén (2001) discussed that the Okun's curve is nonlinear because of the fact that output growth have greater influence on unemployment when output is high and unemployment is low, and vice versa. Therefore, implementations of policies are needed to encourage job creation in short-run and so a stable job recovery.

However, some of the studies found that Okun’s law have some limitations as the Okun’s framework does not take other factors (labour force participation, hours worked and productivity) into account which also can influence the changes between output and unemployment (Mohd Noor et. al, 2007). Prachowny (1993) think that Okun’s law only provides partial measure for both output growth and unemployment rate relationship.

There are three explanations given by Holmes and Silverstone (2006) regarding the empirical finding of an inverse relationship between the unemployment rate and output which are the changes in labour force participation, hours worked and productivity. During the downturn period, drop in labour force participation due to the capable employees are discouraged to work when their prospects are weak, therefore they quit from the labour force to seek for other plans or goals. As a result, decrease in labour force participation will cause unemployment rate to increase and decrease in output growth.

Another factor which is the employee working hours during recessions is shorter due to the drop in demand. The firm reduce hours worked by employee rather than cut down the workforce and this causes the output grow very slow and thus increase in unemployment.

Third, the growth in labour productivity can bring stable output even though the employee's working hours is being cut as the average labour productivity is measured according to GDP per hour worked that influence unemployment to increase while drop in output growth. According to the production theory, change in unemployment rate is due to the changes in output growth (Holmes & Silverstone, 2006).

2.5 Conclusion

As long as the central bank communicates with the market it will caused the unconventional monetary policy to be effective due to market expectations that enhanced the effectiveness of unconventional monetary policy. Besides, Federal Reserve indicated that under the effect of QE, the conditions in labour market had recovered and almost reached full unemployment.

Many of the studies stated that the effectiveness of QE had allowed the U.S. economy to recover rapidly. However in the near three recessions, although economy recovered from recession but the unemployment rate remains high. This is due to either QE was not effective or the strong forces of recessionary. Furthermore, some researcher also found that although the inflation and real interest rate was anchored by QE but the employment and aggregate output still persist low except if large and constant of the LSAP.

Moreover, majority of the researchers stated that the relationship between unemployment rate and output growth are inverse relationship and after the GFC took place, there was a phenomenon named "jobless recovery". In the aftermath of great recession in U.S, there are several reasons that lead to slow employment recovery in the middle of 1970s and early in 1980s. Since, Okun's Law are fundamentally come from U.S, thus most of the studies regarding Okun's Law are mainly focus on U.S..

After reviewing the literatures done by the researchers upon QE and Okun's Law, we have noticed that despite of all the studies regarding QE and Okun's Law, no one had actually studied QE together with Okun's Law. Since there have not been any studies that focuses on the impact of QE on Okun's relation, therefore in this literature we would like to fill in the research gap by studying the macroeconomic impact of QE on unemployment through Okun's Law.

CHAPTER 3: DATA AND METHODOLOGY

3.0 Introduction

As indicated in the title, in this chapter we will introduce the theoretical background of our study as a headstart to carry out the process of the analysis and test. Regarding the research methodology, research design, data collection methods and the methodology we used in this study for analysing the data will be revealed.

3.1 Theoretical Framework

The original model we used in the empirical analysis is the Okun's Law which empirically observed the relationship between unemployment and output gap of a country. As shown below, the transformation from the Okun's Law function to the function used in this study.

3.1.1 Theoretical Framework: Okun's Law

Okun's Law is used in this study to investigate the relationship between unemployment and gross domestic product (GDP) in U.S. This Okun's Law is so called the standard model of how the growth rate of output is related to the unemployment. It examines the effect of a percentage change in unemployment rate on the output or gross domestic product, whereby theoretically a percentage decrease in unemployment rate causes a 3 percent increase in output (Makun & Azu, 2015). It states that output is negatively correlated with the unemployment (Ball, Jalles & Loungani, 2014). The below equation shows the original function of the Okun's Law:

$$U_t - U_t^* = \beta\ (Y_t - Y_t^*) + \varepsilon_t, \beta < 0 \quad (1)$$

Where U_t denotes actual unemployment rate, U_t^* denotes natural rate of unemployment, Y_t denotes real gross domestic product, Y_t^* denotes real potential gross domestic product, ε_t denotes error term. The coefficient β in Okun's Law depends on the coefficients in the two relationships that underlie the Law.

By rearranging the equation (2), the following equation is applied for the estimation of unemployment rate.

$$U_t = U_t^* + \beta OG + \varepsilon_t$$
$$U_t = \alpha + \beta_1 \, OG + \varepsilon_t, \beta < 0 \quad (2)$$

In this study, we want to look over the effect of QE on unemployment in U.S. In order to investigate the potential effect of QE on the unemployment, we will observe the changes of coefficient value, β before the financial crisis and after the financial crisis period together with the proxies as to represent QE and financial crisis as well as other economic indicator that could bring effect to the unemployment rate.

Therefore, we are using unemployment rate as dependent variable to observe whether QE is useful to make unemployment rate decrease after the influence of the crisis. Employment has always been regarded as one of the important economic variables as it affects the economic development of a country and the stability of the society. Country with low unemployment rate indicates the number of people actively seeking work is low relative to the population of active workers. If there are large number of people are jobless, this will bring severe consequences to the growth of the overall economy of a country if we do not address it in time. This could also bring impacts on future labor market attachment, physical and mental health, children and families, and communities (Nichols, Mitchell & Lindner, 2013).

3.2 Empirical Framework

QE was introduced as an unconventional monetary policy to signal a shift in focusing towards quantity variables in which a central bank purchases government securities or other securities from the market in order boost the cash reserves in the system. QE increases the money supply by flooding financial institutions with capital with an effort to promote increased lending and liquidity. Eventually, this will hopefully increase the lending into the broader economy, and help in stimulating the economy. In this study, we use 2 different variables to represent QE, namely Reserve Balance with Federal Reserve Banks and 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity.

Consider the relationship of the original Okun's Law is demonstrated as below:

$$U_t = \alpha_0 + \alpha_1 OG + \varepsilon_t \tag{1}$$

Where rate of unemployment and output gap (OG), where α_0 refers to the intercept and α_1 is the coefficient of Okun's Law multiplier. Since we are curious that does the Okun's Law multiplier decreases after 1990's, therefore we generated a dummy variable DUM90 and interact with output gap to estimate the Okun's Law multiplier after 1990's

$$U_t = \alpha_0 + \alpha_1 OG + \alpha_2 OG * DUM90 + \varepsilon_t \tag{2}$$

$$\text{DUM90}\begin{cases} 1 & \text{Years after 1990} \\ 0 & \text{Otherwise} \end{cases}$$

We thus repeat the same process to study that does the Okun's Law multiplier decreases after 2000's

$$U_t = \alpha_0 + \alpha_1 OG + \alpha_2 OG * DUM20 + \varepsilon_t \tag{3}$$

$$\text{DUM20}\begin{cases} 1 & \text{Years after 2000} \\ 0 & \text{Otherwise} \end{cases}$$

In order to study the impact of financial crisis on Okun's Law multiplier, we have created a financial crisis dummy variable DUMFC to capture the effects of financial crisis

$$U_t = \alpha_0 + \alpha_1 OG + \alpha_2 OG * DUMFC + \varepsilon_t \tag{4}$$

$$\text{DUMFC}\begin{cases} 1 & \text{If it is in financial crisis period} \\ 0 & \text{Otherwise} \end{cases}$$

The signs of the initial Okun's Law multiplier and also the Okun's Law multiplier after 1990's, 2000's and during financial crisis is expected to be negative because of the Okun's Law negative relationship of unemployment and output gap. We then proceed by studying the individual effect of government deficit spending (GDS), inflation expectations (INFEXP) and QE on Okun's Law.

$$U_t = \alpha_0 + \alpha_1 OG + \alpha_2 GDS + \alpha_3 INFEXP + \alpha_4 LNRB + \varepsilon_t \tag{5}$$

$$U_t = \alpha_0 + \alpha_1 OG + \alpha_2 GDS + \alpha_3 INFEXP + \alpha_4 TS + \varepsilon_t \tag{6}$$

We used reserve balance of US federal reserves (LNRB) and 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity (TS) as a proxy for QE, where LNRB represents the cause of QE (quantitative effect) and TS represents consequences of QE (price effect).

Initially, we would like to proxy QE by looking at the total assets purchased by Federal Reserves. Nevertheless, due to the limitations of data which that we will discuss later in Section 5, therefore instead of looking at the total assets purchased by Federal Reserves, we choses the Federal Reserve's reserve balance to represent QE because it serves as a mirror image of the total assets purchased by looking at how much the Federal Reserved has paid.

We expect the sign for OG is negative and Saeidi and Valizadeh (2012) have found that government deficit spending has a significant impact on unemployment, as an increase in budget deficit lowers unemployment by 13%, therefore the expected sign for GDS is negative. People often expect inflation when economy is booming with high employment rate and thus the expected sign for INFEXP is negative.

However, in order to have a clearer picture on how QE affects the Okun's Law multiplier, we develop the model further by interact the two QE variables with OG

$$U_t = \alpha_0 + \alpha_1 OG + \alpha_2 LNRB + \alpha_3 OG * LNRB + \varepsilon_t \tag{7}$$

$$U_t = \alpha_0 + \alpha_1 OG + \alpha_2 TS + \alpha_3 OG * TS + \varepsilon_t \tag{8}$$

To understand how QE influenced the impact of financial crisis on Okun's Law multiplier, we further develop another two models by interacting DUMFC with the QE variables and OG

$$U_t = \alpha_0 + \alpha_1 OG + \alpha_2 OG * DUMFC + \alpha_3 OG * DUMFC * LNRB + \varepsilon_t \quad (9)$$
$$U_t = \alpha_0 + \alpha_1 OG + \alpha_2 OG * DUMFC + \alpha_3 OG * DUMFC * TS + \varepsilon_t \quad (10)$$

By the assumption of effective QE (by looking at the amount of assets bought by central bank, that is using LNRB as a proxy for QE) will reduce the unemployment rate, the expected sign LNRB will be negative and therefore the negative relationship of unemployment rate and output gap of Okun's Law will be further strengthen if QE is proven to be effective.

However, if we proxy QE using TS, we expect a sign which is otherwise. According to a study done by Liu et al. (2012), it was found that TS has a positive relationship with unemployment. This is because the aimed of QE is to lower the long-term rate and if QE is effective, the yield spread will reduce as well.

Model 12 and 13 is developed to study the impact of QE on Okun's Law under the influence of government deficit spending, where we interacts GDS with QE variables and OG

$$U_t = \alpha_0 + \alpha_1 OG + \alpha_2 OG * LNRB + \alpha_3 OG * GDS * LNRB + \varepsilon_t \quad (11)$$
$$U_t = \alpha_0 + \alpha_1 OG + \alpha_2 OG * TS + \alpha_3 OG * GDS * TS + \varepsilon_t \quad (12)$$

Moreover, we interact INFEXP with the QE variables and OG in model 14 and 15 study how inflation expectations influence the impact of QE on Okun's Law.

$$U_t = \alpha_0 + \alpha_1 OG + \alpha_2 OG * LNRB + \alpha_3 OG * INFEXP * LNRB + \varepsilon_t \quad (13)$$
$$U_t = \alpha_0 + \alpha_1 OG + \alpha_2 OG * TS + \alpha_3 OG * INFEXP * TS + \varepsilon_t \quad (14)$$

One of the strategies conducting unconventional monetary policy proposed by Bernanke and Reinhart (2004) is forming expectations of low future short-terms rates. Both GDS and INFEXP serves as a signal to the market that Federal Reserved are committed to their actions of remaining low future short-terms rate and would not reverse their policy in near future. Therefore, the expected sign for GDS and INFEXP is negative as both serves as a complement for QE to be effective in strengthen the negative Okun's relation.

3.2.1 Discussion of Quantitative Easing (QE) Variables

3.2.1.1 The Relationship between Reserve Balance (RB) and Unemployment

Reserve balances with Federal Reserve Banks are the difference between "total factors supplying reserve funds" and "total factors, other than reserve balances, absorbing reserve funds." This item includes balances at the Federal Reserve of all depository institutions that are used to satisfy reserve requirements and balances held in excess of balance requirements. It excludes reserves held in the form of cash in bank vaults, and excludes service-related deposits. According to Blinder (2010), QE is an unconventional monetary policy that changes the size or composition of a central bank's balance sheet to increase the liquidity or the market. It occurs when the central bank cut the nominal interest rate all the way to zero but still unable to stimulate the economy sufficiently, in other words, the economy has entered into the "liquidity trap". According to Joyce et al. (2012), Japan was the first country who applied QE to deal with the downfall of the real estate market and the pressure of deflation in Japan. Bank of Japan (BOJ) decreased their policy rate by purchasing bonds and other securities via open-market purchases, which will consequently increase supply of bank reserve. Since then, the central bank of U.S., Europe, and United Kingdom have a followed the footstep of Japan. Although there were significant differences in the way of implementing QE between the countries, it eventually led to a substantial increase in their balance sheets. From the approach of QE, the Federal Reserve had acquired a variety of securities that they had not acquired before, this led to the increase in the asset of Federal Reserve from 907 billion USD in September 2008 to 2.214 trillion USD in November 2008.

3.2.1.2 The Relationship between 10-Year Treasury Constant Maturity minus 2-Year Treasury Constant Maturity and Unemployment

The yield spread reveals the difference between the yields on different debt instruments by deducting the yield of one instrument from another. The other name of yield spread is called the credit spread. Normally, the higher the risk of a debt instrument shows a higher yield spread. Liu et al. (2012) suggest that the Federal Reserve's long-term asset purchase, which is the action of QE, enables them to lower the 10-year interest rate spread by an average 0.9 percent over the period of economic recession. This leads to the decrease of unemployment rate by approximately 0.7 percentage points and boost the inflation rate by approximately 1 percentage points. By using a Bayesian time-varying parameter structural VAR for U.S., Europe, Japan and United Kingdom, the long-term yield spread, which is the proxy for QE, holds a significant effect in both output growth and inflation (Baumeister & Benati, 2010). In addition, a study conducted by Giannone et al. (2011) found that the interest rate spread has a rather significant impact on the unemployment rate during the economic recession compared to other regimes in the study. Besides that, they also suggest the announcement of QE helped to decrease the 10-year spread by approximately 0.9 percent between November 2008 and April 2009, which is consistent with the study conducted by Gagnon et al. (2010). The purchases of Federal Reserve were estimated to help in restoring the liquidity of the economy and decrease the yield spread on agency debt and mortgage-backed securities relative to the yield on Treasury securities.

3.3 Data Source

In this research, time series data is being selected and used to carry out this study. Time series is a set of observation on the values that the variables taken at different time. Time series data are arranged chronologically, usually at regular intervals such as daily, monthly, quarterly, semi-annually, or annually.
Moreover, in this study we only employed one country which is U.S., covering the period from year 1985 until year 2015. We are using quarterly data to carry out the tests which means there are total of 124 observations in this study. In addition, Federal Reserve Bank of St. Louis, Organization for Economic Cooperation and Development Data (OECD), and World Development Indicators had becomes the sources of data. Nevertheless, EViews 9, an econometric modeling and analysis software is being utilized to conduct this study.

Our sample consists of quarterly data on below variables from year 1985 to 2015 in U.S. We used different proxies to present each situation and economic indicators which are unemployment, output, financial crisis, QE, technological progress, job creation, wage and offshoring.

3.4 Data Processing

There are few steps involved in our data processing. First, we collected the data from few data sources. After that, we edited and arranged the data so that the data will become more applicable and fitting to our empirical analysis with EViews 9. Next, we carried out all the models and results by using the empirical econometric software, EViews 9. After the EViews results have been carried out, we interpreted the results and analysed the findings related to our topic.

Table 3.1: Summary Table of Variables and Data

Variables	Proxy	Indicator	Sources	Definition
Unemployment	Civilian unemployment rate	U	Federal Reserve Bank of St. Louis (FRED)	Unemployment rate represents the fraction of people in the labor force who are unemployed and currently searching for work.
Output	Output Gap	OG	Federal Reserve Bank of St. Louis (FRED)	Output gap is indicating the differences between the real gross domestic product and real potential gross domestic product of a country.
Quantitative Easing	Reserve Balances with Federal Reserve Banks	LNRB	Federal Reserve Bank of St. Louis (FRED)	Reserve balances include balances at the Federal Reserve of all depository institutions that are used to meet the reserve requirements and balances held in excess of balance requirements.
	10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity	TS	Federal Reserve Bank of St. Louis (FRED)	TS is the difference between 10-Year Treasury Constant Maturity and 2-Year Treasury Constant Maturity. The data is later divided by 100.
Inflation Expectation	Inflation Expectation	INFEXP	Federal Reserve Bank of St. Louis (FRED)	Inflation expectation is the changes of price that people are expected to happen in the future.
Government Deficit Spending	Government Deficit Spending	GDS	Federal Reserve Bank of St. Louis (FRED)	GDS happens when expenditure is greater than tax revenue. It is obtained by Federal government current tax receipts minus government total expenditure. After subtracting, it is divided by Real GDP.

3.5 Empirical Methodology

Time series analysis approach is the studying of the observations at different point in times at where the data collected are serially autocorrelated. We collected the data on the same variable at regular intervals, for example annually, monthly, weekly, quarterly, etc.

There are some reasons time series data approach is being employed in this study. First of all, as we are wanted to find out the impact of QE on unemployment in United State, we are only considered one country in our study which is within 30 years from 1985 to 2015. Time series data is more appropriate to the purpose of this study. Time series outline useful for establishing a baseline measure and describing changes over time as its goal is to forecast the future of the series as well as modeling and smoothing structure.

We applied time series method in our research as it only involves a country, which is U.S. across different time periods from 1980 to 2015. The following section will show the descriptive statistics, diagnostic checking and the cointegration test of the models.

