DETERMINANTS OF GOLD PRICE IN MALAYSIA

BY

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DECLARATION

We hereby declare that:

(1) This postgraduate 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.

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey Fuller test
CPI	Consumer Price Index
INF	Inflation rate
INT	Interest rate
SIC	Schwartz Information Criterion
USD	United State Dollar
VAR	Vector Autoregressive Model

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ABSTRACT

Gold's prices have been volatile in recent developments. Therefore this study will be focusing on determining factors that influence gold prices in Malaysia. Independent variables namely Malaysia's Inflation rate, Exchange Rate, Interest Rate and Brent Crude Oil Price is included. Quarterly data from 2007 Q1 to 2016 Q4 is collected for this study. Vector Autoregressive Model (VAR) as well as Multiple Linear Regression Model is formulated to compare results of the model. Empirical results showed that Malaysia's Inflation Rate, Exchange Rate and Interest Rate is significant in influencing gold price in Malaysia. However, further improvements can be done to our model in order to get better results in the future.

Chapter 1: Introduction

1.0 Introduction

Gold is a valuable asset that has been used by investors because of its hedging properties. However in recent developments gold prices have been getting volatile. This chapter will provide a brief history of gold, as well as discussing the research background, problem statement, research objectives, research questions, significance of study and chapter layout.

1.1 History of Gold

Gold has been used as a reserve of value and a way of payment since ancient times. Gold standard was introduced as a monetary system, which utilize fixed quantity of gold as the standard economic unit of account. Arthur Bloomfield, a specialist in international trade and finance, defined gold standard as "The national monetary unit which is defined in terms of a fixed quantity of gold, and could be freely exported and imported, forming a significant part of the circulating medium in the world" (Cooper, Dornbusch & Hall, 1982). The use of gold as a means of trade can be dated back to 5000 years ago in Egypt and Nubia, which is a part of Sudan. In that period around 1500BC, gold was mainly used by merchants of the Middle-East as a median of exchange. China began using golden leaflets as a means of trade as well in 1091 BC. Romans on the other hand used Aereus, a golden coin for trading in first century BC.

During 1377 AD Great Britain had introduced a new monetary system, based on both gold and silver. The gold standard is a monetary system where the issued amount of paper is tightly or loosely tied to the central bank's gold reserve. Central banks will adjust their interest rates to maintain the fixed exchange rate. The international gold standard began to gain attention in 1800s. United States adopted the gold standard on

1870s, while Great Britain had adopted the standard since 1816 (“Gold Standard”, 2003.). It is Great Britain that made the gold standard popular. As after the Napoleonic wars, Great Britain became one of the most powerful military and economic superpower in the nineteenth century, which influenced other countries such as Germany and Japan to adopt the gold standard as well (Cooper, Dornbusch & Hall, 1982).

In late nineteenth century, most countries were adopting bimetallic standard, which were the gold standard and the silver standard. Some countries were adopting silver alone, such as Mexico and China as they deemed that gold standard is unstable to be able to provide a good basis for the currency. United States on the other hand adopted a de facto gold standard in 1879, and only formally switched to the Gold Standard Act in 1990. Gold standard was adopted mainly because they faced difficulties for not adopting the standard, such as unable to attract money into their countries as well as higher inflation and investment volatility.

In the 20th century, gold standard started to lose influence in the world. During the outbreak of World War I, Great Britain decided to abandon the gold standard, so they could print more paper money to finance the war. After the war they have made some efforts in an attempt to re-adopt the gold standard but to no avail. While the gold standard started to fall off, Bretton Woods System was introduced, where currencies are tied to United States Dollar and the dollar is tied to gold by the end of the World War II. However this system was abandoned as well as the United States continued to print more and more money to finance its war in Vietnam.

During the 1970s, gold price is set to freely move in the market, with its price fluctuating depending on the market supply and demand. In 1999 Central Bank Agreement On Gold (CBGA) agreement is established to limit the sale of gold by central bank as they deemed that gold is a vital reserve asset for countries. The agreement was initially set to limit sale of gold by central banks in the world by 400 tons a year and 2000 tons in the next 5 years, but was revised in 2004 to change the amount to 500 tons a year and 2500 tons in the next 5 years (Dierinck, Frömmel, Schrauwen, & Hermans, 2012).

1.2 Research Background

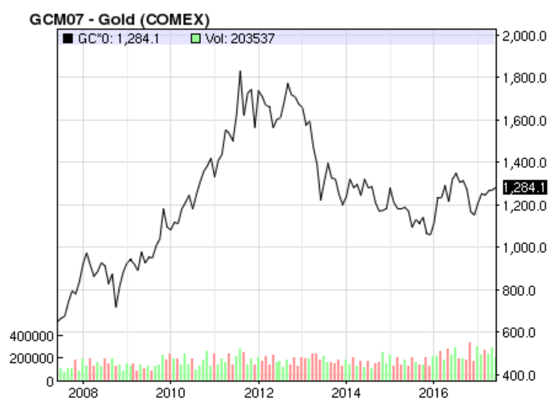
Investors are always seeking assets to create a diversified portfolio to mitigate risks faced in the market, and gold is a popular choice to be considered. Gold is a type of precious metal commonly used in transactions with its value, and has been regarded as a commodity that provides financial and material safe haven for people all over the world (Baur, 2010). It has been functioning as an alternative for paper money and investment for a long period of time. According to Sindhu (2013), gold gives a foundations for investors to better manage their own risk as well as preserving their capital more efficiently, even more so during times of financial crisis.

Since 2005, gold prices have been on a continuous rise, from $502 an ounce in 2005 to $1282 an ounce, which caught the eye of investors in the market (Kollewe, 2010). Gold has several attractive properties to investors, such as providing inflation protection, portfolio diversification and dollar hedge to counter various risks in the market. According to Baur & Mcdermott (2010), gold is proven to be a strong safe haven and a way to reduce losses when facing extreme negative market shocks or crisis. Among several commodities and precious metals that are present in the market, Gold remains as one of the most preferred commodity as an investment choice for investors (Low, Yao & Faff, 2016). Ghosh, Levin, Macmillan & Wright (2004) proved that gold is an effective long-run inflation hedge against US dollar exchange rate, meaning that gold prices will increase if dollar were to depreciate against other currencies. As evidence, gold outperformed the stock market and other currencies before and after the United States President’s election, when the market is in an unstable state (Creamer, 2016).

1.3 Problem Statement

Gold remains as a very popular investment to investors all over the world. Long (2016) indicated that China’s gold imports have risen to over 700% since 2010, and have a reserve of 1778 tons in 2015. Following the plummeting of oil prices in 2015, Gold purchases in Russia increases from 2014's 172 tons to 206 tons as investors resort to gold to hedge against risks ('Astonishing: Russian Gold', 2016). As gold is an inflation hedge and reacts positively to adverse market shocks, it gains its popularity and surging prices during financial crisis. It is no doubt that gold remains a popular commodity and investment from large and developed countries, as World Gold Council reported that China is the largest producer and miner of gold with 14% of total global production, followed by countries such as Australia, Russia and the United States. Other countries include Turkey, India, Indonesia, Thailand, United Arab Emirates (UAE) and so on. During the subprime crisis in September 2008, gold rises sharply in value as we can see from figure 1. In 2009, maximum price for gold was $1220, and it continues to rise to an all-time high of over $1660 per ounce in 2010.

Figure 1.0: End of gold futures price quotes



Source: NASDAQ

However in recent developments gold prices have been getting unstable. In mid-2015 gold prices dropped to lowest level in 2015 at $1104.90 an ounce, following the United States interest rate increase (BBC, 2015). In late 2015 gold prices rebounded, with its prices rising to US $1120 per ounce (Kamalavacini, 2015). According to president of Malaysian Indian Goldsmiths and Jewelers Association, the price of gold hit a low point in 2014, dropping from RM180 per gram to RM130 per gram.

Some investors have begun to doubt gold as a safe haven investment choice to protect them from risks. Baur & McDermott (2010) stated that gold can be an investment hedge and protection against losses, but only applies to developed markets such as European and US markets. Ghazali, Lean & Bahari (2013), stated that gold's characteristic as a hedge and safe haven is not as effective for stockholders in emerging market such as Malaysia, during stock market slump. Baur & Lucey's (2010) investigation on whether gold is a safe haven using United States, United Kingdom and Germany stocks and bonds returns showed that gold only functions as a safe haven for around 15 trading days, and that investors only buy gold on extreme negative returns.

Therefore, this paper seeks to examine the potential of Gold as an investment in Malaysia, and to construct a model which could explain the fluctuating prices of gold in recent developments.

1.4 Research Objectives

1.4.1 General Objective

This study intends to find out what are the relationship of gold prices and independent variables which are inflation rate, exchange rate and Brent crude oil prices. As gold prices have been showing volatility in their prices for recent years, this research intends to see what variables will influence gold price movements in Malaysia. Therefore this research will investigate the impact of inflation rate, brendt crude oil prices and exchange rate on gold price in Malaysia.

1.4.2 Specific Objective

i) To examine the relationship between gold price and its deterministic impact on inflation

ii) To examine the relationship between gold price and its deterministic impact on Malaysia exchange rate

iii) To examine the relationship between gold price and its deterministic impact on Brent crude oil prices

iv) To examine the relationship between gold price and its deterministic impact on Malaysia Interest Rate

1.5 Research Question

Several doubts have been discovered when examining the relationship between gold price, inflation rate, Brent crude oil prices and exchange rate in Malaysia. Crude oil market is going on an increasing trend since 2002, but has been volatile in recent periods due to oversupply in the market. As previous researchers noted that crude oil prices have some degree of impact on gold prices, it is vital to examine what are the relationship between gold price and Brent crude oil price with current developments in the economy taken into consideration. Therefore, what is the relationship that exists between gold price and Brent crude oil prices?

Other than oil price, inflation is closely related to gold prices as well. When inflation is rising, consumers in the market will turn into gold investment in order to keep the value of their money from depreciating. However in recent years gold prices have been getting unstable as well. So it is vital to examine the current relationship between gold prices and inflation rate, to determine whether gold is still an effective hedge against inflation. Therefore, what is the relationship that exists between gold price and inflation rate?

Other than that, exchange rate will exert an impact on gold prices. Gold prices are commonly denominated in United States Dollar. Therefore exchange rate movement s will surely have an impact on gold prices worldwide. In 2016, Malaysia's exchange rate has been depreciating, and currently breaches the RM3.80/USD rate that was pegged in 1997 financial crisis. Therefore, what is the current relationship that exist between gold price and exchange rate in Malaysia?

1.6 Significance of Study

Gold price is influenced by several factors in the market. While previous research such as Escribano & Granger (1997) and Zhang and Wei (2010) focuses the relationship of gold price with only one factor such as crude oil price and silver price, gold price should be regressed so that the relationships of gold price and other factors are observed. This can help to evaluate which factor is the most significant to influence gold price as well as their degree of influence.

Ordinary Least Square (OLS) technique is employed in this study to observe the relationship of gold price and independent variables such as crude oil price, exchange rate and inflation rate. Simple linear regression and multiple linear regression is formulated as well to see their relationship and check the consistency of results. Through multiple linear regression, it will display clearly which variables have more influence on gold price in general.

As gold price is getting volatile in recent developments, it is vital to determine which factor influence gold prices as gold will act as a safeguard in portfolios of investors. By determining the factors that affect gold price, it serves as a guideline for investors on whether they can continue to invest in gold to safeguard their assets.

1.7 Chapter Layout

Chapter 1 : Introduction

This chapter intends to introduce the background of gold prices. Brendt crude oil prices, inflation rate and exchange rate. This study also formulates objective, research questions and significance of the study.

Chapter 2: Literature Review

This chapter will provide reviews on past studies of gold prices. Relevant theoretical model as well as discussion from journals of previous authors is included in this chapter as well.

Chapter 3: Research Methodology

This chapter gives insight on the data collection method, definition of variables and the model formulation that is used in this study. Model that is utilized in this study will be simple linear regression and multiple linear regression.

Chapter 4: Data Analysis

This chapter discusses the results and findings after estimation has been done.

Chapter 5: Conclusion

This chapter gives a summary of this study as well as discussion for future improvements, limitation, recommendation and conclusion of the study.

Chapter 2: Literature Review

2.0 Introduction

This section focuses on reviewing past research related to gold prices that has been done by existing researchers. The chapter starts with literature review of effects of independent variables on gold prices, namely inflation rate, US Dollar trade weighted index and crude oil prices. Next, a review of theoretical model will be conducted, which will explain the rationale of gold price movements. After that, theoretical and conceptual framework will be presented to identify the relationship of variables. Finally, testable hypothesis will be formed to test the validity of the theory.

2.1 Review of Literature

2.1.1 Inflation rate (Consumer Price Index)

Gold has been widely regarded as the hedge against inflation. Inflation means that there is a decrease of value of flat money (paper, unbacked by metals). During inflation, paper currencies tend to lose their value and purchasing power. Gold on the other hand is much stable on its value, therefore investors and consumers often turn to assets that provide value and proved to be money, which is silver and gold ('Gold & Inflation', n.d.). Gold has been regarded to provide a "safe haven" against inflation as well, as some studies have shown that gold prices have inflation hedging properties (Tufail & Batool, 2013).

Gold has been getting attention as it was found to have inflation predicting properties and behavior, and was regarded as a leading indicator of inflation by past researchers (Tufail & Batool, 2013). Mahdavi and Zhou (1997) pointed out that among variables and determinants that have been tested in previous studies, gold emerge as the leading indicator of the inflation rate. Referring to findings from previous researchers, it seems that gold price (consumer price index) and inflation's relationship were found to be positive.

Ahmad & Rahim (2013) investigated on the relationship between dollar exchange rate, gold price and petrol prices on inflation using simple linear regression. The results indicated that the three variables have a strong influence on inflation, and that they have some influence on the recent increasing inflation in Pakistan.

Ghosh et.al. (2004) stated that gold prices and inflation have a positive relationship for both long run and short run movements, thus making gold an effective hedge against inflation. However, this relationship can be disrupted if other variables such as real interest rate, default risk, dollar/world exchange rate come into play.

Worthington & Pahlavani (2007) found that there is a stable long run relationship between inflation and gold prices in the United States from 1945 to 2006. There is a cointegrating relationship between both variables as well, thus indicating gold as an effective inflationary hedge.

