DETERMINANTS OF GOLD PRICE: USING SIMPLE AND MULTIPLE LINEAR REGRESSION

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DECLARATION

We hereby declare that:

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

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

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

(4) The word count of this research report is 18308.

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LIST OF ABBREVIATIONS

ARCH	Autoregressive conditional heteroscedasticity
BLUE	Best Linear Unbiased Estimator
CLRM	Classical Linear Regression Model
CNLRM	Classical Normality Linear Regression Model
CRD	Brent Crude Oil Price
ECM	Error Correction Model
GFD	Global Financial Data
GOLD	Gold Price
IFS	International Financial Statistics
InCRD	Logarithm of Gold price
INF	World Consumer Price Index
InGOLD	Logarithm of Gold price
InINF	Logarithm of Gold price
InSIL	Logarithm of Silver price
M1	Money Supply
OLS	Ordinary Least Square
RESET	Regression Specification Error Test
SIL	Silver Price
USD	USA Dollar Trade Weighted Index
VECM	Vector Error Correction Model
VIF	Variance Inflation Factor

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ABSTRACT

The gold related research had been highlighted in the recent years due to the sharp increasing trend of gold price since 2005. Gold price stated an average price of USD 427 per ounce in 2005 had increased dramatically to USD 1384 per ounce in first quarter of 2011. Besides, the important characteristics of gold hedge against uncertainty of economic condition had made gold served as an important investment tools in the market. The main objective of this paper was to examine the determinants of gold price by investigating the four keys influencing variables affecting gold price, such as inflation, silver price, USA dollar trade weighted index and Brent crude oil price. Quarterly data which obtained from the period of 1971 to first quarter of 2011 were sourced from International Financial Statistics (IFS) and Global Financial Data (GFD). Simple linear regression model and multiple linear regression model were constructed to investigate the relationship between independent variables and gold price by using Ordinary Least Square (OLS) procedure. The study findings showed there were positive relationship between inflation, silver price and Brent crude oil price with gold price. On the other hand, the negative relationship could be observed between USA Dollar trade weighted index and gold price. A more comprehensive model could be provided in this study by capturing various factors into consideration. This framework contributed to a better understanding of which factors could significantly affecting gold price. In addition, financial planners were provided with better decision aid in the investment strategy.

CHAPTER 1: INTRODUCTION

1.0 Introduction

This chapter focused on the research background of gold, followed by problem statement, research objectives which consist of general objectives and specific objectives, research question, hypothesis of study, significance of study and chapter layout.

1.1 Research background

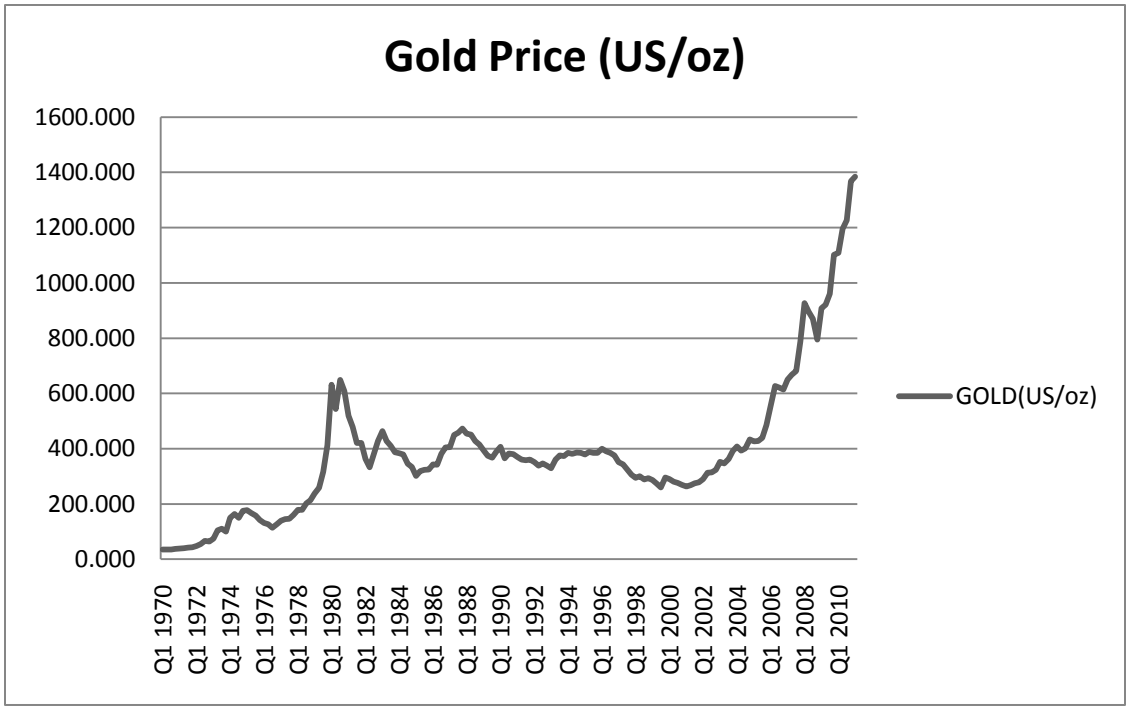
The continuous rising of gold price since the year of 2005 had pulled the attentions from researchers and investors. At the year of 2005, gold only recorded at the average price of USD444.84 per ounce and the increasing trend of gold price was continued to grow at a faster rate. At the first quarter of year 2011, gold price had reached at its peak of USD 1384.38 per ounce. There were several reasons which led gold price at increasing trend. One of the reasons that caused the increasing trend of gold price was due to the gold characteristics that served as the inflation hedge. Gold served as the inflation hedge meant the gold value will increase accordingly when inflation rate increase. In other words, the gold preserved its value even though inflation happened. Therefore, gold was proven to have inflation hedge capabilities. The evidence of gold as inflation hedge enabled investors to allocate better in their asset portfolio in order to minimize the losses caused by inflation. As most of the investors had concern over the prospect of resurgence in inflation, many investors chose to invest in gold related products due to gold was recognized as an outperform asset during high-inflation period (Oxford Economics, 2011). Moreover, gold also served as an effective hedge against US dollar exchange rate (Baur, 2011). In fact, majority of the gold