3.5.1 Descriptive Statistics

Descriptive statistics measures the basic features and the trend of the data. There are two types of descriptive statistics, measures of central tendency and measures of spread. Descriptive statistics consist of mean, median, maximum, minimum, standard deviation, skewness and kurtosis. Mean and median measure the central tendency, maximum and minimum refer to the largest and smallest data value and it is used to measure outliers. Standard deviation is used to measure how the data is disperse around the mean, while skewness is to measure whether the data is symmetric or asymmetric. Lastly, kurtosis measures how the peak and tail are different from normal distribution.

3.5.2 Unit Root Test

Unit root test is used to examine the stationarity of a times series variable. In a stationary time series, the mean, variance and covariance does not change over time. In contrast, in a non-stationary time series, its mean, variance and covariance changes over time and it is unlikely to return to a long-run path. If the variables are non-stationary, the regression results, such as t-test and F-test will turn out to be misleading. T-statistics will be highly significant and R^2 will be high as well, which results in spurious regression. We used Augmented Dickey-Fuller test and Phillips-Perron test to test the stationarity of time series variables.
The commonly used unit root test are Dickey-Fuller (DF) unit root test (1979), Augmented Dickey-Fuller (ADF) unit root test (1981) and Phillips-Perron (PP) unit root test (1988). Both DF and ADF tests are known as parametric testing, whereas PP test is non-parametric testing.

Augmented Dickey-Fuller (ADF) unit root test was further developed by Dickey and Fuller (1981), and it is a stationarity test to solve the limitations of Dickey-Fuller (DF) test. This test includes lagged of dependent variable (ΔYt). The null and alternative hypotheses are as follows:

H_0: βt is non-stationary (βt has unit root).
H_1: βt is stationary (βt does not have unit root).

Decision Rule: Reject H_0 if the test statistic is larger than the critical value. Otherwise, do not reject H_0.
Phillips-Perron (PP) unit root test was developed by Phillips and Perron in 1988 to examine the stationarity of time series variables. PP test is able to solve the autocorrelation problem in DF test and it can only be used if the data has a small sample size. The null and alternative hypotheses are as follows:

H0: βt is non-stationary (βt has unit root).
H1: βt is stationary (βt has no unit root).

Decision Rule: Reject Ho if the test statistic is smaller than the critical value. Otherwise, do not reject Ho.

A time series have an integrated of order d, written I(d), if are being difference d times only become stationary. Series with an integrated order of I(0) are said to be stationary at level form without differencing. Many series are I(1) and hence they become stationary after differencing once. Series with I(2) mean that they are not stationary at level form and first difference, but at second difference.

3.5.3 Johansen and Juselius (JJ) Cointegration Test

This test was developed by Johansen and Juselius (1988) and it is used to test the number of cointegration when there exist more than one cointegrating relationship. It is able to test the relationship of time series variables in the model. The null and alternative hypothesis are as follows:

H_0: There is no long run relationship between the variables.
H_1: There is long run relationship between the variables.

There are two types of cointegration test, which are Maximum Eigenvalue test and Trace test (Dwyer, 2015). Maximum Eigenvalue test is a test based on one Eigenvalue at a time, where the values are arranged from largest to smallest. The null hypothesis for Maximum Eigenvalue is *r* (number of cointegrating vectors) and the alternative hypothesis is *r*+1. On the other hand, Trace test is a test that uses the total number of Eigenvalues together at the same time to perform hypothesis testing. The null hypothesis of Trace test is *r* is larger than or equal to the number of cointegrating vector.

JJ cointegration test possess advantages as it is able to capture more than one cointegrating vector and the model is able to have more than 2 variables.

3.5.4 Ordinary Least Square (OLS)

Ordinary Least Square (OLS) is a method commonly used by researches to analyze and interpret data (Hutcheson, 2011). It is used to study and examine how dependent variable changes in response to the changes in independent variables. OLS results can only be trusted if only all the nine assumptions of CLRM are fulfilled, which are linear in the parameters, data obtained is a random sample of population, mean or the expected value of the random disturbance term is zero, no autocorrelation between the disturbance, homoscedasticity, number of observations (n) must be greater than the number of parameters (k), nature of independent variables, model is correctly specified and no exact collinearity between the independent variables (Gujarati & Porter, 2009).

If all the assumptions above are fulfilled, the OLS estimators are said to be BLUE, that is, best, linear, unbiased and efficient, and the hypothesis testing is able to be conducted by using t-test and F-test and thus result can be trusted.

3.5.5 Diagnostic Checking

3.5.5.1 Multicollinearity

Multicollinearity arises when all the independent variables or the response variables are highly correlated among each other in a regression model (Mason & Perreault, 1991).This problem is common when people are using multiple regression analysis, and often being discussed among the researcher. If it presents, it violates the assumption of the classical ordinary least squares (OLS) regression model that no exact collinearity between the independent variables. There are two types of multicollinearity, which are perfect multicollinearity and imperfect multicollinearity. Perfect multicollinearity is a potential problem to the model, as long as the regression model is not perfect multicollinearity, it violates no regression assumptions and OLS estimators are still remained unbiased, efficient, have correctly estimated standard errors and the estimation of the regression coefficients is still possible.

Gujarati and Porter (2009) stated there are four factors of multicollinearity.

i) The method we used to collect the data in the study. For example, when the ranges of independent variables are small, in other word, there is limited data for a particular independent variable, multicollinearity problem would occur.

ii) Model Specification. For example, regression model with polynomial terms will have high probability of facing multicollinearity especially when the range of the independent variable is small.

iii) Model with constraints being sampled. For example, in the regression of consumer expenditures (Y) on income (X) there is physical constraint in population that people with higher incomes tend to have higher expenditures than people with lower incomes.

iv) Model that is overdetermined. This could happen when a model have more independent variables (k) than the number of observations (n).

According to Mason and Perreault (1991), multicollinearity leads to analytical problems and theoretical consequences. Ordinary Least Square estimators are still Best Linear Unbiased Estimators (BLUE) even with existence of multicollinearity due to few reasons ("Multicollinearity in Regression," 2003). First reason is that unbiasedness is a multi-sample or repeated sampling property. Second, as collinearity does not destroy the property of BLUE thus it remains minimum variance and efficient. Third, multicollinearity is a sample regression phenomenon at where the independent variables might related in the particular sample even if they are not linearly related in the population. The only effect of multicollinearity is that it makes harder to obtain the estimated coefficient (β) with small standard error as multicollinearity will cause the standard error inflated.

In addition, multicollinearity brings several practical consequences to the model (Gujarati & Porter, 2009).

i) Large variances and covariances of coefficients. As a result, the estimation is not reliable and difficult.

ii) Wider confidence intervals due to the standard error of the estimator increase and leads to not rejecting the false hypothesis increase.

iii) Insignificant t-ratio and high R^2 value. As the standard error of the estimator increases, test statistic value will become smaller, leading the t-ratio of the coefficient to be more statistically insignificant, while R^2, the overall measure of goodness to fit is high which is greater than 0.8. When R^2 is high, we know that the two particular independent variables are quite correlated, F-test is significant.

iv) High sensitivity of the OLS estimators and the standard errors to even a small change in the data. For example, when observation is changed, standard error would tend to change a lot.

Therefore, we can said that the symptom or the detection of multicollinearity are insignificant t-ratio, high overall R^2 greater than 0.8, significant F-test, and additional of high Variance Inflation Factor (VIF) larger than 10 and low tolerance (TOL) smaller than 0.1. When VIF is high, it indicates there is high relationship or collinearity between the independent variables. When TOL is low, there is strong collinearity between the independent variables.

Gujarati and Porter (2009) stated there are two remedial measures to deal with multicollinearity. Firstly, do nothing as the regression model is still remain BLUE even with multicollinearity problem.

Secondly is the rule of thumb procedure. There are six procedures included, which are using a prior information, using the panel data, dropping a variable to reduce the possibility of highly correlated among the variables, transforming the variables, adding new data and avoiding of using the polynomial regressions.

3.5.5.2 Heteroscedasticity

One of the assumption underlie classical normal linear regression model (CNLRM) is the constant variance of error term independent of i, μ_i, which is known as homoscedasticity.

$E(\mu_i^2) = 0$

$Var(\mu_i) = \sigma^2$ (homoscedasticity)

In opposite, heteroscedasticity happens when the error variance is non-constant at where the variance of the error term depends on the observation discussed.

$E(\mu_i^2) = Var(\mu_i) = \sigma_i^2$ (heteroscedasticity)

According to Gujarati and Porter (2009), there are seven factors of heteroscedasticity, which are the regression follow error-learning models, human behaviour, techniques of collecting data, presence of outliers, regression model is not correctly specified, skewness and improper data transformation or inappropriate functional form.

Presence of heteroscedasticity on the OLS estimation is no longer BLUE. The models are still unbiased and consistent as all the independent variables are uncorrelated with the error term. However, they are no longer with minimum variance and efficient. The variance of the estimators is not minimum but higher together with inefficient estimators. Therefore, variances and standard errors of the estimated coefficients are not correctly measured, thus they become biased and this influence the test statistics and confidence interval biased as well. Hypothesis testing result is invalid due to the unreliable t statistics values and F statistics. Conclusion may be misleading due to uncertain variance and causing a false precision.

Gujarati and Porter (2009) stated there are two methods to detect the presence of heteroscedasticity, which are informal methods and formal methods. Informal methods are where we considered it as a nature of the problem that heteroscedasticity is generally expected and also graphical method. There are five methods that can be used to detect this problem which are Park test, Glejser test, Breusch-Pagan test, White test and Autoregressive conditional heteroscedasticity (ARCH) test. In this study we apply the ARCH test to test for heteroscedasticity. The null and alternative hypothesis of ARCH test is as follows:

H_0: The model has homoscedasticity.
H_1: The model has heteroscedasticity.

We reject the null hypothesis if the test statistics is greater than the critical values. Otherwise, do not reject the null hypothesis. When the null hypothesis is rejected, we can conclude that at least one of α is different from zero, which indicates there is heteroscedasticity in the regression model.

Moreover, ARCH model and Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model also can be used to capture a series with changing conditional variance (Engle, 2001). These two models use the Breusch-Pagan LM test for heteroscedasticity. Conditional variance is unexpected events occur and produce new information which in turn influence the shock of the return.

In addition, we can use the remedial measure of Generalized Least Squares (GLS) or Weighted Least Squares (WLS) when the error variance for an observation is known. With this way we re-estimate the model in order to get a new set of parameter estimates, covariance and t statistics that would be more efficient than the OLS ones.

3.5.5.3 Autocorrelation LM Test

Autocorrelation is an econometric problem where correlation exists between disturbances and it violates the assumption of Ordinary Least Square (OLS) which states that there is no correlation among disturbances. According to Gujarati and Porter (2009), autocorrelation occurs when there is correlation among observations in time series or cross sectional data.

Autocorrelation comes in 2 forms, which are pure autocorrelation and impure autocorrelation. Impure autocorrelation exist due to specification error of the model, such as omission of important variables or incorrect functional form. Autocorrelation brings serious consequences, for instance, estimators become inefficient, t-statistics become higher and variance of estimators will be underestimated.

Durbin-Watson test and Breusch-Godfrey LM test can be used to detect the presence of autocorrelation. However, Durbin-Watson can only detect first order autocorrelation but it is unable to detect higher order autocorrelation (Levich & Rizzo, 1998). In contrast, Breusch-Godfrey LM test is able to detect higher order autocorrelation, and therefore we adopt Breusch-Godfrey LM test in our study to detect autocorrelation. The null and alternative hypothesis of Breusch-Godfrey LM test is as follows:

H_0: *There is no autocorrelation.*
H_1: *There is autocorrelation.*

We reject the null hypothesis if the p-value is smaller than the critical value, and we conclude that there is autocorrelation problem. If autocorrelation is found, we can apply Generalized Least Square (GLS) (Gujarati & Porter, 2009) or Newey-West standard errors to solve the autocorrelation problem (Newey & West, 1987).

3.5.5.4 Jarque-Bera (JB) Test for Normality Test

Jarque-Bera Normality Test is to examine the normality of error term. According to Gujarati and Porter (2009), it is an asymptotic or large sample test. Under OLS assumption, it is assumed that error term follows normal distribution and the results of hypothesis testing will be reliable. Hence, if error term is not normally distributed, the results of hypothesis testing will turn out to be misleading and inaccurate. The null hypothesis and alternative hypothesis are as follows:

H_0: *Error term is normally distributed*
H_1: *Error term is not normally distributed.*

We reject the null hypothesis if the p-value is smaller than the critical value. Otherwise, we do not reject the null hypothesis. If we are unable to fulfill the normality assumption, we will apply bootstrapping technique or invoke the large asymptotic or large sample theory (Gujarati & Porter, 2009).

3.5.5.5 Ramsey RESET Test

This test was proposed by Ramsey (1969) and is used to detect model specification error, which includes omission of important variables, include unnecessary variables, incorrect functional form, measurement errors, error term is wrongly specified and assumption of normality of error term.

If important variables are omitted, the OLS estimators become biased and inconsistent. Moreover, the confidence interval and hypothesis testing results produce misleading results. If the model has unnecessary variables, the estimators will be unbiased and consistent. However, the variance estimated will turn out larger, which leads to a larger confidence interval (Gujarati & Porter, 2009). The null and alternative hypotheses are as follows:

H_0: Model has no specification error problem.
H_1: Model has specification error problem.

We reject the null hypothesis if the p-value is smaller than the critical value, otherwise we do not reject the null hypothesis.

3.6 Conclusion

This chapter summarize all the data sources and methodologies of this study which will be used in the following chapter. In next section, all the models and their empirical findings will be revealed by using all the methodologies listed in this chapter.

CHAPTER 4: DATA ANALYSIS

4.0 Introduction

In this chapter, we are going to analyse and review the test by using the methodologies discussed in Chapter 3. The results in this chapter are generated by using EViews 9 software. The test used in this research are diagnostic checking which comprises of Multicollinearity, Heteroscedasticity, Autocorrelation, Normality test (Jarque Bera), Unit Root test and Model Specification. The following section consists of Ordinary Least Square (OLS) Test and Johansen-Juselius (JJ) Cointegration Test. Detailed interpretation and discussion of all the results which generated by using EViews 9 software will be provided for each test presented above.

4.1 Descriptive Analysis

Descriptive statistics measures the basic features and the trend of the data. There are two types of descriptive statistics, which are measures of central tendency and measures of spread. Besides, descriptive statistics consist of mean, median, maximum, minimum, standard deviation, skewness and kurtosis.

Mean and median measures the central tendency; whereas maximum and minimum refers to the largest and smallest data value and it is used to measure outliers. Standard deviation is used to measure how the data is dispersed around the mean; while skewness is to measure whether the data is symmetric or asymmetric. Last but not least, kurtosis measures how the peak and tail are different from normal distribution.

The dataset consist of 124 observations, ranging from 1985 to 2015. The summary results for descriptive statistics are presented in Table 4.1, where LNRB has the highest level of mean, median, maximum, minimum and standard deviation among all the other variables; while GDS has the lowest mean, median, maximum, minimum and skewness.

Table 4.1: Summary results of Descriptive Statistics for all variables

No. of Obs. =124	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis
U	0.0611	0.0611	0.0990	0.0390	0.0146	0.8166	3.0391
GDS	-0.1922	-0.1750	-0.1275	-0.3134	0.0511	-0.7893	2.4760
INFEXP	0.0307	0.0300	0.0500	0.0110	0.0052	0.7164	6.2667
LNRB	3.8508	3.1589	7.9175	1.6976	2.0143	1.0867	2.5399
OG	-0.0150	-0.0131	0.0193	-0.0631	0.0169	-0.6012	3.1502
TS	0.0117	0.0123	0.0280	-0.0039	0.0087	0.0497	1.7823

Notes: Unemployment (U), Government Deficit Spending (GDS), Inflation Expectation (INFEXP), Reserve Balances with Federal Reserve Banks (LNRB), Output Gap (OG) denotes the differences between the real and real potential gross domestic product of a country $(Y_t - Y_t^*)$, and 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity (TS).

Furthermore, most of the variables are positively skewed, except for OG and GDS. Leptokurtic occurs in U, INFEXP and OG, as the kurtosis are larger than 3; while platykurtic occurs in GDS, LNRB and TS as the kurtosis are lesser than 3.

4.2 Unit Root Test

The stationarity of the variables was tested by using Augmented Dickey-Fuller (ADF) test and Phillips-Perron (PP) test and the results were presented in table 4.2 and table 4.3.

We test the variables in level form with trend and intercept, followed by trend without intercept. After that, we carried out the same test in first difference to determine whether the variables are stationary at level form or first difference. The optimal numbers of lag length are chosen based on Schwartz Information Criterion (SIC) for ADF test and Newey-West Bandwidth using Bartlett kernel spectral estimation method for PP test.

In ADF test and PP test, the null hypothesis is non-stationary or unit root while the alternative hypothesis is stationary or no unit root. We reject the null hypothesis if the t-statistics is lower than the critical value, otherwise we do not reject the null hypothesis.

H_0: GDS/ INFEXP/ LNRB/ OG/ TS are non-stationary with presence of unit root.
H_1: GDS/ INFEXP/ LNRB/ OG/ TS are stationary without presence of unit root.

4.2.1 Augmented Dickey-Fuller (ADF) Test

According to Table 4.2, ADF test in level form showed that the t-statistic for all variables were lesser than 1%, 5% and 10% significance level, except for LNRB and U. Therefore, we reject the null hypothesis, and we have sufficient evidence to conclude that the variables are stationary at level form besides LNRB and U.

We then proceed on to first difference and it was found that all the test statistics are smaller than the critical value. Therefore, we have enough evidence to conclude that the all the variables are stationary at 10% significance level.