Batten, Ciner & Lucey (2014) examined the relationship between inflation (consumer price index) and price of gold. They demonstrated that there is no cointegration relationship between inflation and gold prices if data of 1980s is included in their analysis. Gold can be regarded as an alternative for paper currency as well as a precious commodity in the market, but its role as an inflationary hedge is doubted by the authors.

Tufail & Batool (2013) analyzed the relationship between gold price and inflation in Pakistan using Vector Error Correction Model (VECM) and cointegration techniques, from year 1960-2010. Their results indicated that gold price are positively and significantly related to inflation to Pakistan, and that gold provides a complete hedge against unexpected inflation but not expected inflation. Among gold, stock exchange and real exchange, stock exchange provides a better performance in providing hedge against unexpected inflation.

Aleemi, Tariq & Ahmed (2016) investigated the relationship of gold prices, exchange rate and interest rate on inflation rate in Pakistan as well, using vector error correction model and cointegration tests. They found that gold prices is positively and significantly related with inflation of Pakistan in the long run, meaning that rise in gold prices will cause an increase in inflation rate of Pakistan.

Christie-David, Chaudhry & Koch (2000) focused on investigating news releases on gold and silver price. Through their study, they found that gold prices responded strongly to Consumer Price Index (CPI) news, with Gross Domestic Product, unemployment rate and Producer Price Index having significant effects as well.

Narang & Singh (2012) tried to investigate whether there is unidirectional or bidirectional relationship between gold and the Bombay Exchange Sensitive Index (SENSEX) through correlation and Johansen co-integration test. They found that the SENSEX index have no relationship with gold price, as the returns of SENSEX index does cause increase or decrease in gold price vice versa. The author notes that the correlation of stock returns and gold price started to fade after the economic crisis in 2008.

Overall, it is expected that gold price in Malaysia have a positive relationship with inflation rate, as several researchers have proven that gold is an effective hedge against inflation, therefore increasing inflation will cause gold price to rise because of increasing demand. However, some findings indicated that gold price have no relationship with inflation rate, especially in emerging countries.

2.1.2 Exchange Rate (MYR/USD)

The US Dollar exchange rate has significant influence on gold prices. Before currency was introduced and adopted by the world, the gold standard is the monetary system, in which the standard economic unit of account is based on a fixed quantity of gold. Gold is often used as a hedge against currency, as when dollar’s exchange value decreases, it takes more dollars to buy gold, which increases value of gold (Nair, Choudhary & Purohit, 2015). Sujit and Kumar (2011) indicated that the US Dollar will influence gold price, as gold price is generally denominated in US Dollar. The exchange rate, MYR per USD is used in order to observe the effect of fluctuations of exchange rate in Malaysia on gold price of Malaysia.

According to Sjaastad (2008), it is found that gold prices are unstable because of fluctuations of currencies. Appreciations and depreciation of US Dollar have strongest effects on the price of gold, and that gold should not be considered as a store of value against world inflation anymore.

Chin's (2011) study on the relationship of gold price and various ASEAN exchange rates through Vector Error Correction Model (VECM) showed that there is a long term relationship between gold prices and exchange rate of MYR/USD, SGD/USD and THB/USD. Gold prices exhibit positive relationship with MYR/USD exchange rate.

Haque, Topal & Lilford's (2015) study on gold price and Australian dollar-US dollar relationship found that the two variables have a strong positive correlation, with one percent increase in gold price leading to 0.5% increase in AUD/USD exchange rate. Vector Autoregression (VAR) test showed that there is bi-directional causality between the two variables as well.

Azar (2015) studied on the relationship between United States gold prices, oil prices and stocks with the trade-weighted US dollar exchange rate. The author found that the law of one price applies to gold, oil and stock prices with US dollar exchange rate, stating that there is an inverse relationship between US dollar and the three variables. When US dollar appreciates, the three assets should fall by the same amount as these assets are denominated in US dollars.

Samantha and Zadeh (2012) investigation of co-movement of gold prices, real exchange rate of US dollar, stock index and oil price found that the exchange rate is more likely to be affected by other variables in the economy, while gold prices have the tendency to move on its own.

Nair, Choudhary, & Purohit's (2015) investigation on relationship of exchange rate and gold prices in India using Vector Auto Regression (VAR) and co-integration test showed inconclusive results. They stated that their relationship was impacted and disrupted by recession in India, USD appreciation after recession as well as stressful global macroeconomic scenario.

Omag's (2012) investigation on the relationship of gold prices and various economic variables including exchange rate using regression model showed that gold prices demonstrated strong positive relationship with Istanbul Stock Exchange 100 Index and the exchange rate between Turkish Lira and the Dollar.

Overall, exchange rate should exhibit a positive relationship with exchange rate. As the value of exchange rate (MYR/USD) increases, the currency of Malaysian Ringgit depreciates. Therefore investors and consumers in the market will switch to gold in order to prevent the loss of value in their money.

2.1.3 Brent Crude Oil Prices (USD per barrel)

Crude oil is one of the factors that is related to inflation. According to Sindhu (2013), economy will always fall into a recession when crude oil prices increase, as it puts inflation pressure on the economy. To counter the pressure, investors and consumers hedge inflation by investing in gold. In recent developments we have seen crude oil prices getting more volatile, with its value dropped from over $100 per barrel in 2014 to $35-$40 per barrel in 2017. As crude oil prices are getting unstable, we are interested to see how the investor will react to the market, and whether they will turn their attention to gold in order to preserve their value or to stabilize their portfolios.

Arfaoui and Ben (2016) examined the relationship and interdependency of gold prices, stock prices, oil prices and the US dollar exchange rate using simultaneous equations systems. The results indicated that gold price is affected by the volatility in oil prices, stock prices and the US dollar exchange rate. The four variables exhibit significant relationship and interdependencies between each other.

Sujit and Kumar (2011) examined the dynamic relationship between gold prices, crude oil prices, US dollar exchange rate and stock price index using time series data and Vector Auto Regressive (VAR) model. It is found that fluctuation in gold prices will influence the WTI crude oil prices and exchange rate. Other than that, the author stated that there is presence of cointegration relationship between these variables, and that they have a weak long run relationship. The author also emphasized that changes in the US dollar exchange rate will affect gold prices as gold prices are generally denominated in US dollars.

Nirmala (2015) investigated the relationship between gold and crude oil prices through correlation analysis and gold-oil ratio. The results show that gold prices and crude oil price have a positively correlated relationship. The author states that it is because gold and oil are denominated in US dollars in the global market.

Weng (2011) analyzed the relationships between crude oil price, gold price, exchange rate and international stock market index in US, Japan, Hong Kong, Singapore and Malaysia using Vector Error Correction model, Variance Decomposition and Impulse Response Function. The results show that the four variables have a long term and stable equilibrium relationship, as well as multiple short term relationships between the variables. The author noted that these four variables are inter-related with each other.

Samantha & Zadeh (2012) analyzed the co-movements of return and volatilities of gold prices, US dollar exchange rate, oil prices and stock prices in the market using vector auto regression model. They found that there is existence of co-movements among variables, but the variables are not necessarily moving simultaneously. Gold prices and stock index is more likely to be independent and move on their own, while the US dollar exchange rate and oil price are more likely to be influenced by other variables.

Overall, Brent crude oil price is likely to have a positive relationship with gold price. As crude oil prices increases indirectly indicates inflation in the market. Therefore gold price should have a positive relationship with Brent crude oil price, as when oil price increase, the volatility in the market will cause investors to revert to gold for the stability of their portfolio.

2.1.4 Interest Rates

Gold price is related with interest rates. According to the World Gold Council (2013), gold price responded to United States interest rates through investment channels, as global investment from all around the world constitutes over 25% of gold demand. United States and Europe's markets have a high influence on gold prices because of their accessibility as well as the sheer size of the transactions done in their markets. In general, World Gold Council (2013) stated that lower interest rates will stimulate the gold and jewelry market; however this may not hold for emerging markets, as they are lacking access to financial services.

Abdullah (2013) examined the relationship of interest rates and gold prices through Gibson's Paradox. Gibson's Paradox is an observation in which the prices of goods and commodities are positively correlated with interest rates around the world. Through their observations in patterns of United States and England, it is concluded that gold standard, interest rates and other commodities prices are positively correlated. The relationship of interest rates and gold prices is inversed in the United States.

Boris (2015) examined the relationship between gold price and United States long term interest rate as well as short term interest rates through correlation analysis. He found that interest rate rising in the United States can lead to a lower price of gold. However, the author stated as well their approach to examine this relationship is flawed, and should be revised to reach better conclusions.

Ghosh, Levin, Macmilan & Wright (2004) investigated the relationship between price of gold and various independent variables such as interest rates, inflation rate and gold lease rate through co-integration regression techniques. They found that variables such as real interest can cause a disruption in the equilibrium price of gold, causing volatility of gold's price. Short run relationship of gold is more significant compared to long run.

Baber, Baber & Thomas (2013) investigated relationship of gold price and interest rates from 2002 to 2012 through correlation methods. They found that an interest rates increase will cause an increase the gold price in general.

Interest rates in general should exhibit a negative relationship with gold prices. As interest rates increases, consumers and investors are more likely to invest in fixed deposits to gain more returns.

Summarizing findings form the researchers, the expected relationship of independent variables and gold price in Malaysia is expected as follow:

Table 1.0 Expected Relationship of Variables

Variable	**Expected Relationship**
Inflation Rate (CPI Index)	Positive
Exchange Rate (MYR/USD)	Positive
Brent Crude Oil Price (USD per barrel)	Positive
Interest Rate (%)	Negative

2.2 Review of Relevant Theoretical Model

Sari, Hammoudeh & Soytas (2009) stated that the theory of co-movements and information transmission is sufficient in explaining the relationship between two commodities, which is how Brent crude can be related to gold price.

On the other hand, the carrying cost hypothesis and expected inflation effect hypothesis is sufficient to explain the impact of inflation on volatility of gold price. It suggested that there is a relationship between gold prices, interest rates and expected inflation. Carrying cost includes the cost of holding physical assets (gold), including maintenance cost, storage cost, opportunity cost and so on. Carrying cost will be able to offset speculation benefits on the market, and contributes to the unexpected changes in the consumer price index (Blose, 2009). Besides, the expected inflation hypothesis states that investors will purchase assets such as gold to hedge against inflation or speculate for increase in gold price, if they expect an upcoming inflation in the future. This theory suggest that gold price have a positive relationship with gold price, as investors with knowledge or good at predicting inflation can benefit from the inflation by buying and selling gold.

Furthermore, efficient market theory is able to explain the volatility of gold price in the market. As information transmission in the modern era is efficient and swift, gold is volatile as it reacts to volatility of other commodities and exchange rate.

2.3 Hypothesis Development

2.3.1 Gold Price and Inflation Rate

$H_0 \ : \ \beta_1 = 0$ (There is no relationship between Malaysia's gold price and Inflation Rate)

$H_1 \ : \ \beta_1 =/= 0$ (There is a relationship between Malaysia's gold price and Inflation Rate)

Consumer price index (CPI) is used as a proxy for inflation rate, as it is commonly used and easily understandable to calculate the price change in goods and services. When there is a rising inflation, it is commonly agreed that gold price will increase as it is a better option to hedge against inflation or used as a store of value. Gold is most likely to outperform other financial instruments when the economy is experiencing inflation (Dempster & Artigas, 2010).

2.3.2 Gold Price and Exchange Rate

$H_0 : \beta_1 = 0$ (There is no relationship between Malaysia's gold price and Exchange Rate)

$H_1 : \beta_1 =/= 0$ (There is a relationship between Malaysia's gold price and Exchange Rate)

Gold is commonly used as a hedging tool for inflation in various countries. Gold is a safe alternative to lower down risk of investor's portfolio as well as providing stability (Aftab, Shah & Ismail, 2017). The Asia market understands benefits of gold commodity as well, as they have large gold stocks in their reserve (Ziaei, 2012). As Malaysia is a part of Asia, this study is interested to find out whether Malaysia can benefit from the purchase of gold to hedge against currency volatility in the market.

2.3.3 Gold Price and Brent Crude Oil Price

$H_0 : \beta_1 = 0$ (There is no relationship between Malaysia's gold price and Brent Crude Oil Price)

$H_1 : \beta_1 =/= 0$ (There is a relationship between Malaysia's gold price and Brent Crude Oil Price)

Crude oil plays an important role in the industrial field as well as the overall economy. Historically, gold was related to oil as the purchases of oil were paid in gold ('What is the', n.d.). Other than that, oil price volatility also heavily influences the overall economy. As crude oil prices is getting below $50 per barrel during recent developments, it will certainly have an effect on economy (Roubini, 2004)

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2.3.4 Gold Price and Interest Rate

H_0 : $\beta_1 = 0$ (There is no relationship between Malaysia's gold price and Interest Rate)

H_1 : $\beta_1 =/= 0$ (There is a relationship between Malaysia's gold price and Interest Rate)

Beckmann & Czudaj (2013) stated that there is a highly significant negative relationship between interest rates and price of gold in the United States. It is generally perceived that when interest rate is high, investor will hold lesser amount of gold and more financial assets in order to reap the benefits of higher interest rates. Therefore this study intends to investigate whether this relationship is present in the Malaysian financial market.

Chapter 3: Methodology

3.0 Introduction

This chapter intends to shed light on the research methodology used to examine the hypothesis developed from previous chapter. First, Simple and Multiple Linear Regression model is developed to analyze the relationships that are present between our dependent variable, gold price and the independent variables, which are inflation rate, crude oil prices and USD/MYR nominal exchange rate. Ordinary Least Square (OLS) technique is used in our study. Diagnostic checking is included as well to make sure that the model is free from errors. Finally, log-log model is constructed to further reduce errors that may be present in the model.

3.1 Description of Data

In this research, data of gold price, crude oil price, MYR/USD nominal exchange rate as well as Consumer price index (Inflation rate) is collected. Monthly time series data from January 2007 to December 2016 is collected with a total of 120 observations for each variable. Gold Prices are obtained from central bank of Malaysia, Bank Negara Malaysia. The gold price is denominated in RM per ounce. Inflation rate is denominated as Consumer price index. Bent Crude Oil Prices are denominated in US dollar per barrel. MYR/USD nominal exchange rate is included in this study as well.

3.2 Analysis Flow

This section describes the flow of methodology that will be carried out in this study.

1. Unit Root Test

In the first part of the study, unit root test will be conducted to check the whether the data collected is stationary or not. This is important as multiple linear regression required stationary data in order to be efficient and avoid spurious regression. This is a requirement for vector autoregressive as well.