transactions in the world were in US dollar. Thus if dollar depreciated against other currency, gold price would increased, thus it could preserved the real value of gold.

According to Parisi and Diaz (2007), gold had proved to be the most effective commodity for cash return during the stock exchange crisis in year 1987 and Asian Crisis in 1997. Therefore, investors viewed gold as a safe haven asset to hedge against economic crisis. Besides, gold was widely used as investment tool by governments, households institutional and private equity investors to safeguard the investment value. This was because gold could act as insurance in preserving the value if there were economic crisis. For example, when there was high inflation in an economy, US dollar was to lose its value as overall price of goods and services were increased. On the other hand, gold price would increase when inflation happened thus the gold investment value was protected. Therefore, gold could protect investors suffer losses from inflation (Bolgorian & Gharli, 2010). However, Baur (2011) had found the gold characteristic of inflation hedge only applicable in univariate framework which assumed no other variables could affect gold price.

According to Baur (2011), gold also occupied an important role in hedge against US dollar exchange rate. This was because majority of gold transactions in the world were priced in US dollar. When US dollar depreciated against other currencies, the nominal gold price in US dollar will increased in its value thus the real value of gold could be sustained. With the characteristics stated above, gold served as a hedge against US dollar exchange rate risk. Furthermore, gold was proven to hold the function of store value of money against currency devaluation and commodity price changes. As a result, investors had higher tendency to invest in gold which served as the store of value especially during economy uncertainty. The uncertainty of economy condition had made the prediction difficult in securities market.

Figure 1: Gold price from the year Q1 1971 to Q1 2011



*Sourced: International Financial Statistics, (IFS).

According to Mills (2003), gold price had tied closely to gold standard at USD 20.67 per ounce before the year of 1934. After the collapsed of gold standard, gold price was raised to USD 35 per ounce and the price remained unchanged until the year of 1968. The gold price was freely determined by the market supply and demand after the breakdown of the Bretton Woods[1] system at 1971. However, the unique gold pricing mechanism had to be fixed twice a day in London.

Based on Figure 1, gold price recorded at the level of USD 38.50 in the first quarter of 1971. It had shoot up to USD 631.08 at the first quarter of 1980. The reasons behind of the increasing trend of gold price were the lack of new mining supply and the oil crisis happened at the year of 1973 (Mills, 2003). Besides, the incident of high inflation, the uncertainty in international politics and losing confidence towards US

[1] Bretton Woods is a system which required all the central banks from different countries to maintain fixed exchange rate with US dollar.

dollar from 1976 to 1980 had forced gold price to increase further. The increased gold price in 1980 was caused by trading in future market (Mills, 2003). However, gold price had quickly dropped to the level of USD 362 per ounce in 1982. Later on, gold price had recorded a rather stable price from the range of USD 250 per ounce to USD 450 per ounce from the year of 1982 to 2005. From Figure 1, gold price was observed to be quite stable in the market throughout the above period. However, the stable gold price did not hold longer than that. Since 2005, gold price had increased dramatically from price level of USD 427 per ounce to USD 1384 per ounce at early year of 2011. Within this period, gold price had increased USD 957 per ounce or 224% compared to year 2005. This phenomenon had attracted attention of many researchers in investigating the factors affecting the appreciation of gold price.