Table 4.2: Summary results of Augmented Dickey-Fuller (ADF) test on variables

Variables	Level Form		First Difference	
	Trend and Intercept	Intercept	Trend and Intercept	Intercept
GDS	-3.1512 (4)*	-1.2355 (2)	-4.9427 (1)***	-4.9599 (1)***
INFEXP	-4.9255 (0)***	-4.9019 (0)***	-11.1494(1)***	-11.1898 (1)***
LNRB	-1.2565 (1)	-0.3520 (1)	-8.3644 (0)***	-8.2578 (0)***
OG	-3.2304 (2)**	-3.1396 (2)***	-7.9927 (0)***	-8.0260 (0)***
TS	-3.4303 (2)***	-2.7268 (1)*	-6.8009 (0)***	-6.8275 (0)***
U	-3.1131 (2)	-3.0681 (2)**	-4.6993 (0)***	-4.7188 (0)***

Notes: Unemployment (U), Government Deficit Spending (GDS), Inflation Expectation (INFEXP), Reserve Balances with Federal Reserve Banks (LNRB), Output Gap (OG) denotes the differences between the real and real potential gross domestic product of a country $(Y_t - Y_t^*)$, and 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity (TS). ***, ** & * indicates rejection of null hypothesis at 1%, 5% & 10% levels of significance. The figure in parentheses represents the optimal lag length based on Schwarz Information Criterion (SIC).

4.2.2 Phillips Perron (PP) Test

PP test is further conducted to complement the result of ADF test with the results as shown in Table 4.3. In level form, only INFEXP is found to be stationary at 1%, 5% and 10% significance level, as its t-statistic is smaller than the critical value. Therefore, we have sufficient evidence to conclude that all the variables are not stationary at level form, except INFEXP.
It was followed by PP test in first difference and the t-statistics of all variables are found to be stationary at 1%, 5% and 10% significance level. Hence, we reject the null hypothesis and conclude that all the variables are stationary at 10% significance level.

After conducting both ADF and PP test, we are able to conclude that all the variables are stationary at the first difference. In other words, they are integrated at order I (1).

Table 4.3: Summary of Phillips Perron (PP) test on variables

Variables	Level Form		First Difference	
	Trend and Intercept	Intercept	Trend and Intercept	Intercept
GDS	-1.9775 (8)	-1.2643 (8)	-9.5378 (7)***	-9.5630 (7)***
INFEXP	-4.8708 (2)***	-4.8446 (2)***	-17.2876 (18)***	-17.4010 (18)***
LNRB	-1.0986 (3)	-0.2096 (4)	-8.3554 (2)***	-8.2578 (0)***
OG	-2.6034 (5)	-2.5101 (5)	-8.1558 (4)***	-8.1875 (4)***
TS	-2.8344 (6)	-2.5763 (6)	-6.7414 (1)***	-6.7685 (1)***
U	-2.2296 (8)	-2.1918 (8)	-4.5688 (2)***	-4.5890 (2)***

Notes: Unemployment (U), Government Deficit Spending (GDS), Inflation Expectation (INFEXP), Reserve Balances with Federal Reserve Banks (LNRB), Output Gap (OG) denotes the differences between the real and real potential gross domestic product of a country $(Y_t - Y_t^*)$, and 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity (TS). ***, ** & * indicates rejection of null hypothesis at 1%, 5% & 10% levels of significance. The figure in parentheses represents the optimal lag length based on Schwarz Information Criterion (SIC).

4.3 Johansen-Juselius (JJ) Cointegration Test

Johansen-Juselius Cointegration test was performed to examine the existence of long run relationship between the time series data (Johansen & Juselius, 2009). Table 4.4 summarised the results of Johansen-Juselius Cointegration test, where Akaike Information Criterion (AIC) and Schwartz Information Criterion (SIC) are used to determine to optimal lag length.

Table 4.4: Summary Results of JJ Cointegration Test

Hypothesized No. of CE(s)	Trace			Maximum-Eigenvalue		
	Statistic	Critical Value (5%)	p-value	Statistic	Critical Value (5%)	p-value
r = 0	132.7392**	95.7537	0.0000	45.5205**	40.0776	0.0111
r ≤ 1	87.2187**	69.8189	0.0011	41.4710**	33.8769	0.0051
r ≤ 2	45.7477	47.8561	0.0779	26.3200	27.5843	0.0719
r ≤ 3	19.4276	29.7971	0.4625	11.6406	21.1316	0.5834
r ≤ 4	7.7871	15.4947	0.4885	6.6297	14.2646	0.5338
r ≤ 5	1.1573	3.8415	0.2820	1.1573	3.8415	0.2820

Notes: ***, **,* indicates rejection of null hypothesis at 1%, 5% and 10% levels of significance.

Trace test and Maximum Eigenvalue shows that there is long run cointegrating relationship at 5% significance level as the test statistic is larger than the critical value. We reject the null hypothesis and conclude that there is long run relationship between the variables at 5% significance level. In other words, there are 2 cointegrating equations between the variables at 5% significance level.

4.4 Quantitative Easing (QE) and Okun's Law in United States: Baseline Models

In this session, we use Ordinary Least Square (OLS) approach to investigate how QE, GDS and INFEXP impact the unemployment rate in United States. Starting with Okun's Law equation proposed by Arthur Melvin Okun in 1962 regarding the empirical relationship of output gap and unemployment rate, we further extended the model by incorporating QE, GDS and INFEXP variables into the original Okun's Law model. This allows us to study the individual effect of those variables on the rate of unemployment.

Table 4.5: Summary Results of OLS for Baseline Models

	(1)	**(2)**	**(3)**
C	0.0497	0.0435	0.0391
OG	-0.7617***	-0.7046***	-0.6876***
	(0.0675)	(0.0931)	(0.0670)
GDS	--	0.0302	-0.0056
		(0.0343)	(0.0171)
INFEXP	--	0.2021	0.2787**
		(0.1575)	(0.1217)
LNRB	--	0.0017*	--
		(0.0010)	
TS	--	--	0.1753
			(0.1267)
Adj R^2	0.7751	0.8030	0.7823
DW Statistic	0.2542	0.2875	0.2579
F-statistic	424.7890	126.3265	111.4876
Multicollinearity	No serious multicollinearity problem		
ARCH Test	159.3970***	102.6172***	124.2411***
Breusch-Godfrey test	171.6391***	155.8771***	179.5967***
Jarque-Bera test		0.3112	
RESET test: t-statistic	0.4904	1.8985*	2.0407**
F-statistic	0.2405	3.6042*	4.1647**

Notes: Unemployment (U), Government Deficit Spending (GDS), Inflation Expectation (INFEXP), Reserve Balances with Federal Reserve Banks (LNRB), Output Gap (OG) denotes the differences between the real and real potential gross domestic product of a country $(Y_t - Y_t^*)$, and 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity (TS). ***, **,* indicates rejection of null hypothesis at 1%, 5% and 10% levels of significance.

Model 1 in Table 4.5 estimates the original Okun's Law equation which only consists of unemployment and output gap, whereby the coefficient of Okun's relation is -0.7617. This indicates that for 1 percent increase in output gap, unemployment rate will decrease by 0.7617.

Referring to Table 4.5, the test result shows that GDS is insignificant in both Model 2 and Model 3. As for INFEXP, the variable is insignificant in Model 2, but significant at 5% significance level in Model 3.

The expected sign for INFEXP is negative because we assumed that people often expect for inflation when economy is doing well and therefore decrease in unemployment rate. However, our result shows that inflation expectation is positively related to unemployment. The positive relation between inflation expectation and unemployment may due to overheating of the economy and employers expect that inflation in the future will increase future cost of production and thus slow down their hiring.

According to Model 2 in Table 4.5, the coefficient for LNRB is 0.0017, which means that for every percent increase in LNRB, the rate of unemployment will increase by 0.0017. Note that LNRB is significant at 10% significance level. Nevertheless, TS is insignificant in Model 3 from Table 4.5.

Initially, we expect a negative relationship between QE and unemployment but instead the relationship of LNRB and unemployment is positive as shown in Model 2, Table 4.5. Therefore, we are curious about why unemployment rate increases in the presence of QE:

i) Is it because important variables have been omitted by us in the models shown in Table 4.5 or;
ii) Is it because of the way of inserting QE variable into the model is inappropriate?

4.5 Diagnostic Checking

4.5.1 Multicollinearity

To measure how much the increases of the variance of the OLS estimators, we can determine it through the Variance Inflation Factor (VIF).
Based on Table 4.5, the result of Variance Inflation Factor (VIF) for all the variables which are GDS, INFEXP, LNRB, OG and TS are less than 10 that indicate there is no serious multicollinearity problem. This means that there is no high correlation between the independent variables in the regression

analysis. According to Gujarati and Porter (2009), multicollinearity problem will occur when VIF of the independent variables are greater than 10. Multicollinearity is a problem of degree whether it is serious or not serious, but multicollinearity will definitely exist. Therefore, we do not test for multicollinearity but we can measure its degree on the regression analysis. Gujarati and Porter (2009) stated that as long as the multicollinearity is not perfect (=1), the estimation of the regression coefficients is still possible, however the estimates and standard error become more sensitive toward even a slightest change in the data. In other words, existence of multicollinearity will cause the variance and standard errors of the estimates to be higher, confidence intervals tend to be larger, but in fact it does not affect the BLUE property of OLS.

4.5.2 Heteroscedasticity

Heteroscedasticity is the variance of the error term is not constant and depends on the observation. When heteroscedasticity problem occurs, values of t statistic and F-test statistic are inefficient and unreliable. This will make the p-value and the confidence interval of the estimated coefficients become biased and thus result in a questionable conclusion. There are few solutions to detect heteroscedasticity problem, but in this study we are using the Autoregressive Conditional Heteroscedasticity (ARCH) test to detect the existence of the heteroscedasticity problem.

Based on Table 4.5, by using the Autoregressive Conditional Heteroscedasticity (ARCH) test in all the models, the result show that all the p-values (0.0000) are less than 5% levels of significance as well as all the F-statistics are significant at 5% levels of significance. Therefore, the null hypothesis is rejected for all the models. We have sufficient to conclude that at least one of the estimated coefficient is different from zero, in other words, there is heteroscedasticity problem. To solve this problem, we apply heteroscedasticity and autocorrelation-consistent (HAC) standard errors and covariance, therefore the models do not suffer from heteroscedasticity problem.

4.5.3 Autocorrelation (Breusch-Godfrey Serial Correlation LM Test)

Autocorrelation is a common econometric problem which occurs when the model is misspecified, important variables are omitted, lag variables and data manipulation. We employ the Breusch-Godfrey Serial Correlation LM test to detect autocorrelation in our models. The result is shown in Table 4.5. We reject the null hypothesis if the p-value is smaller than 5% significance level. From the table, the p-value for all models are rejected at 5% significance level as it is smaller than 0.05. Hence, we have sufficient evidence to conclude that all the models suffer from autocorrelation problem. To solve this problem, we apply heteroscedasticity and autocorrelation-consistent (HAC) standard errors and covariance, therefore the models do not suffer from autocorrelation problem.

4.5.4 Normality Test: Jarque-Bera Test

Jarque-Bera test is adopted to determine whether the error term is normally distributed or not normally distributed. The test result is shown in Table 4.5 is presented as follows:

We reject the null hypothesis if the p-value is smaller than the 5% significance level. From the table above, the p-value is 0.8559, which is larger than 0.05. Hence, we do not reject the null hypothesis and we have sufficient evidence to conclude that the error term is normally distributed.

4.5.5 Model Specification Test: Ramsey RESET Test

Ramsey RESET test is used for the detection of model specification errors. The models should not be suffered from model specification error so that the hypothesis testing results will be reliable. The results of Ramsey RESET Test are presented in Table 4.5.

4.6 Quantitative Easing (QE) and Okun's Law in United States: Interactive Models

The result obtained in Table 4.5 leave us curious about why in the presence of QE, unemployment rate increases? Therefore in this session, we first use interaction terms to estimate Okun's Law multiplier after 1990's and during financial crisis using Ordinary Least Square (OLS) method. We then further develop our model by using interaction terms to examine the effect of QE, GDS and INFEXP on Okun's Law.

Table 4.6: Summary Results of OLS for Interactive Models

	(1)	(2)	(3)	(4)	(5)
C	0.0488	0.0497	0.0493	0.0493	0.0494
OG	-1.3730***	-0.7637***	-0.8468***	-0.4429***	-0.5561***
	(0.2438)	(0.0985)	(0.0720)	(0.1340)	(0.1313)
OG*DUM90	0.6052	--	--	--	--
	(0.2506)				
OG*DUM20	--	0.0024	--	--	--
		(0.1285)			
OG*DUMFC	--	--	0.2597***	--	--
			(0.0815)		
LNRB	--	--	--	0.0003	--
				(0.0012)	
OG*LNRB	--	--	--	-0.0522	--
				(0.0344)	
TS	--	--	--	--	0.0658
					(0.1813)
OG*TS	--	--	--	--	-8.9801
					(6.3852)
Adj R^2	0.8009	0.7732	0.8058	0.8081	0.7809
DW Statistic	0.3452	0.2546	0.3284	0.2551	0.2204
F-statistic	248.3179	210.6566	256.2374	173.6186	147.1417
ARCH Test	100.3578***	159.0068***	151.8870***	164.7712***	203.6346***
Breusch-Godfrey test	127.3757***	170.3071***	126.7911***	159.5217***	202.7673***
RESET test: t-statistic	1.3355	0.5506	2.7206***	3.0993***	0.8226
F-statistic	1.7835	0.3031	7.4016***	9.6056***	0.6766

Notes: Unemployment (U), Government Deficit Spending (GDS), Inflation Expectation (INFEXP). Reserve Balances with Federal Reserve Banks (LNRB), Output Gap (OG) denotes the differences between the real and real potential gross domestic product of a country $(Y_t - Y_t^*)$, and TS denotes 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity. ***, **,* indicates rejection of null hypothesis at 1%, 5% and 10% levels of significance.

4.6.1 Does Okun's Law Multiplier Decreases After 1990's?

To investigate that whether does Okun's relation decreased after 1990's, we generate dummy variables to capture the effect after 1990's and 2000's. Refer to Model 1 from Table 4.6, Okun's Law multiplier after 1990's is -0.7678 and the Okun's Law multiplier after 2000's is -0.7613, which is presented in Table 4.6, Model 2. This implies that after 1990's, for every percent increase in output gap, unemployment rate will decrease by 0.7678; whereby after 2000's, unemployment rate will decrease by 0.7613 for every percent increase in output gap.

Referring back to our original Okun's Law multiplier in Model 1 from Table 4.5, that is -0.7617, we notice that in fact the Okun's Law multiplier after 1990's remain almost the same as the original Okun's Law multiplier. This indicates that regardless before or after 1990's, given the Okun's Law multiplier, employment recovery should remain the same whenever the economy is out of recession.

However, this cannot explain the jobless recovery phenomenon that we encounter in our previous literature studies. Since Okun's Law multiplier remains the same even after 1990's, why unemployment is still slow to recover even when the economy recovers?

4.6.2 Does Financial Crisis Affects Okun's Law Multiplier?

Given that Okun's Law multiplier does not decrease after 1990's, why is the rate of unemployment still remains high even though output recovers? Does Okun's Law multiplier decreases during financial crisis? To examine the impact of financial crisis on Okun's relation, we thus generate a financial crisis dummy variable to capture the period of financial crisis.

We then found that under the influence of financial crisis, the Okun's Law multiplier is -0.5871. This also indicates that for every percent increase in output gap, the unemployment rate will decrease by 0.5871, where the result is shown in Table 4.6, Model 3. Therefore with a lower Okun's Law multiplier, this implies that employment recovery will be slower when the economy experience recession.

4.6.3 Quantitative Easing (QE) and Okun's Law: Under normal economy condition

Model 4 and Model 5 from Table 4.6 study how QE affects the Okun's Law multiplier under normal economy condition. However, the results of QE variables were insignificant in all 1%, 5% and 10% significance level. Hence, we concluded that when the economy is not experiencing financial crisis, QE has no impact on Okun's Law multiplier.

4.6.4 How Quantitative Easing (QE) Influence the Impact of Financial Crisis on Okun's Law?

From our findings, we have notice that QE is insignificant on Okun's Law when the economy doing fine, however what if the economy is undergoing a financial crisis? How would the impact of financial crisis on Okun's Law be influenced by QE? Is QE effective in offsetting the negative impact of financial crisis and fasten the employment recovery?

Because financial crisis will cause unemployment rate to rise, therefore if QE is effective, we expect a negative sign to offset the positive impact of financial crisis on Okun's Law. From Table 4.7, Model 1 shows that QE successfully bring back the negative relation of Okun's Law.

Therefore this suggest that QE is efficient in reducing the unemployment rate when economy is in the midst of crisis, or else the recovery will be a jobless recovery, where unemployment remains high even when the economy recover from a recession. Note that all variables are significant in all 1%, 5% and 10% significance level.

