THE CHANGES OF HOUSING PRICE AND ITS RELATIONSHIP WITH THE MACROECONOMIC FACTORS IN THE UNITED STATES

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DECLARATION

We hereby declare that:

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

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

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

(4) The word count of this research report is 12,384 words.

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DEDICATION

We would like to dedicate this final year project to:

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Our supervisor who has provided us with useful guidance, valuable supports, constructive feedbacks and precious encouragement to us.

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LIST OF ABBREVIATIONS

ARCH	Autoregressive Conditional Heteroscedasticity
CPI	Consumer Price Index
DOL	United States Department of Labor
FHFA	Federal Housing Finance Agency
GDP	Gross Domestic Product
HPI	Housing Price Index
MSA	Metropolitan Statistical Area
OECD	Organisation for Economic Co-operation and Development
OFHEO	Office of Federal Housing Enterprise Oversight
OLS	Ordinary Least Squares
OPAC	Online Public Access Catalogue
RGDP	Real Gross Domestic Product
RINR	Real Interest Rate
SSRN	Social Science Research Network
UE	Unemployment Rate
UTAR	Universiti Tunku Abdul Rahman

PREFACE

The United States is one of the world largest economies and also one of the most influential countries. As such, it plays an important role in leading other countries. The housing prices in the United States have undergone a series of ups and downs over the years and previous studies found that there are actually many factors that cause such fluctuations in the country. Thus, it has intrigued the researchers to carry out further research on this area.

In this research, the researchers will examine the relationship between the fluctuation of housing price in the United States and the macroeconomic variables, which are namely Real Gross Domestic Product, Real Interest Rate and the Unemployment Rate. The researchers expect these variables to have a significant relationship with the housing price.

As housing prices may be a concern to several parties like the investors, government and policymakers, this research may provide a better understanding for its readers about the connection between these macroeconomic variables and the housing price in the United States in order for them to make optimal decisions.

ABSTRACT

This paper examines the relationship between the changes of housing price and the macroeconomic factors in the United States from 1999 to 2013 which consist of quarterly data of 60 observations. This paper uses the Ordinary Least Square (OLS) method to capture the effect of independent variables, which are the Real Gross Domestic Product, the Real Interest Rate and the Unemployment Rate on the dependent variable, which is the Housing Price. The data of the variables in this study are obtained through secondary sources. A time-series analysis is conducted to acquire the results. The results obtained found that the Real Gross Domestic Product, the Real Interest Rate and the Unemployment Rate display strong correlation with the Housing Price. The Real Gross Domestic Product and the Real Interest Rate showed positive relationships with the Housing Price. On the other hand, the Unemployment Rate showed a negative relationship with the Housing Price.

CHAPTER 1: RESEARCH OVERVIEW

1.0 Introduction

This study aims to examine the relationship between the fluctuations of housing price in the United States and its macroeconomic variables. The macroeconomic variables included in this study are Real Gross Domestic Product (RGDP), Real Interest Rate (RINR) and Unemployment Rate (UE). This chapter is comprised of the research background, problem statement, objectives, research questions, hypotheses, significance of the study and followed by the chapter layout.

1.1 Research Background

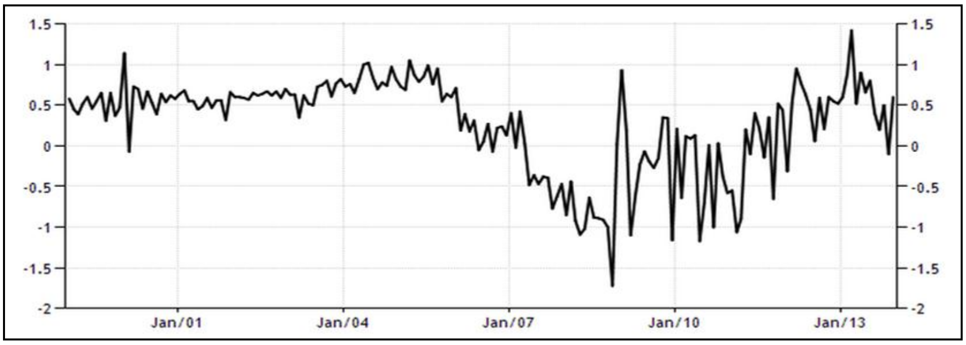
A house is an important and necessary asset which allows the user to live and work in a protected environment. It acts as a living space for the accommodation of people and is essential for their long-term physical well-being. Houses not only function as places for shelter and protection, they can also be used for the purpose of investment. Hence, this phenomenon led to the creation of the housing market (Chohan, Che-Ani, Abdullah, Tawil, & Kamaruzzaman, 2011). The market for homes has expanded rapidly in the United States since the 2000s and peaked just before the financial crisis of 2007-2008 (Goswami, Tan, & Waisman, 2014). According to Guirguis, Giannikos and Anderson (2005), the housing market has a significant effect on the global economy. Consequently, it is the reason why investors and policymakers usually monitor the prices of homes in the housing market in order to see structural changes and economic fluctuations.

The occurrence of the global financial and economic crisis which originated in the United States in mid-2007 has greatly affected the housing market and stock market (Schneider & Kirchgassner, 2009). During this event of uncertainty, households tend to feel financial panic and such situations will lead to the fluctuations in the housing market as well as the labor market. Furthermore, investors have an opportunity to speculate in an attempt to earn more money. As such, the United States government plays an important role by changing the existing economic regulations and policies to control the economic situation so that the housing market performance will return back to a level of economic stability.

Generally, the performance of the housing price is significant to the country (Guirguis, Giannikos & Anderson, 2005). This is because it will not only affect the citizens of the country, but it will affect the economy of the country as well. Thus, this study aims to look into the changes of housing price in the United States and the macroeconomic variables, which are RGDP, RINR and UE.

1.1.1 Trend of Housing Price in the United States

Figure 1.1: United States FHFA Housing Price Index from year 1999-2013



Adapted from: Federal Housing Finance Agency (2014). *Housing price index statistic.*

Over the course of the 21st century, housing prices in the United States have been going through ups and downs. It begins from its steady increase in the early 2000s, to the dramatic collapse in 2007 that caused the worst financial crisis since the Great Depression and subsequently led to a global recession (Crotty, 2009). According to the statistic done by the Federal

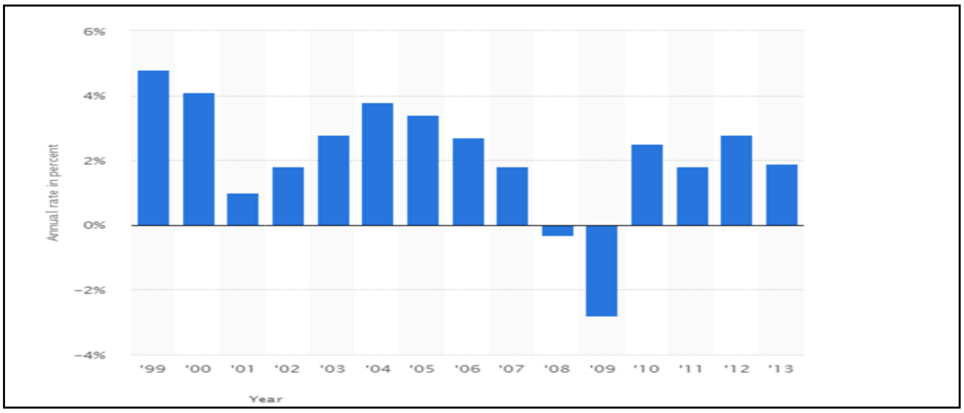
Housing Finance Agency (FHFA), the housing price in the United States increased steadily from the year 1999 to 2006 and it then started to drop gradually until the year 2009 and rose back sharply after that.

During the middle of the first decade, there was an occurrence of a housing price shock. Specifically, during financial crisis in 2007 and 2008, the housing prices in the United States were in drastic decline. This adverse situation was primarily due to the occurrence of a housing bubble phenomenon right before the financial meltdown in 2007 (Helleiner, 2011).

This trend of housing price volatility has led to investor uncertainty regarding the future of the United States' housing prices (Guo, 2010). Due to the inherent volatility of the housing market, it is a challenge to accurately measure or forecast housing prices. This was true when declining US housing prices led to the increase in default levels, primarily among the less creditworthy debtors (Reinhart & Rogoff, 2008). As a result, this has led many of the researchers attempt to examine the variation of house prices in the United States from 2000 until 2009 and look for the deciding macroeconomic factors that influenced this fluctuation in prices in order to gain a better understanding regarding this subject.

1.1.2 Trend of Real Gross Domestic Product in the United States

Figure 1.2: United States Real Gross Domestic Product from year 1999-2013



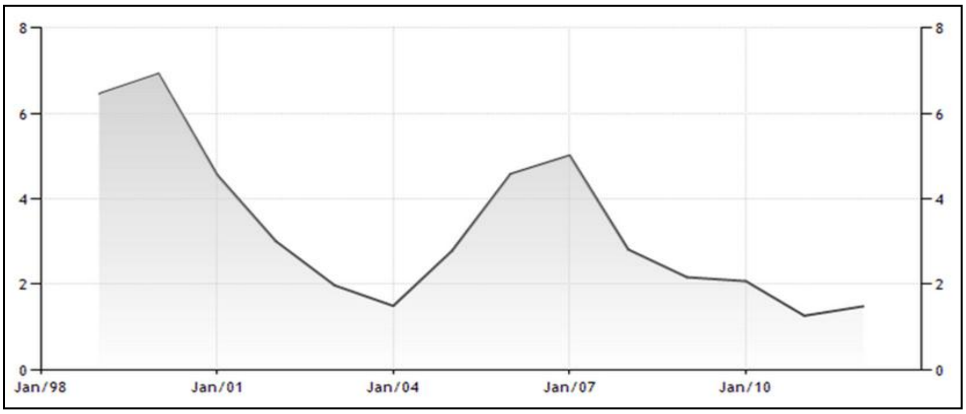
Adapted from: Federal Housing Finance Agency (2014). *Real gross domestic product statistic.*

According to the statistic done by the FHFA, the growth in RGDP in the United States increased steadily from the year 2001 to 2004 and it started to drop gradually until the year 2007. In 2008 and 2009, the United States suffered its first negative growth in RGDP of the 21st century but rose back sharply after that. Figure 1.2 shows that the United States achieved its highest RGDP in 1999 and the lowest point in 2009.

According to Gallagher and Buchanan (2012), the growth of RGDP in the United States caused the housing market boom in the United States economy. Nevertheless, this housing market growth could not keep up with the growth of RGDP. This phenomenon led to the start of falling house prices in middle of 2006. As the decline of house prices accelerated in 2008, the housing market collapsed and the United States economy stagnated.

1.1.3 Trend of Real Interest Rate in the United States

Figure 1.3: United States Real Interest Rate from year 1999-2013

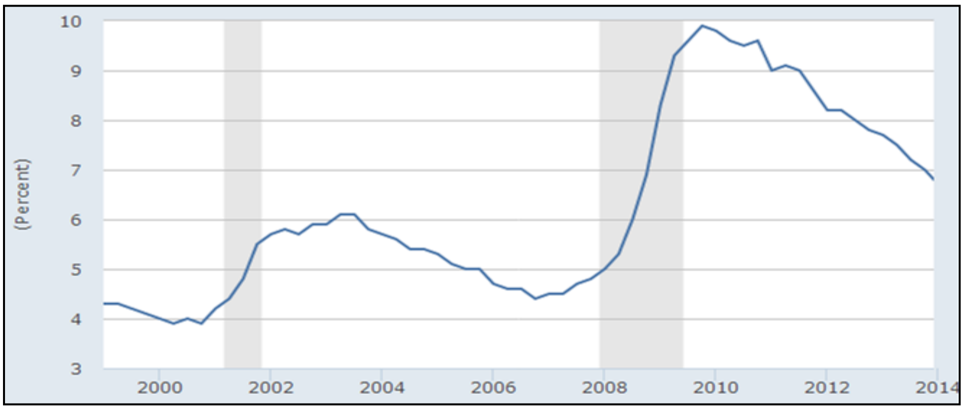


Adapted from: Federal Housing Finance Agency (2014). *Real interest rate statistic.*

According to the statistic done by the FHFA, RINR in the United States decreased drastically from the year 2000 to 2004 and it started to rise until the year 2007 while dropping gradually after that. Figure 1.3 shows the highest RINR in the United States was in 2000 and it reached its lowest point in 2011. Poole and Wheelock (2008) and Drakopoulos (2011) stated that the government's monetary policy of RINR in 2004 was aimed at increasing the employment rate. Mayer-Foulkes (2010) indicated that RINR was one of the deciding factors that sparked the housing crisis as when RINR is low, it will lead to the occurrence of housing crisis.