There were two main factors which explained the increasing trend of gold price in short run. First, when economy was attacked by crisis, most of the investors lost confidence towards security market. Therefore, investors tend to switch their investment funds to gold market which believed to be more insurable and riskless from the unstable financial market. From company perspective, multinational companies were often exposed to currency exchange risk when transactions were held between subsidiaries and parent company. Therefore, big corporate often employ gold to hedge against the fluctuation of US dollar against other currencies. Besides, the increased oil price which led to inflation was another reason for companies to hold gold as the inflation hedge. This resulted the gold trading could help to protect the real value for investment against US dollar oscillation and inflation (Shafiee & Topal, 2010).

On the other hand, there were three major reasons which led gold price to increase in long run. Firstly, the increased mining costs, decreased exploration and difficulties in finding new deposits had heavily reduced gold production in the recent years. This was because gold resources were getting lesser as it had been widely explored. Therefore, gold price would be traded in higher price for its depleted production or gold supply. Secondly, market uncertainty had contributed to the increasing of gold

price. High market volatility led to ambiguous condition in future. From investors' perspective, in order to hedge against economy uncertainty, investors tend to allocate gold as part of the investments portfolio. This was to ensure the safety return regardless the condition of economy. In this case, gold served as an insurance against economic uncertainty as it held the characteristic of high liquidity. This feature enabled gold to be marketable even in unstable financial markets, thus gold demand had hugely increased in the recent years. The third reason was gold was easy and convenient for investors to invest and trade via gold Exchange Traded Funds (ETFs), thus it helped in stimulating the demand in gold. With the excessive demand over gold, eventually it led gold price to increased (Shafiee & Topal, 2010).

There were numbers of recent studies had been done related to gold. Baur (2011) had done a study related to the additional role of gold as a hedge of financial losses and a safe haven asset despite of its traditional role which acted as a store value of money and inflation hedge. However, Rockerbie (1999) had developed a model to examine the gold production in South Africa from 1970 to 1995. Apart from that, there were researchers suggested that gold price can be forecasted using crude oil price (Zhang & Wei, 2010) and silver price (Escribano & Granger, 1997). This was because both commodities had high correlation with gold price. Furthermore, Pukthuanthong and Roll (2011) study had contributed to the research of the puzzling behavior between gold and US dollar. On the other hand, Wang, Lee and Nguyen Thi (2011) had done a research on short run and long run inflation hedging effectiveness of gold in United States and Japan. The paper was to examine the effectiveness of gold hedge against expected inflation in short run and long run.

Moreover, some research also had been done from the perspective of gold price behavior. Ismail, Yahya and Shabri (2009) who studied the gold price behavior found that gold price was significantly affected and it could be forecasted using economy factors like Commodity Research Bureau future index; USD/Euro foreign exchange rate; inflation rate; money supply; New York Stock Exchange; Standard and Poor 500; Treasury bill rate and US dollar index. The study found that jewellery demand

had significantly contributed to the rise in gold price (Batchelor & Gulley, 1995). Meanwhile, Salant and Henderson (1978) clarified the anticipation of government policy could affect the real gold price.

1.2 Problem Statement

Ever since 1971, gold price had dramatically increased from USD 38.50 per ounce to USD 631.10 per ounce at first quarter of 1980. This trend continued to grow until gold price reached the peak level at August of 2011. At that time, gold price had recorded the highest price of USD 1917 per ounce. The reason of gold breakthrough its highest price was due to the downgrade of S&P rating on US Treasury bond from AAA to AA+ (Detrixhe, 2011). The downgrade of US Treasury bond had led to US Debt Crises. This was due to the investors had lost confidence in US paper currency. As a result, most of the investor had shifted their investment into gold which served as shield to protect the investment value. With all the factors above, an increased demand in gold had caused gold price to reach at USD 1917 per ounce in August 2011 (Yi Tian, 2011).

However, the high gold price trend had become anxious to some investors. This was because gold price might not stay long at the current increasing trend. The excessive demand of gold for speculating needs might be another reason which led to high gold price. Based on the information provided in World Gold Council's demand trend report in Q3 2011, the gold demand in the particular quarter had reached at 1053.9 tonnes. The demand had increased by 6% compared to Q3 2010. The reason of the increased in gold demand was mainly caused by the increased demand in gold investment. The 33% increased in gold investment on year to year had supported the excessive gold demand in the market (Global gold demand, 2011). Unlike paper currency, gold production was limited due to its nature of scarcity. This excessive demand would cause gold to reach at higher price from its real value. Therefore, gold bubble might exist in the market. If in the case of bubble burst, gold investors would

suffer losses. On the other hand, gold increasing trend had made gold investment became more attractive compared to other investments. The increasing trend allowed gold investors to speculate in gold price with the hope of the trend could maintain in long run. In fact, the trend might stop if the gold bubble burst in the market.