Table 4.7: Summary Results of OLS for Interactive Models

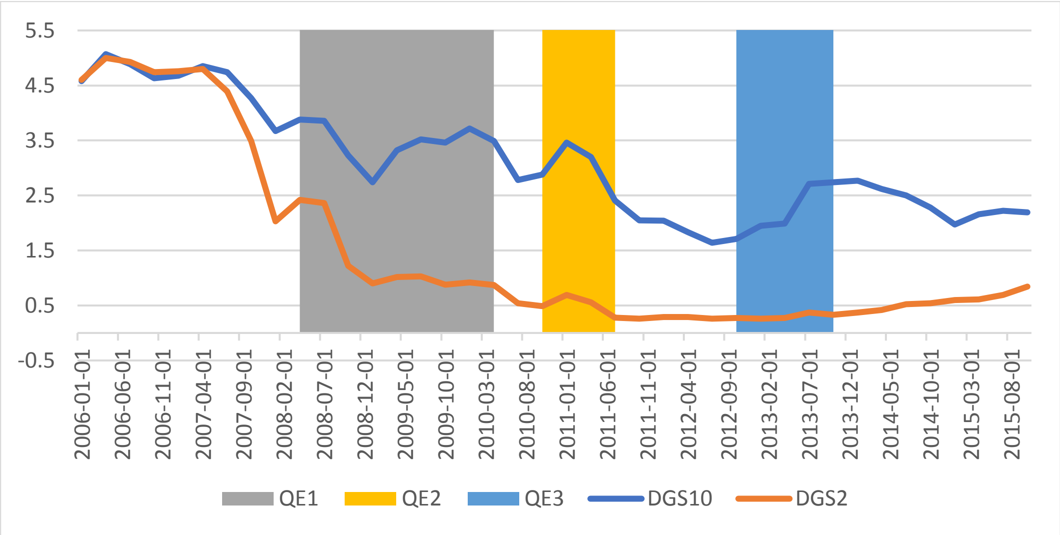
	(1)	(2)	(3)	(4)	(5)	(6)
C	0.0496	0.0495	0.0498	0.0505	0.0499	0.0496
OG	-0.8364***	-0.8398***	-0.3305	-0.6624***	-0.4447***	-0.5745***
	(0.0721)	(0.0720)	(0.2010)	(0.1445)	(0.1279)	(0.1285)
OG*DUMFC	0.6864***	0.6549***	--	--	--	--
	(0.1794)	(0.1766)				
OG*DUMFC*LNRB	-0.0758***	--	--	--	--	--
	(0.0257)					
OG*DUMFC*TS	--	-20.5142***	--	--	--	--
		(6.9526)				
OG*LNRB	--	--	-0.1347	--	0.0089	--
			(0.1113)		(0.0422)	
OG*GDS*LNRB	--	--	-0.2140	--	--	--
			(0.3009)			
OG*TS	--	--	--	16.1004	--	15.9238
				(22.9312)		(13.2087)
OG*GDS*TS	--	--	--	77.03768	--	--
				(66.2003)		
OG*INFEXP*LNRB	--	--	--	--	-2.2193**	--
					(1.0088)	
OG*INFEXP*TS	--	--	--	--	--	-880.1812***
						(317.8163)
Adj R^2	0.8143	0.8120	0.8102	0.7916	0.8174	0.8008
DW Statistic	0.3893	0.3404	0.2849	0.2371	0.3258	0.3830
F-statistic	180.7521	178.0585	176.0027	156.7657	184.5180	165.7762
ARCH Test	149.6631***	167.8988***	131.7465***	190.5773***	136.9574***	110.7818***
Breusch-Godfrey test	101.1932***	117.9902***	153.2055***	182.0592***	136.6693***	127.7285***
RESET test: t-statistic	2.1216**	2.3644**	2.1708**	3.3610***	1.1614	0.6087
F-statistic	4.5013**	5.5906**	4.7123**	11.2961***	1.3489	0.3705

Notes: Unemployment (U), Government Deficit Spending (GDS), Inflation Expectation (INFEXP), Reserve Balances with Federal Reserve Banks (LNRB), Output Gap (OG) denotes the differences between the real and real potential gross domestic product of a country $(Y_t - Y_t^*)$, and TS denotes 10-Year Treasury Constant Maturity Minus 2-Year Treasury Constant Maturity. ***, **,* indicates rejection of null hypothesis at 1%, 5% and 10% levels of significance.

Nevertheless, while we proxy QE using TS in Model 2 from Table 4.7, the sign of QE is different from what we expected. Instead of a positive relation, our result shows a negative relation between QE and unemployment.

The reverse relation may due to the decreased in 2-years bond yields is greater than the reduction in 10-years bond yields and as a result, the yield spread increase instead of decrease. Thus, this implies that increased in yield spread will reduced the unemployment rate, which gives a negative relationship of QE and unemployment.

Figure 4.1: 10-Year Treasury Constant Maturity and 2-Year Treasury Constant Maturity in United States



Notes: DGS10 refers to 10-Year Treasury Constant Maturity and DGS2 refers to 2-Year Treasury Constant Maturity.

From Figure 4.1, we have noticed that DGS2 is steeper compares to DGS10. This implies that 2-year bond yields decreases much more than 10-year bond yields.

Given this scenario, when Federal Reserved purchased long-term assets in the hope of reducing the long-term rates, investors had also revised their portfolio and causes 2-year bond yields plunged more than 10-year bond yields which cause the yield spread to increase rather than to decrease.

Since yield spread is a result of long-term minus short-term yield (which in this case it's more of an intermediate term rather than short-term), and an increased in yield spread implies that the relationship of TS and unemployment will be reversed from our initial assumption and therefore this explains why we obtained a negative relationship between TS and unemployment. Note that the variables are significant in all 1%, 5% and 10% significance level.

4.6.5 How Government Deficit Spending and Inflation Expectations Influence the Impact of Quantitative Easing (QE) on Okun's Law?

Model 3 and Model 4 from Table 4.7 show that the government deficit spending is insignificant in influencing the impact of QE on Okun's Law. The expected sign for INFEXP is negative because we assumed that people often expect for inflation when economy is doing well and therefore decrease in unemployment rate.

From Table 4.7, Model 5 and Model 6 suggest that inflation expectations could enhance the negative effect of original Okun's Law. The variable is significant in 5% significance level in Model 5, Table 4.7 and significant in all 1%, 5% and 10% in Model 6, Table 4.7.

4.6.6 Optimal Amount of Quantitative Easing (QE) needed to bring back pre-crisis Okun's Law Multiplier

Using Model 1 from Table 4.7, in order to obtain the optimal amount of QE should the Federal Reserve conduct to bring back pre-crisis Okun's relation which is -0.7617, we first substitute -0.7617 into Model 1 from Table 4.7 and calculate the optimal amount LNRB needed.

The optimal amount of LNRB needed is calculated as follows:

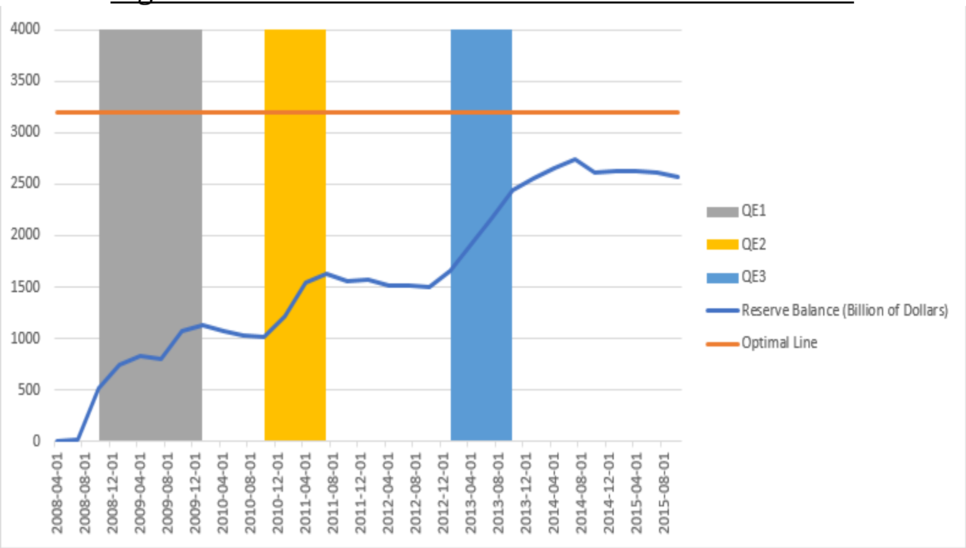
-0.7617 = -0.8364 + (0.6864 – 0.0758 LNRB)

LNRB = 8.0724

We then exponential the 8.0724, which in turn we obtain 2560.354

Therefore, based on our own calculation, in order to achieve the pre-crisis Okun's Law multiplier, Federal Reserve needs to have 3204.672 billion USD in their reserve balance. However as at 1st January 2014, the Federal Reserve only had 2560.354 billion USD in their reserve balance. This implies that the amount of QE conducted by Federal Reserve is insufficient to support the economy, as well as allow labour market condition to recover to the pre-crisis level.

Figure 4.2: Reserve Balances with Federal Reserve Banks



4.7 Conclusion

In conclusion, this chapter provides the empirical results of the descriptive statistics, diagnostic checking, and OLS results. The empirical results for all models have been estimate using EViews 9 with detailed explanation and interpretation for each model. Therefore, we will further proceed to the final chapter by summarizing the entire research.

CHAPTER 5: DISCUSSION, CONCLUSION AND IMPLICATIONS

5.0 Introduction

In this paper we have studied the effect of QE on Okun's Law multiplier through developing a baseline model and further extended the model by using interaction terms. Therefore, in this chapter we will discuss about the findings obtained by applying the methodologies discussed in the preceding chapters in this chapter. The first part will discuss about the discussion of major findings, followed by implications of the study, limitations and recommendation for future research, and conclusion.

5.1 Discussion of Major Findings

There are mainly three notable questions been asked in this paper, that is firstly, does Okun's Law multiplier decreases after 1990's? Secondly, does Okun's Law multiplier decreases during financial crisis? Thirdly, by using Okun's Law, is QE effective in speeding up employment recovery during financial crisis? To answer these questions, we had developed a baseline model using original Okun's Law equation and further extended the baseline model by incorporating different combination of interaction terms into the equations. We then estimate the models by using Ordinary Least Square approach. Our findings can be summarized as below:

Does Okun's Law multiplier decreases after 1990's? No, Okun's Law multiplier does not decreased after 1990's. As our results has shown that the Okun's Law multiplier remains the same even after 1990's. However, this finding does not explain the jobless recovery phenomenon as observed by many previous researches which claimed that the unemployment rate remains high even though output had recovered in recent three economic downturns. Thus, we have noticed that the key in answering this is to consider the effect of financial crisis on Okun's Law and thereby leads us to our second question.

Does Okun's Law multiplier decreases during financial crisis? Yes, Financial crisis had decreases the Okun's Law multiplier. When considering the effect of financial crisis, Okun's Law multiplier has decreases which indicate that whenever the economy experience recessions, employment recovery will be slower as compared to when the economy is not in financial crisis. Therefore, this explains the slow employment recovery during economic downfall despite the increased in output and thus the jobless recovery phenomenon is justified.

Using Okun's Law, is QE effective in speeding up employment recovery during financial crisis? Yes, QE is effective in bringing back negative Okun's Law relationship in the midst of financial crisis. The effect of QE on Okun's Law is insignificant in a normal economic condition. Nevertheless, whenever the economy is in a financial crisis, QE is able to offset the negative impact of financial crisis by restoring the negative impact of Okun's Law and therefore speeds up employment recover for every increased in output. Therefore, this means that despite QE is an unconventional monetary policy, however by looking at how QE affects the Okun's Law relationship, we have found that QE is in fact efficient and very much effective in terms employment recovery.

As for the proxy of QE, initially we would like to use total assets purchased by Federal Reserves as a proxy of QE as QE is also known as Large Scale Asset Purchasing, but unfortunately, we were unable to use it due to small and limited sample size. Hence, we use reserve balance to represent QE as it reflects the total assets purchased by Federal Reserve. While there are no literature reviews to support our results, we believed that as LNRB increase, unemployment will decrease in a period of financial crisis. This is because QE is implemented with the intention of strengthening the economic growth and also to support the labour market. The result of LNRB in Model 1 from table 4.7 shows that LNRB and unemployment has a negative relationship and thus the finding is consistent with what we expected.

5.2 Implications of Study

5.2.1 Implications for policy makers

In this literature, we study the impact of QE from both its cause by looking at the Federal Reserve reserve's balance as well as its effect by using yield spread as a proxy of QE and we had concluded that although financial crisis had offset the original impact of Okun's Law, QE is effective in bringing back the negative relationship of Okun's Law. This finding is crucial and serves as an important policy implication for policy makers of central banks in their future application of unconventional monetary policy, especially in terms of supporting the job market and economic growth.
From our findings, we have found that the Reserve Balances of Federal Reserve on average is USD499.44 billion. While based on our own calculation, in order to get the initial Okun's Law multiplier, Federal Reserve needs to have USD 3204.672 billion in their reserve balance to reach the pre-crisis Okun's Law multiplier -0.7617. This means that Federal Reserve have not purchase enough amount of assets to support the economy as well as the labour market in order for them to return to the pre-crisis level and this may cause the occurrence of the "jobless recovery" phenomenon. Therefore, in order to for the economy achieved full recovery and for the unemployment back to pre-crisis level, the amount of reserve balance of Federal Reserve should be USD 3204.672 billion.

This serves as an important lesson for the policy makers in the Federal Reserve when it comes to deciding the optimal amount of QE they should conduct in order to achieved the optimal macroeconomics impact. Furthermore, this also illustrates the usefulness of Okun's Law in terms of evaluating the macroeconomic impact of QE and is highly relevant when it comes to solving the puzzle of how can QE helps in improving the labour market conditions and to what point is the optimal amount of QE should the

Federal Reserve conduct in order for the labour market conditions to return to the pre-crisis level.

Moreover, Blanchard and Johnson (2012) stated that U.S. recovery remains slow and high unemployment is expected to last for many years even though the economy is currently experiencing positive output growth. Under the speech titled “Monetary Policy since the Onset of the Crisis” given by Ben Bernanke in 2012, he concluded that despite the limitations and difficulties of applying the non-traditional policies, Federal Reserve has by all means acted to support the labour market and strengthen economic growth of U.S. in the past five years. In our study regarding how QE affects the Okun’s coefficient, we had successfully proven that QE is especially effective in bringing back the unemployment rate during financial crisis by looking at the effect of QE on Okun’s Law relationship.

5.2.2 Implications for Researchers

According to Ball, Leigh and Loungani (2013), it is not common to refer a macroeconomic relationship as “law” but they believed that Okun’s law under the standards of macroeconomics is indeed strong and stable. Therefore, we strongly believed that it is of the utmost importance for researchers to consider the effects of QE on Okun’s Law multiplier in their studies regarding the macroeconomic impact of QE. Due to the complicated transmission process for QE to take effect on macroeconomic factors, therefore by studying the effect of QE on Okun’s coefficient, researchers can thus gain a better understanding on how QE helps in reducing unemployment rate through examine QE together with Okun’s relation.

5.3 Limitations of the Research

In this study, there are a few limitations and obstacles that we faced in our study. First of all, we only captured the liability side of QE by using LNRB and we are unable to study the asset side of QE, as the sample size of the data is too small, that is from 2003 to 2008. Therefore, we only managed to study the liability side of QE, which is LNRB.

This study only focus on QE in U.S., thus the results obtained in this study is only applicable to U.S. But in reality, this study does not clearly portray QE because QE is not only adopted by U.S., but in several countries such as Japan, United Kingdom and Europe.

There are 3 phases of QE in U.S., and each of the phases brings different impact to the economy. However, we did not individually study each phase of QE, but QE as a whole. The results drawn from this study does not represent the individual phases of QE.

5.4 Recommendation for Future Research

Future research could study QE in other countries as mentioned above, as the way of implementing QE varies across countries, hence the effect of QE also varies across countries. Researchers who are interested to study QE are encouraged to study QE in the countries mentioned above to examine the effect of QE to gain a better picture of QE.

It is recommended that researchers study specifically on QE 1, QE 2 and QE 3, and study the impact of each QE independently. For instance, Fed purchased mortgaged-backed securities (MBS) in QE 1, purchased treasury securities in QE 2 and made monthly purchases instead of bulk purchases in QE 3. Each QE brings different effect and its outcome might be useful for policymakers to refer and implement new policies. Researchers are able to understand more about each phases of QE.

This study can be further extended by studying the international spillover effects from QE and Okun's Law. For example, researchers should study the spillover effects of QE and Okun's Law in emerging market economies to see whether QE brings positive or adverse spillover effect. Many researches have been done on the spillover effects of QE by previous researchers, but no research has been done on the spillover effect of QE and Okun's Law.

5.5 Conclusion

As a conclusion, we have found that QE is effective in bringing back the negative relationship of Okun's Law in the wake of financial crisis. However, we had also found that the amount of QE conducted by the Federal Reserve so far is not sufficient to bring US economy back to the pre-crisis level. Therefore, this may lead to the occurrence of the "jobless recovery" phenomenon.