2. Vector Autoregressive Model

Next, vector autoregressive model will be formulated. Lag length selection, johansen cointegration test, variance decomposition as well as impulse response function will be conducted in order to analyze and discuss the results given.

3. Multiple Linear Regression

$$Y_{Gold\ Price} = \beta_0 + \beta_1 X_{1(inflation\ rate)} + \beta_2 X_{2(Crude\ oil\ price)} + \beta_3 X_{3(Exchange\ Rate)}$$

Multiple linear regression is intended to capture possible factors that are affecting gold price, as gold price can be influenced by different factors at once. Multiple linear regression is used to check consistency of results with simple linear regression as well.

3.3 Unit Root Test

Zivot & Wang (2005) pointed out that economic and financial time series data tends to be non-stationary, thus unit root test should be conducted to test whether the data is stationary before performing analysis. Phoong & Tahir (2014) stated that stationary test allows the transformation of non-stationary variables to become stationary using first difference. In this study, Augmented Dickey Fuller (ADF) test will be used in order to test the stationary of data. Regression of ADF is shown as below:

$$\Delta\sum_{j=1}^{k-1} \beta_j \Delta\varkappa_{t-j} + \epsilon_t$$

where as,

Δ = the difference operator,

β_j, where $\beta_1, \dots \dots, \beta_k$ = estimate based on t-statistics test,

ϵ_t = white noise

The hypotheses testing for ADF test is shown as below,

H_0: β = 0 or the series has unit root / it has non stationary in time series,

H_1: β≠ 0 or the series has no unit root / it has stationary in time series.

Next, the ADF test t-statistics is estimated by least square method where the formula has been shown as below,

$$ADF_t = t_{\beta=1} = \frac{\beta-1}{SE(\beta)}$$

If the t-statistics is larger or greater than the critical value, the null hypothesis (H_0) can be rejected, otherwise do not reject H_0. If the data is non-stationary, then method of transformation can be applied through difference-stationary process or trend-stationary process to transform the non-stationary series to stationary series (Phoong & Tahir, 2014).

3.4 Vector Autoregressive model (VAR)

Vector autoregressive model is a common statistical model used in financial and econometric research. It is a statistical method that is used to capture the linear interdependencies among multiple time series (Stock & Watson, 2001). Each variable in a VAR model is a linear function of past lags of itself as well as past lags of other variable. Compare with other econometric models and methods, VAR is easily justified, and requires lesser assumptions compared to other econometric methods (Vu, Liu, Thomas, Hazel, 2016).

VAR model can be expressed as below:

$$A_t = B_1 A_{t-1} + B_2 A_{t-2} + \cdots + B_n A_{t-n} + \varepsilon_t$$

Where

A_t represent the endogenous variable at time period of t,

B_t (i=1, 2, 3,….,p) are coefficient vectors,

n represent the number of lags included in the model,

$\varepsilon_t$represent vector of error term.

3.4.1 Impulse Response Function

Impulse response function is used to examine how a variable reacts when under shock of another variable. Impulse response function is able to trace the changes of the dependent variable. Through impulse response function, it allows seeing which shocks are affecting other variable, or it is affecting the variables itself. This study includes impulse response function to have a better view of the research variables and how they react to shocks of another variable.

3.4.2 Variance Decomposition

Variance decomposition is required to interpret the results of vector autoregressive model once it has been fitted. Through variance decomposition, it can be observed how a variable adjust under the effect of individual shock or exogenous shock to the other variable. This is to determine and allow the researcher to observe which independent variable is affecting the dependent variable in the VAR model.

3.4.3 Diagnostic Checking

3.4.3.1 Autocorrelation

Autocorrelation, or serial correlation, is where a time series data is influenced by its own lagged values. To detect the problem of autocorrelation in the regression model, Breusch-Godfrey Serial Correlation LM Test will be carried out, comparing generated p-value of F-statistic with α at significance level 5%.

H_0 : There is no autocorrelation problem.

H_1 : Autocorrelation problem is present in the regression model.

Decision: Reject H_0 if p-value is smaller than the critical value. Otherwise do not rejectH_0 .

3.4.3.2 Heteroskedasticity

Heteroskedasticity refers to variance of an independent variable is inconsistent across a range of values during estimation (Gujarati, 2009). To detect heteroskedasticity in the regression model, White heteroskedasticity test will be used. Hypothesis testing to test heteroskedasticity is stated as:

H_0 : Homoscedasticity.

H_1 : Heteroskedasticity problem is present in the regression model.

Decision: Reject H_0 if p-value is smaller than the critical value. Otherwise do not reject H_0 .

3.5 Multiple Linear Regression Model

Gold Price = f (Inflation Rate, Brendt Crude Oil Price, Exchange Rate)

$Y_{Gold\ Price} = \beta_0 + \beta_1 X_{1(inflation\ rate)} + \beta_2 X_{2(Crude\ oil\ price)} + \beta_3 X_{3(Exchange\ Rate)}$

$LOG(G\hat{O}LD_t) = \beta_0 + \beta_1 LOG(INF_t) + \beta_2 LOG(OIL_t) + \beta_3 LOG(EXR_t) + \beta_4 LOG(INT_t)$

Where

$LOG(G\hat{O}LD_t)$ = Logarithm of Gold Price (RM/Ounce).

$LOG(INF_t)$ = Logarithm of Malaysia Inflation Rate

(Consumer Price Index, Year 2010=100)

$LOG(OIL_t)$ = Logarithm of Brendt Crude Oil Price (USD/barrel).

$LOG(EXR_t)$ = Logarithm of Malaysia Exchange Rate (MYR/USD).

$LOG(INT_t)$ = Logarithm of Malaysia Interest Rates.

Multiple Linear Regression is adopted in this study in order to determine what factors will affect Gold Price at once. Consistency of variables is checked by comparing the results of multiple linear regression and simple linear regression. Logarithm transformation of gold price and independent variables is used as log transformation is effective in stabilizing variance in a series of data, as well as reducing the problem of heteroscedasticity and autocorrelation (Lutkepohl & Xu, 2012).

3.5.1 Assumptions of Ordinary Least Squares

To be able to estimate multiple linear regression model through Ordinary Least Squares, 10 assumptions of Ordinary Least Squares need to be fulfilled (Gujarati, 2009).

1. Number of Observations (n) greater than number of Parameters (k).

According to Gujarati (2009), the number of observations included in an estimation or regression must be greater than the number of parameters (explanatory variables) in a regression ($n > k$). The number of observations included in this study is greater than the number of independent variables of the regression model. Therefore this study fulfills this assumptions of Ordinary Least Square.

2. Homoskedasticity

According to Gujarati (2009), conditional variance of the error term must be constant in all x and over time. This implies that model uncertainty is identical across observations. If there is heteroskedasticity (variance of error term varies across observation) detected, regression coefficients will be biased and the inference will not be valid.

3. The Expected value of Error term is Zero across observations

According to Gujarati (2009), the expected value of error term or the conditional mean of disturbance term must be zero across observations. In other words, $E(ui \mid Xi) = 0$. This ensures that specification bias is absent in the estimation.

.4. Linear in Parameters alpha and beta

The dependent variable in a regression must be a linear function of a set of independent variable and a random error component. Non-linear regression breaches the assumption of Ordinary Least Squares and cannot be estimated through OLS (Gujarati, 2009).

5. There is no Serial Correlation in the regression

Gujarati (2009) stated that serial correlation or autocorrelation should not exist in a regression in order to use Ordinary Least Squares. Error term must be independently distributed and not correlation. There should not be correlation between observations of the dependent variables as well. In other words, Cov ($\varepsilon_i, \varepsilon_j$) = E ($\varepsilon_i, \varepsilon_j$) = 0, i =/= j.

6. X variables are not correlated with error term

Since Xi is deterministic, it must not be correlated with the error term and should be fixed in repeated sampling. In other words, X values are assumed to be non-stochastic, and should exert impact on dependent variables. This is due to the fact that causal relationship is intended to be studied, not correlation of the variables. Other than that, the statistical result of linear regression based on the case of fixed regressors will be valid even if the X values were fixed.

3.5.2 Additional assumptions of Multiple Linear Regression

According to Gujarati (2009), other than the assumptions of simple linear regression, additional assumptions need to be fulfilled by multiple linear regression model to get the best linear unbiased estimator (BLUE).

1. No Specification Bias

According to Gujarati (2009), model used in regression analysis must contain no specification error, which may occur if important variables are ignored or adding unnecessary unimportant variables.

2. No perfect Multicollinearity

Other than that, multicollinearity problem should not exist in Multiple Linear Regression.

3.5.3 Least-Squares Estimators Properties

According to Gauss-Markov Theorem, a few conditions of the least square estimators need to be fulfilled so that OLS estimators can be BLUE and unbiased.

1. It is a linear function of a random variable. For example, X independent variable is a linear function of Y dependent variable.
2. The Estimated value is equal to its true value.
3. Variance is to be at minimum in all class of linear unbiased estimator, making it an efficient estimator.

3.5.4 Overall Model Significance Test (F-Test)

H_0 : $\beta_1 = \beta_2 = \beta_3 = \beta_4 = 0$

H_1 : At least one β is not zero.

Critical value at $\alpha = 0.05$

Decision rule: Reject H_0 if F-statistic is larger than critical value. Otherwise do not rejectH_0 .

F-test is utilized in order to identify whether the model is significant to explain gold price variations.

3.5.5 Diagnostic Checking (Multiple Linear Regression)

After estimating simple regression model and multiple regression model, diagnostic checking is carried out in order to detect errors such as multicollinearity, model misspecification, autocorrelation and heteroscedasticity.

3.5.5.1 Multicollinearity

To detect whether multicollinearity is present in the regression model, Variance Inflation Factor (VIF) value is calculated. VIF = ($\frac{1}{1-R^2}$). Other than the informal way of observing high r-squared value with only few significant t-ratios to spot multicollinearity, variance inflation factor is another more effective way to detect multicollinearity problem. Highly correlated pair of variables will be regressed to determine the VIF value again, if multicollinearity problem is found to be existent in the regression model (Gujarati, 2009). The commonly accepted VIF value for regression model is less than 10, as several researches have indicated 10 as a maximum acceptable value of VIF (Kennedy, 1992; Neter, Wasserman & Kutner, 1989, Marquardt, 1970). VIF value of 10 or more than 10 indicates that there is multicollinearity problem.

3.5.5.2 Model Misspecification

Model misspecification means that the regression model is constructed wrongly, by including irrelevant variables, omitting important variables, using the wrong functional form or incorrect specifications. Consequences of model misspecification are that the model can have biased coefficient and error terms (Gujarati, 2009). In this study, model misspecification problem will be identified by using Ramsey RESET test with significance level at 5%. Hypothesis testing will be conducted.

H_0 : There is no model misspecification problem

H_1 : Model misspecification problem is present in the regression model.

Decision: Reject H_0 if p-value is smaller than the critical value. Otherwise do not reject H_0 .

3.5.5.3 Autocorrelation

Autocorrelation, or serial correlation, is where a time series data is influenced by its own lagged values. To detect the problem of autocorrelation in the regression model, Autocorrelation LM Test will be carried out, comparing generated p-value of F-statistic with α at significance level 5%.

H_0 : There is no autocorrelation problem.

H_1 : Autocorrelation problem is present in the regression model.

Decision: Reject H_0 if p-value is smaller than the critical value. Otherwise do not reject H_0 .

3.5.5.4 Heteroskedasticity

Heteroskedasticity refers to variance of an independent variable is inconsistent across a range of values during estimation (Gujarati, 2009). To detect heteroskedasticity in the regression model, Autoregressive conditional heteroskedasticity (ARCH) test will be used. Hypothesis testing to test heteroskedasticity is stated as:

H_0 : There is no heteroskedasticity problem.

H_1 : Heteroskedasticity problem is present in the regression model.

Decision: Reject H_0 if p-value is smaller than the critical value. Otherwise do not reject H_0 .

3.6 Conclusion

Eviews will be used to run statistical test listed in this chapter. The data from diagnostic checking will be obtained from Eviews as well to check for errors in the regression models. In the next chapter, the results obtained from Eviews will be analyzed to prove the hypothesis listed.

Chapter 4: Data Analysis

4.0 Introduction

This chapter will present the results obtained from estimation as well as discuss the output of the results. First, descriptive statistic of the data is presented, which includes mean, median, maximum, minimum, standard deviation, variance, skewness and kurtosis. The next section will focus on results on unit root test through Augmented Dickey Fuller (ADF) test to determine stationarity of data. Results of Johansen Cointegration test and results of Vector Autoregressive Model is presented in the following part.

4.1 Descriptive Statistics

Table 2.0 Descriptive Statistics Results

	LOGOFGOLD	LOGOFINTEREST	LOGOFOIL	LOGOFEXRATE	LOGOFCPI
Mean	8.296810	1.077894	4.367520	1.228153	4.646731
Median	8.367416	1.098612	4.438692	1.193995	4.647750
Maximum	8.625689	1.258461	4.885223	1.494543	4.758749
Minimum	7.209340	0.688135	3.637849	1.107539	4.523960
Std. Dev.	0.286833	0.162229	0.363919	0.105980	0.066779
Skewness	-1.646489	-1.361668	-0.548202	1.047566	-0.089483
Kurtosis	6.523520	4.037187	2.080680	3.146646	2.023772
Jarque-Bera	38.76483	14.15386	3.412084	7.351807	1.641749
Probability	0.000000	0.000844	0.181583	0.025327	0.440047
Sum	331.8724	43.11577	174.7008	49.12611	185.8692
Sum Sq. Dev.	3.208647	1.026410	5.165040	0.438036	0.173916
Observations	40	40	40	40	40

Mean is computed by summing all values of the data and dividing the number of observations in the group. Total observations of this study are 40, which is quarterly data of all variables. The mean value is shown in the table above.

Median is the midpoint of a set of data. It is at the point at which one half of the data.

Minimum of the sample is the smallest data in the whole sample, and Maximum will be the largest data in the sample.

Standard deviation shows the amount of variability inside a series of data. The larger the value of standard deviation, the larger the average distance each data point is from the mean of distribution.

Skewness is to measure the symmetry of the time series. When the mean of distribution is more than median, the skewness value will be positive. When the mean is less than the median, the skewness value will be negative.

4.2 Augmented Dickey Fuller Test (ADF)

The table below shows individual results of ADF test of 5 variables included in this study, taken from Eviews.