With the consideration above, this study had constructed a gold price model which could provide the rationale for the fluctuation of gold price. The important factors which could affect gold price were included in the model. Besides, an indicator for the investors and financial planners to make decision on gold investment was provided by the framework. In addition, this study also served as the piece of advice for financial planners and investors to hold a better understanding of the variables which could affect gold price. Thus, this could help the investors and financial planners with a better decision aid in asset allocation especially in gold investment.

1.3 Research Objective

1.3.1 General Objective

To examine the relationship between inflation (Consumer Price Index), silver price, USA dollar trade weighted index and Brent crude oil price on the gold price.
To examine to what extent the Classical Normal Linear Regression Model (CNLRM) is useful in analyzing factors affecting gold price. Is CNLRM an appropriate model to study the determinants of gold price in this research?

1.3.2 Specific Objective

i) To examine on the relationship between inflation and gold price by developing simple and multiple linear regressions.
ii) To determine the relationship between silver price and gold price by developing simple and multiple linear regressions.
iii) To examine on the relationship between USA Dollar Trade Weighted Index and gold price by developing simple and multiple linear regressions.
iv) To investigate the relationship between Brent crude oil price and gold price by developing simple and multiple linear regressions.

1.4 Research Question

There were several questions arose regarding to gold price, inflation (consumer price index), silver price, USA dollar trade weighted index and Brent crude oil price when the study was conducted. Crude oil market had been booming since the year of 2002 (Fattouh, 2010). The increased crude oil price had influential impact on gold market. Therefore, the question arose as what would be the relationship exist between the crude oil price and gold price? Besides, gold had been mentioned as safety tool to protect the investment value when there were high inflation and depreciation of US currency against other currencies. Therefore, what would be the relationships existed between gold price with inflation and US dollar exchange rate?

Apart from that, gold and silver had been identified as the main commodities in the market. Moreover, both gold and silver had similar characteristics. Thus the question arose as what would be relationship exist between gold price and silver price? Lastly, since Classical Normal Linear Regression Model (CNLRM) was said to produce the best linear unbiased estimators (BLUE) if all the assumptions were fulfilled (Gujarati & Porter, 2004). The question arose as to what extent the CNLRM is useful in the

study? Therefore, this research was conducted with the aim to address the problems arose on the related issue.

1.5 Hypothesis of Study

1. H_0: $\beta_1 = 0$ (There is no relationship between inflation and gold price)
   H_1 : $\beta_1 \neq 0$ (There is a relationship between inflation and gold price)
   Decision rule: Reject H_0 if t-statistic is larger than positive critical value or smaller than negative critical value, otherwise do not reject H_0.

2. H_0: $\beta_2 = 0$ (There is no relationship between silver price and gold price)
   H_1 : $\beta_2 \neq 0$ (There is a relationship between silver price and gold price)
   Decision rule: Reject H_0 if t-statistic is larger than positive critical value or smaller than negative critical value, otherwise do not reject H_0.

3. H_0: $\beta_3 = 0$ (There is no relationship between USA dollar trade weighted index and gold price)
   H_1 : $\beta_3 \neq 0$ (There is a relationship between USA dollar trade weighted index and gold price)
   Decision rule: Reject H_0 if t-statistic is larger than positive critical value or smaller than negative critical value, otherwise do not reject H_0.

4. H_0: $\beta_4 = 0$ (There is no relationship between Brent crude oil price and gold price)
   H_1 : $\beta_4 \neq 0$ (There is a relationship between Brent crude oil price and gold price)
   Decision rule: Reject H_0 if t-statistic is larger than positive critical value or smaller than negative critical value, otherwise do not reject H_0.

1.6 Significance of Study

The previous researchers such as Zhang and Wei (2010) and Escribano and Granger (1997) had focused their research area into the relationship between solely one factor and gold price. For example, Zhang and Wei (2010) had examined the relationship between crude oil market and gold market. On the other hand, Escribano and Granger (1997) had done their research in examined the relationship between silver price and gold price. However, in reality gold price did not solely affected by single factor. Therefore, the research model in this study which captured four different factors in determining gold price enabled the analysis to be more accurate and comprehensive. In the study, the relationship between the proposed independent variables such as inflation (world consumer price index as a proxy for inflation), silver price, USA Dollar Trade Weighted Index and Brent crude oil price with gold price were being investigated.

Besides, ordinary least square (OLS) procedure was employed in this research methodology to investigate the relationship between gold price and four independent variables. Simple linear regression model was carried out to test the significance of relationship for each independent variable towards gold price. Next, multiple linear regressions model was constructed to examine the significance relationship of all the four independent variables with gold price. In the meantime, the consistency of expected sign of each independent variable in multiple linear regression and simple linear regression were observed. Furthermore, the findings of the study could determine the fitness of CNLRM in determining gold price.