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APPENDICES

Appendix 4.1: ADF test for GDS with trend and intercept at level

Null Hypothesis: GDS has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 4 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.151210	0.0996
Test critical values:	1% level	-4.036983	
	5% level	-3.448021	
	10% level	-3.149135	

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

Appendix 4.2: ADF test for GDS with intercept at level

Null Hypothesis: GDS has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.235474	0.6575
Test critical values:	1% level	-3.485115	
	5% level	-2.885450	
	10% level	-2.579598	

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

Appendix 4.3: ADF test for INFEXP with trend and intercept at level

Null Hypothesis: INFEXP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.925463	0.0005
Test critical values:	1% level	-4.034356	
	5% level	-3.446765	
	10% level	-3.148399	

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

Appendix 4.4: ADF test for INFEXP with intercept at level

Null Hypothesis: INFEXP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.901944	0.0001
Test critical values:	1% level	-3.484198	
	5% level	-2.885051	
	10% level	-2.579386	

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

Appendix 4.5: ADF test for LNRB with trend and intercept at level

Null Hypothesis: LNRB has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.256488	0.8935
Test critical values:	1% level	-4.034997	
	5% level	-3.447072	
	10% level	-3.148578	

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

Appendix 4.6: ADF test for LNRB with intercept at level

Null Hypothesis: LNRB has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.351989	0.9125
Test critical values:	1% level	-3.484653	
	5% level	-2.885249	
	10% level	-2.579491	

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

Appendix 4.7: ADF test for OG with trend and intercept at level

Null Hypothesis: OG has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.230427	0.0835
Test critical values:	1% level	-4.035648	
	5% level	-3.447383	
	10% level	-3.148761	

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

Appendix 4.8: ADF test for OG with intercept at level

Null Hypothesis: OG has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.139552	0.0263
Test critical values:	1% level	-3.485115	
	5% level	-2.885450	
	10% level	-2.579598	

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

Appendix 4.9: ADF test for TS with trend and intercept at level

Null Hypothesis: TS has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.430252	0.0521
Test critical values:	1% level	-4.035648	
	5% level	-3.447383	
	10% level	-3.148761	

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

Appendix 4.10: ADF test for TS with intercept at level

Null Hypothesis: TS has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.726833	0.0724
Test critical values:	1% level	-3.484653	
	5% level	-2.885249	
	10% level	-2.579491	

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

Appendix 4.11: ADF test for U with trend and intercept at level

Null Hypothesis: U has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.113098	0.1080
Test critical values:	1% level	-4.035648	
	5% level	-3.447383	
	10% level	-3.148761	

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

Appendix 4.12: ADF test for U with intercept at level

Null Hypothesis: U has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.068112	0.0317
Test critical values:	1% level	-3.485115	
	5% level	-2.885450	
	10% level	-2.579598	

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

Appendix 4.13: PP test for GDS with trend and intercept at level

Null Hypothesis: GDS has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.977515	0.6074
Test critical values:	1% level	-4.034356	
	5% level	-3.446765	
	10% level	-3.148399	

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

Appendix 4.14: PP test for GDS with intercept at level

Null Hypothesis: GDS has a unit root
Exogenous: Constant
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.264277	0.6446
Test critical values:	1% level	-3.484198	
	5% level	-2.885051	
	10% level	-2.579386	

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

Appendix 4.15: PP test for INFEXP with trend and intercept at level

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.870805	0.0006
Test critical values:	1% level	-4.034356	
	5% level	-3.446765	
	10% level	-3.148399	

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

Appendix 4.16: PP test for INFEXP with intercept at level

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.844646	0.0001
Test critical values:	1% level	-3.484198	
	5% level	-2.885051	
	10% level	-2.579386	

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

Appendix 4.17: PP test for LNRB with trend and intercept at level

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.098560	0.9244
Test critical values:	1% level	-4.034356	
	5% level	-3.446765	
	10% level	-3.148399	

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

Appendix 4.18: PP test for LNRB with intercept at level

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.209555	0.9331
Test critical values:	1% level	-3.484198	
	5% level	-2.885051	
	10% level	-2.579386	

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

Appendix 4.19: PP test for OG with trend and intercept at level

Null Hypothesis: OG has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.603436	0.2797
Test critical values:	1% level	-4.034356	
	5% level	-3.446765	
	10% level	-3.148399	

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

Appendix 4.20: PP test for OG with intercept at level

Null Hypothesis: OG has a unit root
Exogenous: Constant
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.510115	0.1155
Test critical values:	1% level	-3.484198	
	5% level	-2.885051	
	10% level	-2.579386	

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

Appendix 4.21: PP test for TS with trend and intercept at level

Null Hypothesis: TS has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 6 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.834395	0.1880
Test critical values:	1% level	-4.034356	
	5% level	-3.446765	
	10% level	-3.148399	

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

Appendix 4.22: PP test for TS with intercept at level

Null Hypothesis: TS has a unit root
Exogenous: Constant
Bandwidth: 6 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.576251	0.1007
Test critical values:	1% level	-3.484198	
	5% level	-2.885051	
	10% level	-2.579386	

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

Appendix 4.23: PP test for U with trend and intercept at level

Null Hypothesis: U has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.229638	0.4687
Test critical values:	1% level	-4.034356	
	5% level	-3.446765	
	10% level	-3.148399	

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

Appendix 4.24: PP test for U with intercept at level

Null Hypothesis: U has a unit root
Exogenous: Constant
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.191770	0.2104
Test critical values:	1% level	-3.484198	
	5% level	-2.885051	
	10% level	-2.579386	

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

Appendix 4.25: ADF test for GDS with trend and intercept at first difference

Null Hypothesis: D(GDS) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.942711	0.0005
Test critical values:	1% level	-4.035648	
	5% level	-3.447383	
	10% level	-3.148761	

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

Appendix 4.26: ADF test for GDS with intercept at first difference

Null Hypothesis: D(GDS) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.959933	0.0001
Test critical values:	1% level	-3.485115	
	5% level	-2.885450	
	10% level	-2.579598	

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

Appendix 4.27: ADF test for INFEXP with trend and intercept at first difference

Null Hypothesis: D(INFEXP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.14943	0.0000
Test critical values:	1% level	-4.035648	
	5% level	-3.447383	
	10% level	-3.148761	

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

Appendix 4.28: ADF test for INFEXP with intercept at first difference

Null Hypothesis: D(INFEXP) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-11.18982	0.0000
Test critical values:	1% level	-3.485115	
	5% level	-2.885450	
	10% level	-2.579598	

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

Appendix 4.29: ADF test for LNRB with trend and intercept at first difference

Null Hypothesis: D(LNRB) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.364447	0.0000
Test critical values:	1% level	-4.034997	
	5% level	-3.447072	
	10% level	-3.148578	

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

Appendix 4.30: ADF test for LNRB with intercept at first difference

Null Hypothesis: D(LNRB) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.257820	0.0000
Test critical values:	1% level	-3.484653	
	5% level	-2.885249	
	10% level	-2.579491	

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

Appendix 4.31: ADF test for OG with trend and intercept at first difference

Null Hypothesis: D(OG) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.992694	0.0000
Test critical values:	1% level	-4.034997	
	5% level	-3.447072	
	10% level	-3.148578	

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

Appendix 4.32: ADF test for OG with intercept at first difference

Null Hypothesis: D(OG) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.026047	0.0000
Test critical values:	1% level	-3.484653	
	5% level	-2.885249	
	10% level	-2.579491	

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

Appendix 4.33: ADF test for TS with trend and intercept at first difference

Null Hypothesis: D(TS) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.800905	0.0000
Test critical values:	1% level	-4.034997	
	5% level	-3.447072	
	10% level	-3.148578	

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

Appendix 4.34: ADF test for TS with intercept at first difference

Null Hypothesis: D(TS) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.827526	0.0000
Test critical values:	1% level	-3.484653	
	5% level	-2.885249	
	10% level	-2.579491	

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

Appendix 4.35: ADF test for U with trend and intercept at first difference

Null Hypothesis: D(U) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.699280	0.0011
Test critical values:	1% level	-4.034997	
	5% level	-3.447072	
	10% level	-3.148578	

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

Appendix 4.36: ADF test for U with intercept at first difference

Null Hypothesis: D(U) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=12)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.718842	0.0001
Test critical values:	1% level	-3.484653	
	5% level	-2.885249	
	10% level	-2.579491	

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

Appendix 4.37: PP test for GDS with trend and intercept at first difference

Null Hypothesis: D(GDS) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-9.537753	0.0000
Test critical values:	1% level	-4.034997	
	5% level	-3.447072	
	10% level	-3.148578	

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

Residual variance (no correction)	3.48E-05
HAC corrected variance (Bartlett kernel)	5.99E-05

Appendix 4.38: PP test for GDS with intercept at first difference

Null Hypothesis: D(GDS) has a unit root
Exogenous: Constant
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-9.562983	0.0000
Test critical values:	1% level	-3.484653	
	5% level	-2.885249	
	10% level	-2.579491	

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

Residual variance (no correction)	3.48E-05
HAC corrected variance (Bartlett kernel)	5.99E-05

Appendix 4.39: PP test for INFEXP with trend and intercept at first difference

Null Hypothesis: D(INFEXP) has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 18 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-17.28762	0.0000
Test critical values:	1% level	-4.034997	
	5% level	-3.447072	
	10% level	-3.148578	

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

Residual variance (no correction)	1.82E-05
HAC corrected variance (Bartlett kernel)	3.53E-06

Appendix 4.40: PP test for INFEXP with intercept at first difference

Null Hypothesis: D(INFEXP) has a unit root
Exogenous: Constant
Bandwidth: 18 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-17.40104	0.0000
Test critical values:	1% level	-3.484653	
	5% level	-2.885249	
	10% level	-2.579491	

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

Residual variance (no correction)	1.82E-05
HAC corrected variance (Bartlett kernel)	3.53E-06

Appendix 4.41: PP test for LNRB with trend and intercept at first difference

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.355397	0.0000
Test critical values:	1% level	-4.034997	
	5% level	-3.447072	
	10% level	-3.148578	

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

Residual variance (no correction)	0.093348
HAC corrected variance (Bartlett kernel)	0.092613

Appendix 4.42: PP test for LNRB with intercept at first difference

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.257820	0.0000
Test critical values:	1% level	-3.484653	

	5% level	-2.885249	
	10% level	-2.579491	

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

Residual variance (no correction)	0.094519
HAC corrected variance (Bartlett kernel)	0.094519

Appendix 4.43: PP test for OG with trend and intercept at first difference

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.155773	0.0000
Test critical values:	1% level	-4.034997	
	5% level	-3.447072	
	10% level	-3.148578	

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

Residual variance (no correction)	2.79E-05
HAC corrected variance (Bartlett kernel)	3.13E-05

Appendix 4.44: PP test for OG with intercept at first difference

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-8.187531	0.0000
Test critical values:	1% level	-3.484653	
	5% level	-2.885249	
	10% level	-2.579491	

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

Residual variance (no correction)	2.79E-05
HAC corrected variance (Bartlett kernel)	3.14E-05

Appendix 4.45: PP test for TS with trend and intercept at first difference

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.741421	0.0000
Test critical values:	1% level	-4.034997	
	5% level	-3.447072	
	10% level	-3.148578	

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

Residual variance (no correction)	5.45E-06
HAC corrected variance (Bartlett kernel)	5.24E-06

Appendix 4.46: PP test for TS with intercept at first difference

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.768530	0.0000
Test critical values:	1% level	-3.484653	
	5% level	-2.885249	
	10% level	-2.579491	

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

Residual variance (no correction)	5.45E-06
HAC corrected variance (Bartlett kernel)	5.24E-06

Appendix 4.47: PP test for U with trend and intercept at first difference

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.568842	0.0018
Test critical values:	1% level	-4.034997	
	5% level	-3.447072	
	10% level	-3.148578	

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

Residual variance (no correction)	4.20E-06
HAC corrected variance (Bartlett kernel)	3.88E-06

Appendix 4.48: PP test for U with intercept at first difference

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.589016	0.0002
Test critical values:	1% level	-3.484653	
	5% level	-2.885249	
	10% level	-2.579491	

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

Residual variance (no correction)	4.20E-06
HAC corrected variance (Bartlett kernel)	3.88E-06

Appendix 4.49: Johansen-Juselius Cointegration test

Date: 07/25/17 Time: 02:53
Sample (adjusted): 1986Q2 2015Q4
Included observations: 119 after adjustments
Trend assumption: Linear deterministic trend
Series: GDS INFEXP LNRB OG TS U
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.317863	132.7392	95.75366	0.0000
At most 1 *	0.294251	87.21871	69.81889	0.0011
At most 2	0.198425	45.74770	47.85613	0.0779
At most 3	0.093188	19.42764	29.79707	0.4625
At most 4	0.054188	7.787055	15.49471	0.4885
At most 5	0.009678	1.157337	3.841466	0.2820

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

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.317863	45.52050	40.07757	0.0111
At most 1 *	0.294251	41.47101	33.87687	0.0051
At most 2	0.198425	26.32005	27.58434	0.0719

At most 3	0.093188	11.64059	21.13162	0.5834
At most 4	0.054188	6.629718	14.26460	0.5338
At most 5	0.009678	1.157337	3.841466	0.2820

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

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

GDS	INFEXP	LNRB	OG	TS	U
-8.319690	107.1114	0.038793	310.7942	275.4814	174.6588
13.32469	217.9054	-0.110843	-43.63495	191.1126	-168.1922
21.80431	-163.6119	0.244492	60.02242	164.3525	55.55879
-21.57325	120.5108	-0.552461	-37.62592	89.51376	-23.97975
-19.88233	-52.17327	-0.977423	46.60216	-6.060226	67.08842
12.01634	179.9484	-0.456779	-20.11097	-18.66058	73.84415

Unrestricted Adjustment Coefficients (alpha):

D(GDS)	-0.000907	-0.001232	0.000827	5.93E-05	-0.000345	0.000194
D(INFEXP)	0.000423	-0.000323	0.000113	-0.000131	0.000641	-1.24E-06
D(LNRB)	0.085961	-0.033535	-0.028449	0.046782	-0.009583	-0.006376
D(OG)	-0.001817	0.000426	0.000692	0.000642	0.000309	-3.60E-05
D(TS)	-0.000171	-0.000763	-0.000439	-0.000154	-6.62E-05	-8.35E-05
D(U)	4.71E-05	1.09E-06	-0.000579	2.20E-05	-8.68E-06	5.04E-05

1 Cointegrating Equation(s): Log likelihood 2728.848

Normalized cointegrating coefficients (standard error in parentheses)

GDS	INFEXP	LNRB	OG	TS	U
1.000000	-12.87445	-0.004663	-37.35647	-33.11198	-20.99342
	(6.70422)	(0.01864)	(5.86699)	(6.97518)	(4.79759)

Adjustment coefficients (standard error in parentheses)

D(GDS)	0.007549
	(0.00351)
D(INFEXP)	-0.003520
	(0.00253)
D(LNRB)	-0.715168
	(0.19887)
D(OG)	0.015114
	(0.00350)
D(TS)	0.001426
	(0.00174)
D(U)	-0.000392
	(0.00121)

2 Cointegrating Equation(s): Log likelihood 2749.584

Normalized cointegrating coefficients (standard error in parentheses)

GDS	INFEXP	LNRB	OG	TS	U
1.000000	0.000000	-0.006273	-22.34402	-12.20894	-17.30621
		(0.01089)	(3.69884)	(4.07213)	(2.94930)
0.000000	1.000000	-0.000125	1.166066	1.623607	0.286398
		(0.00071)	(0.24048)	(0.26475)	(0.19175)

Adjustment coefficients (standard error in parentheses)

D(GDS)	-0.008873	-0.365731
	(0.00631)	(0.09747)
D(INFEXP)	-0.007830	-0.025171
	(0.00474)	(0.07329)
D(LNRB)	-1.162009	1.899965
	(0.37150)	(5.74224)
D(OG)	0.020785	-0.101853
	(0.00656)	(0.10146)
D(TS)	-0.008746	-0.184718
	(0.00304)	(0.04704)
D(U)	-0.000377	0.005278
	(0.00228)	(0.03527)

3 Cointegrating Equation(s): Log likelihood 2762.744

Normalized cointegrating coefficients (standard error in parentheses)

GDS	INFEXP	LNRB	OG	TS	U
1.000000	0.000000	0.000000	-9.512937	-0.104588	-8.964852
			(2.31951)	(2.59355)	(1.86855)
0.000000	1.000000	0.000000	1.421903	1.864955	0.452715
			(0.26522)	(0.29655)	(0.21366)
0.000000	0.000000	1.000000	2045.406	1929.558	1329.698
			(340.506)	(380.736)	(274.305)

Adjustment coefficients (standard error in parentheses)

D(GDS)	0.009158	-0.501030	0.000304
	(0.01054)	(0.11483)	(0.00011)
D(INFEXP)	-0.005370	-0.043631	7.99E-05
	(0.00811)	(0.08831)	(8.2E-05)
D(LNRB)	-1.782329	6.554629	9.61E-05
	(0.63058)	(6.87014)	(0.00636)
D(OG)	0.035872	-0.215064	5.15E-05
	(0.01106)	(0.12053)	(0.00011)
D(TS)	-0.018329	-0.112813	-2.95E-05
	(0.00506)	(0.05513)	(5.1E-05)
D(U)	-0.012999	0.099986	-0.000140
	(0.00355)	(0.03873)	(3.6E-05)

4 Cointegrating Equation(s): Log likelihood 2768.564

Normalized cointegrating coefficients (standard error in parentheses)

GDS	INFEXP	LNRB	OG	TS	U
1.000000	0.000000	0.000000	0.000000	12.23530	-2.816029
				(2.46403)	(1.51513)
0.000000	1.000000	0.000000	0.000000	0.020505	-0.466352
				(0.24484)	(0.15055)
0.000000	0.000000	1.000000	0.000000	-723.6806	7.620640
				(247.736)	(152.333)
0.000000	0.000000	0.000000	1.000000	1.297169	0.646364
				(0.19226)	(0.11822)

Adjustment coefficients (standard error in parentheses)

D(GDS)	0.007880	-0.493889	0.000271	-0.180808
	(0.01351)	(0.12416)	(0.00024)	(0.12616)
D(INFEXP)	-0.002546	-0.059403	0.000152	0.157297
	(0.01038)	(0.09540)	(0.00019)	(0.09694)
D(LNRB)	-2.791565	12.19235	-0.025749	24.71162
	(0.79116)	(7.26883)	(0.01413)	(7.38636)
D(OG)	0.022031	-0.137745	-0.000303	-0.565790

	(0.01400)	(0.12862)	(0.00025)	(0.13070)
D(TS)	-0.015006	-0.131376	5.56E-05	-0.040557
	(0.00647)	(0.05940)	(0.00012)	(0.06036)
D(U)	-0.013473	0.102638	-0.000152	-0.020992
	(0.00456)	(0.04187)	(8.1E-05)	(0.04255)

5 Cointegrating Equation(s): Log likelihood 2771.879

Normalized cointegrating coefficients (standard error in parentheses)

GDS	INFEXP	LNRB	OG	TS	U
1.000000	0.000000	0.000000	0.000000	0.000000	-3.645676
					(1.96414)
0.000000	1.000000	0.000000	0.000000	0.000000	-0.467743
					(0.10968)
0.000000	0.000000	1.000000	0.000000	0.000000	56.69171
					(66.8156)
0.000000	0.000000	0.000000	1.000000	0.000000	0.558406
					(0.21023)
0.000000	0.000000	0.000000	0.000000	1.000000	0.067808
					(0.20121)

Adjustment coefficients (standard error in parentheses)