1.1.4 Trend of Unemployment Rate in the United States

Figure 1.4: United States Unemployment Rate from year 1999-2013



Adapted from: United States Department of Labor (2014). *Unemployment rate statistic.*

According to the statistic done by the United States Department of Labor (DOL), the UE in the United States increased steadily from the year 2007 to 2010 and dropped gradually after that. Figure 1.4 shows that the UE in the United States has increased over the years since 1999. The country experienced a peak of unemployment during the year 2010. The high UE was due to the high amount of low-skill workers that have relatively low graduation rates (Gautier, 2002).

1.2 Problem Statement

The housing prices in the United States have undergone a series of dramatic fluctuations in the 2000s, which ultimately led to the worst housing crisis of the century. From 2006 until 2011, the United States housing market collapsed due to the great recession. This volatility in the housing market has gained significant media attention as the United States housing market experienced explosive growth from 2001 until 2006, and crashed dramatically shortly afterwards (Demyanyk & Van Hemert, 2011). It has also badly affected the German and Japan labor market

(Rinne & Zimmermann, 2012). For instance, Rinne and Zimmermann (2012) discovered that Germany's GDP declined by 4.7% in the year 2009 compared to the year 2008.

Previous researchers such as Wheeler and Chowdhury (1993) and Rahman and Mustafa (1997) had not conducted studies on the United States housing market during the period of economic recession. Regarding the impact on the United States housing prices, some researchers focused on other determinants such as the role of people's expectations (Huang, 2013), and the asymmetric wealth effect (Tsai, Lee, & Chiang, 2012). Nevertheless, the rise, fall and subsequent recovery of the housing market have intrigued the researchers to attempt to gain a better understanding about it. The variability of the United States housing prices is influenced by a number of possible factors that this study will look into.

However, to obtain a broad understanding about the housing prices and how they are affected, this study focuses on the macroeconomic aspect of this situation, namely the RGDP (Valadez, 2010), RINR (Hubbard & Mayer, 2009), and UE (Vermeulen & Ommeren, 2009). Consequently, this study is an in-depth analysis of these factors in order to investigate the extent of the relationship between the RGDP, RINR, UE, and the housing prices in the United States. By determining the type of relationship between these macroeconomic factors and the United States housing price, the researchers will be able to deduce how these elements correlate with the United States housing market.

1.3 Objectives of the Study

1.3.1 General Objective

The general purpose of this study is to examine the connection between the macroeconomic factors and the fluctuation of housing prices in the United States.

1.3.2 Specific Objectives

In order to clarify the general objective, the specific objectives are as follows:

(i) To identify the relationship between the real gross domestic product and the housing price in the United States.
(ii) To identify the relationship between the real interest rate and the housing price in the United States.
(iii) To identify the relationship between the unemployment rate and the housing price in the United States.

1.4 Research Questions

From the above problem statement and objectives of the study, the following research questions are proposed:

(i) Is there a significant relationship between the real gross domestic product and the housing price in the United States?

(ii) Is there a significant relationship between the real interest rate and the housing price in the United States?

(iii) Is there a significant relationship between the unemployment rate and the housing price in the United States?

1.5 Hypotheses of the Study

In this study, there are three hypotheses to examine the relationship between the macroeconomic factors and the housing price in the United States.

1.5.1 Real Gross Domestic Product (RGDP)

According to Baker (2008), and Mahalik and Mallick (2011), the empirical results show that RGDP has a positive relationship with housing price. Hence, this hypothesis is established to examine the relationship between RGDP and the housing price in order to test whether RGDP significantly correlates with the housing price in the United States.

H_0 : There is no relationship between the Real Gross Domestic Product and the Housing Price in the United States.

H_1 : There is a significant relationship between the Real Gross Domestic Product and the Housing Price in the United States.

1.5.2 Real Interest Rate (RINR)

Based on the findings obtained by Hubbard and Mayer (2009), and Levin and Pryce (2009), RINR has a negative relationship with housing price. Therefore, this hypothesis is established to examine the connection between housing price and RINR in order to identify whether the housing price correlates significantly with the RINR in the United States.

H_0 : There is no relationship between the Real Interest Rate and the Housing Price in the United States.

H_1 : There is a significant relationship between the Real Interest Rate and the Housing Price in the United States.

1.5.3 Unemployment Rate (UE)

According to Abelson, Joyeux, Milunovich, and Chung (2005) and Lee (2009), the empirical results indicated that UE is negatively correlated with housing price. Hence, this hypothesis is established to examine the connection between the UE and housing price in order to test whether unemployment rate has a significant correlation with the housing price in the United States.

H_0 : There is no relationship between the Unemployment Rate and the Housing Price in the United States.

H_1 : There is a significant relationship between the Unemployment Rate and the Housing Price in the United States.

1.6 Significance of the Study

The importance of the macroeconomic conditions on the housing market has been a subject of discussion recently. The advent of research presented by Leung (2004) on the review of macroeconomics and housing has called for further research on this subject. The researcher places emphasis on the relationship between the housing market and the macroeconomic factors because housing constitutes a large portion of the overall macroeconomy. Consequently, this study focuses on the empirical analysis on the RGDP, RINR, and UE in order to determine the relationship between these factors and the United States housing prices.

Investors and potential house purchasers may use the results obtained from this study to assist them in buying a house. They may analyze certain aspects of this study, for instance the relationship between RINR and housing prices, to determine the optimal time to be involved in the housing market. The decision to invest in the housing market is a major decision due to the huge investment cost and the potential of a substantial loss. Thus, an approach to determine housing valuation is important (Guo, 2010).

The government and policymakers should also take into account the relationship between these macroeconomic factors and the housing market. This is because a significant fluctuation in housing prices would imply similarly significant fluctuation in consumer wealth and the effects that consequently follow it. Therefore, it is important to understand the consumers’ consumption decisions that are affected by these fluctuations (Campbell & Cocco, 2007). Furthermore, Vermeulen and Ommeren (2009) interpreted their findings to suggest that local labor market conditions and house prices have a strong negative correlation in the European Union. This study is conducted using data from the United States housing market to find out whether they have similar results.

Prior researchers have conducted an extensive study on these macroeconomic factors separately and how a singular variable correlates with housing prices. On the other hand, this study also attempts to combine these factors in order to find out the overall correlation of these factors with the United States housing prices.

1.7 Chapter Layout

1.7.1 Chapter 1

Chapter 1 covers an overview of the research background and the research problem. Apart from that, this chapter also mentions about the research objectives, hypotheses, research questions, and the significance of the study. Lastly, this chapter will be concluded with a brief summary of this study.

1.7.2 Chapter 2

Chapter 2 provides the review of literature in this study. The review of literature presents clear and relevant theoretical models or conceptual framework, proposed theoretical or conceptual framework, hypotheses development, and concludes with a summary of the literature review.

1.7.3 Chapter 3

Chapter 3 depicts the overview of methodology used in this study. For instance, this chapter explains how the study is carried out in terms of research design, data collection methods, sampling design, research instrument and method of data analysis, and concludes with a summary of the chapter.

1.7.4 Chapter 4

Chapter 4 presents the significance of independent variables, the statistical outcome of the model specification test, as well as the diagnostic checking results. Apart from that, some suggestions are given in solving the econometric problems found in this study. At last, this chapter will be concluded with a short summary of the chapter.

1.7.5 Chapter 5

Chapter 5 comes up with the summary of statistical analyses, followed by discussions of major findings, implications which form a linkage to the main study, limitations and recommendations for the future research. Before the end of this chapter, an overall conclusion is formed for the entire of the study which links with the research objectives.

1.8 Conclusion

The United States housing market is subject to numerous discussions and debates. The factors that influence the rise and fall of its prices are considered to be one of the most widely talked-about topics of this century. With the purpose of obtaining a deeper understanding on the roles of each macroeconomics variable (RGDP, RINR, and UE), this study keens to examine how these factors correlate with the United States housing price. By utilizing an empirical approach to this situation, the researchers are able to find out the relationship of these variables.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

There are various views and debates regarding the relationship between housing prices and macroeconomic variables such as RGDP, RINR, and UE. Therefore, the literature review will discuss about the relationship between the dependent variable (Housing Price) and independent variables (RGDP, RINR, and UE) in greater detail. Firstly, this chapter will review the literature and discuss the findings of past researchers. Following that, the relevant theoretical framework and model will be discussed and a new theoretical framework will be proposed. Consequently, three hypotheses will be developed about the relationship of the macroeconomic variables and the United States housing prices. Finally, the conclusion will outline a brief summary about this chapter.

2.1 Review of the Literature

2.1.1 Dependent Variable

2.1.1.1 Housing Price

Generally, the housing price is a key factor which indicates the overall health of the housing market. In order to measure the changes in price of housing, the Housing Price Index (HPI) is used. HPI is crucial for scholarly research that is aimed at obtaining an in-depth understanding of the housing market such as to study the determinants of housing prices (Bourassa, Hoesli, & Sun, 2004).

This study employs the FHFA HPI as main source of data. FHFA, previously known as the Office of Federal Housing Enterprise Oversight (OFHEO), provides a weighted index that captures repeat sales and the changes of the average price of properties in the United States on a quarterly basis. The use of FHFA HPI was also documented in the study conducted by Nanda and Pancak (2010), in tracking the changes in housing prices while monitoring economic activity.

2.1.2 Independent Variables

2.1.2.1 Real Gross Domestic Product (RGDP)

Gross Domestic Product (GDP) is the fair market value of a country's production of all final goods and services on annual basis, over a period of time. It is one of the major indicators for economists and policymakers to analyze the growth of the country's economy and its performance (Henderson, Storeyguard, & Weil, 2012). A high GDP in a country usually means that the country is currently experiencing economic growth, thus every country attempts to maximize the rate of growth of GDP (Divya & Devi, 2014). Typically, GDP can be divided into two types which are nominal GDP and real GDP.

According to Hashim (2010) and Pour, Khani, Zamanian, and Barghandan (2013), they state that housing market plays a significant role to affect the economic performance of a country. Based on the results obtained by Pour et al. (2013), it is found that GDP has a negative and significant effect on the housing price. This statement shows that when the particular country's economy growth increases, there is a larger supply of the house production and thus results in lower house prices. In other words, there is indication that there will be some fluctuations in the housing price when GDP is high (Pour et al., 2013).

However, the studies done by Valadez (2010) and Baker (2008) mentions that the RGDP is highly correlated with the housing price. Specifically, Baker (2008) discovers that RGDP implies a significant positive relationship with the housing price. When the United States suffered a fall in RGDP during the economic meltdown, it led to an increase in job uncertainty and thus resulted in decreased demand for houses, and consequently drove down the prices of houses (Baker, 2008). Also, Mahalik and Mallick (2011) found similar results to Baker (2008). Their findings show that RGDP positively and significantly influences housing price. The results show that when the RGDP increases, the housing price will increase as well. This phenomenon is due to an increase of the income of citizens. Consequently, this leads to an excessive demand of houses over the supply in the housing market. Hence, RGDP of a country is an important indicator in determining the changes of house prices.

2.1.2.2 Real Interest Rate (RINR)

In defining RINR, Ang, Bekaert, and Wei (2008), Neely and Rapach (2008), Shi, Jou, and Tripe (2014), and Everaert (2014) came up with different but related views or ideas. Neely and Rapach (2008), and Everaert (2014) defined the RINR as the interest rate adjusted for the existence of neither realized nor expected inflation. Similarly, Ang et al. (2008) and Shi et al. (2014)

defined RINR as nominal interest rates adjusted by the Consumer Price Index (CPI).

According to Lai (2008), the RINR generally plays an important role in affecting the investment decision. On the other hand, Arestis and Chortareas (2008), and Duan, Wei, and Chen (2014) indicate that the RINR is an important benchmark rate for economists. Further, Kose, Emirmahmutoglu, and Aksoy (2012) and Albert, Coti-Zelati, and Araujo (2014) reveal that a strong relationship exists between interest rate and inflation rate in the economy.