When there was economy crisis, investors often shift their investments from securities market to gold market in order to safeguard the investment value. However, the increasing trend of gold price did not always held, the increased gold price might due to the over demand of speculating needs. With the reason stated above, gold market might collapse once the gold bubble burst in the market. In that case, many investors who allocate investments in gold investment might suffer from losses. Therefore, this

study which examined the important factors that significantly affect gold price provided financial planners, investors and policymakers with crucial information to hold a better decision framework when dealing with gold market.

1.7 Chapter Layout

The rest of the chapters were organized as followed. In chapter 2, a brief synoptic review of the empirical literature will be provided. Next, chapter 3 discussed the empirical methodology employed in the study. The research was followed by the result interpretations based on the estimation outputs in chapter 4. Lastly, chapter 5 had concluded our research by summarize the major findings, contributions of study, limitations of study and some of the recommendations for future research.

CHAPTER 2: LITERATURE REVIEW

2.0 Introduction

The comprehensive review of research from the existing researchers related to gold had been documented in this chapter. This chapter was started with the literature review of the previous researchers on the effect of inflation, silver price, USA dollar trade weighted index and Brent crude oil price with gold price. Next, the chapter was followed by the review of theoretical model which could explain the rationale of gold price movement. The theoretical or conceptual framework was presented at the following part, identified the network relationships between the variables. Finally, testable hypothesis was formulated to test the validity of the theory.

2.1 Review of the literature

In the recently year, gold price had been triggered the attention from the academic researchers due to the high price in the market. Many researches had been done related to gold in the past such as the role of gold, gold as the inflationary hedge, the existence of gold bubble and others. Besides, there were numbers of empirical studies related to gold price forecasting had been done in previous. For example, Kaufmann and Winters (1989) had derived a formula in forecasting annual gold price using Ordinary Least Squares regression analysis. The model took into consideration of changes in inflation rate, US dollar exchange rate index and annual gold production to predict the annual gold price in 1989. Not only that, Ismail et al. (2009) also had developed a similar forecasting model using Multiple Linear Regression. In the research, eight variables had been identified to have influencing power on gold price. The variables included Commodity Research Bureau future index, USD/Euro foreign exchange rate, inflation rate, money supply, New York Stock Exchange, Standard and

Poor 500, Treasury bill and US dollar index. In the research findings, Commodity Research Bureau future index, USD/Euro foreign exchange rate, inflation rate and money supply were found to have higher explanatory power compared to other variables in gold price forecasting model. In addition, Shaffiee and Topal (2010) had employed the reverting jump diffusion model to forecast the gold price for next 10 years. However, the study findings showed that gold price was non-stationary in long term.

2.1.1 Gold price and Inflation

Based on the previous researchers' findings, the relationship between gold price and inflation (consumer price index, CPI as a proxy for inflation) were found to be mixed.

Several researchers had supported their researches findings as gold was served as the inflation hedge. The findings indicated there was positive relationship existed between gold and inflation. For example, Narayan et al. (2010) and Ismail et al. (2009) had found the statistically significant and positive relationship between gold price and inflation in their research. According to Kaufmann and Winter (1989), gold price was expected to group with parameter inflation. Since gold served as the inflation hedge, therefore higher inflation in the economy would increase gold demand in the market. Consequently, overall gold price increased due to high demand. Besides, Sjaastad and Scacciavillani (1996) had reported gold could serve as the store of value against inflation. When there was increased in world inflation rate, the real gold price would also increased, thus putting upward pressure on gold demand. Moreover, Worthington and Pahlavani (2006) had done their research on the exploration of long run relationship between gold price and the general price level. Their ultimate objective was to investigate the inflation hedge effectiveness of gold from year 1875 to 2006. A strong cointegration relationship was found between gold price and inflation in the research findings. The result suggested gold could act as the instrument to hedge against inflation especially during the post-war and post 1970s period. In conclusion,

gold was effectively served as inflation hedge when the long-term stable relationship between gold price and inflation was existed.

In addition, Wang et al. (2011) was investigated the inflation hedging ability of gold in United Stated and Japan using non-linear VAR model. In the result findings, gold as the inflation hedge served well at United States in long run but not in Japan. The research showed the effectiveness of gold served as the inflation hedge was not absolute but it depended on market and time selection key factors. This investigation provided a useful decision aids for investors whether when gold could served effectively as inflation hedge. It showed that gold return was not able to hedge against inflation pressure both in United States and Japan during the low price adjustment regime. However, during the high momentum regime, gold return can be fully hedged against the inflation in United State but not in Japan. The reason behind of the above phenomena was due to the asymmetric behaviour existed between gold price expressed in Yen and CPI in Japanese market. While the cross-elasticity between gold price and inflation was high in United States and there was no rigidity of price adjustments. Therefore, gold could be the effective hedge in United State but not in Japan.