Table 3.0: Augmented Dickey Fuller Test results

Variables	**Level** -T-statistic -p-value	**First Difference** -T-statistic -p-value
LOG(GOLD)	-2.269046 0.1867	-9.224878 0.0000
LOG(CPI)	-0.900175 0.7774	-5.820169 0.0000
LOG(EXRATE)	0.220555 0.9705	-4.944179 0.0003
LOG(OIL)	-1.829097 0.3614	-5.251826 0.0001
LOG(INTEREST)	-.2300897 0.1782	-4.762886 0.0006

H_o: β = 0, The series has unit root / The time series is stationary.

H_1: β≠ 0, The series has no unit root / The time series is non-stationary.

Decision rule:

Reject H0, if the p-value is smaller than level of significance at α = 0.05. Otherwise do not reject H0.

Referring to table 4.2, logarithm transformation of variables included in this study, namely Malaysia gold price, Malaysia inflation rate, exchange rate, brendt crude oil price and Malaysia interest rate is all non-stationary at level. All of the p-values is larger than level of significance (p>0.05).

However, the time series data of the variables becomes stationary when it is integrated order (1), or first differenced. To get stationary data to be used in Vector Autoregressive model, the variables shall be first differenced as it shows no unit root at first difference.

4.3 Vector Autoregressive (VAR)

4.3.1 Optimum Lag Length Selection

There are several ways to determine lag length for Vector Autoregressive mode (VAR) or Vector Error Correction model. The most common method used is through Akaike Information Criterion (AIC) and Schwartz Information Criterion (Ozcicek, 1999). This study will refer to Schwartz Information Criterion for the selection of lag length, The lag length with smallest SIC value will be selected.

Table 4.0: Schwartz Information Criteria Results

Lag	Schwartz Information Criteria (SIC)
0	-8.010476
1	-14.43492**
2	-13.71325
3	-13.13822
4	-12.65858
5	-13.94597

Based on table 4.3, the lowest SIC value is from lag 1, therefore the optimum lag selected should be lag 1.

4.3.2 Johansen Cointegration Test

Table 4.4: Johansen Cointegration Test Results

Date: 08/10/17 Time: 17:16
Sample (adjusted): 2007Q3 2016Q4
Included observations: 38 after adjustments
Trend assumption: Linear deterministic trend
Series: LOGGOLD LOGEXRATE LOGINT LOGOIL LOGCPI
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None	0.471284	52.56467	69.81889	0.5244
At most 1	0.313738	28.34714	47.85613	0.7984
At most 2	0.168921	14.04031	29.79707	0.8384
At most 3	0.163552	7.009166	15.49471	0.5766
At most 4	0.005844	0.222705	3.841466	0.6370

Trace test indicates no cointegration at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

H_o: β = 0, There is no cointegration in the series.

H_1: β≠ 0, Cointegration is present in the series.

Decision rule:

Reject H0, if the p-value is smaller than level of significance at α = 0.05. Otherwise do not reject H0.

According to Johansen Cointegration test, there is no cointegration at 5% level of significance. Therefore Vector Autoregressive Model shall be used instead of Vector Error Correction Model.

4.3.3 VAR Model

From the results computed from Eviews, the estimated VAR model will be:

$LOG(\hat{GOLD_t})$ = -3.533996 + 0.409384 $LOGGOLD(-1)$ + 2.251765 $LOGCPI(-1)$ - 0.965681$LOGEXRATE(-1)$ - 0.143701$LOGOIL(-1)$ – 0.183316$LOGINT(-1)$

Where

$LOG(\hat{GOLD_t})$ = Logarithm of Gold Price (RM/Ounce).

$LOG(CPI_t)$ = Logarithm of Malaysia Inflation Rate (Consumer Price Index, Year 2010=100)

$LOG(EXRATE_t)$ = Logarithm of Malaysia Exchange Rate (MYR/USD).

$LOG(OIL_t)$ = Logarithm of Brendt Crude Oil Price (USD/barrel).

$LOG(INT_t)$ = Logarithm of Malaysia Interest Rates.

4.3.4 Variance Decomposition

Table 4.5 Variance Decomposition of LogofGold

Variance Decomposition of LOGOFGOLD: Period	S.E.	LOGOFGOLD	LOGOFEXRATE	LOGOFCPI	LOGOFINTEREST	LOGOFOIL
1	0.083917	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.098548	91.47743	0.114997	2.693575	1.674490	4.039511
3	0.110478	92.10740	1.030138	2.152730	1.495358	3.214379
4	0.129841	82.46963	3.385089	1.962842	2.879849	9.302589
5	0.137203	79.92916	6.165629	2.119853	3.427903	8.357454
6	0.145568	75.54073	5.954120	2.195983	3.396868	12.91230
7	0.151142	71.16448	5.777580	2.484638	3.304008	17.26929
8	0.154589	68.12582	9.551373	2.594213	3.218953	16.50965
9	0.155149	67.63521	9.688262	2.809149	3.441602	16.42578
10	0.157981	66.24015	11.48684	2.869764	3.367457	16.03578

According to Lutkepohl (1990), standard error can be used to determine the significance of results of variance decomposition. The smaller the standard error, the more significant and accurate the results are. In this discussion only the variance decomposition of logofgold is interpreted, as this research is interested to find out which variable will have a more significant influence of the price change of gold.

Based on table 4.5, It can be seen that most variables affect the dependent variable in the 10 year period, with LOGOFOIL exhibiting the highest impact, from 4.03%% rising to 16.03% in the 10 year period, making it as the most high impact variable.

Other variable also play a role in affecting the dependent variable in the 10 year period. In the first period, all independent variables show no influence to the dependent variable, and start to have an impact during the second period. The influences of exchange rate, inflation rate, oil price and interest rate has increasing influences throughout the period. The lowest impact of all the variables will be LOGOFCPI, inflation rate, which exhibits the lowest impact of 2.87% in period 10 as compared to other variables.

4.3.5 Impulse Response Function

Figure 2: Malaysia Gold Price impulse response to inflation rate shocks from 2007 Q1 to 2016 Q4

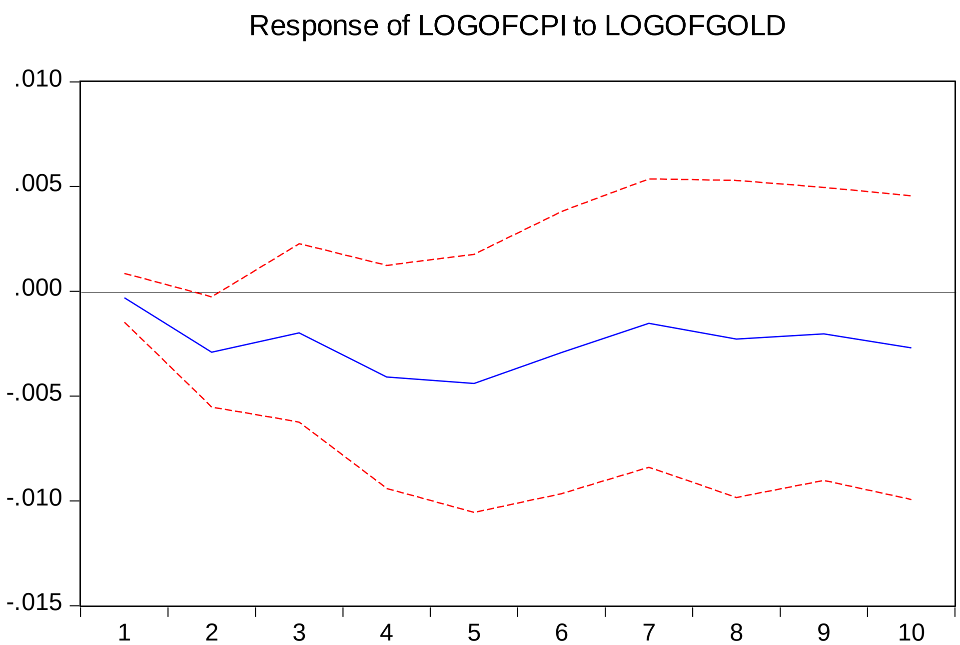


Figure 3: Malaysia Gold Price impulse response to exchange rate shocks

from 2007 Q1 to 2016 Q4

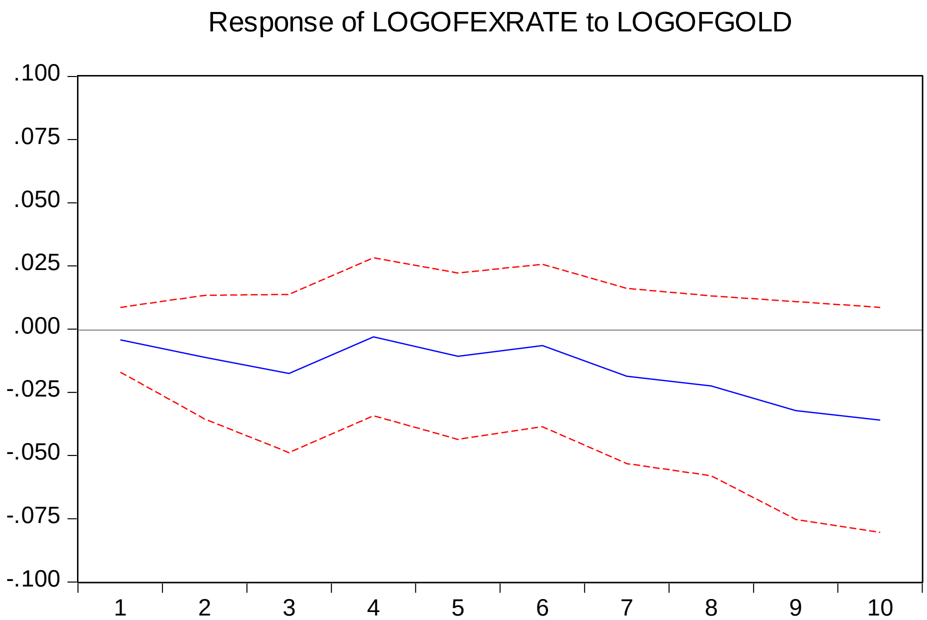


Figure 4: Malaysia Gold Price impulse response to oil price shocks from 2007 Q1 to 2016 Q4