Based on Leung, Leong, and Wong (2006), they found that the effect of RINR on housing prices is complicated. The results indicate that RINR and the housing price have neither positive nor negative relationship. Furthermore, the results were found to be insignificant. In the perspective of the seller, when there is a rise in RINR, it means the opportunity cost of an existing offer has dropped, thus the seller tends to increase the price of the house. Hence, it implies that there is positive relationship between RINR and housing price. Meanwhile, in the perspective of the buyer, when the RINR increases, it tends to reduce the purchasing power of buyer, and this leads to the decrease in the housing price. As a result, this implies that the RINR has a negative influence on housing price.

On the other hand, Hubbard and Mayer (2009) and Levin and Pryce (2009) also provides the same empirical results which is negative and significant relationship between RINR and housing price. They stated that appreciation in RINR will cause the housing price to decrease, while on the contrary, depreciation in RINR will cause the housing price to increase in the economy.

However, Xu and Tang (2014) concluded that the RINR had a significant and positive relationship with the housing price. They used a cointegration test in their research and found that when RINR in the United Kingdom increased by 1%, on average, the housing price went up by 0.924%, ceteris paribus. They stated that the increase in housing price was due to the overheating of the economy. They explained that due to the situation of the economy, the government will reduce the amount of currency in circulation to prevent inflation. As a result, the RINR is raised. Shi et al. (2014) arrived with the same conclusion as their results indicated a significant and strong positive correlation between RINR and New Zealand housing prices at 1% significance level.

2.1.2.3 Unemployment Rate (UE)

Jerome and T (2011), and Khan, Shamshad, and Hassan (2012) defined unemployment as a circumstance in which people who are jobless and actively looking for working opportunities. Similarly, Katz (1988) describes unemployment as a situation that arises in the labor market whenever the supply of labor is more than the demand of labor. Jerome and T (2011) consequently state that the UE rises whenever the labor market is seeking better jobs with a higher wage rate. Khan et al. (2012), Samuel (2012), Cheema and Atta (2014), Kostrzewski and Worach-Kardas (2014), and Rocheteau and Rodriguez-Lopez (2014) provide a review of unemployment studies and come to the conclusion that unemployment among diversified groups of workers is a negative macroeconomic phenomenon.

The UE plays a crucial role in the research conducted by Holmes, Otero, and Panagiotidis (2013) as it is shown that there was a sharp rise of unemployment in the United States during the timespan, primarily during the 2007-2009 economic recessions. Hornstein (2013) concurs with the previous researchers and states that the UE increased rapidly during the great economic recession. Moreover, Juhn and Potter (2006) state that the UE is one of the key indicators of market conditions which can be used as an overview of local economic trends for both policymakers and economists.

García and Hernández (2004) came to the same conclusion as prior researchers, where they found an inverse relationship between the UE and housing price too. Their reasoning is that a high UE will discourage home-ownership, where the demand for houses drops, it will drag down the housing price as well.

Abelson et al. (2005), Leung et al. (2006), Lee (2009), and Vermeulen and Ommeren (2009) found that house prices are negatively and significantly impacted by the UE. They found that high UE imply a decrease in purchasing power of consumers, thus with the decrease in potential buyers, sellers tend to lower the prices of their houses in order to ensure the sale.

2.2 Review of Relevant Theoretical Model / Framework

2.2.1 Theory of Macroeconomic on House Prices

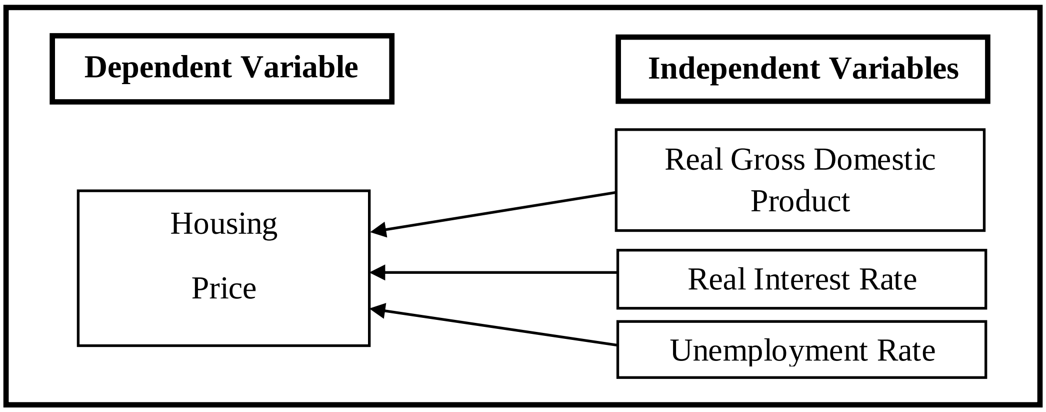
According to Ong and Chang (2013), macroeconomics represents the trends and movement of the entire economy. The researchers used this macroeconomic theory to identify the relationship between macroeconomic factors and house prices in Malaysia. It was found that the growth in the housing market is largely contributed by a well-regulated and stable macroeconomic environment. Besides that, they emphasized that the housing market is different from the markets for many other goods and services.

According to the standard economic theory, a rapidly developing economy is likely to drive up the housing prices. Housing could affect the wider economy in various ways. In other words, the relationship between house prices and economy is more pervasive. Therefore, housing prices are generally affected by macroeconomic variables and the overall growth rate of the economy. Hence, the results obtained by Ong and Chang (2013) concluded that the RGDP is significant and has a positive effect towards the housing price.

Similarly, Valadez (2010) focused on the effects of macroeconomic variables on housing prices during the period between 2005 and 2009. By measuring RGDP and housing prices during this period of economic uncertainty, the results indicate that there is a possible relationship between RGDP and housing price. Nevertheless, Valadez (2010) states that it is challenging to establish a scientific causal effect due to the difficulty in managing control groups in this arena.

2.3 Proposed Theoretical/ Conceptual Framework

Figure 2.1 Relationship between Housing Price and Macroeconomic Variables in the United States



Source: Developed for the research

Valadez (2010) stated in his study that there is a strong relationship between RGDP and housing price in the United States. However, he suggests that future research could be done in order to examine a clearer relationship between the two variables. According to Baker (2008) and Mahalik and Mallick (2011), they found that RGDP has a positive impact on housing price. Thus, this study forecast a positive relationship between RGDP and housing price in the United States.

Lee (2009) discovered that RINR is one of the main reasons that cause the changes in housing price. This statement is also supported by Orsal (2014). Based on Hubbard and Mayer (2009) and Levin and Pryce (2009), they discovered that RINR has a negative relationship with housing price. However Leung et al. (2006) argued that RINR can be either positively or negatively related to housing price. Hence, this study predicts that RINR is negatively related with the housing price in the United States.

Luo, Liu, and Picken (2007) used Granger Causality to conduct an experiment to test the relationship between UE and housing price. In addition, Lee (2009) found that the UE has an influence on house price volatility. According to García and

Hernández (2004), Leung et al. (2006) and Vermeulen and Ommeren (2009), they realized there is a strong negative correlation between UE and housing price. So, this study forecast that there is a negative relationship between the UE and the housing price in the United States.

2.4 Hypotheses Development

In this study, three hypotheses are formed to examine the effect of the three particular macroeconomic factors on the fluctuations of housing prices in the United States which are related with the main objective of this study:

2.4.1 Real Gross Domestic Product (RGDP)

H_0 : There is no relationship between the Real Gross Domestic Product and the Housing Price in the United States.

H_1 : There is a significant relationship between the Real Gross Domestic Product and the Housing Price in the United States.

According to Baker (2008), and Mahalik and Mallick (2011), the empirical results show that RGDP has a positive effect on housing price. Therefore, this indicates that when the RGDP increases, the housing price will increase as well. Hence, this hypothesis is adopted to examine the relationship between the RGDP and the housing price in order to test whether RGDP significantly affects the housing price in the United States.

2.4.2 Real Interest Rate (RINR)

H_0 : There is no relationship between the Real Interest Rate and the Housing Price in the United States.

H_1 : There is a significant relationship between the Real Interest Rate and the Housing Price in the United States.

Based on the findings obtained by Hubbard and Mayer (2009), and Levin and Pryce (2009), RINR negatively influence the housing price. This hypothesis is also supported by Leung et al. (2006). Yet, Shi et al. (2014) argued that RINR can also be positively related to housing price. Therefore, this hypothesis is adopted to examine the relationship between RINR and housing price in order to test whether RINR significantly affects the housing price in the United States.

2.4.3 Unemployment Rate (UE)

H_0 : There is no relationship between the Unemployment Rate and the Housing Price in the United States.

H_1 : There is a significant relationship between the Unemployment Rate and the Housing Price in the United States.

According to Abelson et al. (2005) and Lee (2009), the empirical results indicated that UE is negatively correlated with housing price. Thus, this indicates that when the UE increases, the housing price will decrease, and vice versa. Hence, this hypothesis is adopted to examine the connection between the UE and housing price in order to test whether UE has a significant effect on the housing price in the United States.

2.5 Conclusion

In conclusion, many researchers conducted studies on the housing price as discussed in the literature review. Throughout the discussion in the literature review, those studies have stated that there is a strong correlation between the housing price and the macroeconomic factors such as RGDP, RINR, and UE. Apart from that, a review of "Theory of Macroeconomic on House Prices" that was explored by previous researcher is also covered in this chapter. Accordingly, a theoretical or conceptual framework is proposed where housing price is set as the dependent variable while the RGDP, RINR and UE are set as the independent variables. Lastly, three hypotheses are adopted in order to provide readers with a clearer picture about this study on whether the relationships between the chosen independent variables and the housing price are significant or not.

CHAPTER 3: METHODOLOGY

3.0 Introduction

In this chapter, research methodologies are developed and discussed. This study primarily attempts to investigate the relationship between the housing price in the United States and its macroeconomic variables. Thus, it is of utmost importance to have a well-designed research methodology that includes macroeconomic variables in order to improve the degree of accuracy and provide an exceptional contribution to the study.

Therefore, this chapter consists of research design, data collection method, sampling design, research instrument, data processing, and data analysis. Through this process, this study attempts to meet the primary objective which is to discover the relationship between the Independent Variables (RGDP, RINR, and UE) and the Dependent Variable (Housing Price).

This study utilizes E-views 6.0 software as a tool to analyze the data. The Ordinary Least Squares (OLS) method is used in this study. The OLS method is able to determine the biasness, efficiency and consistency of coefficient parameters whenever the regression model fulfils the 10 classic linear regression model assumptions. Furthermore, the OLS method is applicable to the study since the sample size of the data is large, that is more than 30 observations (Gujarati, 2004).

3.1 Research Design

This study is a quantitative research. It uses numeric and quantifiable data that are obtained from the Federal Reserve Bank of St. Louis, Organisation for Economic

Co-operation and Development (OECD), United States Bureau of Economic Analysis, and FHFA.

A research design is basically a blueprint of a research topic. This plan is used to determine the methods of collection and utilization of data to ascertain the validity of the hypothesis (Greener, 2008). Research designs can be either qualitative or quantitative in nature. Based on the scope of this study, a quantitatively-based research design is more suitable. Consequently, this research design is formed in order to quantitatively analyze the data collected.

3.2 Data Collection Method

Generally, all researchers and economists work with data in order to analyze or investigate something that they wish to know. The empirical analysis of the pattern of the housing price in the United States can easily be conducted with the existence of a computer database. Hence, it is important to note that this study uses the quarterly time series data obtained from the Federal Reserve Bank of St. Louis, OECD, United States Bureau of Economic Analysis and FHFA.

3.2.1 Secondary Data

Typically, secondary data is free and available in the text, tables and appendices of the published articles or upon the original data (Church, 2001). As such, this study conducts analyses based upon secondary data collected from the Federal Reserve Bank of St. Louis, OECD, United States Bureau of Economic Analysis and FHFA. As this study is to discover the relationship between the fluctuations of housing price in the United States and its macroeconomic variables, the literature review places emphasis on the dependent variable (Housing Price) and independent variables (RGDP, RINR, and UE). Furthermore, this study contains relevant sources of secondary data from FHFA which is related to the performance of housing price in the United States. In addition, the nature of secondary data allows it to be sourced and located more quickly compared to the more tedious task of collecting primary data. It is important to note that primary data requires six steps of market research process, and necessitates longer collection time as well as higher collection cost.