In contrary, there were other researchers who had found negative relationship between gold price and inflation. The negative relationship between gold price and inflation was supported by Baur (2011). The study findings showed the negative relationship existed between the gold price and inflation by testing the variables using Multiple Linear Regression. Therefore, the evidence of gold served as an inflation hedge was weak. As compared to Multiple Linear Regression model developed in the same study by Baur, positive coefficient could be found in simple linear regression model. The positive relationship implied gold price increased with higher inflation and decreased with lower inflation. However, multiple linear regression model had a more promising result compared to simple linear regression model. This is because the model captured more variables than simple linear regression in examining the possible interaction between variables with gold price in the model. Therefore, the

positive relationship between gold price and Consumer Price Index, CPI (as a proxy of inflation) was abandoned by the author. This was because the evidence showed there was a decline of real gold price for 30-year period which exclude the possibility of investors was directly compensated for the rising in CPI using gold. In addition, the author argued the positive relationship between gold and price level in an economy had been eliminated once the gold standard was removed. Moreover, Sjaastad (2008) also supported the negative effect of world inflation on gold price. The result had once again made the negative relationship established.

On the other hand, there were some studies indicated there was no significant relationship between gold price and inflation. For example, Shafiee and Topal (2010) stated an increased in nominal gold price was not significantly caused by inflation. Therefore, there was no significant relationship existed between nominal gold price movements and inflation. The study findings showed a low correlation which was around 9 percent existed between gold price and inflation.

Similarly, insignificant relationship between inflation and gold price was found in the findings from Tully and Lucey (2007) using a power GARCH approach. Also, Blose (2009) stated there was no significant relationship existed between CPI and gold. Unexpected changes in CPI (as a proxy of inflation) did not affect gold price. In addition, the author argued the unexpected changes in CPI would only affects risk free rate and the carrying cost of gold, but not the gold spot price. This result was consistent with the carrying cost hypothesis which stated the higher expectation inflation would lead to higher interest rates. Thus, carrying cost for gold would increase. This result would offset the benefits of speculation in gold price during the inflationary periods.

Not only that, some studies had examined the bidirectional relationship between gold price and inflation. The bidirectional relationship could examine the two ways relationship between gold price and inflation. For example, the study findings from Blose (2009) had concluded bilateral relationship was not found between gold and

inflation. Therefore, gold market could not used to speculate the changes of inflation expectation. In other terminology, gold spot price was not able to determine the market inflation expectations. On top of that, Blose (2009) suggested the inflationary expectations on gold prices were followed closely by the carrying cost and expected inflation effect hypotheses.

In conclusion, many researches had been done between gold price and inflation. The result showed the historical data of both inflation and gold price were highly correlated between each others. However, the interaction effect between gold price and inflation was still unclear. Thus, it raised the interest in investigate the relationship between inflation and gold price.

2.1.2 Gold price and silver price

A numbers of investigations between gold price and silver price had been carried out by the previous researchers. For example, Ciner (2001) had reported the disappearance of stable long-run relationship between gold and silver price on the Tokyo Commodity Exchange in the 1990s. This researcher noted the gold and silver had their own separate markets as they were considered to have different economic users. Therefore, the relationships seem to break more recently.

Next, Escribano and Granger (1998) had found the evidence of cointegration existed between gold and silver in the study but with different intercept, which of during bubble period and after bubble periods. The above happened was mainly due to the structural change that occurs with a reduction in the variance. Based on the evidence from the behavior during bubble period, a strong simultaneous relationship was found in the regression. The result indicated gold and silver price was strongly related.

Moreover, Tully and Lucey (2006) indicated historically, gold and silver were precious metals that could be used as currency, thus both gold and silver act as close

substitutes for each another. In the study findings, stable long run relationship was existed between gold and silver. According to Ferretti and Gonzalo (2010), the study suggested gold and silver were better approached as substitute goods when there was economic uncertainties and weak dollar condition. Besides, Lee and Lin (2010) found that gold and silver were reflected as substitute goods to each other. In the study, Copula model was employed to investigate the dynamic relationships between gold and silver futures. The high correlation existed between gold and silver market was found in the study. Therefore, the study implied that both markets could act as substitute to hedge against similar risks.

According to Solt and Swanson (1981), the nature and efficiency of both gold and silver markets in United States were found to be positive relationship. This research finding showed gold and silver price were positively related but the relationship was not stable. However, researchers supported the stable long-run relationship existed between gold price and silver price even though only weak correlation existed among them.