D(GDS)	0.014748	-0.475868	0.000608	-0.196905	-0.342167
	(0.01554)	(0.12530)	(0.00045)	(0.12695)	(0.14996)
D(INFEXP)	-0.015297	-0.092862	-0.000475	0.187182	0.057670
	(0.01169)	(0.09430)	(0.00034)	(0.09554)	(0.11285)
D(LNRB)	-2.601028	12.69234	-0.016382	24.26502	16.84165
	(0.91253)	(7.35995)	(0.02649)	(7.45644)	(8.80806)
D(OG)	0.015896	-0.153845	-0.000605	-0.551410	-0.249845
	(0.01611)	(0.12995)	(0.00047)	(0.13166)	(0.15552)
D(TS)	-0.013689	-0.127921	0.000120	-0.043643	-0.278748
	(0.00746)	(0.06016)	(0.00022)	(0.06095)	(0.07200)
D(U)	-0.013301	0.103091	-0.000143	-0.021397	-0.079941
	(0.00526)	(0.04244)	(0.00015)	(0.04300)	(0.05079)

Appendix 4.50: Multicollinearity Test for GDS, INFEXP, LNRB, OG, TS,

Variance Inflation Factors
Date: 07/25/17 Time: 03:02
Sample: 1985Q1 2015Q4
Included observations: 124

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
GDS	0.000377	44.12223	2.889549
INFEXP	0.013426	38.53094	1.079357
LNRB	2.03E-07	11.35884	2.424903
OG	0.004146	6.247419	3.495636
TS	0.014390	9.037432	3.199044
C	1.86E-05	55.24451	NA

Appendix 4.51: Heteroscedasticity ARCH test for Model 1

Heteroskedasticity Test: ARCH

F-statistic	159.3970	Prob. F(1,121)	0.0000
Obs*R-squared	69.92168	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/09/17 Time: 22:06
Sample (adjusted): 1985Q2 2015Q4
Included observations: 123 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.13E-05	4.04E-06	2.809304	0.0058
RESID^2(-1)	0.747783	0.067076	11.14830	0.0000

R-squared	0.568469	Mean dependent var	4.66E-05
Adjusted R-squared	0.564903	S.D. dependent var	6.62E-05
S.E. of regression	4.37E-05	Akaike info criterion	-17.22400
Sum squared resid	2.31E-07	Schwarz criterion	-17.17827
Log likelihood	1061.276	Hannan-Quinn criter.	-17.20542
F-statistic	159.3970	Durbin-Watson stat	1.930937
Prob(F-statistic)	0.000000		

Appendix 4.52: Heteroscedasticity ARCH test for Model 2

Heteroskedasticity Test: ARCH

F-statistic	100.3578	Prob. F(1,121)	0.0000
Obs*R-squared	55.76497	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/09/17 Time: 22:10
Sample (adjusted): 1985Q2 2015Q4
Included observations: 123 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.39E-05	4.15E-06	3.338925	0.0011
RESID^2(-1)	0.673558	0.075002	8.980514	0.0000

R-squared	0.453374	Mean dependent var	4.17E-05
Adjusted R-squared	0.448856	S.D. dependent var	5.85E-05
S.E. of regression	4.35E-05	Akaike info criterion	-17.23320
Sum squared resid	2.29E-07	Schwarz criterion	-17.18747
Log likelihood	1061.842	Hannan-Quinn criter.	-17.21463
F-statistic	100.3578	Durbin-Watson stat	2.002121
Prob(F-statistic)	0.000000		

Appendix 4.53: Heteroscedasticity ARCH test for Model 3

Heteroskedasticity Test: ARCH

F-statistic	159.0068	Prob. F(1,121)	0.0000
Obs*R-squared	69.84772	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/10/17 Time: 18:18
Sample (adjusted): 1985Q2 2015Q4
Included observations: 123 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.14E-05	4.04E-06	2.810574	0.0058
RESID^2(-1)	0.747444	0.067020	11.15251	0.0000

R-squared	0.567868	Mean dependent var	4.66E-05
Adjusted R-squared	0.564296	S.D. dependent var	6.62E-05
S.E. of regression	4.37E-05	Akaike info criterion	-17.22354
Sum squared resid	2.31E-07	Schwarz criterion	-17.17781
Log likelihood	1061.248	Hannan-Quinn criter.	-17.20496
F-statistic	159.0068	Durbin-Watson stat	1.932512
Prob(F-statistic)	0.000000		

Appendix 4.54: Heteroscedasticity ARCH test for Model 4

Heteroskedasticity Test: ARCH

F-statistic	102.6172	Prob. F(1,121)	0.0000
Obs*R-squared	56.44430	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/14/17 Time: 22:52
Sample (adjusted): 1985Q2 2015Q4
Included observations: 123 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.26E-05	4.06E-06	3.113475	0.0023
RESID^2(-1)	0.690306	0.092144	7.491635	0.0000

R-squared	0.458897	Mean dependent var	3.97E-05
Adjusted R-squared	0.454425	S.D. dependent var	5.68E-05
S.E. of regression	4.20E-05	Akaike info criterion	-17.30267
Sum squared resid	2.13E-07	Schwarz criterion	-17.25694
Log likelihood	1066.114	Hannan-Quinn criter.	-17.28410
F-statistic	102.6172	Durbin-Watson stat	1.946741
Prob(F-statistic)	0.000000		

Appendix 4.55: Heteroscedasticity ARCH test for Model 5

Heteroskedasticity Test: ARCH

F-statistic	124.2411	Prob. F(1,121)	0.0000
Obs*R-squared	62.31279	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/14/17 Time: 22:55
Sample (adjusted): 1985Q2 2015Q4
Included observations: 123 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.25E-05	4.88E-06	2.572014	0.0113
RESID^2(-1)	0.704138	0.063172	11.14635	0.0000

R-squared	0.506608	Mean dependent var	4.39E-05
Adjusted R-squared	0.502530	S.D. dependent var	6.27E-05
S.E. of regression	4.42E-05	Akaike info criterion	-17.19780
Sum squared resid	2.37E-07	Schwarz criterion	-17.15207
Log likelihood	1059.665	Hannan-Quinn criter.	-17.17923
F-statistic	124.2411	Durbin-Watson stat	1.942494
Prob(F-statistic)	0.000000		

Appendix 4.56: Heteroscedasticity ARCH test for Model 6

Heteroskedasticity Test: ARCH

F-statistic	151.8870	Prob. F(1,121)	0.0000
Obs*R-squared	68.46095	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/14/17 Time: 22:57
Sample (adjusted): 1985Q2 2015Q4
Included observations: 123 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed
bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.

C	1.01E-05	3.30E-06	3.044301	0.0029
RESID^2(-1)	0.741712	0.093604	7.923928	0.0000

R-squared	0.556593	Mean dependent var	3.98E-05
Adjusted R-squared	0.552929	S.D. dependent var	6.14E-05
S.E. of regression	4.10E-05	Akaike info criterion	-17.34885
Sum squared resid	2.04E-07	Schwarz criterion	-17.30312
Log likelihood	1068.954	Hannan-Quinn criter.	-17.33027
F-statistic	151.8870	Durbin-Watson stat	1.969147
Prob(F-statistic)	0.000000		

Appendix 4.57: Heteroscedasticity ARCH test for Model 7

Heteroskedasticity Test: ARCH

F-statistic	164.7712	Prob. F(1,121)	0.0000
Obs*R-squared	70.91988	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/14/17 Time: 22:58
Sample (adjusted): 1985Q2 2015Q4
Included observations: 123 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.40E-06	3.66E-06	2.569584	0.0114
RESID^2(-1)	0.748327	0.089062	8.402297	0.0000

R-squared	0.576584	Mean dependent var	3.85E-05
Adjusted R-squared	0.573085	S.D. dependent var	5.84E-05
S.E. of regression	3.82E-05	Akaike info criterion	-17.49219
Sum squared resid	1.76E-07	Schwarz criterion	-17.44646
Log likelihood	1077.770	Hannan-Quinn criter.	-17.47362
F-statistic	164.7712	Durbin-Watson stat	1.810657
Prob(F-statistic)	0.000000		

Appendix 4.58: Heteroscedasticity ARCH test for Model 8

Heteroskedasticity Test: ARCH

F-statistic	203.6346	Prob. F(1,121)	0.0000
Obs*R-squared	77.15462	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/14/17 Time: 23:08
Sample (adjusted): 1985Q2 2015Q4
Included observations: 123 after adjustments

HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.09E-06	3.54E-06	2.569731	0.0114
RESID^2(-1)	0.782376	0.070684	11.06871	0.0000

R-squared	0.627273	Mean dependent var	4.44E-05
Adjusted R-squared	0.624193	S.D. dependent var	6.61E-05
S.E. of regression	4.05E-05	Akaike info criterion	-17.37364
Sum squared resid	1.99E-07	Schwarz criterion	-17.32792
Log likelihood	1070.479	Hannan-Quinn criter.	-17.35507
F-statistic	203.6346	Durbin-Watson stat	1.810821
Prob(F-statistic)	0.000000		

Appendix 4.59: Heteroscedasticity ARCH test for Model 9

Heteroskedasticity Test: ARCH

F-statistic	149.6631	Prob. F(1,121)	0.0000
Obs*R-squared	68.01282	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/14/17 Time: 23:10
Sample (adjusted): 1985Q2 2015Q4
Included observations: 123 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.64E-06	3.16E-06	3.054835	0.0028
RESID^2(-1)	0.739904	0.097218	7.610798	0.0000

R-squared	0.552950	Mean dependent var	3.78E-05
Adjusted R-squared	0.549255	S.D. dependent var	5.96E-05
S.E. of regression	4.00E-05	Akaike info criterion	-17.39827
Sum squared resid	1.94E-07	Schwarz criterion	-17.35254
Log likelihood	1071.993	Hannan-Quinn criter.	-17.37969
F-statistic	149.6631	Durbin-Watson stat	1.915439
Prob(F-statistic)	0.000000		

Appendix 4.60: Heteroscedasticity ARCH test for Model 10

Heteroskedasticity Test: ARCH

F-statistic	167.8988	Prob. F(1,121)	0.0000
Obs*R-squared	71.48369	Prob. Chi-Square(1)	0.0000

Test Equation:

Dependent Variable: RESID^2
Method: Least Squares
Date: 06/14/17 Time: 23:11
Sample (adjusted): 1985Q2 2015Q4
Included observations: 123 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.04E-06	3.13E-06	2.890777	0.0046
RESID^2(-1)	0.758307	0.097893	7.746273	0.0000

R-squared	0.581168	Mean dependent var	3.82E-05
Adjusted R-squared	0.577707	S.D. dependent var	6.02E-05
S.E. of regression	3.91E-05	Akaike info criterion	-17.44520
Sum squared resid	1.85E-07	Schwarz criterion	-17.39947
Log likelihood	1074.880	Hannan-Quinn criter.	-17.42662
F-statistic	167.8988	Durbin-Watson stat	1.912440
Prob(F-statistic)	0.000000		

Appendix 4.61: Heteroscedasticity ARCH test for Model 11

Heteroskedasticity Test: ARCH

F-statistic	131.7465	Prob. F(1,121)	0.0000
Obs*R-squared	64.11491	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/14/17 Time: 23:11
Sample (adjusted): 1985Q2 2015Q4
Included observations: 123 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.07E-05	3.96E-06	2.704329	0.0078
RESID^2(-1)	0.713358	0.098007	7.278666	0.0000

R-squared	0.521259	Mean dependent var	3.82E-05
Adjusted R-squared	0.517303	S.D. dependent var	5.80E-05
S.E. of regression	4.03E-05	Akaike info criterion	-17.38448
Sum squared resid	1.96E-07	Schwarz criterion	-17.33875
Log likelihood	1071.145	Hannan-Quinn criter.	-17.36590
F-statistic	131.7465	Durbin-Watson stat	1.861647
Prob(F-statistic)	0.000000		

Appendix 4.62: Heteroscedasticity ARCH test for Model 12

Heteroskedasticity Test: ARCH

F-statistic	190.5773	Prob. F(1,121)	0.0000
Obs*R-squared	75.23336	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/14/17 Time: 23:12
Sample (adjusted): 1985Q2 2015Q4
Included observations: 123 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.19E-06	3.61E-06	2.543172	0.0122
RESID^2(-1)	0.764990	0.071168	10.74909	0.0000

R-squared	0.611653	Mean dependent var	4.20E-05
Adjusted R-squared	0.608444	S.D. dependent var	6.03E-05
S.E. of regression	3.77E-05	Akaike info criterion	-17.51747
Sum squared resid	1.72E-07	Schwarz criterion	-17.47175
Log likelihood	1079.325	Hannan-Quinn criter.	-17.49890
F-statistic	190.5773	Durbin-Watson stat	1.773489
Prob(F-statistic)	0.000000		

Appendix 4.63: Heteroscedasticity ARCH test for Model 13

Heteroskedasticity Test: ARCH

F-statistic	136.9574	Prob. F(1,121)	0.0000
Obs*R-squared	65.30442	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/14/17 Time: 23:13
Sample (adjusted): 1985Q2 2015Q4
Included observations: 123 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.00E-05	3.52E-06	2.852740	0.0051
RESID^2(-1)	0.711926	0.101983	6.980842	0.0000

R-squared	0.530930	Mean dependent var	3.66E-05
Adjusted R-squared	0.527054	S.D. dependent var	5.74E-05
S.E. of regression	3.95E-05	Akaike info criterion	-17.42594
Sum squared resid	1.89E-07	Schwarz criterion	-17.38021
Log likelihood	1073.695	Hannan-Quinn criter.	-17.40737

F-statistic	136.9574	Durbin-Watson stat	1.988898
Prob(F-statistic)	0.000000		

Appendix 4.64: Heteroscedasticity ARCH test for Model 14

Heteroskedasticity Test: ARCH

F-statistic	110.7818	Prob. F(1,121)	0.0000
Obs*R-squared	58.78876	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/14/17 Time: 23:14
Sample (adjusted): 1985Q2 2015Q4
Included observations: 123 after adjustments
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.23E-05	3.83E-06	3.203948	0.0017
RESID^2(-1)	0.680323	0.087436	7.780777	0.0000

R-squared	0.477957	Mean dependent var	4.03E-05
Adjusted R-squared	0.473643	S.D. dependent var	6.26E-05
S.E. of regression	4.54E-05	Akaike info criterion	-17.14506
Sum squared resid	2.50E-07	Schwarz criterion	-17.09933
Log likelihood	1056.421	Hannan-Quinn criter.	-17.12648
F-statistic	110.7818	Durbin-Watson stat	1.980642
Prob(F-statistic)	0.000000		

Appendix 4.65: Autocorrelation Breusch-Godfrey Serial Correlation LM Test for Model 1

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	171.6391	Prob. F(2,120)	0.0000
Obs*R-squared	91.88107	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/14/17 Time: 12:12
Sample: 1985Q1 2015Q4
Included observations: 124
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.

C	-0.000202	0.000428	-0.471145	0.6384
OG	-0.009618	0.018982	-0.506707	0.6133
RESID(-1)	0.934026	0.091234	10.23773	0.0000
RESID(-2)	-0.079318	0.091608	-0.865844	0.3883

R-squared	0.740976	Mean dependent var	-6.27E-18
Adjusted R-squared	0.734501	S.D. dependent var	0.006912
S.E. of regression	0.003561	Akaike info criterion	-8.405674
Sum squared resid	0.001522	Schwarz criterion	-8.314698
Log likelihood	525.1518	Hannan-Quinn criter.	-8.368717
F-statistic	114.4261	Durbin-Watson stat	1.941945
Prob(F-statistic)	0.000000		

Appendix 4.66: Autocorrelation Breusch-Godfrey Serial Correlation LM Test for Model 2

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	127.3757	Prob. F(2,119)	0.0000
Obs*R-squared	84.51920	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/14/17 Time: 12:13
Sample: 1985Q1 2015Q4
Included observations: 124
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.49E-05	0.000464	-0.075241	0.9401
OG	0.067148	0.087338	0.768832	0.4435
OG*DUM90	-0.072590	0.084265	-0.861451	0.3907
RESID(-1)	0.854544	0.091643	9.324719	0.0000
RESID(-2)	-0.027231	0.092082	-0.295728	0.7680

R-squared	0.681606	Mean dependent var	-1.26E-17
Adjusted R-squared	0.670904	S.D. dependent var	0.006476
S.E. of regression	0.003715	Akaike info criterion	-8.313243
Sum squared resid	0.001643	Schwarz criterion	-8.199522
Log likelihood	520.4211	Hannan-Quinn criter.	-8.267047
F-statistic	63.68783	Durbin-Watson stat	1.978732
Prob(F-statistic)	0.000000		

Appendix 4.67: Autocorrelation Breusch-Godfrey Serial Correlation LM Test for Model 3

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	170.3071	Prob. F(2,119)	0.0000
Obs*R-squared	91.89481	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/14/17 Time: 12:14
Sample: 1985Q1 2015Q4
Included observations: 124
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000172	0.000436	-0.395479	0.6932
OG	0.001435	0.033275	0.043137	0.9657
OG*DUM20	-0.013550	0.033494	-0.404535	0.6865
RESID(-1)	0.932541	0.091602	10.18034	0.0000
RESID(-2)	-0.077234	0.092054	-0.839002	0.4032

R-squared	0.741087	Mean dependent var	-1.22E-17
Adjusted R-squared	0.732384	S.D. dependent var	0.006911
S.E. of regression	0.003575	Akaike info criterion	-8.389985
Sum squared resid	0.001521	Schwarz criterion	-8.276264
Log likelihood	525.1791	Hannan-Quinn criter.	-8.343789
F-statistic	85.15354	Durbin-Watson stat	1.933804
Prob(F-statistic)	0.000000		

Appendix 4.68: Autocorrelation Breusch-Godfrey Serial Correlation LM Test for Model 4