3.3 Sampling Design

3.3.1 Target Population

This study targets the United States Housing Price which is measured by the HPI, and analyzes the relationship between housing price and its macroeconomic variables in the United States. This study will be using the FHFA HPI as the source to determine housing price. The FHFA, previously known as the OFHEO, provides a weighted index that will track repeat sales and the quarterly changes of the average price of properties in 363 urban cities in the United States (Calhoun, 1996).

3.3.2 Sampling Location

The sampling location of housing prices is based on the average price of properties in 363 metropolitan cities (each city with a population of at least 2.5 million people) across all states in the United States. The FHFA HPI includes indexes for all of the nine census divisions in the United States, the fifty states and the District of Columbia, as well as every Metropolitan

Statistical Area (MSA) in the United States, not including Puerto Rico (Federal Housing Finance Agency, 2014).

3.3.3 Sampling Technique

The housing price index is based on the data collected from more than six million repeat sales transactions. These transactions are only based on single-family properties in the United States. The technique used by the FHFA is known as the modified geometric weighted repeat-sales procedure. The sampling technique selects transactions that are involved in conventional mortgages under the mortgage loan limit which are bought by Fannie Mae or Freddie Mac. The current mortgage loan limit in the United States is $417,000 (Federal Housing Finance Agency, 2014).

3.3.4 Sampling Size

This study consists of 60 samples of quarterly data for the United States HPI, RGDP, RINR and UE, which covers the period from 1999 to 2013.

3.4 Research Instrument

3.4.1 E-views 6.0 software

This study utilizes E-views 6.0 software to analyze the data collected from the Federal Reserve Bank of St. Louis, OECD, United States Bureau of Economic Analysis and FHFA. Accordingly, data analysis is important in order to detect the problems that might occur in the model. E-views 6.0 software is the most commonly used software for time series data analysis in academics, enterprise, and government. The major advantage of this software is that it allows the user to save the results and to retrieve these results for further analysis. Furthermore, E-views 6.0 software is able to produce graphs and bar charts that can clearly show the trend and results. Last but not least, E-views 6.0 software works in the Windows operating system, which is compatible with most personal computers.

3.5 Data Processing

According to Rudo (2013), the data processing cycle consists of six important steps in order to effectively extract relevant and useful information from the data collection. In other words, the data processing involves the conversion of original data to useful information through six steps of the data processing cycle. The six steps of the data processing cycle consists of data collection, data preparation, data input, data processing, data output and interpretation, as well as data storage.

Figure 3.1: Data Processing Cycle

Step 1	**Data Collection**
Step 2	**Data Preparation**
Step 3	**Data Input**
Step 4	**Data Processing**
Step 5	**Data Output and Interpretation**
Step 6	**Data Storage**

Source: Developed for the research

Step 1: Data Collection. Collect data from the Federal Reserve Bank of St. Louis, OECD, United States Bureau of Economic Analysis, FHFA; journal articles from UTAR Library Database (OPAC), Social Science Research Network (SSRN) and Google Scholar.

Step 2: Data Preparation. Construct and create a dataset from collected data in order to be used for further processing and investigation. The data needs to be carefully screened for potential problems to avoid producing misleading results. Thus, it can ensure the data is of high quality and therefore the results provided will be more reliable.

Step 3: Data Input. After collecting the data from different sources, analyze the data by using the E-views 6.0 software in order to obtain empirical results.

Step 4: Data Processing. By using E-views 6.0 software, various tests can be conducted including testing for overall significance of model (F-test), testing for individual variables (T-test), normality residuals test (Jarque-Bera Test), high pair-wise correlation approach, Breausch-Godfrey serial correlation LM test, Autoregressive Conditional Heteroscedasticity (ARCH) test, and Ramsey's RESET test.

Step 5: Data Output and Interpretation. The output from data processing is presented to readers in various report formats like tables and figures. In addition, the data output needs to be interpreted in order to provide meaningful information to the readers.

Step 6: Data Storage. Store the data and information in computers for future use in order for quick access and retrieval when there is a need.

3.6 Data Analysis

This study examined the relationship of housing price in the United States and the macroeconomic variables by using OLS method and time series quarterly data from the year 1999 (Q1) to 2013 (Q4).

The estimated model is as the following:

Model 1

$$\boxed{\mathbf{HP_t} = \hat{\beta}_0 + \hat{\beta}_1\, \mathbf{RGDP_t} - \hat{\beta}_2 \mathbf{RINR_t} - \hat{\beta}_3\, \mathbf{UE_t} + \hat{\mu}_t}$$

HP_t	: Housing Price (Housing Price Index)
$RGDP_t$	: Real Gross Domestic Product (United States Dollar)
$RINR_t$	: Real Interest Rate (Percentage)
UE_t	: Unemployment Rate (Percentage)
μ_t	: Error Term
t	: Quarterly period (1999-2013)

3.6.1 P-value Approach

The P-value (also known as Probability Value) is the probability of obtaining a value of the sample test statistic which is at least as extreme as the one found from the sample data, assuming that Ho is correct. This P-value approach is applied in both hypotheses testing and diagnostic checking in this research. When P-value is smaller than the 5% significance level, Ho is rejected.

3.6.2 Hypotheses Testing

3.6.2.1 T-test

Basically, the t-test is employed in order to examine the significance of each independent variable individually. The t-test assumption requires normality distribution sample of the population and equal variances. The test statistic (estimator) and the sampling distribution are essential to test the significance of the variables. The decision to reject or not to reject the H_0 is based on the test statistic and the probability obtained from the data. The formula for a t-test statistic is $\boxed{\frac{\widehat{\beta 1}-\beta 1}{s.e.(\widehat{\beta 1})}}$, and the degree of freedom in the t-distribution is (n-2). Nevertheless, there are two decision rules to be made, which are based on the test statistic and p-value. If the test statistic is greater or smaller than the critical value, it will reject H_0; in contrast, if the probability is smaller than the significance level of 5%, the H_0 is rejected.

3.6.2.2 F-test

F-test is normally used in order to examine the overall significance of the estimated Multiple Linear Regression model. There are several properties of F-statistic value. One of the properties is that the F-distribution is always skewed to the right and which ranges from zero to infinity. Other than that, F-distribution becomes nearer to the normal distribution as its degree of freedom becomes larger. If the probability value is smaller than the significance level of 5%, then reject the H_0. Therefore, the overall model is significantly meaningful to explain the dependent variable.

3.6.3 Diagnostic Checking

3.6.3.1 Multicollinearity

Multicollinearity happens when some or all of the independent variables are highly correlated with one another. With the presence of it, the regression model will face difficulty in telling which independent variable is influencing the dependent variable. The following approaches are developed in order to test whether there is multicollinearity problem exist in the model:

3.6.3.1.1 High Pair Wise Correlation Approach

If an *r* is high in absolute value, it indicates the two independent variables are quite correlated and that multicollinearity is a potential problem.

3.6.3.1.2 VIF Approach

The Variance-inflating Factor (VIF) can be calculated as below:

$$\boxed{\frac{1}{1 - R^2}}$$

The larger the value of VIF, it indicates the more serious is the problem of multicollinearity. As a rule of thumb, if the VIF of a variable has a value which is more than 10, where this situation will happen when R^2 exceeds 0.90, the variable can be concluded as having high collinearity.

3.6.3.2 Autocorrelation

Autocorrelation is the one of the econometric problems in which the error term for any observations is correlated to the error term of other observations and it is associated with time series data. The following test is developed in order to test whether there is autocorrelation problem exist in the model:

3.6.3.2.1 Breusch-Godfrey Serial Correlation LM Test

In order to detect whether there is an occurrence of autocorrelation in the model, Breusch-Godfrey LM test is used rather than Durbin-Watson test and Durbin's h test. This is because Breusch-Godfrey LM test is applicable for higher orders of series correlation, as well as when there is lagged dependent variable. By comparing the p-value results obtained with the significance level of 5%, the researchers will know whether the model is having autocorrelation problem or not. Reject the H_0 when p-value is smaller than the 5% significance level and this indicates there is autocorrelation problem in the model. Otherwise, do not reject H_0 and this implies that the model do not have autocorrelation problem.

3.6.3.3 Heteroscedasticity

Heteroscedasticity occurs when the error variance is non-constant. The following test is developed in order to test whether there is heteroscedasticity problem exist in the model:

3.6.3.3.1 Autoregressive Conditional Heteroscedasticity (ARCH) test

Autoregressive conditional heteroscedasticity (ARCH) test is normally used in econometrics to detect heteroscedasticity in time series analysis. It assumes that the variance of the current error term is related to the size of the previous periods' error terms.

Given the following model:

$$\boxed{Y_t = \beta_0 + \beta_1 X_t + u_t}$$

$$\boxed{u_t \sim N(0, \alpha_0 + \alpha_1 u_{t-1}^2)}$$

This indicates that the error term is normally distributed with zero mean and conditional variance depending on the squared error term lagged one time period. The conditional variance is the variance given the values of the error term lagged once, twice etc.:

$$\boxed{\sigma_t^2 = \mathrm{var}(u_t \setminus u_{t-1}, u_{t-2} \ldots .) = E(u_t^2 \setminus u_{t-1}, u_{t-2})}$$

Where σ_t^2 is the conditional variance of the error term.

The ARCH effect is then modelled by:

$$\boxed{\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2}$$

This is an ARCH(1) model as it contains only a single lag on the squared error term, however it is possible to extend this to any number of lags. If there are q lags, it is termed as an ARCH(q) model.

3.6.3.4 Model Specification

3.6.3.4.1 Ramsey RESET test

Ramsey RESET test is applied in order to make sure that the model specification is correct or good. The model specification bias arises due to several reasons such as omitting an important regressor, including an irrelevant regressor and adopting an incorrect functional form. With the occurrence of model specification bias, there will be an inaccurate interpretations and inferences. By comparing the p-value results with the significance level, the researchers can get to know whether the model has this issue or not. Reject the H_0 when p-value is smaller than the 5% significance level and it shows there is model specification error in the model. Otherwise, do not reject H_0 and this indicates that the model is correctly specified.

3.6.3.5 Normality Test

3.6.3.5.1 Jarque–Bera test

Jarque–Bera test is used in statistics to test whether the sample skewness and sample kurtosis matches the skewness and kurtosis of a normal distribution.

The Jarque-Bera test statistic is defined as:

$$\boxed{JB=\frac{N}{6}\left(S^2+\frac{(K-3)^2}{24}\right)}$$

Where *N* denotes the sample size, *S* denotes the sample skewness, and *K* denotes the sample kurtosis. The p-value is calculated using a table of distribution quantiles. A sufficiently large value of JB will lead to reject the hypothesis in which the errors are normally distributed at the significance level of 5%.

3.7 Conclusion

In conclusion, this chapter discusses about the research design, how the data is collected, sampling design, the research instrument used, data processing, as well as data analysis. The OLS regression is applied in this study to conduct the data analysis. Consequently, diagnostic checking is conducted in order to detect any econometric problems in the model.

CHAPTER 4: DATA ANALYSIS

4.0 Introduction

This study aims to investigate the relationship between the macroeconomic variables and the fluctuations of housing price in the United States. Thus, it is important to run all the data collection, demonstrate and discuss the results of the Multiple Linear Regression model that are obtained from the E-views 6.0 software. Apart from this, the diagnostic checking such as Multicollinearity, Heteroscedasticity, Autocorrelation, Model Specification, and Normality test will be conducted in order to analyze whether the regression model has any econometric issue and problem. Furthermore, suggestions and solutions for the econometric problems will also be discussed in this chapter.

4.1 Multiple Linear Regression Model

Model 1:

$$\boxed{\mathbf{HP_t} = -\hat{\beta}_0 + \hat{\beta}_1\,\mathbf{RGDP_t} + \hat{\beta}_2\mathbf{RINR}_{\mathbf{t}} - \hat{\beta}_3\,\mathbf{UE_t} + \hat{\mu}_{\mathbf{t}}}$$

$$\mathbf{HP_t} = -13.10015 + 0.011894\mathbf{RGDP_t} + 5.907803\mathbf{RINR}_{\mathbf{t}} - 4.207088\mathbf{UE_t} + \hat{\mu}_{\mathbf{t}}$$

SE = (30.03286) (0.001303) (2.931213) (1.363520)

R^2 = 0.684535 Adjusted R^2 = 0.667635

Number of Observations: 60

HP_t	: Housing Price (Housing Price Index)
$RGDP_t$	: Real Gross Domestic Product (United States Dollar)
$RINR_t$	: Real Interest Rate (Percentage)
UE_t	: Unemployment Rate (Percentage)
μ_t	: Error Term
SE	: Standard Error
t	: Quarterly period (1999-2013)

4.1.1 Hypotheses Testing

4.1.1.1 T-test

<u>Hypothesis testing for individual variables (P-value Approach)</u>

For this test, the level of significance used is 5% which is $\alpha = 0.05$. While the decision rule is reject H_o if the p-value is smaller than α (0.05). Otherwise, do not reject H_o.