The mixed relationship produced by previous researchers led to a question such as did the short and long run relationship existed between gold with silver? Therefore, the ambiguous result raised the interest of examine the relationship between silver price and gold price.

2.1.3 Gold price and USA Dollar trade weighted index

Based on the previous researchers' findings, inconclusive results were found between gold price and US dollar exchange rate. According to Soytas et al. (2009), the unilateral relationship could be observed in the model. The findings indicated US dollar exchange rate had predictive power over the gold market. Gold can be used to hedge against US dollar exchange rate. The negative relationship indicated gold served as a safe haven during currency crisis and it was able to hedge in diversified

portfolio. Besides, Levin and Wright (2006) applied various cointegration regression techniques to examine the key determinants for gold price movement. The authors discovered there was a statistically significant negative relationship between changes in gold price with changes in the US dollar trade weighted exchange rate and gold lease rate.

Furthermore, negative relationship between gold price and US dollar exchange rate was further supported by Kaufmann and Winter (1989). In the findings, gold price should fluctuate inversely against the value of US dollar in relation to other currencies. Significant negative relationship was found between gold price and US dollar exchange rate. This was because majority of gold transactions in the world were quoted in US dollar. In addition, similar results had been found by Ismail et al. (2009). The authors reported there linear correlation existed between gold price and USD/Euro foreign exchange rate as well as US dollar index. This relationship was further explained by Tully and Lucey (2007). The authors stated US dollar was the sole macroeconomic variable which influenced gold price. The result concluded that gold served as the hedge of US dollar.

Besides, exponential generalized autoregressive conditional heteroskedasticity (EGARCH) technique was employed by Capie et al. (2005) in examined the relationship between gold price and US dollar exchange rate. The study findings revealed that gold return served as the hedge against US dollar depreciation. Therefore, there was negative relationship between gold price and Sterling-Dollar and Yen-dollar exchange rates but the relationship was varied over time. The reasons of the relationship was varied over time was due to the firm expectations over the temporary fluctuation of currencies and government attitudes towards gold.

In addition, Joy (2011) who studied the properties of gold concluded strong negative correlation existed between gold returns and US dollar returns based on multivariate GARCH model. The strong negative relationship was found in the study from year 2001 to year 2008. The correlation between these two variables had been turned into

increasing negative trend for the past 7 years. The study suggested the increased in gold price associated with a decreased in US dollar currency.

Sjaastad and Scacciavillani (1996) and Sjaastad (2008) who studied the relationship between Euro dollar exchange rate, US dollar exchange rate and gold price confirmed gold acted as a hedge against exchange rate risk. This result was supported by the market efficiency hypothesis[2]. In other words, gold and exchange rate market was efficient where gold price was fully reflected by all available information. Furthermore, Sjaastad and Scacciavillani (1996) found gold price was dominated by Euro dollar in 1980s, but later in 1990s, Sjaastad (2008) found US dollar had gradually replaced Euro dollar in dominating gold price. Therefore, when gold market was dominated by Euro currency, the fluctuations of Euro currency was said to held significant effect in affecting gold price. On the other hand, when US dollar was dominating in gold price, the appreciation of Euro and Yen would increase gold price in US dollar.

Pukthuanthong and Roll (2011) found that the gold price was related to the appreciation or depreciation of currencies. In other words, gold price had close interaction with US dollar currency. From the findings, the researchers pointed that gold price and Dollar currency posed negative relationship. When Dollar depreciated, gold price would increase.

On the other hand, Akar (2011) used dynamic conditional correlations GARCH (DCC-GARCH) model to investigate the relationship between stock exchange, gold and foreign exchange returns in Turkey from the period of 1990 to 2010. The findings revealed that the dollar to gold relationship was found to be positive throughout the sampling period, except for 2000. Based on the results, crisis on year 2001 was a significant turning point in the dynamic relationships between various investments.

[2] Market efficiency hypothesis was known as random walk theory. It means that current price was fully reflected by all the available information and no other ways to earn abnormal profit (Malkiel, 2003).

These results were useful for those investors who practiced diversification in the portfolio to prevent risk.

From the findings from previous researchers, mixed results were produced between gold price and US dollar exchange rate. Therefore, the relationship existed between the variables was still unclear. This unclear situation could motivate the researcher to investigate the relationship between gold price and silver price.

2.1.4 Gold price and Brent crude oil price

In recently years, the biggest portion of commodities market which was the gold and crude oil was no longer solely determined by the traditional effect of demand and supply. In fact, there were more factors could affects the market price of the two commodities. Based on the past researchers findings, the positive relationship were found between gold price and Brent crude oil price. Besides, there were some studies argued on the bilateral and unilateral relationships existed among them.