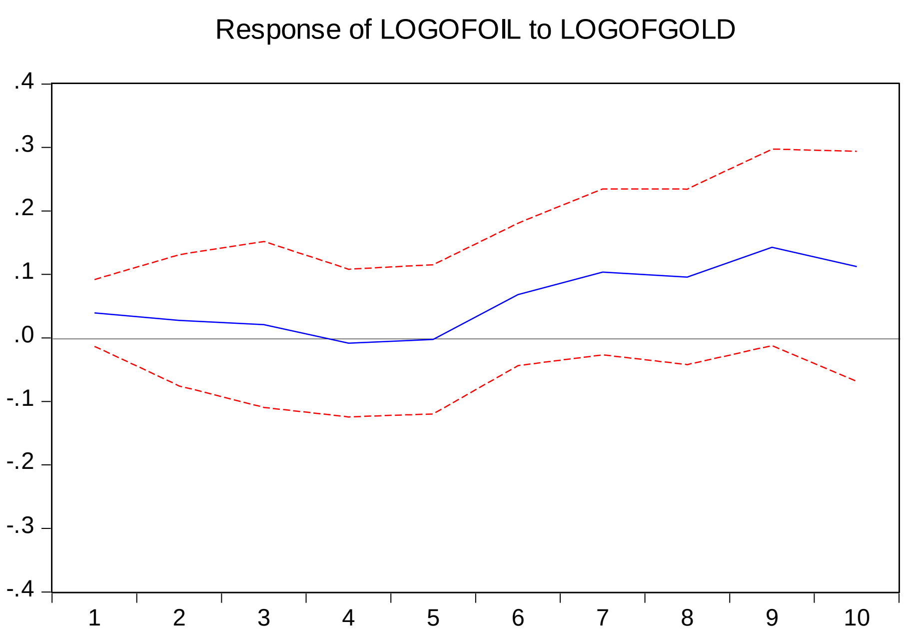


Figure 5: Malaysia Gold Price impulse response to interest rates shocks

from 2007 Q1 to 2016 Q4

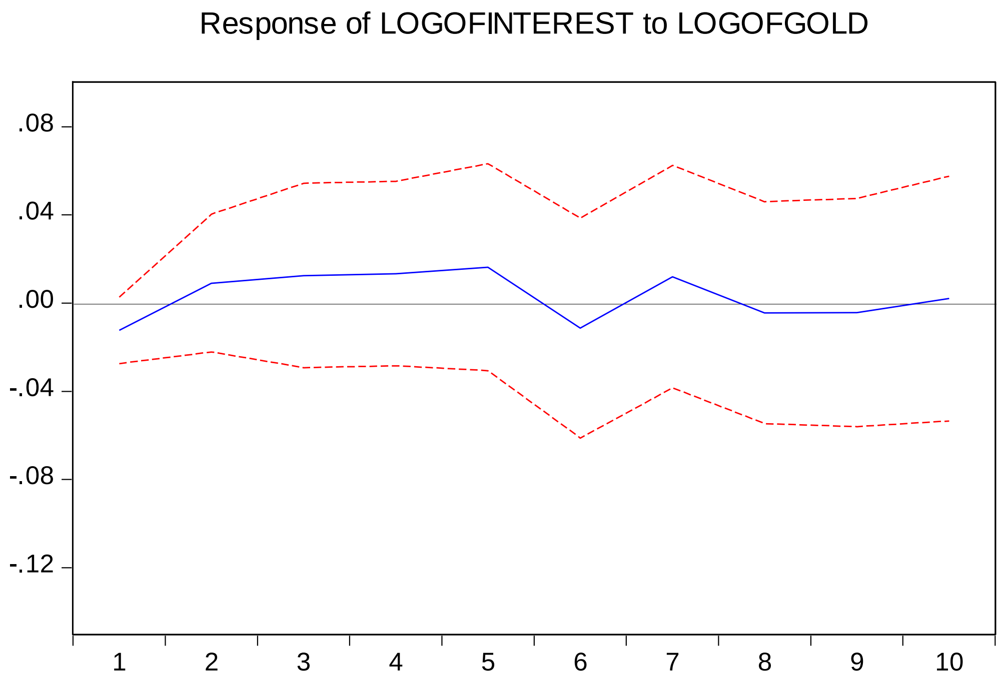


Figure 6: Malaysia Gold Price impulse response to gold price shocks

from 2007 Q1 to 2016 Q4

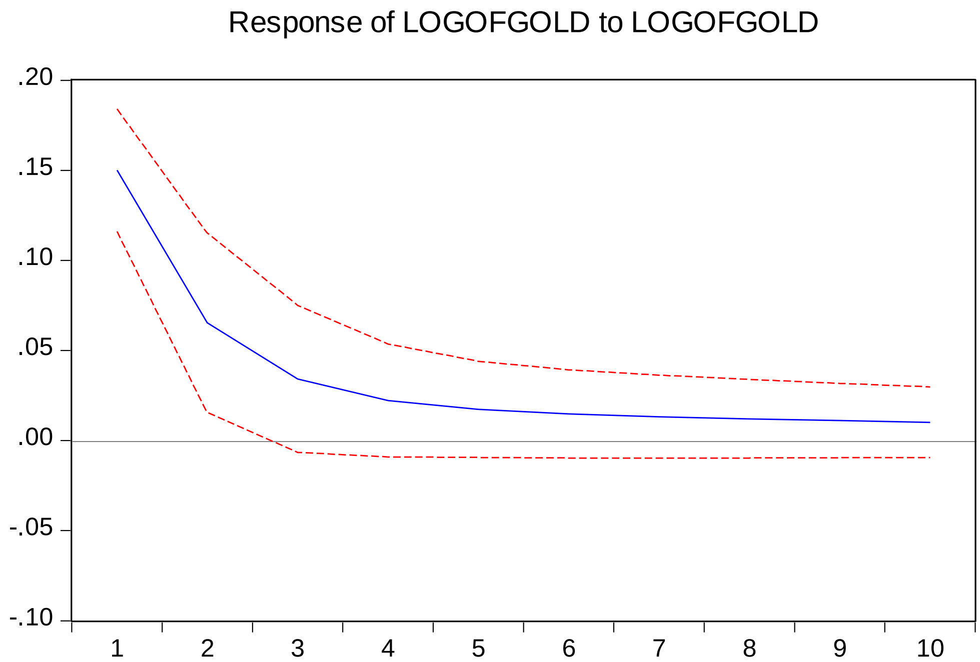


Figure 2, 3, 4 and 5 illustrates impulse response of independent variables on gold price changes in Malaysia, during the period from 2007 Q1 to 2016 Q4. From the graph, it is observed that exchange rate shocks were expected to lower the gold price in Malaysia. Exchange rate have negative impact on gold price as well, with gold price experiencing a decline in price when the exchange rate is higher (Ringgit depreciates). Oil price shocks on the other than causes the gold price to decline in the early period, then went rising after period 5. In terms of interest rates, gold price in Malaysia exhibits an increasing trend first with interest rates shocks, following a sharp decline in period 5 and sharp increase in period 6. Overall, oil price shocks have a greater percentage influence on gold prices in Malaysia.

4.3.6 Diagnostic Checking

4.3.6.1 Autocorrelation

Autocorrelation LM test for VAR residual is used to detect autocorrelation problem in the VAR model that is developed. According to the output generated from Eviews, the LM-statistic shows a value of 32.39689, with a p-value of 0.1468. As the p-value (0.1468) is smaller than the level of significance at 5% ($p<0.05$), the null hypothesis (There is no autocorrelation) cannot be rejected. Therefore it is concluded that autocorrelation problem is absent in this VAR model.

4.3.6.2 Heteroskedasticity

White heteroskedasticity test for VAR residual is used to detect heteroskedasticty problem in the VAR model that is developed. According to the output generated from Eviews, the Chi-square statistic shows a value of 202.3872, with a p-value of 0.0028. As the p-value (0.0028) is larger than the level of significance at 5% ($p>0.05$), the null hypothesis (Homoscadasticity) is rejected. Therefore it is concluded that heteroskedasticity problem is present in this VAR model.

4.4 Multiple Linear Regression

After confirming our data is stationary, this study proceeds to estimate the multiple regression model through ordinary least squares. The results are as follow:

Sample: 2007Q1 2016Q4
Included observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGCPI	4.179734	0.445596	9.380098	0.0000
LOGEXRATE	-1.212098	0.561456	-2.158847	0.0378
LOGINTEREST	-0.394553	0.160831	-2.453224	0.0193
LOGOIL	-0.083439	0.151248	-0.551669	0.5847
C	-8.846941	1.911455	-4.628380	0.0000

R-squared	0.735495	Mean dependent var	8.296810
Adjusted R-squared	0.705266	S.D. dependent var	0.286833
S.E. of regression	0.155720	Akaike info criterion	-0.765048
Sum squared resid	0.848704	Schwarz criterion	-0.553938
Log likelihood	20.30096	Hannan-Quinn criter.	-0.688717
F-statistic	24.33064	Durbin-Watson stat	1.260754
Prob(F-statistic)	0.000000		

From the Eviews output,

$LOG(\hat{GOLD})$ = -8.846941 + 4.179734 $LOG(CPI)$ - 1.212098 $LOG(EXRATE)$ - 0.083439$LOG(OIL)$ – 0.394553 $LOG(INTEREST)$

Where

$LOG(G\hat{O}LD_t)$ = Logarithm of Gold Price (RM/Ounce).

$LOG(INF_t)$ = Logarithm of Malaysia Inflation Rate

(Consumer Price Index, Year 2010=100)

$LOG(OIL_t)$ = Logarithm of Brendt Crude Oil Price (USD/barrel).

$LOG(EXR_t)$ = Logarithm of Malaysia Exchange Rate (MYR/USD).

$LOG(INT_t)$ = Logarithm of Malaysia Interest Rates.

4.4.1 Results Interpretation

4.4.1.1 Gold Price and Inflation (LOGCPI)

The coefficients estimated from Eviews suggested that there is a relationship between gold price in Malaysia and inflation rates in consumer price index. The coefficient suggested that an increase in inflation rate will have a significant positive effect on price of gold at 5% significance level. This is because the p-value of inflation rate (0.0000) is smaller than the level of significance at 0.05 ($p < 0.05$). One percent increase of Malaysia's inflation rate will result in 4.179734% increase in gold prices of Malaysia, holding other variables constant. When inflation rate is experiencing an upward trend, gold price of Malaysia will follow suite, and vice versa.

4.4.1.2 Gold Price and Malaysia Exchange Rate (LOGEXRATE)

The coefficients estimated from Eviews suggested that there is a relationship between gold price in Malaysia and exchange rate in consumer price index. The coefficient suggested that an increase in inflation rate will have a significant negative effect on price of gold at 5% significance level. This is because the p-value of inflation rate (0.0378) is smaller than the level of significance at 0.05 ($p < 0.05$). One percent increase of Malaysia's inflation rate will result in 1.212098% decrease in gold prices of Malaysia, holding other variables constant. When exchange rate of Malaysia is experiencing an upward trend, gold price of Malaysia move in an opposite direction, and vice versa.

4.4.1.3 Gold Price and Brent Crude Oil Price (LOGOIL)

The coefficients estimated from Eviews suggested that there is no relationship between gold price in Malaysia and brendt crude oil prices. This is because the p-value of brendt crude oil price (0.5847) is smaller than the level of significance at 0.05 ($p > 0.05$).

4.4.1.4 Gold Price and Malaysia's Interest Rates (LOGINTEREST)

The coefficients estimated from Eviews suggested that there is a relationship between gold price in Malaysia and Malaysia's interest rates. The coefficient suggested that an increase in inflation rate will have a significant positive effect on price of gold at 5% significance level. This is because the p-value of inflation rate (0.0193) is smaller than the level of significance at 0.05 ($p < 0.05$). One percent increase of Malaysia's inflation rate will result in 0.394553% decrease in gold prices of Malaysia, holding other variables constant. When exchange rate of Malaysia is experiencing an upward trend, gold price of Malaysia move in an opposite direction, and vice versa.

4.4.1.5 Adjusted R-squared Value

The adjusted r-squared value of the model is 0.705266, indicating that the model is able to explain 70.53% of the variations in gold price of Malaysia.

4.5 Diagnostic Checking

Diagnostic checking is used to confirm the multiple linear regression in this model is free from economic problems, namely multicollinearity, heteroskedasticity, autocorrelation and model misspecification problem. Any of these problems present in the model will make the results inaccurate, biased and spurious, leading to false conclusion.

4.5.1 Model Significance

From the output obtained from Eviews, it is observed that the probability of F-statistic is less than 0.000000. Since the p-value of F-statistic is less than 0.05 ($p < 0.05$), the null hypothesis is rejected. The results concluded that this multiple linear regression model is significant to explain fluctuations of gold price in Malaysia. From the adjusted r-squared value of 0.705266, 70.52% of variations of gold prices in Malaysia can be explained by independent variables at 95% confidence level. In short, the independent variables in this regression model, namely Malaysia’s inflation rate, Malaysia’s exchange rate, Brent crude oil prices as well as Malaysia’s interest rate is sufficient to explain the variation in Malaysia’s gold price.

4.5.2 Multicollinearity

To detect multicollinearity in the model, variance inflation factor (VIF) will be used, as there are no formal ways to detect multicollinearity. When there is high r-squared value of the model but only few significant t-statistics of the independent variables, it is suspected that the model will have multicollinearity problem. Calculating our VIF, a value of 3.780657 is obtained. The VIF value obtained is less than 10, indicating that there is no serious multicollinearity problem in the multiple regression model.

4.5.3 Model Misspecification

Ramsey RESET test is conducted to observe whether our model suffers from model misspecification problem. The p-value of f-statistic shows value of 0.0009, which is less than 5% significance level ($p<0.05$). The null hypothesis that the model have no model misspecification problem is rejected. Therefore it is concluded that this multiple regression model suffers from model misspecification problem.

4.5.4 Autocorrelation

To detect autocorrelation problem in the regression model, Breusch-Godfrey Serial Correlation LM Test is used. The p-value of F-statistic shows value of 0.0528, , which is larger than the significance level ($p > 0.05$). Thus the null hypothesis is not rejected. It is concluded that autocorrelation does not exist in this model.

4.5.5 Heteroskedasticity

ARCH heteroskedasticity test is used to detect heteroskedasticty problem in the regression model. After computing through Eviews, the p-value of F-statistic for ARCH heteroskedasticity test shows a value of 0.9814, which is smaller than the level of significance ($p<0.05$). This indicates that the regression model formulated is free from heteroskedasticity problem.

4.6Results Comparison and Interpretation

Table 5.0 Results Comparison for Multiple Regression Model and Vector Autoregression Model

Variable	**Vector Autoregression (VAR)**	**Multiple Linear Regression**	**Expected Relationship**
Inflation Rate	Positive (2.251765)	Positive (4.179734)	Positive
Exchange Rate	Positive (0.965681)	Negative (-1.212098)	Positive
Brent Crude oil Price	Negative (-0.143701)	Negative (Insignificant variable)	Positive
Interest Rate	Negative (-0.183316)	Negative (-0.394553)	Negative

4.6.1 Inflation Rate

Table 5.0 shows the comparison of the results obtained from Vector Autoregression (VAR) model and multiple linear regression model. Both of the models show that inflation rate exhibits positive relationship with Malaysia's gold price, which is consistent with the expected relationship of the variable. Previous studies by other researchers (Mahdavi & Zhou, 2997; Tufail & Batool, 2013; Ahmad & Rahim, 2013; Ghosh et.al., 2004; Worthington & Pahlavani, 2007; Batten et.al., 2014; Aleemi, Tariq & Ahmeed, 2016; Christie-David, Chaudhry & Koch 2000) indicated that inflation rate and gold prices have positive and significant relationship as well.

This indicates that inflation rate of Malaysia is an important determinant of Malaysia's gold price. When inflation rate increases in Malaysia, gold prices will be increasing as well, indicating that gold is recognized in Malaysia as an inflation hedge, providing a safe haven for investors in Malaysia.

4.6.2 Exchange Rate

In terms of exchange rate in Malaysia, Vector Autoregressive (VAR) model shows conflicting results with multiple linear regression model. VAR model's result is consistent with the expected relationship (positive), while multiple linear regression shows that the relationship of exchange rate and gold price in Malaysia should be negative. The positive relationship demonstrated by VAR model is more valid and justifiable than multiple regression model, as the depreciation of Malaysian Ringgit should cause the rise in gold prices. As investors in the market do not want to lose value of their money during currency depreciation, they resort to gold as an alternative in order to preserve the value of their money. Previous studies by researchers (Nair, et.al., 2015; Sujit & Kumar, 2011; Chin, 2011, Haque, Topal & Lilford, 2015; Omag, 2012) demonstrated that the relationship of exchange rate and gold price is positive as well. As gold price is denominated in Malaysian Ringgit, depreciation in Malaysia Ringgit means the gold price will increase, as gold price provided by Bank Negara Malaysia is denominated in Ringgit Malaysia.

4.6.3 Brent Crude Oil Price

As for Brent Crude Oil Price, both VAR and multiple linear regression model showed negative relationship of Brent crude oil price and Malaysia's gold prices. This contradicts with the expected relationship, which should be positive. While the variable's coefficient is significant in the VAR model, the multiple regression model showed that Brent crude oil prices is insignificant, and have no influence on gold prices of Malaysia. Compared to other variables, Brent crude oil prices have smaller effects on gold prices as well. With 1% increase in Brent crude oil price, the gold price only decreases by 0.143701%. This indicates that Brent crude oil prices have less and negative influence on Malaysia's gold prices (suggested by VAR), or no influence at all on Malaysia's gold prices (suggested by Multiple Linear Regression).

4.6.4 Interest Rate

In the case of Malaysia's interest rate, VAR and multiple linear regression model demonstrated the same result, indicating that Malaysia's interest rate have a negative relationship with Malaysia gold price. As interest rate increases, investors in the market have the tendency to save their money in banks as they generate more return compared to gold prices, causing a decrease in gold prices. Previous studies (World Gold Council, 2013; Abdullah, 2013; Boris, 2015; Ghosh, et.al., 2004; Baber, Baber & Thomas, 2013) proved the same relationship as well. Therefore as Malaysia's interest rates increases, gold price in Malaysia will drop.

Chapter 5: Conclusion

5.0 Introduction

This study analyzes the relationship of gold price and various independent variables, namely Malaysia's inflation rate, Malaysia's exchange rate, Brent crude oil prices as well as Malaysia's interest rate. In this final chapter, summary of the paper and findings will be presented, followerd by contributions of study, limitations of study and recommendations for future research.