<u>Table 4.1: T-Test Statistic for Real Gross Domestic Product ($RGDP_t$)</u>

Variables	T-statistic	P-value
$RGDP_t$	9.129737	0.0000

<u>Source</u>: Developed for the research

H_o refers to there is no significant relationship between RGDP and housing price in the United States, while H_1 refers to there is a significant relationship between RGDP and housing price in the United States. Based on the result shown in Table 4.1, it rejects H_o given that the p-value (0.0000) is smaller than α (0.05). Thus, it can be concluded that there is a significant relationship between RGDP and housing price in the United States at the significance level of 5%.

<u>Table 4.2: T-Test Statistic for Real Interest Rate ($RINR_t$)</u>

Variables	T-statistic	P-value
$RINR_t$	2.015481	0.0487

<u>Source</u>: Developed for the research

H_o refers to there is no significant relationship between RINR and housing price in the United States, while H_1 refers to there is a significant relationship between RINR and housing price in the United States. Based on the result shown in Table 4.2, it rejects H_o given that the p-value (0.0487) is smaller than α (0.05). Thus, it can be concluded that there is a significant relationship between RINR and housing price in the United States at the significance level of 5%.

Table 4.3: T-Test Statistic for Unemployment Rate (UE_t)

Variables	T-statistic	P-value
UE_t	-3.085461	0.0032

Source: Developed for the research

H_o refers to there is no significant relationship between UE and housing price in the United States, while H_1 refers to there is a significant relationship between UE and housing price in the United States. Based on the result shown in Table 4.3, it rejects H_o given that the p-value (0.0032) is smaller than α (0.05). Thus, it can be concluded that there is a significant relationship between UE and housing price in the United States at the significance level of 5%.

4.1.1.2 F-test

Hypothesis testing for overall significance of model (P-value Approach)

For this test, the level of significance used is 5% which is α = 0.05. While the decision rule is reject H_o if the p-value is smaller than α (0.05). Otherwise, do not reject H_o.

Table 4.4: F- Test Statistic

The overall significance of model: F- Test			
F-statistic	40.50523	Prob. F	0.000000

Source: Developed for the research

H_o refers to the model is not significant, while H_1 refers to the model is significant. Based on the result shown in Table 4.4, it rejects H_0 given that the p-value (0.000000) is smaller than α (0.05). Hence, there is sufficient evidence to conclude that this model is significant enough to explain the housing price at the significance level of 5%.

4.1.1.3 Coefficient of determination (R^2)

Based on Appendix 4.1, the coefficient of determination (R^2) of the model is 0.684535. It indicates that 68.4535% of the variation in estimating the housing price can be explained by the variation in RGDP, RINR, and UE.

4.1.2 Diagnostic checking of the model

4.1.2.1 Multicollinearity problem

4.1.2.1.1 Pair-Wise Correlation Approach

Table 4.5: Correlation Matrix

	RGDP	RINR	UE
RGDP	1.000000	-0.834448	0.661879
RINR	-0.834448	1.000000	-0.788496
UE	0.661879	-0.788496	1.000000

Source: Developed for the research

Correlation matrix represents the relationship among the independent variables. If the correlation is higher than 0.8, it means both of the independent variables are strongly correlated and it may consist of multicollinearity problem that will violate the result to become inefficient. Based on the result in Table 4.5, there is no any correlated relationship between each of the independent variable since the highest value is 0.661879.

However, 0.661879 is near to 0.8. Thus, the Variance-Inflating Factor (VIF) test for each of the variables will be conducted in the following to determine whether there is the presence of serious multicollinearity problem in the model.

4.1.2.1.2 Variance-Inflating Factor (VIF)

Table 4.6: Summary of each of the Variables

X_i, X_j	**R^2**	**VIF = $\frac{1}{1-R^2}$**	**Multicollinearity Problem**
X_{RGDP}, X_{RINR}	0.696304	3.29277	Not serious
X_{RGDP}, X_{UE}	0.438084	1.77963	Not serious
X_{RINR}, X_{UE}	0.621726	2.64359	Not serious

Source: Developed for the research

If the value of VIF is greater than 10, it indicates that the model consists of high or serious multicollinearity problem. In other words, when the VIF value falls within the range of 1 to 10, it means that there is no serious or low multicollinearity in the model. On the other hand, if the value of VIF is equal to 1, it indicates that there is no multicollinearity in the model. Thus, from the result shown in the Table 4.6, it can be concluded that this model has multicollinearity problem, yet it is not that serious.

4.1.2.2 Autocorrelation problem

In detecting autocorrelation problem, the researchers have carried out Breusch-Godfrey Serial Correlation LM Test. Due to different lag lengths may produce different results, so the best lag length should be determined before running the test. From the Table 4.7, it shows that the optimal lag length obtained is 2 where it has the minimum Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC). This procedure will be used in Autoregressive Conditional Heteroscedasticity **(**ARCH) test as well.

Table 4.7: Comparison of AIC & SIC

Lag Length	**AIC**	**SIC**
1	5.37	5.50
2	**5.36**	**5.50**
3	5.38	5.62
4	5.36	5.64
5	5.40	5.71
6	5.43	5.78

Source: Developed for the research

For this Breusch-Godfrey Serial Correlation LM Test, the level of significance used is 5% which is $\alpha = 0.05$. While the decision rule is reject H_o if the p-value is smaller than α (0.05). Otherwise, do not reject H_o.

Table 4.8: Test Statistics of Breusch-Godfrey Serial Correlation LM Test

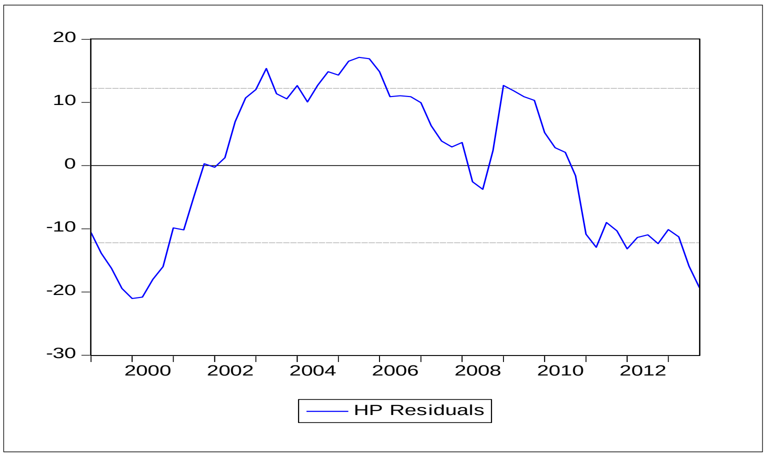
Breusch-Godfrey Serial Correlation LM Test			
F-statistic	342.0590	Prob. F (2,54)	0.0000
Obs*R-squared	55.61046	Prob. Chi-square (2)	0.0000

Source: Developed for the research

H_o refers to there is no autocorrelation problem in the model, while H_1 refers to there is autocorrelation problem in the model. Based on Table 4.8, the result shown is rejecting H_0 given that the p-value (0.0000) is smaller than α (0.05). Hence, there is sufficient evidence to conclude that there is a problem of autocorrelation in the model at 5% significance level.

4.1.2.3 Heteroscedasticity problem

Figure 4.1: Residual Graph



Adapted from: E-views outcomes

Based on the residual graph shown in Figure 4.1, the residual is fluctuating from time to time. This implies that the variances of error term are not constant. In order to confirm the presence of heteroscedasticity problem, this study uses the Autoregressive Conditional Heteroscedasticity (ARCH) test for hypothesis testing.

For this ARCH Test, the level of significance used is 5% which is α = 0.05. While the decision rule is reject H_o if the p-value is smaller than α (0.05). Otherwise, do not reject H_o.

Table 4.9: Test Statistic of ARCH Test

ARCH Test			
F-statistic	76.26534	Prob. F (2,55)	0.0000
Obs*R-squared	42.62878	Prob. Chi-square (2)	0.0000

Source: Developed for the research

H_o refers to there is no heteroscedasticity problem in the model, while H_1 refers to there is heteroscedasticity problem in the model. Based on Table 4.9, the result shown is rejecting H_0 given that the p-value (0.0000) is smaller than α (0.05). Hence, there is sufficient evidence to conclude that there is a problem of heteroscedasticity in the model at 5% significance level.

4.1.2.4 Model Specification problem

This research uses the Ramsey's RESET test for the diagnostic checking of model specification error. For this Ramsey's RESET Test, the level of significance used is 5% which is α = 0.05. While the decision rule is reject H_o if the p-value is smaller than α (0.05). Otherwise, do not reject H_o.

Table 4.10: Test Statistic of Ramsey's RESET test

Ramsey's RESET Test			
F-statistic	2.971134	Prob. F (2,54)	0.06
Log likelihood ratio	6.263871	Prob. Chi-square (2)	0.04

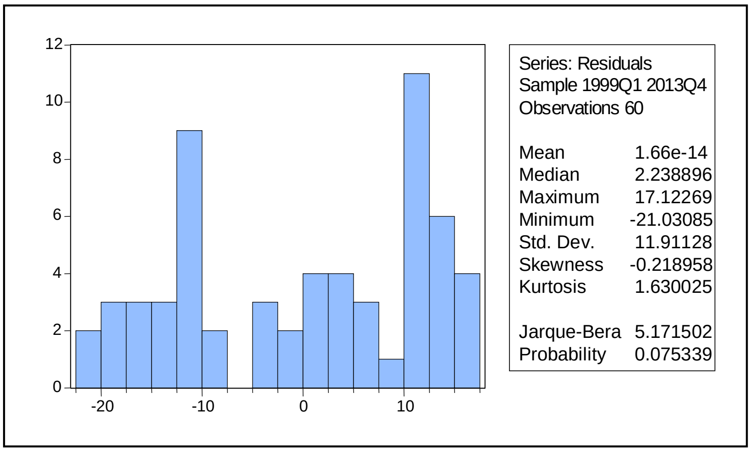
Source: Developed for the research

H_o refers to there is no model specification error in the model, while H_1 refers to there is model specification error in the model. Based on Table 4.10, the result shows do not reject H_0 given that the p-value (0.06) is greater than α (0.05). Hence, there is sufficient evidence to conclude that there is no model specification error in the model at 5% significance level.

4.1.2.5 Normality test

To detect the normal distribution of error term, this research has conducted a hypothesis testing by using Jarque-Bera normality test. For this Jarque-Bera normality test, the level of significance used is 5% which is $\alpha = 0.05$. While the decision rule is reject H_o if p-value is smaller than α (0.05). Otherwise, do not reject H_o.

Figure 4.2: Normality Graph



Adapted from: E-views outcomes

H_o refers to the error term is normally distributed in the model, while H_1 refers to the error term is not normally distributed in the model. Based on Figure 4.2, the result shows do not reject H_0 since the p-value (0.075339) is greater than α (0.05). Hence, there is sufficient evidence to conclude that the error term is normally distributed in the model at 5% significance level.

4.2 Suggestions or Solutions for Autocorrelation and Heteroscedasticity problem

4.2.1 Newey-West test

Newey-West test is one of the ways that is applied to obtain the corrected standard errors of OLS estimators.

Table 4.11: Statistic Comparison of Newey-West and Multiple Linear Regression

Variables	**Standard error**		**T-Statistic**	
	Multiple Linear Regression	**Newey-West**	**Multiple Linear Regression**	**Newey-West**
RGDP	0.001303	0.001999	9.129737	5.949742
RINR	2.931213	4.866677	2.015481	1.213930
UE	1.363520	1.901002	3.085461	2.213090

Source: Developed for the research

The result in Table 4.11 shows that the standard errors of RGDP, RINR, and UE which are obtained from the Newey-West are greater than the standard errors in the Multiple Linear Regression. Therefore, the t-statistics for Newey-West are smaller than the Multiple Linear Regression's. This means that the Multiple Linear Regression has underestimated the true standard errors whereas the Newey-West has adjusted the error term according to its procedure. As a result, it shows that Newey-West has helped in reducing the autocorrelation problem.