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	155.8771	Prob. F(2,117)	0.0000
Obs*R-squared	90.16243	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/14/17 Time: 12:14
Sample: 1985Q1 2015Q4
Included observations: 124
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.004064	0.002276	1.785646	0.0767
OG	-0.010164	0.026050	-0.390169	0.6971
GDS	-0.007061	0.010145	-0.695969	0.4878
INFEXP	-0.153219	0.061845	-2.477476	0.0147
LNRB	-0.000251	0.000241	-1.042859	0.2992
RESID(-1)	0.910730	0.090018	10.11715	0.0000
RESID(-2)	-0.035455	0.093326	-0.379901	0.7047

R-squared	0.727116	Mean dependent var	-1.43E-17
Adjusted R-squared	0.713122	S.D. dependent var	0.006388
S.E. of regression	0.003422	Akaike info criterion	-8.462636
Sum squared resid	0.001370	Schwarz criterion	-8.303427
Log likelihood	531.6834	Hannan-Quinn criter.	-8.397962
F-statistic	51.95903	Durbin-Watson stat	1.902303

Prob(F-statistic)	0.000000

Appendix 4.69: Autocorrelation Breusch-Godfrey Serial Correlation LM Test for Model 5

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	179.5967	Prob. F(2,117)	0.0000
Obs*R-squared	93.53339	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/14/17 Time: 12:14
Sample: 1985Q1 2015Q4
Included observations: 124
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.004754	0.002270	2.094528	0.0384
OG	0.002628	0.033555	0.078314	0.9377
GDS	-0.002724	0.008546	-0.318738	0.7505
INFEXP	-0.178805	0.063158	-2.831098	0.0055
TS	0.015651	0.063610	0.246042	0.8061
RESID(-1)	0.889222	0.090064	9.873228	0.0000
RESID(-2)	-0.002841	0.092871	-0.030592	0.9756

R-squared	0.754302	Mean dependent var	-8.28E-18
Adjusted R-squared	0.741702	S.D. dependent var	0.006715
S.E. of regression	0.003413	Akaike info criterion	-8.467674
Sum squared resid	0.001363	Schwarz criterion	-8.308465
Log likelihood	531.9958	Hannan-Quinn criter.	-8.403000
F-statistic	59.86558	Durbin-Watson stat	1.807069
Prob(F-statistic)	0.000000		

Appendix 4.70: Autocorrelation Breusch-Godfrey Serial Correlation LM Test for Model 6

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	126.7911	Prob. F(2,119)	0.0000
Obs*R-squared	84.39532	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/14/17 Time: 12:15
Sample: 1985Q1 2015Q4
Included observations: 124
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	6.07E-05	0.000444	0.136657	0.8915
OG	0.019325	0.022395	0.862898	0.3899
OG*DUMFC	-0.049288	0.033043	-1.491637	0.1384
RESID(-1)	0.824648	0.091238	9.038394	0.0000
RESID(-2)	0.014417	0.091953	0.156788	0.8757

R-squared	0.680607	Mean dependent var	-1.42E-17
Adjusted R-squared	0.669871	S.D. dependent var	0.006395
S.E. of regression	0.003674	Akaike info criterion	-8.335431
Sum squared resid	0.001607	Schwarz criterion	-8.221710
Log likelihood	521.7967	Hannan-Quinn criter.	-8.289235
F-statistic	63.39555	Durbin-Watson stat	1.850062
Prob(F-statistic)	0.000000		

Appendix 4.71: Autocorrelation Breusch-Godfrey Serial Correlation LM Test for Model 7

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	159.5217	Prob. F(2,118)	0.0000
Obs*R-squared	90.52049	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/14/17 Time: 12:17
Sample: 1985Q1 2015Q4
Included observations: 124
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000679	0.000938	0.723952	0.4705
OG	-0.001263	0.046415	-0.027220	0.9783
LNRB	-0.000311	0.000290	-1.072741	0.2856
OG*LNRB	-0.005370	0.009879	-0.543574	0.5878
RESID(-1)	0.929754	0.091761	10.13235	0.0000
RESID(-2)	-0.073061	0.092988	-0.785700	0.4336

R-squared	0.730004	Mean dependent var	-5.20E-18
Adjusted R-squared	0.718563	S.D. dependent var	0.006332
S.E. of regression	0.003359	Akaike info criterion	-8.507199
Sum squared resid	0.001331	Schwarz criterion	-8.370734
Log likelihood	533.4463	Hannan-Quinn criter.	-8.451764
F-statistic	63.80869	Durbin-Watson stat	1.910231
Prob(F-statistic)	0.000000		

Appendix 4.72: Autocorrelation Breusch-Godfrey Serial Correlation LM Test for Model 8

Dependent Variable: U
Method: Least Squares
Date: 06/10/17 Time: 14:54
Sample: 1985Q1 2015Q4
Included observations: 124
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.049378	0.001121	44.02949	0.0000
OG	-0.556050	0.131305	-4.234808	0.0000
TS	0.065808	0.181267	0.363044	0.7172
OG*TS	-8.980068	6.385241	-1.406379	0.1622

R-squared	0.786258	Mean dependent var	0.061105
Adjusted R-squared	0.780915	S.D. dependent var	0.014632
S.E. of regression	0.006849	Akaike info criterion	-7.097783
Sum squared resid	0.005629	Schwarz criterion	-7.006806
Log likelihood	444.0626	Hannan-Quinn criter.	-7.060826
F-statistic	147.1417	Durbin-Watson stat	0.220385
Prob(F-statistic)	0.000000	Wald F-statistic	52.19364
Prob(Wald F-statistic)	0.000000		

Appendix 4.73: Autocorrelation Breusch-Godfrey Serial Correlation LM Test for Model 9

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	101.1932	Prob. F(2,118)	0.0000
Obs*R-squared	78.33014	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/14/17 Time: 12:17
Sample: 1985Q1 2015Q4
Included observations: 124
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	7.31E-05	0.000473	0.154410	0.8775
OG	0.021378	0.023703	0.901926	0.3689
OG*DUMFC	-0.099820	0.108353	-0.921243	0.3588
OG*DUMFC*LNRB	0.009100	0.018206	0.499827	0.6181
RESID(-1)	0.785900	0.091632	8.576743	0.0000
RESID(-2)	0.027493	0.092481	0.297283	0.7668

R-squared	0.631695	Mean dependent var	-1.09E-17
Adjusted R-squared	0.616089	S.D. dependent var	0.006228
S.E. of regression	0.003859	Akaike info criterion	-8.229542

Sum squared resid	0.001757	Schwarz criterion	-8.093077
Log likelihood	516.2316	Hannan-Quinn criter.	-8.174107
F-statistic	40.47727	Durbin-Watson stat	1.832414
Prob(F-statistic)	0.000000		

Appendix 4.74: Autocorrelation Breusch-Godfrey Serial Correlation LM Test for Model 10

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	117.9902	Prob. F(2,118)	0.0000
Obs*R-squared	82.66437	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/14/17 Time: 12:18
Sample: 1985Q1 2015Q4
Included observations: 124
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.78E-05	0.000451	0.194818	0.8459
OG	0.016404	0.022610	0.725529	0.4696
OG*DUMFC	-0.035380	0.108812	-0.325150	0.7456
OG*DUMFC*TS	0.449489	5.389890	0.083395	0.9337
RESID(-1)	0.801987	0.092481	8.671912	0.0000
RESID(-2)	0.029610	0.093313	0.317315	0.7516

R-squared	0.666648	Mean dependent var	-1.13E-17
Adjusted R-squared	0.652523	S.D. dependent var	0.006267
S.E. of regression	0.003694	Akaike info criterion	-8.316979
Sum squared resid	0.001610	Schwarz criterion	-8.180514
Log likelihood	521.6527	Hannan-Quinn criter.	-8.261544
F-statistic	47.19607	Durbin-Watson stat	1.865352
Prob(F-statistic)	0.000000		

Appendix 4.75: Autocorrelation Breusch-Godfrey Serial Correlation LM Test for Model 11

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	153.2055	Prob. F(2,118)	0.0000
Obs*R-squared	89.52399	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/14/17 Time: 12:18
Sample: 1985Q1 2015Q4
Included observations: 124

Presampe missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.000181	0.000433	0.416691	0.6777
OG	-0.140214	0.058438	-2.399347	0.0180
OG*LNRB	0.096341	0.033565	2.870308	0.0049
OG*GDS*LNRB	0.265487	0.093401	2.842434	0.0053
RESID(-1)	0.879550	0.089793	9.795260	0.0000
RESID(-2)	-0.005460	0.092732	-0.058876	0.9532

R-squared	0.721968	Mean dependent var	-1.38E-17
Adjusted R-squared	0.710187	S.D. dependent var	0.006297
S.E. of regression	0.003390	Akaike info criterion	-8.488968
Sum squared resid	0.001356	Schwarz criterion	-8.352503
Log likelihood	532.3160	Hannan-Quinn criter.	-8.433532
F-statistic	61.28222	Durbin-Watson stat	1.812927
Prob(F-statistic)	0.000000		

Appendix 4.76: Autocorrelation Breusch-Godfrey Serial Correlation LM Test for Model 12

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	182.0592	Prob. F(2,118)	0.0000
Obs*R-squared	93.65060	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 06/14/17 Time: 12:19
Sample: 1985Q1 2015Q4
Included observations: 124
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000293	0.000429	-0.683464	0.4957
OG	0.084392	0.050477	1.671886	0.0972
OG*TS	-7.259017	5.590849	-1.298375	0.1967
OG*GDS*TS	-9.082650	15.21270	-0.597044	0.5516
RESID(-1)	0.907067	0.091879	9.872402	0.0000
RESID(-2)	-0.030113	0.094327	-0.319245	0.7501

R-squared	0.755247	Mean dependent var	-3.64E-18
Adjusted R-squared	0.744876	S.D. dependent var	0.006597
S.E. of regression	0.003332	Akaike info criterion	-8.523177
Sum squared resid	0.001310	Schwarz criterion	-8.386712
Log likelihood	534.4370	Hannan-Quinn criter.	-8.467742
F-statistic	72.82367	Durbin-Watson stat	1.841998
Prob(F-statistic)	0.000000		

Appendix 4.77: Autocorrelation Breusch-Godfrey Serial Correlation LM Test for Model 13

Dependent Variable: U
Method: Least Squares
Date: 06/12/17 Time: 22:06
Sample: 1985Q1 2015Q4
Included observations: 124
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.049900	0.001075	46.43790	0.0000
OG	-0.444698	0.127892	-3.477144	0.0007
OG*LNRB	0.008888	0.042190	0.210673	0.8335
OG*INFEXP*LNRB	-2.219284	1.008790	-2.199947	0.0297

R-squared	0.821841	Mean dependent var	0.061105
Adjusted R-squared	0.817387	S.D. dependent var	0.014632
S.E. of regression	0.006253	Akaike info criterion	-7.279873
Sum squared resid	0.004692	Schwarz criterion	-7.188896
Log likelihood	455.3521	Hannan-Quinn criter.	-7.242916
F-statistic	184.5180	Durbin-Watson stat	0.325798
Prob(F-statistic)	0.000000	Wald F-statistic	128.5338
Prob(Wald F-statistic)	0.000000		

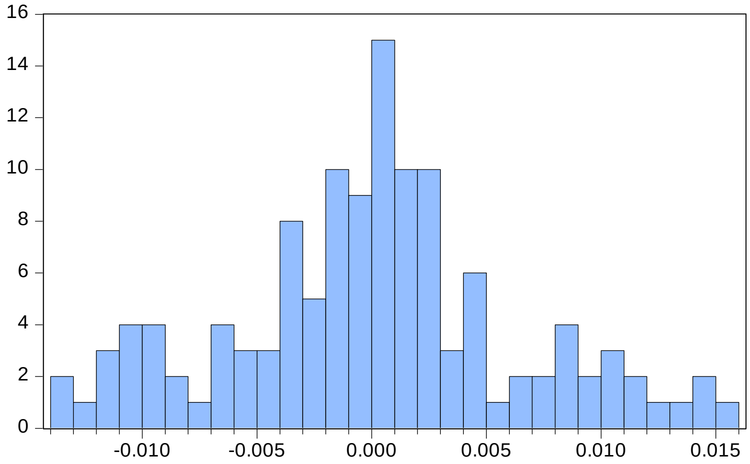
Appendix 4.78: Autocorrelation Breusch-Godfrey Serial Correlation LM Test for Model 14

Dependent Variable: U
Method: Least Squares
Date: 06/12/17 Time: 22:06
Sample: 1985Q1 2015Q4
Included observations: 124
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.049559	0.001057	46.86464	0.0000
OG	-0.574523	0.128540	-4.469612	0.0000
OG*TS	15.92381	13.20874	1.205551	0.2304
OG*INFEXP*TS	-880.1812	317.8163	-2.769465	0.0065

R-squared	0.805614	Mean dependent var	0.061105
Adjusted R-squared	0.800754	S.D. dependent var	0.014632
S.E. of regression	0.006531	Akaike info criterion	-7.192706
Sum squared resid	0.005119	Schwarz criterion	-7.101730
Log likelihood	449.9478	Hannan-Quinn criter.	-7.155750
F-statistic	165.7762	Durbin-Watson stat	0.383022
Prob(F-statistic)	0.000000	Wald F-statistic	106.3070
Prob(Wald F-statistic)	0.000000		

Appendix 4.79: Normality test- Jarque-Bera



Series: Residuals
Sample 1985Q1 2015Q4
Observations 124

Mean	3.44e-18
Median	0.000191
Maximum	0.015884
Minimum	-0.013975
Std. Dev.	0.006334
Skewness	0.122653
Kurtosis	2.992583
Jarque-Bera	0.311189
Probability	0.855906

Appendix 4.80: Model Specification: Ramsey RESET Test for Model 1

Ramsey RESET Test
Equation: EQ_01
Specification: U C OG
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.490370	121	0.6248
F-statistic	0.240462	(1, 121)	0.6248
Likelihood ratio	0.246180	1	0.6198

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	1.17E-05	1	1.17E-05
Restricted SSR	0.005876	122	4.82E-05
Unrestricted SSR	0.005864	121	4.85E-05

LR test summary:

	Value	df
Restricted LogL	441.4000	122
Unrestricted LogL	441.5231	121

Unrestricted Test Equation:
Dependent Variable: U
Method: Least Squares
Date: 06/10/17 Time: 18:26
Sample: 1985Q1 2015Q4
Included observations: 124
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.046349	0.009912	4.675992	0.0000
OG	-0.624236	0.364528	-1.712450	0.0894

FITTED^2	1.389287	3.785505	0.367002	0.7143

R-squared	0.777322	Mean dependent var	0.061105
Adjusted R-squared	0.773641	S.D. dependent var	0.014632
S.E. of regression	0.006961	Akaike info criterion	-7.072953
Sum squared resid	0.005864	Schwarz criterion	-7.004720
Log likelihood	441.5231	Hannan-Quinn criter.	-7.045235
F-statistic	211.1924	Durbin-Watson stat	0.251669
Prob(F-statistic)	0.000000	Wald F-statistic	65.56533
Prob(Wald F-statistic)	0.000000		

Appendix 4.81: Model Specification: Ramsey RESET Test for Model 2

Ramsey RESET Test
Equation: EQ_02
Specification: U C OG OG*DUM90
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	1.335459	120	0.1843
F-statistic	1.783450	(1, 120)	0.1843
Likelihood ratio	1.829338	1	0.1762

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	7.56E-05	1	7.56E-05
Restricted SSR	0.005159	121	4.26E-05
Unrestricted SSR	0.005083	120	4.24E-05

LR test summary:

	Value	df
Restricted LogL	449.4641	121
Unrestricted LogL	450.3788	120

Unrestricted Test Equation:
Dependent Variable: U
Method: Least Squares
Date: 06/10/17 Time: 20:14
Sample: 1985Q1 2015Q4
Included observations: 124
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.040461	0.009577	4.224690	0.0000
OG	-0.794896	0.642631	-1.236940	0.2185
OG*DUM90	0.377130	0.342087	1.102440	0.2725
FITTED^2	3.553983	3.859990	0.920723	0.3590

R-squared	0.806961	Mean dependent var	0.061105
Adjusted R-squared	0.802135	S.D. dependent var	0.014632
S.E. of regression	0.006509	Akaike info criterion	-7.199658
Sum squared resid	0.005083	Schwarz criterion	-7.108681
Log likelihood	450.3788	Hannan-Quinn criter.	-7.162701

F-statistic	167.2116	Durbin-Watson stat	0.347722
Prob(F-statistic)	0.000000	Wald F-statistic	50.56402
Prob(Wald F-statistic)	0.000000		

Appendix 4.82: Model Specification: Ramsey RESET Test for Model 3

Ramsey RESET Test
Equation: EQ_03
Specification: U C OG OG*DUM20
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.550576	120	0.5829
F-statistic	0.303134	(1, 120)	0.5829
Likelihood ratio	0.312843	1	0.5759

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	1.48E-05	1	1.48E-05
Restricted SSR	0.005876	121	4.86E-05
Unrestricted SSR	0.005861	120	4.88E-05

LR test summary:

	Value	df
Restricted LogL	441.4007	121
Unrestricted LogL	441.5571	120

Unrestricted Test Equation:
Dependent Variable: U
Method: Least Squares
Date: 06/10/17 Time: 20:15
Sample: 1985Q1 2015Q4
Included observations: 124
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.045485	0.012339	3.686463	0.0003
OG	-0.605843	0.408926	-1.481546	0.1411
OG*DUM20	0.018687	0.153232	0.121951	0.9031
FITTED^2	1.729475	4.777093	0.362035	0.7180

R-squared	0.777444	Mean dependent var	0.061105
Adjusted R-squared	0.771880	S.D. dependent var	0.014632
S.E. of regression	0.006989	Akaike info criterion	-7.057373
Sum squared resid	0.005861	Schwarz criterion	-6.966396
Log likelihood	441.5571	Hannan-Quinn criter.	-7.020416
F-statistic	139.7300	Durbin-Watson stat	0.254038
Prob(F-statistic)	0.000000	Wald F-statistic	48.94501
Prob(Wald F-statistic)	0.000000		