5.1 Summary and Discussion of Major Findings

The main objective of this paper is to determine which factor influences the gold price movements in Malaysia. Multiple Linear Regression model and Vector Autoregressive (VAR) model is formulated to compare the results of the findings and find out which model is more suitable in investigating gold price's determinants. A total of 40 observations is derived from quarterly data, from year 2007 to 2016 from Bloomberg and Federal Reserve Economic Data.

Firstly, the VAR model is derived and estimated. Variance decomposition and impulse response function are included in order to better explain the variable's movement and relationship with Malaysia's gold price. Diagnostic checking is done to check for econometric errors, namely autocorrelation and heteroskedasticity. After that, Multiple Linear Regression model is formulated. Diagnostic checking is done on the multiple linear regression model as well, to detect econometric problems in the model.

5.1.1 Malaysia's Inflation Rate

For the VAR model, inflation rate of Malaysia matched the expected sign for the variables. Multiple linear regression model showed similar results as well, indicating that Malaysia's inflation rate have a positive and significant relationship with Malaysia's gold price. Inflation rate of Malaysia showed significant and positive relationship with Malaysia's gold price. The positive relationship can be explained as when inflation rises, investors resort to gold for protection of value, causing a rise in gold price. This proves that inflation rate is an important hedge for inflation in the Malaysian market.

5.1.2 Malaysia's Exchange Rate

For the VAR model, empirical results demonstrated that Exchange rate of Malaysia (MYR/USD) exhibits positive and significant relationship with Malaysia's gold price. However, Multiple linear regression showed conflicting results, indicating that exchange rate should be of negative relationship with Malaysia's gold price. The positive relationship of exchange rate with gold price is more justifiable, as depreciation of exchange rate will increase the demand for gold due to the protection that gold provides. Other than that, gold price in Malaysia is denominated in Ringgit Malaysia, therefore a rise in the exchange value will cause a rise of price in gold as well.

5.1.3 Brent Crude Oil Price

For the VAR model, estimation output showed that Brent crude oil price has a negative relationship with Malaysia's gold price. Multiple linear regression on the other hand suggested that Brent crude oil price have no effect on gold price in Malaysia. This suggests that Brent crude oil price might not be an important factor that causes gold price movements in Malaysia. The results conflicts with expected relationship of gold price and Brent crude oil price.

5.1.4 Malaysia's Interest Rates

For the VAR model, estimation results showed that interest rates have a negative relationship with Malaysia's gold price. Multiple linear regression showed similar results as well. The results from both models matches the expected relationship of the variables, as interest rates rises will cause investors to revert to fixed deposits for more lucrative return. Therefore gold price in Malaysia will drop as a result.

5.2 Implications of the Study to public & private policy

This study provides a view on a number of different factors that have an influence on gold prices in Malaysia. Comparisons of the results based on two different models are provided as well to check the consistency as well as validity of the results. From this study it is concluded that Malaysia's inflation rate, exchange rate as well as interest rates have some degree of influence in the gold market in Malaysia. With the factors influencing gold price determined, it can provide some guidelines to monitor gold price movements. Fund managers can have a better control and insight on the gold market, and have a better diversification of their funds into different segments such as money market funds, stock funds, gold market funds and so on. Knowing the movements of gold price can aid in preventing investors from suffering losses as well, as investors will be able to buy gold at low and sell at high if the timing is right.

This study provides an insight on the factors affecting gold prices in Malaysia from 2007 to 2016. Therefore it could provide researchers or investors an additional reference when they are investigating the determinants of gold price in Malaysia.

5.3 Limitations of Study

As this study includes the period of 2007 financial crisis into our model, it may have some disruptive effects on our results. Structural breaks are defined as an unexpected shift in time series, which may have some effects that will lead to forecasting errors and unreliability of the model (Gujarati, 2009). Future research should exclude financial crisis, to observe whether the financial crisis have any effects on the estimation output. The VAR model and multiple linear regression model in this study can still be further improved to obtain more accurate results.

5.4 Recommendations for future Research

To be able to study on the full effects of variables influencing gold prices in Malaysia, a longer time period should be included in future studies, as this study only includes 10year data. Besides, there are several models that can be tested to explain the relationship between gold price and other variables.. Future researchers can experiment with other models such as the Error Correction Model (ECM) and GARCH to examine if they can have a more reliable and valid result than multiple linear regression and VAR.

Other than that, the variables that this study has selected are inflation rate, exchange rate, Brent crude oil price and interest rates. There are a lot of variables in the economy that might have an influence on gold price, such as money supply, jewellery demand, gold lease rate, gross domestic product and so on. More variables should be included in order to have a better and bigger view on what are the factors influencing gold prices in Malaysia.

5.5 Conclusion

This study intends to investigate the relationship of Malaysia's gold price with Malaysia's inflation rate, exchange rate, interest rate and Brent Crude oil prices. A comparison of results from two models, using multiple linear regression and vector autoregression is provided. Inflation rate exhibits a positive and significant relationship with Malaysia's gold price, while interest rates exhibits a negative and significant relationship with Malaysia;s gold price. The results suggested by VAR and multiple linear regression model is different, as exchange rate showed conflicting results while multiple linear regression shows that Brent Crude oil prices is insignificant. The model used in this study is sufficient to explain relationship of gold price and inflation rate, exchange rate, Brent crude oil prices and interest rates in Malaysia. Future researchers can try out other models to determining factors affecting gold prices in Malaysia.

References

Abdullah, A. (2013). The gibson paradox: Real gold, interest rates and prices. *International Business Research*, 6(4), 32.

Aftab, M., Shah, S. Z. A., & Ismail, I. (2017). Does gold act as a hedge or a safe haven against equity and currency in Asia?.

Ahmad, Z., & Rahim, Y. (2013). The Influence of Dollar, Gold, and Petrol Prices on Inflation. Abasyn *University Journal of Social Sciences*, 6(2), 16-33.

Aleemi, A. R., Tariq, M., & Ahmed, S. (2016). The Role Of Gold Prices, Exchange Rate and Interest Rate on the Continuity of Inflation in *Pakistan. Pakistan Business Review*, 18(1), 37-54.

Arfaoui, M., & Ben R. A. (2016). Oil, Gold, US dollar and Stock market interdependencies: A global analytical insight.

Astonishing: Russian Gold Demand Increases Despite Serious Economic Troubles. (2016). Retrieved from: http://www.birchgold.com/news/russian-gold-demand-increases-despite-economy

Azar, S. A. (2015). The Relation of the US Dollar with Oil Prices, Gold Prices, and the US Stock Market. *Research in World Economy*, 6(1), 159.

Baber, P., Baber, R., & Thomas, G. (2013). Factors affecting Gold prices: a case study of India. *Proc. Evolving Management Paradigms in Manufacturing and Service Sectors*.

Baur, D. G., & Lucey, B. M. (2010). Is gold a hedge or a safe haven? An analysis of stocks, bonds and gold. *Financial Review*, 45(2), 217-229.

Baur, D. G., & McDermott, T. K. (2010). Is gold a safe haven? International evidence. *Journal of Banking & Finance*, 34(8), 1886-1898.

Batten, J. A., Ciner, C., & Lucey, B. M. (2014). On the economic determinants of the gold–inflation relation. Resources Policy, 41, 101-108.

Beckmann, J. & Czudaj, R. (2013). Gold as an Inflation Hedge in a Time-Varying Coefficeint Framework. The North American Journal of Economics and Finance. 24(1): 208-222.

Blose, L.E. (2010). Gold prices, cost of carry, and expected inflation. Journal of Economics and Business. 62, oo.35-47.

Boris, G. (2015). The Truth About The Impact Of Interest Rates On The Price Of Gold. Retrieved from: http://www.rockstone-research.com/images/PDF/TheTruth.pdf

Chin, A. E. L. (2011). The relationship between gold price and exchange rate of Asean currencies (Ringgit Malaysia, Singapore Dollar, Thai Baht) against US Dollar.

Christie–David, R., Chaudhry, M., & Koch, T. W. (2000). Do macroeconomics news releases affect gold and silver prices?. *Journal of Economics and Business*, 52(5), 405-421.

Cooper, R. N., Dornbusch, R., & Hall, R. E. (1982). The gold standard: historical facts and future prospects. *Brookings Papers on Economic Activity*, 1982(1), 1-56.

Creamer, M. (2016). Safe-haven gold outperforms as Trump's election spooks financial, equity markets. Retrieved from: http://www.miningweekly.com/article/safe-haven-gold-outperforms-as-trumps-election-spooks-financial-equity-markets-2016-11-09/rep_id:3650

Dempster, N. & Artigas, J.C. (2010). Gold: Inflation hedge and long-term strategic asset. *The Journal of Wealth Management*. Pp. 69-75.

Dierinck, B., Frömmel, M., Schrauwen, B., & Hermans, M. (2012). Determinants Of The Gold Price. Unievrsiteit Gent.

Escribano, A. & Granger, C.W.J. (1998). Investigating the relationship between gold and silver prices. Journal of Forecasting. 17, pp.81-107.

Ghazali, M. F., Lean, H. H., & Bahari, Z. (2013). Is gold a hedge or a safe haven? An empirical evidence of gold and stocks in Malaysia. *International Journal of Business and Society*, 14(3), 428.

Ghosh, D., Levin, E. J., Macmillan, P., & Wright, R. E. (2004). Gold as an inflation hedge?. *Studies in Economics and Finance*, 22(1), 1-25.

Gold & Inflation (n.d.). Retrieved from: https://www.sunshineprofits.com/gold-silver/dictionary/gold-inflation/

Gold price falls to five-year low on US rate rise talk. (July 20, 2015). BBC. Retrieved from: http://www.bbc.com/news/business-33590480

"Gold Standard." (2003) Dictionary of American History. . Retrieved July 14, 2017 from: http://www.encyclopedia.com/history/dictionaries-thesauruses-pictures-and-press-releases/gold-standard

Gujarati, D. N. (2009). *Basic econometrics*. Tata McGraw-Hill Education.

Haque, M. A., Topal, E., & Lilford, E. (2015). Relationship between the gold price and the Australian dollar-US dollar exchange rate. *Mineral Economics*, 28(1-2), 65-78.

Ibrahim, S. N., Kamaruddin, N. I., & Hasan, R. (2014). The determinants of gold prices in Malaysia. *Journal of Advanced Management Science* Vol, 2(1).

Kamalavacini, R. (2015). Gold Prices to Continue Uptrend on Ringgit. Retrieved from: http://themalaysianreserve.com/new/story/gold-prices-continue-uptrend-ringgit

Kennedy, P. (1992). A Guide to Econometrics. Oxford: Blackwell.

Kollewe, J. (2010). Gold prices – the highs and lows since 1971. Retrieved from: https://www.theguardian.com/business/2010/sep/17/gold-price-timeline

Long, H. (2016). China is on a massive gold buying spree. CNN. Retrieved from: http://money.cnn.com/2016/02/10/investing/china-gold/index.html

Low, R. K. Y., Yao, Y., & Faff, R. (2016). Diamonds vs. precious metals: What shines brightest in your investment portfolio?. *International Review of Financial Analysis*, 43, 1-14.

Lütkepohl, H., & Xu, F. (2012). The role of the log transformation in forecasting economic variables. *Empirical Economics*, 42(3), 619-638.

Marquardt, D. W. (1970). Generalized inverses, ridge regression, biased linear estimation, and nonlinear estimation. *Technometrics*, 12, 591-256.

Mahdavi, S., & Zhou, s. (1997). Gold and commodity prices as leading indicators of inflation: Test of long-run relationship and predictive performance. *Journal of Economics and Business*, 49(5), 475-489.

Nair, G. K., Choudhary, N., & Purohit, H. (2015). The Relationship between Gold Prices and Exchange Value of US Dollar in India. *Emerging Markets Journal*, 5(1), 17.

Narang, S. P., & Singh, R. P. (2012). Causal relationship between gold price and Sensex: A study in Indian context. *Vivekananda Journal of Research*, 1(1), 33-37.

Neter, J., Wasserman, W. & Kutner, M. H. (1989). Applied Linear Regression Models. Homewood, IL: Irwin.

Nirmala, S., & Deepthy, K. (2015). An analysis of the relationship between gold and crude oil prices. *IJAR*, 1(13), 156-159.

Omag, A. (2012). An observation of the relationship between gold prices and selected financial variables in turkey. *Muhasebe ve finansman dergisi*, (55).

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

Phoong, S.W. & Tahir, I. (2014). Measuring nonlinear behavior in time series data. *International Conference on Quantitative Sciences and Its Applications*.

Samanta, S. K., & Zadeh, A. H. (2012). Co-movements of oil, gold, the US dollar, and stocks. *Modern Economy*, 3(01), 111.

Sari, R., Hammoudeh, S. and Soytas, U. (2010). Dynamics of oil price, precious metal prices and exchange rate. *Energy Economics*. 32, pp.351-362.

Sindhu, D. (2013). A study on impact of select factors on the price of Gold. *Journal of Business and Management*, 8(4), 84-93.

Sjaastad, L. A. (2008). The price of gold and the exchange rates: Once again. *Resources Policy*, 33(2), 118-124.

Sujit, K. S., & Kumar, B. R. (2011). Study on dynamic relationship among gold price, oil price, exchange rate and stock market returns. *International Journal of Applied Business and Economic Research*, 9(2), 145-165.

Tufail, S., & Batool, S. (2013). An analysis of the relationship between inflation and gold prices: evidence from Pakistan. *The Lahore journal of economics*, 18(2), 1.

Vu, V. H., Liu, Z., Thomas, M., Li, W. & Hazel, B. (2016). Output-only identification of model shape coupling in a flexible robot by vector autoregressive modeling. *Mechanism and Machine Theory*, 97, 141-154.

What is the relationship between gold and crude oil? (n.d.). Retrieved from: https://moneymindz.com/articles/Mutual-Funds/Gold-ETFs/What-is-the-relationship-between-gold-and-crude-oil

Weng, Y. W (2011). Causal Relationship Between Gold Price, Oil Price, Exchange Rate and International Stock Markets. *Prosiding Perkem VI, Jilid*, 2, 282-291.

World Gold Council (2013). Gold and US interest rates: a reality check. Retrieved from: https://www.strategicgold.com/white-papers/gold_and_us_interest_rates.pdf

Worthington, A. C., & Pahlavani, M. (2007). Gold investment as an inflationary hedge: Cointegration evidence with allowance for endogenous structural breaks. *Applied Financial Economics Letters*, 3(4), 259-262.