4.2.2 White's Heteroscedasticity Test

White's Heteroscedasticity test is another method that is used to obtain the corrected standard errors of OLS estimators.

Table 4.12: Statistic Comparison of White's Heteroscedasticity and Multiple Linear Regression

Variables	**Standard error**		**T-Statistic**	
	Multiple Linear regression	**White's Heterosce-dasticity**	**Multiple Linear regression**	**White's Heterosce-dasticity**
RGDP	0.001303	0.001202	9.129737	9.893669
RINR	2.931213	2.952897	2.015481	2.000680
UE	1.363520	1.132515	3.085461	3.714818

Source: Developed for the research

The result in Table 4.12 shows that the standard error of RINR which is obtained from the White's Heteroscedasticity is greater than the standard error in the Multiple Linear Regression. In other words, it indicates that the Multiple Linear Regression has underestimated the true standard error of RINR. On the other hand, the standard errors of RGDP and UE that are obtained from the White's Heteroscedasticity are lower than the standard errors in the Multiple Linear Regression. In other words, it indicates that the Multiple Linear Regression has overestimated the true standard errors of RGDP and UE. From these results, it demonstrates that the White's Heteroscedasticity has readjusted the underestimated and overestimated true standard errors. Hence, it can be concluded that the White's Heteroscedasticity has helped in reducing the heteroscedasticity problem.

4.2.3 Log-log Model

There are presences of autocorrelation and heteroscedasticity problems in the model after the diagnostic checking has been done for the Multiple Linear Regression model. According to Kroll & Stedinger (1999), the transformation of this model appears to provide solutions to cure the autocorrelation and heteroscedasticity problems that occur in the Multiple Linear Regression model. Hence, a Log-log model is developed in order to overcome the problems that occurred in the Multiple Linear Regression model of this study.

A suggested data transformation into logarithmic function with respect to:

Model 2:

$$\boxed{\mathbf{Log\ HP_t} = -\hat{\beta}_0 + \hat{\beta}_1\ \mathbf{Log\ RGDP_t} + \hat{\beta}_2 \mathbf{Log\ RINR}_{\mathbf{t}} - \hat{\beta}_3\ \mathbf{Log\ UE_t} + \hat{\mu}_{\mathbf{t}}}$$

The results of T-test statistic and F-test statistic which are obtained from the Log-log model are same as the results obtained from the Multiple Linear Regression model, where it indicates that there is significant relationships between the independent variables and the dependent variable individually and also it shows the model is significant enough to explain the housing price at significance level of 5% (Refer to Appendix 4.8).

Apart from this, the diagnosis checking results that are obtained from the Log-log model are similar with the results obtained from the Multiple Linear Regression model. It demonstrates that there are presences of autocorrelation and heteroscedasticity problems in the Log-log model as well. The results are summarized in Table 4.13 as shown in the following.

Table 4.13: Summary of the Diagnosis Checking Results of Log-log Model and Multiple Linear Regression Model

Diagnostic Checking	Log-log Model (Model 2)	Multiple Linear Regression model (Model 1)
Multicollinearity	Highest VIF = 2.65370	Highest VIF = 3.29277
Autocorrelation	0.0000	0.0000
Heteroscedasticity	0.0000	0.0000
Model Specification	0.0634	0.0600
Normality	0.278359	0.075339

Source: Developed for the research

As mentioned earlier, the Log-log model has been developed in order to solve the problems which have occurred in the Multiple Linear Regression model. As such, the results obtained from the Log-log model are compared with the results obtained from the Multiple Linear Regression model. However, from the comparison results shown in Table 4.13, the Log-log model does not help to solve the problems that have occurred in the Multiple Linear Regression model. This is because the Log-log model does not show any improvement in solving the autocorrelation and heteroscedasticity problems although it does shows some improvements in the problems of multicollinearity, model specification, as well as the normality test. Therefore, this study has remained with using the Multiple Linear Regression model to examine the correlation of the housing price with the independent variables as the Log-log model does not really show its strength in overcoming the econometric problems.

4.3 Conclusion

As a conclusion for this chapter, the data analysis has been done completely through OLS test and diagnostic checking. The results of the study are shown through the tables and figures. All the significant variables that appear in the model have been supported by journals in order to support the results and statements. A short summary of the results will be finalized in the next chapter.

CHAPTER 5: DISCUSSION, CONCLUSION AND IMPLICATIONS

5.0 Introduction

The objective of this study is to investigate the correlation between the housing prices and its macroeconomic factors in the United States. The impact of RGDP, RINR, and UE was empirically tested in order to determine the significance of these independent variables. This chapter will comprise of a summary and discussion of the findings. The purpose of the discussion is to find out if the empirical findings can meet the objectives in the previous chapters. Furthermore, the implications of the study will also be thoroughly discussed, as well as the limitations of the study. Lastly, the researchers will suggest some recommendations for future research.

5.1 Summary of Statistical Analyses

The diagnostic checking results were summarized in the Table 5.1. From the table, it is shown that the regression model did not consist of multicollinearity, model specification, and normality problems. In other words, all the independent variables in the model were not highly correlated with one another. Besides, it also indicated that the model was correctly specified and the error term was normally distributed in the model. However, autocorrelation and heteroscedasticity problems were existed in the regression model. This illustrated that the error terms in the model was correlated and every error term in the model has different variances too. As a consequence, the results obtained from the diagnostic checking demonstrated that the regression model did not achieve the Best Linear Unbiased Estimator (BLUE) condition where the results only show the model were unbiased and consistent, it has left out the efficiency requirement due to the occurrence of autocorrelation and heteroscedasticity problems in the model.

Table 5.1 Summary of the Results of Diagnostic Checking

Test for Econometric Problem	**Explanation for the Results Obtained**
Multicollinearity	Absent. There is no serious multicollinearity problem occurred among each of the independent variables.
Autocorrelation	Present. The regression model consists of autocorrelation problem.
Heteroscedasticity	Present. The regression model consists of heteroscedasticity problem.
Model Specification	Absent. The regression model does not have model specification problem.
Normality	Absent. The regression model does not have normality problem.

Source: Developed for the research

5.2 Discussions of Major Findings

The regression model contains of three independent variables which include RGDP, RINR, and UE. All these independent variables were empirically tested in order to determine and investigate the significance of its impacts on the housing price. The results were summarized in the following Table 5.2.

Table 5.2 Summary of the Major Findings

Independent Variable	Hypotheses Testing	Conclusion
Real Gross Domestic Product (RGDP)	H_o: There is no relationship between the real gross domestic product and the housing price in the United States. H_1: There is a significant relationship between the real gross domestic product and the housing price in the United States.	Reject H_o. RGDP is significant to influence housing price with a positive relationship.
Real Interest Rate (RINR)	H_o: There is no relationship between the real interest rate and the housing price in the United States. H_1: There is a significant relationship between the real interest rate and the housing price in the United States.	Reject H_o. RINR is significant to influence housing price with a positive relationship.
Unemployment Rate (UE)	H_o: There is no relationship between the unemployment rate and the housing price in the United States. H_1: There is a significant relationship between the unemployment rate and the housing price in the United States.	Reject H_o. UE is significant to influence housing price with a negative relationship.

Source: Developed for the research

Based on the results shown in Table 5.2, RGDP has a positively significant relationship with the housing price. It implies that when RGDP increase, the housing price will increase as well. This result is consistent with the research done by Baker (2008) and Mahalik and Mallick (2011). Besides, the RINR was also found to have a positively significant relationship with the housing price. It implies that when RINR rises, the housing price will go up as well. The result is opposite with the researches of Hubbard and Mayer (2009) and Levin and Pryce (2009). However, it is supported by the researches of Shi et al. (2014), Xu and Tang (2014). While for the UE, it has shown a significant and negative relationship with the housing price. It implies that the UE and the housing price will move in a different direction. Anyone of them goes up will cause the other one to go down, vice versa. This result is also consistent and proven by Leung et al. (2006) and Vermeulen and Ommeren (2009).

5.3 Implications of the Study

5.3.1 For investors and potential homebuyers

Considering housing is an important component of investment, investors or potential homeowners looking to join the housing market must have knowledge about certain factors before making a decision. As investors of properties aim to make purchases when the prices of houses are low or undervalued, and to sell when the prices are high, it is important for investors and homebuyers to understand the effects of macroeconomic variables such as the country's RGDP, RINR, and UE on the house prices. Furthermore, it is important to note the effects of housing prices also apply to residential home construction projects as well. High housing prices would benefit investors in home construction. Typically, investors primarily take into account the RINR before committing to an investment decision.

Since the results show that the macroeconomic variables included in this study (RGDP, RINR, and UE) are significantly correlated with housing prices, investors can utilize this study to evaluate the price of the property. As mentioned in the previous chapter, in a situation where RGDP increases, housing prices tend to increase as well. On the other hand, the UE and housing price have a negative relationship. Most importantly, the results show that RINR and housing prices also move in the same direction.

5.3.2 For the government and policymakers

The housing market is an important component in the economy. It is also vulnerable to price fluctuations such as in the case of the United States.

These fluctuations in prices have led to serious macroeconomic and microeconomic consequences for the United States economy (Cohen, Coughlin, & Lopez, 2012).

Since the government plays an important role in determining the country's macroeconomic situation, and is primarily responsible for factors such as the RGDP, RINR and UE of a country, the relationship between these factors and the housing market is of utmost importance for policymakers.
By taking into account the factors discussed in this study and their relationship with the housing prices, the government and policymakers could be able to estimate the value of housing prices based on the RGDP, RINR and UE. As a result, this study allows policymakers to gain a better understanding on the housing market dynamics. With such understanding, policymakers are able to determine the situations in which housing is more affordable for the general population. Furthermore, with the implementation of an appropriate set of policies, the government will be able to ensure a stable housing market.

5.3.3 For future researchers

There is still much debate going on about the topic of housing markets, with researchers coming up with differing conclusions. For example, Leung et al. (2006) and Levin and Pryce (2009) came up with different conclusions regarding the relationship between RINR and housing prices. On the other hand, this study also provides another perspective for the argument. Consequently, this study allows future researchers to utilize the findings and examine the relationships between the macroeconomic variables, such as RGDP, RINR, and UE on the housing prices. As a result, this study could be used as a guide for future research regarding the relationship of housing prices and other variables.

5.4 Limitations of the Study

In reality, a perfect condition does not always exist when conducting a study, as there will be some limitations and difficulties during the process of the study. First and foremost, the data used in this study is collected from various sources. This study has found that these different sources show data discrepancies. The differences are due to the different methodology used by the different sources. As such, this may be one of the reasons that make the results from this study to be different from previous researches.

Moreover, the 2007 Global Financial Crisis happened during the sample period of the study between 1999 and 2013. It was the worst financial crisis since the Great Depression and subsequently led to a global recession. This study did not analyze the indirect effects of the Global Financial Crisis on the housing price. In reality, the financial crisis had indeed brought negative impact on the housing market in the United States.

This study uses three macroeconomic variables (RGDP, RINR, and UE) as the independent variables and tests their relationship with the housing prices. Nevertheless, other variables such as population, real mortgage rate and geographical factors are not taken into consideration in this research. With the inclusion of such variables, the results obtained could vary from the results from this research. This research does not include mortgage rates as an independent variable as the mortgage rates in the United States vary across the different states. Ozdemir and Altinoz (n.d.) analyzed the mortgage rate in different parts of the United States. The research regions were split into five sections, which were the South East, North East, South West, North Central and West. They concluded that the mortgage rates for all regions were affected by regional factors, and the role of local factors increased significantly after the United States financial crisis.

5.5 Recommendations for Future Research

In the future, it is recommended that researchers can attempt to collect the data from other reliable sources such as the World Bank and Asian Development Bank if they are interested to study more on this area. It may be better for them to check the consistency of the data in order to obtain a better result.

Besides, future researchers should take more attention on the global financial crisis which have an impact on the housing price in different countries, no matter is developing countries or developed countries. These might be the important information for the investors. Not only that, future studies could focus on the cause and effects of housing prices before, during, and after the global financial crisis.