Appendix 4.83: Model Specification: Ramsey RESET Test for Model 4

Ramsey RESET Test
Equation: EQ_04
Specification: U C OG GDS INFEXP LNRB
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	1.898472	118	0.0601
F-statistic	3.604196	(1, 118)	0.0601
Likelihood ratio	3.730769	1	0.0534

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.000149	1	0.000149
Restricted SSR	0.005019	119	4.22E-05
Unrestricted SSR	0.004871	118	4.13E-05

LR test summary:

	Value	df
Restricted LogL	451.1634	119
Unrestricted LogL	453.0288	118

Unrestricted Test Equation:
Dependent Variable: U
Method: Least Squares
Date: 08/24/17 Time: 23:16
Sample: 1985Q1 2015Q4
Included observations: 124
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.035323	0.009930	3.557090	0.0005
OG	-0.217483	0.300270	-0.724294	0.4703
GDS	0.024978	0.035284	0.707899	0.4804
INFEXP	0.094314	0.137047	0.688188	0.4927
LNRB	0.000647	0.001345	0.480797	0.6316
FITTED^2	5.618707	3.722026	1.509583	0.1338

R-squared	0.815038	Mean dependent var	0.061105
Adjusted R-squared	0.807200	S.D. dependent var	0.014632
S.E. of regression	0.006425	Akaike info criterion	-7.210142
Sum squared resid	0.004871	Schwarz criterion	-7.073677
Log likelihood	453.0288	Hannan-Quinn criter.	-7.154707
F-statistic	103.9936	Durbin-Watson stat	0.308945
Prob(F-statistic)	0.000000	Wald F-statistic	42.68686
Prob(Wald F-statistic)	0.000000		

Appendix 4.84: Model Specification: Ramsey RESET Test for Model 5

Ramsey RESET Test
Equation: EQ_05
Specification: U C OG GDS INFEXP TS
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	2.040749	118	0.0435
F-statistic	4.164655	(1, 118)	0.0435
Likelihood ratio	4.300958	1	0.0381

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.000189	1	0.000189
Restricted SSR	0.005547	119	4.66E-05
Unrestricted SSR	0.005358	118	4.54E-05

LR test summary:

	Value	df
Restricted LogL	444.9695	119
Unrestricted LogL	447.1200	118

Unrestricted Test Equation:
Dependent Variable: U
Method: Least Squares
Date: 08/24/17 Time: 23:19
Sample: 1985Q1 2015Q4
Included observations: 124

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.031360	0.005829	5.380030	0.0000
OG	-0.073651	0.308028	-0.239106	0.8114
GDS	0.014682	0.019567	0.750344	0.4545
INFEXP	0.113608	0.144800	0.784584	0.4343
TS	0.154486	0.125413	1.231822	0.2205
FITTED^2	6.708616	3.287331	2.040749	0.0435

R-squared	0.796543	Mean dependent var	0.061105
Adjusted R-squared	0.787922	S.D. dependent var	0.014632
S.E. of regression	0.006738	Akaike info criterion	-7.114838
Sum squared resid	0.005358	Schwarz criterion	-6.978373
Log likelihood	447.1200	Hannan-Quinn criter.	-7.059403
F-statistic	92.39491	Durbin-Watson stat	0.271422
Prob(F-statistic)	0.000000		

Appendix 4.85: Model Specification: Ramsey RESET Test for Model 6

Ramsey RESET Test
Equation: EQ_06
Specification: U C OG OG*DUMFC
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	2.720587	120	0.0075
F-statistic	7.401591	(1, 120)	0.0075
Likelihood ratio	7.421709	1	0.0064

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.000292	1	0.000292
Restricted SSR	0.005030	121	4.16E-05
Unrestricted SSR	0.004738	120	3.95E-05

LR test summary:

	Value	df
Restricted LogL	451.0340	121
Unrestricted LogL	454.7449	120

Unrestricted Test Equation:
Dependent Variable: U
Method: Least Squares
Date: 08/24/17 Time: 23:21
Sample: 1985Q1 2015Q4
Included observations: 124
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.031760	0.007883	4.028872	0.0001
OG	-0.063667	0.319671	-0.199165	0.8425
OG*DUMFC	0.031672	0.122025	0.259555	0.7957
FITTED^2	7.296315	2.958012	2.466628	0.0151

R-squared	0.820087	Mean dependent var	0.061105
Adjusted R-squared	0.815589	S.D. dependent var	0.014632
S.E. of regression	0.006283	Akaike info criterion	-7.270079
Sum squared resid	0.004738	Schwarz criterion	-7.179102
Log likelihood	454.7449	Hannan-Quinn criter.	-7.233122
F-statistic	182.3297	Durbin-Watson stat	0.365741
Prob(F-statistic)	0.000000	Wald F-statistic	107.3971
Prob(Wald F-statistic)	0.000000		

Appendix 4.86: Model Specification: Ramsey RESET Test for Model 7

Ramsey RESET Test
Equation: EQ_07
Specification: U C OG LNRB OG*LNRB
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	3.099297	119	0.0024
F-statistic	9.605640	(1, 119)	0.0024
Likelihood ratio	9.625769	1	0.0019

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.000368	1	0.000368
Restricted SSR	0.004931	120	4.11E-05
Unrestricted SSR	0.004563	119	3.83E-05

LR test summary:

	Value	df
Restricted LogL	452.2668	120
Unrestricted LogL	457.0797	119

Unrestricted Test Equation:
Dependent Variable: U
Method: Least Squares
Date: 06/10/17 Time: 20:20
Sample: 1985Q1 2015Q4
Included observations: 124
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.096478	0.020644	4.673383	0.0000
OG	-0.986093	0.243395	-4.051406	0.0001
LNRB	-0.001464	0.001212	-1.207584	0.2296
OG*LNRB	-0.286310	0.109015	-2.626336	0.0098
FITTED^2	-17.14083	7.227201	-2.371711	0.0193

R-squared	0.826736	Mean dependent var	0.061105
Adjusted R-squared	0.820912	S.D. dependent var	0.014632
S.E. of regression	0.006192	Akaike info criterion	-7.291607
Sum squared resid	0.004563	Schwarz criterion	-7.177886
Log likelihood	457.0797	Hannan-Quinn criter.	-7.245411
F-statistic	141.9535	Durbin-Watson stat	0.325923
Prob(F-statistic)	0.000000	Wald F-statistic	70.57927
Prob(Wald F-statistic)	0.000000		

Appendix 4.87: Model Specification: Ramsey RESET Test for Model 8

Ramsey RESET Test
Equation: EQ_08
Specification: U C OG TS OG*TS
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.822586	119	0.4124
F-statistic	0.676648	(1, 119)	0.4124
Likelihood ratio	0.703082	1	0.4018

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	3.18E-05	1	3.18E-05
Restricted SSR	0.005629	120	4.69E-05
Unrestricted SSR	0.005597	119	4.70E-05

LR test summary:

	Value	df
Restricted LogL	444.0626	120
Unrestricted LogL	444.4141	119

Unrestricted Test Equation:
Dependent Variable: U
Method: Least Squares
Date: 06/19/17 Time: 19:31
Sample: 1985Q1 2015Q4
Included observations: 124
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.062842	0.025038	2.509874	0.0134
OG	-0.867571	0.568809	-1.525240	0.1299
TS	-0.028969	0.219976	-0.131691	0.8955
OG*TS	-22.56651	28.39781	-0.794657	0.4284
FITTED^2	-5.385373	10.09549	-0.533443	0.5947

R-squared	0.787467	Mean dependent var	0.061105
Adjusted R-squared	0.780323	S.D. dependent var	0.014632
S.E. of regression	0.006858	Akaike info criterion	-7.087324
Sum squared resid	0.005597	Schwarz criterion	-6.973603
Log likelihood	444.4141	Hannan-Quinn criter.	-7.041128
F-statistic	110.2281	Durbin-Watson stat	0.234464
Prob(F-statistic)	0.000000	Wald F-statistic	58.00051
Prob(Wald F-statistic)	0.000000		

Appendix 4.88: Model Specification: Ramsey RESET Test for Model 9

Ramsey RESET Test
Equation: EQ_09
Specification: U C OG OG*DUMFC OG*DUMFC*LNRB
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	2.121634	119	0.0359
F-statistic	4.501332	(1, 119)	0.0359
Likelihood ratio	4.603927	1	0.0319

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.000174	1	0.000174
Restricted SSR	0.004772	120	3.98E-05
Unrestricted SSR	0.004598	119	3.86E-05

LR test summary:

	Value	df
Restricted LogL	454.3034	120
Unrestricted LogL	456.6053	119

Unrestricted Test Equation:
Dependent Variable: U
Method: Least Squares
Date: 06/19/17 Time: 19:33
Sample: 1985Q1 2015Q4
Included observations: 124
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.035039	0.008580	4.083835	0.0001
OG	-0.206445	0.337861	-0.611037	0.5423
OG*DUMFC	0.069297	0.390610	0.177408	0.8595
OG*DUMFC*LNRB	0.003284	0.051261	0.064072	0.9490
FITTED^2	5.952169	3.205640	1.856780	0.0658

R-squared	0.825406	Mean dependent var	0.061105
Adjusted R-squared	0.819537	S.D. dependent var	0.014632
S.E. of regression	0.006216	Akaike info criterion	-7.283957
Sum squared resid	0.004598	Schwarz criterion	-7.170236
Log likelihood	456.6053	Hannan-Quinn criter.	-7.237761
F-statistic	140.6448	Durbin-Watson stat	0.396869
Prob(F-statistic)	0.000000	Wald F-statistic	150.2100
Prob(Wald F-statistic)	0.000000		

Appendix 4.89: Model Specification: Ramsey RESET Test for Model 10

Ramsey RESET Test
Equation: EQ_10
Specification: U C OG OG*DUMFC OG*DUMFC*TS
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	2.364448	119	0.0197
F-statistic	5.590614	(1, 119)	0.0197
Likelihood ratio	5.692813	1	0.0170

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.000217	1	0.000217
Restricted SSR	0.004831	120	4.03E-05
Unrestricted SSR	0.004614	119	3.88E-05

LR test summary:

	Value	df
Restricted LogL	453.5422	120
Unrestricted LogL	456.3886	119

Unrestricted Test Equation:
Dependent Variable: U
Method: Least Squares
Date: 06/19/17 Time: 19:33
Sample: 1985Q1 2015Q4
Included observations: 124
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.033590	0.008536	3.935028	0.0001
OG	-0.144501	0.339985	-0.425022	0.6716
OG*DUMFC	-0.010919	0.368775	-0.029610	0.9764
OG*DUMFC*TS	4.072904	13.70720	0.297136	0.7669
FITTED^2	6.540115	3.194482	2.047317	0.0428

R-squared	0.824794	Mean dependent var	0.061105
Adjusted R-squared	0.818905	S.D. dependent var	0.014632
S.E. of regression	0.006227	Akaike info criterion	-7.280461
Sum squared resid	0.004614	Schwarz criterion	-7.166740
Log likelihood	456.3886	Hannan-Quinn criter.	-7.234265
F-statistic	140.0502	Durbin-Watson stat	0.354627
Prob(F-statistic)	0.000000	Wald F-statistic	200.3382
Prob(Wald F-statistic)	0.000000		

Appendix 4.90: Model Specification: Ramsey RESET Test for Model 11

Ramsey RESET Test
Equation: EQ_11
Specification: U C OG OG*LNRB OG*GDS*LNRB
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	2.170787	119	0.0319
F-statistic	4.712318	(1, 119)	0.0319
Likelihood ratio	4.815584	1	0.0282

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.000186	1	0.000186
Restricted SSR	0.004877	120	4.06E-05
Unrestricted SSR	0.004691	119	3.94E-05

LR test summary:

	Value	df
Restricted LogL	452.9549	120
Unrestricted LogL	455.3627	119

Unrestricted Test Equation:
Dependent Variable: U
Method: Least Squares
Date: 06/19/17 Time: 19:41
Sample: 1985Q1 2015Q4
Included observations: 124
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.080058	0.020357	3.932642	0.0001
OG	-0.862823	0.392343	-2.199156	0.0298
OG*LNRB	-0.223752	0.131068	-1.707153	0.0904
OG*GDS*LNRB	-0.086458	0.305340	-0.283153	0.7776
FITTED^2	-12.21693	8.093861	-1.509407	0.1338

R-squared	0.821871	Mean dependent var	0.061105
Adjusted R-squared	0.815883	S.D. dependent var	0.014632
S.E. of regression	0.006278	Akaike info criterion	-7.263914
Sum squared resid	0.004691	Schwarz criterion	-7.150193
Log likelihood	455.3627	Hannan-Quinn criter.	-7.217718
F-statistic	137.2637	Durbin-Watson stat	0.241682
Prob(F-statistic)	0.000000	Wald F-statistic	74.16330
Prob(Wald F-statistic)	0.000000		

Appendix 4.91: Model Specification: Ramsey RESET Test for Model 12

Ramsey RESET Test
Equation: EQ_12
Specification: U C OG OG*TS OG*GDS*TS
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	3.360967	119	0.0010
F-statistic	11.29610	(1, 119)	0.0010
Likelihood ratio	11.24507	1	0.0008

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.000464	1	0.000464
Restricted SSR	0.005353	120	4.46E-05
Unrestricted SSR	0.004889	119	4.11E-05

LR test summary:

	Value	df
Restricted LogL	447.1717	120
Unrestricted LogL	452.7942	119

Unrestricted Test Equation:
Dependent Variable: U
Method: Least Squares
Date: 06/19/17 Time: 19:42
Sample: 1985Q1 2015Q4
Included observations: 124
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.086482	0.013173	6.565024	0.0000
OG	-1.693111	0.404266	-4.188114	0.0001
OG*TS	59.79547	29.08313	2.056019	0.0420
OG*GDS*TS	313.2027	113.4693	2.760242	0.0067
FITTED^2	-14.13062	5.098250	-2.771661	0.0065

R-squared	0.814337	Mean dependent var	0.061105
Adjusted R-squared	0.808096	S.D. dependent var	0.014632
S.E. of regression	0.006410	Akaike info criterion	-7.222488
Sum squared resid	0.004889	Schwarz criterion	-7.108767
Log likelihood	452.7942	Hannan-Quinn criter.	-7.176291
F-statistic	130.4862	Durbin-Watson stat	0.254027
Prob(F-statistic)	0.000000	Wald F-statistic	100.5846
Prob(Wald F-statistic)	0.000000		

Appendix 4.92: Model Specification: Ramsey RESET Test for Model 13

Ramsey RESET Test
Equation: EQ_13
Specification: U C OG OG*LNRB OG*INFEXP*LNRB
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	1.161401	119	0.2478
F-statistic	1.348853	(1, 119)	0.2478
Likelihood ratio	1.397621	1	0.2371

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	5.26E-05	1	5.26E-05
Restricted SSR	0.004692	120	3.91E-05
Unrestricted SSR	0.004639	119	3.90E-05

LR test summary:

	Value	df
Restricted LogL	455.3521	120
Unrestricted LogL	456.0509	119

Unrestricted Test Equation:
Dependent Variable: U
Method: Least Squares
Date: 06/19/17 Time: 19:42
Sample: 1985Q1 2015Q4
Included observations: 124
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.059669	0.013361	4.465914	0.0000
OG	-0.609795	0.205095	-2.973236	0.0036
OG*LNRB	-0.003667	0.046324	-0.079151	0.9370
OG*INFEXP*LNRB	-3.248071	1.675578	-1.938477	0.0549
FITTED^2	-4.006376	5.276467	-0.759291	0.4492

R-squared	0.823837	Mean dependent var	0.061105
Adjusted R-squared	0.817916	S.D. dependent var	0.014632
S.E. of regression	0.006244	Akaike info criterion	-7.275015
Sum squared resid	0.004639	Schwarz criterion	-7.161294
Log likelihood	456.0509	Hannan-Quinn criter.	-7.228819
F-statistic	139.1280	Durbin-Watson stat	0.307434
Prob(F-statistic)	0.000000	Wald F-statistic	99.64008
Prob(Wald F-statistic)	0.000000		

Appendix 4.93: Model Specification: Ramsey RESET Test for Model 14

Ramsey RESET Test
Equation: EQ_14
Specification: U C OG OG*TS OG*INFEXP*TS
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.608692	119	0.5439
F-statistic	0.370506	(1, 119)	0.5439
Likelihood ratio	0.385474	1	0.5347

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	1.59E-05	1	1.59E-05
Restricted SSR	0.005119	120	4.27E-05
Unrestricted SSR	0.005103	119	4.29E-05

LR test summary:

	Value	df
Restricted LogL	449.9478	120
Unrestricted LogL	450.1405	119

Unrestricted Test Equation:
Dependent Variable: U
Method: Least Squares
Date: 06/19/17 Time: 19:42
Sample: 1985Q1 2015Q4
Included observations: 124
HAC standard errors & covariance (Bartlett kernel, Newey-West fixed bandwidth = 5.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.055398	0.014496	3.821535	0.0002
OG	-0.705550	0.316396	-2.229961	0.0276
OG*TS	19.18266	10.45712	1.834412	0.0691
OG*INFEXP*TS	-1194.999	626.4782	-1.907487	0.0589
FITTED^2	-2.450850	5.985631	-0.409456	0.6829

R-squared	0.806217	Mean dependent var	0.061105
Adjusted R-squared	0.799704	S.D. dependent var	0.014632
S.E. of regression	0.006548	Akaike info criterion	-7.179686
Sum squared resid	0.005103	Schwarz criterion	-7.065965
Log likelihood	450.1405	Hannan-Quinn criter.	-7.133490
F-statistic	123.7726	Durbin-Watson stat	0.372330
Prob(F-statistic)	0.000000	Wald F-statistic	82.28192
Prob(Wald F-statistic)	0.000000		