Ziaei, S. (2012). Effects of gold price on equity, bond and domestic credit: Evidence from ASEAN+3. Asia Pacific business innovation and technology management society. *Procedia*, Vol.40, pp.341-346.

Zivot, E. & Wang, J. (2005). Modelling financial time series with S-PLUS, second edition. Retrieved from: http://www.springer.com/us/book/9780387279657

Zhang, Y. J. & Wei, Y. M. (2010). The crude oil market and the gold market: Evidence for cointegration, causality and price discovery. *Resource Policy*. 35, pp. 168-177.

APPENDIX

Appendix 4.2 Augmented Dickey Fuller

4.2.1 ADF Test for LOGGOLD (0)

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.269046	0.1867
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGGOLD)
Method: Least Squares
Date: 08/21/17 Time: 17:15
Sample (adjusted): 2007Q2 2016Q4
Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGGOLD(-1)	-0.202264	0.089140	-2.269046	0.0292
C	1.697677	0.739374	2.296102	0.0274

R-squared	0.122153	Mean dependent var	0.020982
Adjusted R-squared	0.098427	S.D. dependent var	0.166053
S.E. of regression	0.157670	Akaike info criterion	-0.806709
Sum squared resid	0.919809	Schwarz criterion	-0.721398
Log likelihood	17.73083	Hannan-Quinn criter.	-0.776101
F-statistic	5.148572	Durbin-Watson stat	2.595266
Prob(F-statistic)	0.029188		

4.2.1 ADF Test for LOGGOLD (1)

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.224878	0.0000
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGGOLD,2)
Method: Least Squares
Date: 08/21/17 Time: 17:17
Sample (adjusted): 2007Q3 2016Q4
Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGGOLD(-1))	-1.406991	0.152521	-9.224878	0.0000
C	0.031397	0.025504	1.231065	0.2263

R-squared	0.702721	Mean dependent var	-0.000734
Adjusted R-squared	0.694463	S.D. dependent var	0.281760
S.E. of regression	0.155744	Akaike info criterion	-0.830008
Sum squared resid	0.873225	Schwarz criterion	-0.743819
Log likelihood	17.77016	Hannan-Quinn criter.	-0.799343
F-statistic	85.09838	Durbin-Watson stat	1.840061
Prob(F-statistic)	0.000000		

4.2.2 ADF Test for LOGCPI (0)

Null Hypothesis: LOGCPI has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.900175	0.7774
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGCPI)
Method: Least Squares
Date: 08/21/17 Time: 17:20
Sample (adjusted): 2007Q3 2016Q4
Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGCPI(-1)	-0.024537	0.027259	-0.900175	0.3742
D(LOGCPI(-1))	0.028363	0.167469	0.169363	0.8665
C	0.119952	0.126683	0.946870	0.3502

R-squared	0.023384	Mean dependent var	0.006093
Adjusted R-squared	-0.032423	S.D. dependent var	0.010261
S.E. of regression	0.010426	Akaike info criterion	-6.213403
Sum squared resid	0.003804	Schwarz criterion	-6.084120
Log likelihood	121.0547	Hannan-Quinn criter.	-6.167406
F-statistic	0.419011	Durbin-Watson stat	1.977639
Prob(F-statistic)	0.660953		

4.2.2 ADF Test for LOGCPI (1)

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.820169	0.0000
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGCPI,2)
Method: Least Squares
Date: 08/21/17 Time: 17:21
Sample (adjusted): 2007Q3 2016Q4
Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGCPI(-1))	-0.972124	0.167027	-5.820169	0.0000
C	0.005929	0.001952	3.037147	0.0044

R-squared	0.484790	Mean dependent var	0.000210
Adjusted R-squared	0.470478	S.D. dependent var	0.014290
S.E. of regression	0.010398	Akaike info criterion	-6.243147
Sum squared resid	0.003893	Schwarz criterion	-6.156958
Log likelihood	120.6198	Hannan-Quinn criter.	-6.212482
F-statistic	33.87437	Durbin-Watson stat	1.979731
Prob(F-statistic)	0.000001		

4.2.3 ADF Test for LOGEXRATE (0)

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.220555	0.9705
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGEXRATE)
Method: Least Squares
Date: 08/21/17 Time: 17:31
Sample (adjusted): 2007Q2 2016Q4
Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGEXRATE(-1)	0.014862	0.067387	0.220555	0.8267
C	-0.011875	0.082559	-0.143832	0.8864

R-squared	0.001313	Mean dependent var	0.006277
Adjusted R-squared	-0.025679	S.D. dependent var	0.040213
S.E. of regression	0.040726	Akaike info criterion	-3.513983
Sum squared resid	0.061368	Schwarz criterion	-3.428673
Log likelihood	70.52268	Hannan-Quinn criter.	-3.483375
F-statistic	0.048644	Durbin-Watson stat	1.666135
Prob(F-statistic)	0.826652		

4.2.3 ADF Test for LOGEXRATE (1)

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.944179	0.0003
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGEXRATE,2)
Method: Least Squares
Date: 08/21/17 Time: 17:32
Sample (adjusted): 2007Q3 2016Q4
Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGEXRATE(-1))	-0.855816	0.173096	-4.944179	0.0000
C	0.006167	0.006659	0.926038	0.3606

R-squared	0.404416	Mean dependent var	0.002503
Adjusted R-squared	0.387872	S.D. dependent var	0.052142
S.E. of regression	0.040795	Akaike info criterion	-3.509298
Sum squared resid	0.059914	Schwarz criterion	-3.423109
Log likelihood	68.67667	Hannan-Quinn criter.	-3.478633
F-statistic	24.44491	Durbin-Watson stat	1.909161
Prob(F-statistic)	0.000018		

4.2.4 ADF Test for LOGOIL (0)

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.829097	0.3614
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGOIL)
Method: Least Squares
Date: 08/21/17 Time: 17:33
Sample (adjusted): 2007Q2 2016Q4
Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGOIL(-1)	-0.175164	0.095765	-1.829097	0.0755
C	0.762887	0.420620	1.813722	0.0778

R-squared	0.082923	Mean dependent var	-0.003902
Adjusted R-squared	0.058138	S.D. dependent var	0.220815
S.E. of regression	0.214300	Akaike info criterion	-0.192957
Sum squared resid	1.699210	Schwarz criterion	-0.107646
Log likelihood	5.762666	Hannan-Quinn criter.	-0.162348
F-statistic	3.345595	Durbin-Watson stat	1.576981
Prob(F-statistic)	0.075454		

4.2.4 ADF Test for LOGOIL (1)

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.251826	0.0001
Test critical values:	1% level	-3.615588	
	5% level	-2.941145	
	10% level	-2.609066	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGOIL,2)
Method: Least Squares
Date: 08/21/17 Time: 17:34
Sample (adjusted): 2007Q3 2016Q4
Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGOIL(-1))	-0.867548	0.165190	-5.251826	0.0000
C	-0.006569	0.036303	-0.180950	0.8574

R-squared	0.433799	Mean dependent var	-1.71E-05
Adjusted R-squared	0.418071	S.D. dependent var	0.293186
S.E. of regression	0.223654	Akaike info criterion	-0.106233
Sum squared resid	1.800767	Schwarz criterion	-0.020044
Log likelihood	4.018431	Hannan-Quinn criter.	-0.075568
F-statistic	27.58167	Durbin-Watson stat	1.908838
Prob(F-statistic)	0.000007		

4.2.5 ADF Test for LOGINT (0)

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.300897	0.1782
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGINT)
Method: Least Squares
Date: 08/21/17 Time: 17:36
Sample (adjusted): 2009Q3 2016Q4
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGINT(-1)	-0.157912	0.068631	-2.300897	0.0329
D(LOGINT(-1))	0.068029	0.173204	0.392771	0.6989
D(LOGINT(-2))	0.112469	0.063667	1.766505	0.0934
D(LOGINT(-3))	0.124803	0.062207	2.006254	0.0593
D(LOGINT(-4))	-0.030241	0.063882	-0.473391	0.6413
D(LOGINT(-5))	-0.056252	0.052856	-1.064247	0.3006
D(LOGINT(-6))	-0.135585	0.050434	-2.688373	0.0145
D(LOGINT(-7))	0.085627	0.055429	1.544811	0.1389
D(LOGINT(-8))	0.064801	0.054553	1.187848	0.2495
D(LOGINT(-9))	-0.106233	0.051476	-2.063721	0.0530
C	0.178228	0.073340	2.430168	0.0252

R-squared	0.768667	Mean dependent var	0.014124
Adjusted R-squared	0.646913	S.D. dependent var	0.038446
S.E. of regression	0.022845	Akaike info criterion	-4.443594
Sum squared resid	0.009916	Schwarz criterion	-3.929822
Log likelihood	77.65392	Hannan-Quinn criter.	-4.279234
F-statistic	6.313283	Durbin-Watson stat	2.114252
Prob(F-statistic)	0.000304		

4.2.5 ADF Test for LOGINT (1)

Null Hypothesis: D(LOGINT) has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.762886	0.0006
Test critical values:	1% level	-3.670170	
	5% level	-2.963972	
	10% level	-2.621007	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LOGINT,2)
Method: Least Squares
Date: 08/21/17 Time: 17:37
Sample (adjusted): 2009Q3 2016Q4
Included observations: 30 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LOGINT(-1))	-1.225157	0.257230	-4.762886	0.0001
D(LOGINT(-1),2)	0.441052	0.138249	3.190274	0.0046
D(LOGINT(-2),2)	0.454094	0.130807	3.471468	0.0024
D(LOGINT(-3),2)	0.482980	0.118717	4.068322	0.0006
D(LOGINT(-4),2)	0.351766	0.114937	3.060510	0.0062
D(LOGINT(-5),2)	0.246508	0.096951	2.542604	0.0194
D(LOGINT(-6),2)	0.077341	0.081420	0.949900	0.3535
D(LOGINT(-7),2)	0.159878	0.064131	2.493010	0.0216
D(LOGINT(-8),2)	0.161398	0.050205	3.214808	0.0043
C	0.009820	0.005123	1.916795	0.0697

R-squared	0.761116	Mean dependent var	0.000720
Adjusted R-squared	0.653618	S.D. dependent var	0.042781
S.E. of regression	0.025178	Akaike info criterion	-4.264465
Sum squared resid	0.012679	Schwarz criterion	-3.797400
Log likelihood	73.96698	Hannan-Quinn criter.	-4.115047
F-statistic	7.080298	Durbin-Watson stat	2.152489
Prob(F-statistic)	0.000141		

Appendix 4.3 Vector Autoregressive (VAR)

4.3.3 Vector Autoregressive (VAR) estimates

Vector Autoregression Estimates
Date: 08/21/17 Time: 17:40
Sample (adjusted): 2007Q2 2016Q4
Included observations: 39 after adjustments
Standard errors in ( ) & t-statistics in [ ]

	LOGGOLD	LOGCPI	LOGEXRATE	LOGOIL	LOGINT
LOGGOLD(-1)	0.409384	0.003702	-0.027538	0.101807	-0.014504
	(0.16489)	(0.01168)	(0.04102)	(0.21477)	(0.08156)
	[2.48271]	[0.31699]	[-0.67126]	[0.47402]	[-0.17783]
LOGCPI(-1)	2.251765	0.964868	0.364158	-0.860534	0.101677
	(0.81372)	(0.05764)	(0.20245)	(1.05986)	(0.40248)
	[2.76725]	[16.7408]	[1.79878]	[-0.81193]	[0.25263]
LOGEXRATE(-1)	-0.965681	0.007683	0.856968	-1.637746	0.748037
	(0.66823)	(0.04733)	(0.16625)	(0.87036)	(0.33052)
	[-1.44514]	[0.16232]	[5.15472]	[-1.88169]	[2.26324]
LOGOIL(-1)	-0.143701	0.004019	-0.017332	0.400471	0.273045
	(0.16065)	(0.01138)	(0.03997)	(0.20925)	(0.07946)
	[-0.89449]	[0.35323]	[-0.43364]	[1.91387]	[3.43623]
LOGINT(-1)	-0.183316	0.007613	0.064691	-0.097004	0.754309
	(0.16814)	(0.01191)	(0.04183)	(0.21900)	(0.08317)
	[-1.09025]	[0.63922]	[1.54644]	[-0.44293]	[9.06997]
C	-3.533996	0.103299	-1.275653	7.877516	-2.199807
	(2.36746)	(0.16769)	(0.58900)	(3.08359)	(1.17098)
	[-1.49274]	[0.61602]	[-2.16578]	[2.55465]	[-1.87860]
R-squared	0.744384	0.976443	0.894747	0.752798	0.817068
Adj. R-squared	0.705654	0.972874	0.878800	0.715343	0.789350
Sum sq. resids	0.744043	0.003733	0.046054	1.262255	0.182026
S.E. equation	0.150156	0.010636	0.037358	0.195576	0.074269
F-statistic	19.21999	273.5690	56.10603	20.09882	29.47889
Log likelihood	21.86616	125.1175	76.12055	11.55930	49.32112
Akaike AIC	-0.813649	-6.108591	-3.595926	-0.285093	-2.221596
Schwarz SC	-0.557717	-5.852659	-3.339993	-0.029160	-1.965663
Mean dependent	8.310628	4.649879	1.227599	4.373663	1.073410
S.D. dependent	0.276766	0.064575	0.107307	0.366569	0.161819

Determinant resid covariance (dof adj.)	2.61E-13
Determinant resid covariance	1.13E-13
Log likelihood	304.5896
Akaike information criterion	-14.08152
Schwarz criterion	-12.80186

4.3.4 Variance Decomposition

Variance Decomposition of LOGGOLD:

Period	S.E.	LOGGOLD	LOGCPI	LOGEXRATE	LOGOIL	LOGINT
1	0.150156	100.0000	0.000000	0.000000	0.000000	0.000000
2	0.166324	96.93552	0.001715	1.258469	1.201381	0.602914
3	0.173259	93.22007	0.112798	2.938831	2.182575	1.545729
4	0.178016	89.87007	0.327207	4.496896	2.816490	2.489335
5	0.181786	87.08495	0.551961	5.810978	3.239943	3.312165
6	0.184894	84.82228	0.736985	6.894347	3.546485	3.999906
7	0.187491	82.98812	0.871316	7.786024	3.784020	4.570520
8	0.189673	81.49359	0.960467	8.522561	3.976920	5.046458
9	0.191514	80.26686	1.014272	9.133309	4.138520	5.447039
10	0.193071	79.25234	1.042376	9.641134	4.276810	5.787344