Furthermore, other macroeconomic variables that have a correlation with the housing price should also be taken into consideration in future studies such as the population, real mortgage rate, and geographical factors. The population growth could be related to the changes in the housing prices because housing needs vary according to the size of family. The real mortgage rate is a potential determinant of house prices since many banks during the economic boom were keen to lend mortgage loans and allow people to borrow in substantially large amounts. Thus, these would tend to increase the demand for housing as now more people have more purchasing power. Lastly, geographical factors are also important because many housing markets are highly geographical. For example, overall the United States house prices may be falling, but certain areas located on the West Coast may still experience a rise in prices.

5.6 Conclusion

The main objective of this study is to examine the changes of housing price and its relationships with the macroeconomic factors in the United States. As a result, the empirical results show that the RGDP and RINR have a positive significant relationship with the housing price. On the other hand, it is shown that the UE has a negatively significant relationship with the housing price.

A Log-log model was used in an attempt to solve the autocorrelation and heteroscedasticity problems that was obtained from the initial Multiple Linear Regression model. However, the problem could not be solved with a Log-log model although it showed some improvements in the multicollinearity and model specification as well as the normality test. Due to the inadequacy of the Log-log model to solve the autocorrelation and heteroscedasticity problems, the researchers reverted back to the Multiple Linear Regression model.

While conducting this study, there are several sources of data for the variables. However, these sources obtained the data using differing methodologies and thus led to inconsistencies. Furthermore, there were a few occurrences of temporary disturbance events throughout the sample period such as the incident of global financial crisis. Another factor to consider would be the number of independent variables in this study. The housing price could be influenced by other variables not discussed in this paper. Thus, this study has provided some suggestions for future researchers to carry out further research on this subject.

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APPENDICES

Appendix 4.1: Multiple Linear Regression Model

Dependent Variable: HP
Method: Least Squares
Date: 01/29/15 Time: 18:17
Sample: 1999Q1 2013Q4
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RGDP	0.011894	0.001303	9.129737	0.0000
RINR	5.907803	2.931213	2.015481	0.0487
UE	-4.207088	1.363520	-3.085461	0.0032
C	-13.10015	30.03286	-0.436194	0.6644

R-squared	0.684535	Mean dependent var	142.4637
Adjusted R-squared	0.667635	S.D. dependent var	21.20717
S.E. of regression	12.22617	Akaike info criterion	7.909374
Sum squared resid	8370.832	Schwarz criterion	8.048997
Log likelihood	-233.2812	Hannan-Quinn criter.	7.963989
F-statistic	40.50523	Durbin-Watson stat	0.080438
Prob(F-statistic)	0.000000		

Multiple Linear Regression Model (Diagnostic Checking)

Appendix 4.2: Multicollinearity Problem

Auxiliary Model – RGDP & RINR

Dependent Variable: RGDP
Method: Least Squares
Date: 01/29/15 Time: 18:21
Sample: 1999Q1 2013Q4
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RINR	-1540.475	133.5861	-11.53171	0.0000
C	19487.64	560.7289	34.75412	0.0000

R-squared	0.696304	Mean dependent var	13287.23
Adjusted R-squared	0.691067	S.D. dependent var	2217.246
S.E. of regression	1232.383	Akaike info criterion	17.10405
Sum squared resid	88088522	Schwarz criterion	17.17386
Log likelihood	-511.1216	Hannan-Quinn criter.	17.13136
F-statistic	132.9802	Durbin-Watson stat	0.237542
Prob(F-statistic)	0.000000		

Auxiliary Model – RGDP & UE

Dependent Variable: RGDP
Method: Least Squares
Date: 01/29/15 Time: 18:21
Sample: 1999Q1 2013Q4
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UE	773.1507	114.9760	6.724455	0.0000
C	8463.237	749.3122	11.29467	0.0000

R-squared	0.438084	Mean dependent var	13287.23
Adjusted R-squared	0.428396	S.D. dependent var	2217.246
S.E. of regression	1676.338	Akaike info criterion	17.71938
Sum squared resid	1.63E+08	Schwarz criterion	17.78919
Log likelihood	-529.5813	Hannan-Quinn criter.	17.74668
F-statistic	45.21830	Durbin-Watson stat	0.048875
Prob(F-statistic)	0.000000		

Auxiliary Model – RINR & UE

Dependent Variable: RINR
Method: Least Squares
Date: 01/29/15 Time: 18:22
Sample: 1999Q1 2013Q4
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UE	-0.498918	0.051100	-9.763603	0.0000
C	7.137945	0.333024	21.43375	0.0000

R-squared	0.621726	Mean dependent var	4.025000
Adjusted R-squared	0.615204	S.D. dependent var	1.201043
S.E. of regression	0.745030	Akaike info criterion	2.281981
Sum squared resid	32.19405	Schwarz criterion	2.351792
Log likelihood	-66.45942	Hannan-Quinn criter.	2.309288
F-statistic	95.32794	Durbin-Watson stat	0.264261
Prob(F-statistic)	0.000000		

Appendix 4.3: Autocorrelation Problem – LM Test

a) Lag Length = 1

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	660.7196	Prob. F(1,55)	0.0000
Obs*R-squared	55.38926	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 01/29/15 Time: 18:22
Sample: 1999Q1 2013Q4
Included observations: 60
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RGDP	-0.001117	0.000367	-3.044359	0.0036
RINR	-2.477228	0.825562	-3.000658	0.0040
UE	-0.511190	0.381921	-1.338470	0.1863
C	27.68603	8.469540	3.268893	0.0019
RESID(-1)	0.991796	0.038585	25.70447	0.0000

R-squared	0.923154	Mean dependent var	1.66E-14
Adjusted R-squared	0.917565	S.D. dependent var	11.91128
S.E. of regression	3.419896	Akaike info criterion	5.376752
Sum squared resid	643.2627	Schwarz criterion	5.551281
Log likelihood	-156.3026	Hannan-Quinn criter.	5.445020
F-statistic	165.1799	Durbin-Watson stat	1.128365
Prob(F-statistic)	0.000000		

b) Lag Length = 2

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	342.0590	Prob. F(2,54)	0.0000
Obs*R-squared	55.61046	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 01/29/15 Time: 18:23
Sample: 1999Q1 2013Q4
Included observations: 60
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RGDP	-0.000839	0.000399	-2.102275	0.0402
RINR	-1.917663	0.880871	-2.177008	0.0339
UE	-0.440227	0.378534	-1.162979	0.2500
C	21.35511	9.180701	2.326087	0.0238
RESID(-1)	1.200839	0.132296	9.076905	0.0000

RESID(-2)	-0.227730	0.138051	-1.649611	0.1048

R-squared	0.926841	Mean dependent var	1.66E-14
Adjusted R-squared	0.920067	S.D. dependent var	11.91128
S.E. of regression	3.367607	Akaike info criterion	5.360921
Sum squared resid	612.4020	Schwarz criterion	5.570356
Log likelihood	-154.8276	Hannan-Quinn criter.	5.442843
F-statistic	136.8236	Durbin-Watson stat	1.537140
Prob(F-statistic)	0.000000		

c) Lag Length = 3

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	226.2553	Prob. F(3,53)	0.0000
Obs*R-squared	55.65435	Prob. Chi-Square(3)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 01/29/15 Time: 18:23
Sample: 1999Q1 2013Q4
Included observations: 60
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RGDP	-0.000888	0.000406	-2.185904	0.0333
RINR	-1.966815	0.887233	-2.216796	0.0309
UE	-0.423765	0.380839	-1.112714	0.2709
C	22.09308	9.275470	2.381883	0.0208
RESID(-1)	1.228964	0.138318	8.885041	0.0000
RESID(-2)	-0.347708	0.214745	-1.619167	0.1113
RESID(-3)	0.099643	0.136194	0.731629	0.4676

R-squared	0.927572	Mean dependent var	1.66E-14
Adjusted R-squared	0.919373	S.D. dependent var	11.91128
S.E. of regression	3.382192	Akaike info criterion	5.384206
Sum squared resid	606.2788	Schwarz criterion	5.628546
Log likelihood	-154.5262	Hannan-Quinn criter.	5.479781
F-statistic	113.1276	Durbin-Watson stat	1.542346
Prob(F-statistic)	0.000000		

d) Lag Length = 4

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	175.7811	Prob. F(4,52)	0.0000
Obs*R-squared	55.86823	Prob. Chi-Square(4)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 01/29/15 Time: 18:23
Sample: 1999Q1 2013Q4

Included observations: 60
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RGDP	-0.000697	0.000417	-1.672198	0.1005
RINR	-1.682404	0.890440	-1.889408	0.0644
UE	-0.441034	0.375050	-1.175934	0.2450
C	18.56038	9.381328	1.978439	0.0532
RESID(-1)	1.260129	0.137481	9.165855	0.0000
RESID(-2)	-0.454495	0.221191	-2.054765	0.0449
RESID(-3)	0.381093	0.217722	1.750365	0.0860
RESID(-4)	-0.226167	0.137850	-1.640670	0.1069

R-squared	0.931137	Mean dependent var	1.66E-14
Adjusted R-squared	0.921867	S.D. dependent var	11.91128
S.E. of regression	3.329470	Akaike info criterion	5.367069
Sum squared resid	576.4393	Schwarz criterion	5.646315
Log likelihood	-153.0121	Hannan-Quinn criter.	5.476298
F-statistic	100.4463	Durbin-Watson stat	1.597111
Prob(F-statistic)	0.000000		

e) Lag Length = 5

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	137.9879	Prob. F(5,51)	0.0000
Obs*R-squared	55.87011	Prob. Chi-Square(5)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 01/29/15 Time: 18:23
Sample: 1999Q1 2013Q4
Included observations: 60
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RGDP	-0.000711	0.000431	-1.648801	0.1053
RINR	-1.696795	0.903873	-1.877249	0.0662
UE	-0.435743	0.380213	-1.146049	0.2571
C	18.77480	9.574733	1.960869	0.0554
RESID(-1)	1.265002	0.142429	8.881612	0.0000
RESID(-2)	-0.462093	0.228800	-2.019634	0.0487
RESID(-3)	0.391481	0.230132	1.701117	0.0950
RESID(-4)	-0.253543	0.227296	-1.115474	0.2699
RESID(-5)	0.022117	0.145192	0.152331	0.8795

R-squared	0.931168	Mean dependent var	1.66E-14
Adjusted R-squared	0.920371	S.D. dependent var	11.91128
S.E. of regression	3.361189	Akaike info criterion	5.399948
Sum squared resid	576.1771	Schwarz criterion	5.714099
Log likelihood	-152.9984	Hannan-Quinn criter.	5.522830
F-statistic	86.24245	Durbin-Watson stat	1.607069
Prob(F-statistic)	0.000000		

f) Lag Length = 6

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	113.1861	Prob. F(6,50)	0.0000
Obs*R-squared	55.88543	Prob. Chi-Square(6)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 01/29/15 Time: 18:23
Sample: 1999Q1 2013Q4
Included observations: 60
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RGDP	-0.000750	0.000444	-1.688911	0.0975
RINR	-1.732173	0.914853	-1.893389	0.0641
UE	-0.423103	0.384401	-1.100683	0.2763
C	19.33520	9.739027	1.985332	0.0526
RESID(-1)	1.263397	0.143628	8.796344	0.0000
RESID(-2)	-0.443715	0.234547	-1.891801	0.0643
RESID(-3)	0.366320	0.239206	1.531404	0.1320
RESID(-4)	-0.222849	0.239918	-0.928854	0.3574
RESID(-5)	-0.055865	0.232553	-0.240225	0.8111
RESID(-6)	0.062816	0.145571	0.431516	0.6679

R-squared	0.931424	Mean dependent var	1.66E-14
Adjusted R-squared	0.919080	S.D. dependent var	11.91128
S.E. of regression	3.388331	Akaike info criterion	5.429564
Sum squared resid	574.0393	Schwarz criterion	5.778621
Log likelihood	-152.8869	Hannan-Quinn criter.	5.566099
F-statistic	75.45740	Durbin-Watson stat	1.604206
Prob(F-statistic)	0.000000		