Variance Decomposition of LOGCPI:

Period	S.E.	LOGGOLD	LOGCPI	LOGEXRATE	LOGOIL	LOGINT
1	0.010636	0.678150	99.32185	0.000000	0.000000	0.000000
2	0.015272	1.239182	98.50171	0.022211	0.113572	0.123326
3	0.018934	1.631662	97.69148	0.088564	0.291189	0.297106
4	0.022062	1.918295	96.92599	0.200166	0.488852	0.466702
5	0.024812	2.146388	96.20755	0.352577	0.682226	0.611265
6	0.027260	2.343161	95.53419	0.540326	0.857799	0.724528
7	0.029447	2.523324	94.90260	0.758213	1.009102	0.806758
8	0.031406	2.694654	94.30859	1.001539	1.134102	0.861110
9	0.033158	2.861150	93.74752	1.266064	1.233393	0.891876
10	0.034723	3.024731	93.21475	1.547905	1.309008	0.903610

Variance Decomposition of LOGEXRATE:

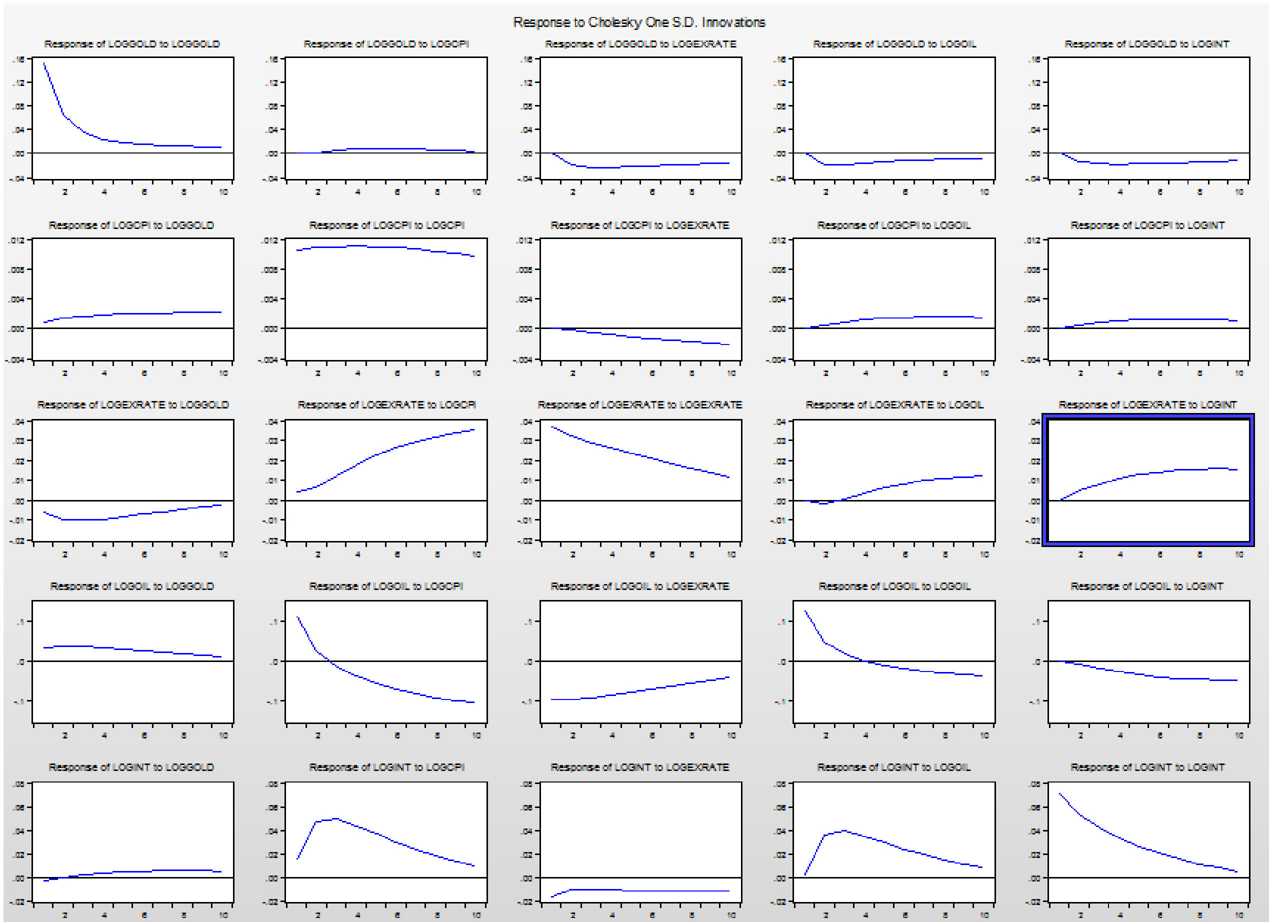
Period	S.E.	LOGGOLD	LOGCPI	LOGEXRATE	LOGOIL	LOGINT
1	0.037358	2.648337	1.239939	96.11172	0.000000	0.000000
2	0.050788	5.153807	2.311725	91.56907	0.160136	0.805258
3	0.061020	6.444582	5.513452	85.64498	0.114785	2.282199
4	0.070197	6.777854	10.44274	78.42876	0.316538	4.034105
5	0.079009	6.537710	16.23504	70.65610	0.823649	5.747496
6	0.087640	6.022165	22.15607	63.06238	1.517906	7.241480
7	0.096085	5.415798	27.76299	56.09988	2.272887	8.448446
8	0.104279	4.817664	32.85103	49.95883	3.002916	9.369558
9	0.112152	4.274108	37.36124	44.66468	3.662059	10.03792
10	0.119641	3.802411	41.30976	40.15979	4.231536	10.49650

Variance Decomposition of LOGOIL:

Period	S.E.	LOGGOLD	LOGCPI	LOGEXRATE	LOGOIL	LOGINT
1	0.195576	2.667321	33.31449	23.54851	40.46968	0.000000
2	0.228538	4.661284	25.86870	35.02488	34.35572	0.089419
3	0.250442	6.011106	21.82677	42.52419	29.09552	0.542416
4	0.270567	6.674185	20.75064	46.21867	24.92820	1.428297
5	0.290832	6.812297	21.82301	47.02230	21.73047	2.611929
6	0.311657	6.607659	24.27339	45.89331	19.32460	3.901036
7	0.332946	6.211399	27.47707	43.63525	17.53765	5.138633
8	0.354404	5.732002	30.98211	40.83922	16.21633	6.230328
9	0.375687	5.239047	34.49524	37.89510	15.23439	7.136225
10	0.396476	4.772594	37.84569	35.03515	14.49417	7.852393

Variance Decomposition of LOGINT: Period	S.E.	LOGGOLD	LOGCPI	LOGEXRATE	LOGOIL	LOGINT
1	0.074269	0.204504	4.663104	5.085898	0.066654	89.97984
2	0.109262	0.096173	20.74440	3.391614	10.53847	65.22934
3	0.133190	0.083033	27.52883	2.913270	15.69527	53.77960
4	0.148597	0.115411	30.65228	2.906353	18.11679	48.20917
5	0.158411	0.172094	32.23035	3.116115	19.33065	45.15079
6	0.164647	0.243052	33.04285	3.440918	19.96215	43.31103
7	0.168589	0.321964	33.42836	3.827787	20.28728	42.13461
8	0.171060	0.403958	33.56005	4.242738	20.44077	41.35248
9	0.172598	0.484983	33.54016	4.661184	20.49452	40.81915
10	0.173557	0.561719	33.43588	5.064583	20.48970	40.44811

4.3.5 Impluse Response Function



4.3.6 Diagnostic Checking

4.3.6.1 Autocorrelation

VAR Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 08/21/17 Time: 17:57
Sample: 2007Q1 2016Q4
Included observations: 39

Lags	LM-Stat	Prob
1	32.39689	0.1468
2	27.71195	0.3213
3	28.24745	0.2966
4	15.65673	0.9247
5	39.73070	0.0311
6	47.55651	0.0042
7	18.80370	0.8064
8	9.235820	0.9983
9	12.42355	0.9828
10	7.533700	0.9997
11	11.41129	0.9907
12	17.02568	0.8809

Probs from chi-square with 25 df.

4.3.6.2 Heteroskedasticity

VAR Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)
Date: 08/21/17 Time: 17:59
Sample: 2007Q1 2016Q4
Included observations: 39

Joint test:

Chi-sq	df	Prob.
202.3872	150	0.0028

Individual components:

Dependent	R-squared	F(10,28)	Prob.	Chi-sq(10)	Prob.
res1*res1	0.404705	1.903547	0.0876	15.78348	0.1060
res2*res2	0.358399	1.564085	0.1694	13.97757	0.1740
res3*res3	0.225490	0.815190	0.6168	8.794115	0.5517
res4*res4	0.465459	2.438139	0.0309	18.15290	0.0524
res5*res5	0.703760	6.651780	0.0000	27.44662	0.0022
res2*res1	0.366307	1.618542	0.1525	14.28597	0.1603
res3*res1	0.612859	4.432507	0.0009	23.90150	0.0079
res3*res2	0.420114	2.028536	0.0686	16.38445	0.0891
res4*res1	0.647745	5.148778	0.0003	25.26204	0.0049
res4*res2	0.429032	2.103957	0.0592	16.73227	0.0805
res4*res3	0.400391	1.869708	0.0936	15.61524	0.1112
res5*res1	0.300465	1.202660	0.3311	11.71814	0.3044
res5*res2	0.491164	2.702756	0.0186	19.15540	0.0383
res5*res3	0.674833	5.810959	0.0001	26.31849	0.0033
res5*res4	0.623265	4.632271	0.0006	24.30732	0.0068

4.4 Multiple Linear Regression

Dependent Variable: LOGGOLD
Method: Least Squares
Date: 08/21/17 Time: 18:00
Sample: 2007Q1 2016Q4
Included observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGCPI	4.179734	0.445596	9.380098	0.0000
LOGEXRATE	-1.212098	0.561456	-2.158847	0.0378
LOGOIL	-0.083439	0.151248	-0.551669	0.5847
LOGINT	-0.394553	0.160831	-2.453224	0.0193
C	-8.846941	1.911455	-4.628380	0.0000

R-squared	0.735495	Mean dependent var	8.296810
Adjusted R-squared	0.705266	S.D. dependent var	0.286833
S.E. of regression	0.155720	Akaike info criterion	-0.765048
Sum squared resid	0.848704	Schwarz criterion	-0.553938
Log likelihood	20.30096	Hannan-Quinn criter.	-0.688717
F-statistic	24.33064	Durbin-Watson stat	1.260754
Prob(F-statistic)	0.000000		

4.5.3 Model Misspecification

Ramsey RESET Test
Equation: UNTITLED
Specification: LOGGOLD LOGCPI LOGEXRATE LOGOIL LOGINT C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	3.643078	34	0.0009
F-statistic	13.27202	(1, 34)	0.0009
Likelihood ratio	13.18232	1	0.0003

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.238281	1	0.238281
Restricted SSR	0.848704	35	0.024249
Unrestricted SSR	0.610423	34	0.017954
Unrestricted SSR	0.610423	34	0.017954

LR test summary:

	Value	df
Restricted LogL	20.30096	35
Unrestricted LogL	26.89211	34

Unrestricted Test Equation:
Dependent Variable: LOGGOLD
Method: Least Squares
Date: 08/21/17 Time: 23:52
Sample: 2007Q1 2016Q4
Included observations: 40

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGCPI	120.0575	31.80998	3.774210	0.0006
LOGEXRATE	-34.75490	9.219937	-3.769538	0.0006
LOGOIL	-2.413429	0.652673	-3.697759	0.0008
LOGINT	-10.95655	2.902498	-3.774870	0.0006
C	-367.6404	98.50008	-3.732386	0.0007
FITTED^2	-1.696800	0.465760	-3.643078	0.0009

R-squared	0.809757	Mean dependent var	8.296810
Adjusted R-squared	0.781780	S.D. dependent var	0.286833
S.E. of regression	0.133991	Akaike info criterion	-1.044606
Sum squared resid	0.610423	Schwarz criterion	-0.791274
Log likelihood	26.89211	Hannan-Quinn criter.	-0.953009
F-statistic	28.94374	Durbin-Watson stat	1.548116
Prob(F-statistic)	0.000000		

4.5.4 Autocorrelation

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	3.220688	Prob. F(2,33)	0.0528
Obs*R-squared	6.532608	Prob. Chi-Square(2)	0.0381

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 08/21/17 Time: 23:53
Sample: 2007Q1 2016Q4
Included observations: 40
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOGCPI	-0.003148	0.420048	-0.007495	0.9941
LOGEXRATE	0.005784	0.530961	0.010894	0.9914
LOGOIL	-0.021265	0.143806	-0.147872	0.8833
LOGINT	0.022342	0.152101	0.146889	0.8841
C	0.078185	1.801617	0.043397	0.9656
RESID(-1)	0.304116	0.172108	1.767011	0.0865
RESID(-2)	0.191022	0.175351	1.089367	0.2839

R-squared	0.163315	Mean dependent var	-2.26E-15
Adjusted R-squared	0.011191	S.D. dependent var	0.147518
S.E. of regression	0.146690	Akaike info criterion	-0.843356
Sum squared resid	0.710097	Schwarz criterion	-0.547802
Log likelihood	23.86711	Hannan-Quinn criter.	-0.736493
F-statistic	1.073563	Durbin-Watson stat	2.054898
Prob(F-statistic)	0.398067		

4.5.5 Heteroskedasticity

Heteroskedasticity Test: ARCH

F-statistic	0.000549	Prob. F(1,37)	0.9814
Obs*R-squared	0.000579	Prob. Chi-Square(1)	0.9808

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 08/22/17 Time: 00:02
Sample (adjusted): 2007Q2 2016Q4
Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.021617	0.008164	2.647744	0.0118
RESID^2(-1)	0.003846	0.164089	0.023438	0.9814

R-squared	0.000015	Mean dependent var	0.021699
Adjusted R-squared	-0.027012	S.D. dependent var	0.045408
S.E. of regression	0.046017	Akaike info criterion	-3.269704
Sum squared resid	0.078349	Schwarz criterion	-3.184393
Log likelihood	65.75923	Hannan-Quinn criter.	-3.239095
F-statistic	0.000549	Durbin-Watson stat	2.003591
Prob(F-statistic)	0.981427		