Appendix 4.4: Heteroscedasticity Problem – ARCH Test

Heteroskedasticity Test: ARCH

F-statistic	76.26534	Prob. F(2,55)	0.0000
Obs*R-squared	42.62878	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 01/29/15 Time: 18:24
Sample (adjusted): 1999Q3 2013Q4
Included observations: 58 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	28.74792	12.83357	2.240055	0.0291

RESID^2(-1)	1.164050	0.130373	8.928627	0.0000
RESID^2(-2)	-0.358905	0.131686	-2.725455	0.0086

R-squared	0.734979	Mean dependent var	139.0846
Adjusted R-squared	0.725342	S.D. dependent var	113.3452
S.E. of regression	59.40179	Akaike info criterion	11.05686
Sum squared resid	194071.5	Schwarz criterion	11.16344
Log likelihood	-317.6491	Hannan-Quinn criter.	11.09838
F-statistic	76.26534	Durbin-Watson stat	2.089115
Prob(F-statistic)	0.000000		

Appendix 4.5: Model Specification Problem – Ramsey RESET Test

Ramsey RESET Test:

F-statistic	2.971134	Prob. F(2,54)	0.0597
Log likelihood ratio	6.263871	Prob. Chi-Square(2)	0.0436

Test Equation:
Dependent Variable: HP
Method: Least Squares
Date: 01/29/15 Time: 18:26
Sample: 1999Q1 2013Q4
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RGDP	-0.044905	0.233194	-0.192563	0.8480
RINR	-23.31340	115.1078	-0.202535	0.8403
UE	14.44720	82.90416	0.174264	0.8623
C	188.6131	1181.351	0.159659	0.8737
FITTED^2	0.048379	0.136623	0.354107	0.7246
FITTED^3	-0.000146	0.000315	-0.464964	0.6438

R-squared	0.715808	Mean dependent var	142.4637
Adjusted R-squared	0.689494	S.D. dependent var	21.20717
S.E. of regression	11.81729	Akaike info criterion	7.871643
Sum squared resid	7541.005	Schwarz criterion	8.081078
Log likelihood	-230.1493	Hannan-Quinn criter.	7.953565
F-statistic	27.20247	Durbin-Watson stat	0.110614
Prob(F-statistic)	0.000000		

Overcome the Autocorrelation Problem

Appendix 4.6: Newey-West HAC Standard Errors & Covariance

Dependent Variable: HP
Method: Least Squares
Date: 03/04/15 Time: 14:20
Sample: 1999Q1 2013Q4
Included observations: 60
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RGDP	0.011894	0.001999	5.949742	0.0000
RINR	5.907803	4.866677	1.213930	0.2299
UE	-4.207088	1.901002	-2.213090	0.0310
C	-13.10015	44.93869	-0.291512	0.7717

R-squared	0.684535	Mean dependent var	142.4637
Adjusted R-squared	0.667635	S.D. dependent var	21.20717
S.E. of regression	12.22617	Akaike info criterion	7.909374
Sum squared resid	8370.832	Schwarz criterion	8.048997
Log likelihood	-233.2812	Hannan-Quinn criter.	7.963989
F-statistic	40.50523	Durbin-Watson stat	0.080438
Prob(F-statistic)	0.000000		

Overcome the Heteroscedasticity Problem

Appendix 4.7: White's Heteroscedasticity-Consistent Standard Errors & Covariance

Dependent Variable: HP
Method: Least Squares
Date: 03/04/15 Time: 14:23
Sample: 1999Q1 2013Q4
Included observations: 60
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RGDP	0.011894	0.001202	9.893669	0.0000
RINR	5.907803	2.952897	2.000680	0.0503
UE	-4.207088	1.132515	-3.714818	0.0005
C	-13.10015	28.13265	-0.465656	0.6433

R-squared	0.684535	Mean dependent var	142.4637
Adjusted R-squared	0.667635	S.D. dependent var	21.20717
S.E. of regression	12.22617	Akaike info criterion	7.909374
Sum squared resid	8370.832	Schwarz criterion	8.048997
Log likelihood	-233.2812	Hannan-Quinn criter.	7.963989
F-statistic	40.50523	Durbin-Watson stat	0.080438
Prob(F-statistic)	0.000000		

Overcome the Autocorrelation & Heteroscedasticity Problems through Transformation of Model

Appendix 4.8: Log-Log Model

Dependent Variable: LOG(HP)
Method: Least Squares
Date: 01/29/15 Time: 21:02
Sample: 1999Q1 2013Q4
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(RGDP)	1.206947	0.092585	13.03614	0.0000
LOG(RINR)	0.229302	0.055198	4.154203	0.0001
LOG(UE)	-0.125711	0.053722	-2.340013	0.0229
C	-6.577431	0.916113	-7.179716	0.0000

R-squared	0.785446	Mean dependent var	4.947497
Adjusted R-squared	0.773952	S.D. dependent var	0.156116
S.E. of regression	0.074225	Akaike info criterion	-2.299104
Sum squared resid	0.308520	Schwarz criterion	-2.159481
Log likelihood	72.97311	Hannan-Quinn criter.	-2.244489
F-statistic	68.33544	Durbin-Watson stat	0.159585
Prob(F-statistic)	0.000000		

Log-Log Model (Diagnostic Checking)

Appendix 4.9: Multicollinearity Problem

Auxiliary Model – Log(RGDP) & Log(RINR)

Dependent Variable: LOG(RGDP)
Method: Least Squares
Date: 01/29/15 Time: 21:04
Sample: 1999Q1 2013Q4
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(RINR)	-0.399053	0.040746	-9.793599	0.0000
C	10.01536	0.056343	177.7575	0.0000

R-squared	0.623168	Mean dependent var	9.480285
Adjusted R-squared	0.616670	S.D. dependent var	0.172253
S.E. of regression	0.106648	Akaike info criterion	-1.605797
Sum squared resid	0.659683	Schwarz criterion	-1.535985
Log likelihood	50.17390	Hannan-Quinn criter.	-1.578489
F-statistic	95.91458	Durbin-Watson stat	0.176984
Prob(F-statistic)	0.000000		

Auxiliary Model – Log(RGDP) & Log(UE)

Dependent Variable: LOG(RGDP)
Method: Least Squares
Date: 01/29/15 Time: 21:04
Sample: 1999Q1 2013Q4
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(UE)	0.399533	0.056693	7.047362	0.0000
C	8.766046	0.102677	85.37519	0.0000

R-squared	0.461294	Mean dependent var	9.480285
Adjusted R-squared	0.452006	S.D. dependent var	0.172253
S.E. of regression	0.127513	Akaike info criterion	-1.248426
Sum squared resid	0.943060	Schwarz criterion	-1.178615
Log likelihood	39.45279	Hannan-Quinn criter.	-1.221119
F-statistic	49.66532	Durbin-Watson stat	0.048878
Prob(F-statistic)	0.000000		

Auxiliary Model – Log(RINR) & Log(UE)

Dependent Variable: LOG(RINR)
Method: Least Squares
Date: 01/29/15 Time: 21:04
Sample: 1999Q1 2013Q4
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(UE)	-0.910876	0.095092	-9.578892	0.0000
C	2.969210	0.172223	17.24052	0.0000

R-squared	0.612701	Mean dependent var	1.340848
Adjusted R-squared	0.606024	S.D. dependent var	0.340752
S.E. of regression	0.213882	Akaike info criterion	-0.214020
Sum squared resid	2.653238	Schwarz criterion	-0.144209
Log likelihood	8.420601	Hannan-Quinn criter.	-0.186713
F-statistic	91.75517	Durbin-Watson stat	0.260163
Prob(F-statistic)	0.000000		

Appendix 4.10: Autocorrelation Problem – LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	168.6932	Prob. F(2,54)	0.0000
Obs*R-squared	51.72173	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 01/29/15 Time: 21:07
Sample: 1999Q1 2013Q4
Included observations: 60
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(RGDP)	-0.074449	0.038927	-1.912518	0.0611
LOG(RINR)	-0.050117	0.023210	-2.159292	0.0353
LOG(UE)	-0.017718	0.020414	-0.867968	0.3893
C	0.803139	0.389473	2.062119	0.0440
RESID(-1)	1.068898	0.135503	7.888349	0.0000
RESID(-2)	-0.126166	0.144084	-0.875642	0.3851

R-squared	0.862029	Mean dependent var	-8.64E-16
Adjusted R-squared	0.849254	S.D. dependent var	0.072313
S.E. of regression	0.028076	Akaike info criterion	-4.213148
Sum squared resid	0.042567	Schwarz criterion	-4.003713
Log likelihood	132.3944	Hannan-Quinn criter.	-4.131227
F-statistic	67.47726	Durbin-Watson stat	1.587102
Prob(F-statistic)	0.000000		

Appendix 4.11: Heteroscedasticity Problem – ARCH Test

Heteroskedasticity Test: ARCH

F-statistic	37.70295	Prob. F(2,55)	0.0000
Obs*R-squared	33.53792	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 01/29/15 Time: 21:09
Sample (adjusted): 1999Q3 2013Q4
Included observations: 58 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.001670	0.000664	2.514953	0.0149
RESID^2(-1)	0.938597	0.131845	7.118951	0.0000
RESID^2(-2)	-0.250982	0.132153	-1.899171	0.0628

R-squared	0.578240	Mean dependent var	0.005181
Adjusted R-squared	0.562903	S.D. dependent var	0.005299

S.E. of regression	0.003504	Akaike info criterion	-8.419765
Sum squared resid	0.000675	Schwarz criterion	-8.313190
Log likelihood	247.1732	Hannan-Quinn criter.	-8.378252
F-statistic	37.70295	Durbin-Watson stat	2.032347
Prob(F-statistic)	0.000000		

Appendix 4.12: Model Specification Problem – Ramsey RESET Test

Ramsey RESET Test:

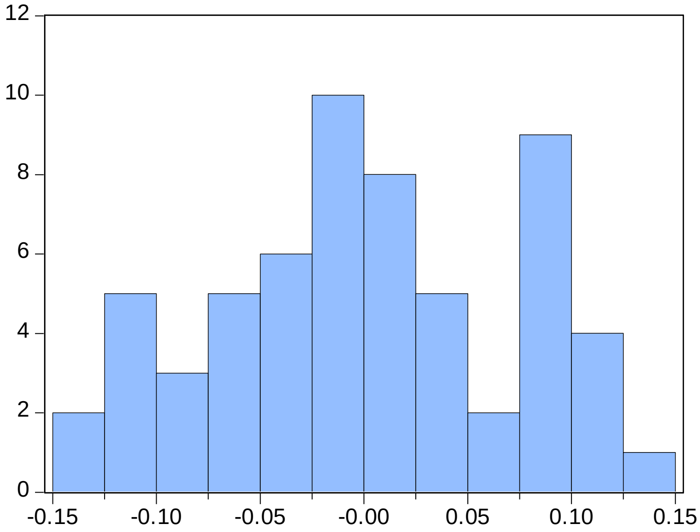
F-statistic	2.903923	Prob. F(2,54)	0.0634
Log likelihood ratio	6.129169	Prob. Chi-Square(2)	0.0467

Test Equation:
Dependent Variable: LOG(HP)
Method: Least Squares
Date: 01/29/15 Time: 21:09
Sample: 1999Q1 2013Q4
Included observations: 60

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(RGDP)	-81.36354	337.0616	-0.241391	0.8102
LOG(RINR)	-15.45497	64.03078	-0.241368	0.8102
LOG(UE)	8.425663	35.09846	0.240058	0.8112
C	543.4446	2294.883	0.236807	0.8137
FITTED^2	15.40245	56.73481	0.271482	0.7871
FITTED^3	-1.143447	3.840446	-0.297738	0.7670

R-squared	0.806281	Mean dependent var	4.947497
Adjusted R-squared	0.788344	S.D. dependent var	0.156116
S.E. of regression	0.071823	Akaike info criterion	-2.334590
Sum squared resid	0.278560	Schwarz criterion	-2.125155
Log likelihood	76.03769	Hannan-Quinn criter.	-2.252668
F-statistic	44.95081	Durbin-Watson stat	0.187260
Prob(F-statistic)	0.000000		

Appendix 4.13: Normality Test



Series: Residuals
Sample 1999Q1 2013Q4
Observations 60

Mean	-8.64e-16
Median	-0.002629
Maximum	0.130100
Minimum	-0.132590
Std. Dev.	0.072313
Skewness	-0.111856
Kurtosis	2.013578
Jarque-Bera	2.557687
Probability	0.278359