Shafiee and Topal (2010) identified there was a positive correlation between gold and crude oil prices. The correlation between gold and Brent crude oil price was extremely high, meaning that an increase of oil price might lead to an increase of gold price. The finding was further corroborated when the two oil shocks happened in between year 1979 to 1980 and another in middle of year 2007, the gold price jumps as well. The nominal oil and gold price from January 1968 till December 2008 increased by 23 and 16 times respectively. Besides, Soytas et al. (2009) also indicated gold prices have significant positive elasticity with respect to oil prices in the short run.

Sari et al. (2010) employed the generalized forecast error variance decompositions and the generalized impulse response functions to assess the impact of oil price shocks on gold returns. The impulse response function indicated the initial impacts of

oil spot price on gold prices were positive and significant but the relationship was only strong in short run whereby an increase of oil price would lead to an increase of gold price. Thus, gold price and oil price were moved in the same direction.

Narayan et al. (2010) examined the long run relationship between gold and oil spot and future prices at different level of maturity by conducting cointegration test. The result found that gold and oil market were highly cointegrated. Thus, implied that oil market can be used to predict the gold market price and vice versa. This showed that there was bilateral relationship existed between gold and oil prices. This can be closely explained by inflation channel. When there was an increase in oil price, it might lead to inflation. Eventually the gold price might increase due to its role of hedge against inflation. Thus, an increase in oil price indicated an increase in gold price.

The bilateral relationship between gold and oil price, however being opposed by few studies done by, Zhang and Wei (2010), Liao and Chen (2008) and Sari et al. (2010). Oil price was said to have positive relationship but consisted of no bilateral relationship. Researchers, Zhang and Wei (2010) found that there existed a significant unilateral linear Granger causality between crude oil and the gold markets. The findings explained that the crude oil price soaring caused the gold price moving at the same direction with the crude oil prices and posed very similar trends. However, gold price returns did not significantly linearly caused the volatility of crude oil price change. This evidence was also supported by the research done by Liao and Chen (2008) and Sari et al. (2010). Liao and Chen (2008) who used TGARCH model had found that gold price return did not had an impact on oil price. On the other hand, the oil price had a significant impact in affecting gold price. While, Sari et al. (2010) mentioned the gold return was unable to explain the oil price return. The unilateral relationship between gold price and oil price could be explained based on their volatility. Gold was less volatile in the precious metal class while oil was a very volatile commodity. Thus, changes in gold price failed in predicting the fluctuation in

oil price. Therefore, the studies provided a reference for investors to monitor the changes of gold price by pay close attention towards the changes of oil price.

In conclusion, mixed results were produced where unilateral and bilateral relationships had found by different researchers. Therefore, an ambiguous situation occurred and led to an interest to test on the causal relationship between Brent crude oil price and gold price.

2.2 Review of Relevant Theoretical Model

According to Blose (2009), the impact of inflation on volatility of gold price was well explained using the rationale of carrying cost hypothesis and expected inflation effect hypothesis. The carrying cost hypothesis concluded the unexpected changes in Consumer Price Index (CPI) did not attribute to the dynamic change of gold price. This was because the carrying cost could offset the speculation benefits. Consequently, it would not have any impact to the gold price changes. On the other hand, the expected inflation effect hypothesis implied that expected inflation will caused investors to purchase gold either to hedge against inflation or speculate in the increase in the gold price. Thus, this scenario would lead to an increase in the gold price. This theory was consistent with the positive relationship between inflation and gold price. Many gold analysts argued that upward revisions in expected inflation might attract investors to speculate or to hedge against inflation using gold. The increased of gold demand had caused an immediate increase in the gold price at the time of the revision in expected inflation. On the other hand, the expected inflation effect hypothesis proposed that investors who have superior knowledge regarding future inflation could make a speculative profit by buying (or selling) gold in anticipation of market adjustments to the changes in expected inflation.

According to Sari et al. (2009), the relationship between two commodities, crude oil and gold, can be explained by the theory of co-movements and information

transmission. In short run, gold price was respond significantly with the volatility of other metal price and dollar exchange rate. Besides, the efficient market theory had explained the highly correlated between gold and crude oil market. When there was an increase in crude oil price, it led to inflation problem in the economy. Therefore, investors tend to demand more gold at this period. Due to the surplus demand in the market, the high demand of gold might translate gold price into a higher level. In conclusion, the highly correlated relationship between the two markets could be explained through inflation channel (Narayan et al. 2010).

2.3 Proposed theoretical and conceptual framework

Proposed Model:

$\widehat{GOLD}_t = \hat{\beta}_0 + \hat{\beta}_1 \text{INF}_t + \hat{\beta}_2 \text{SIL}_t + \hat{\beta}_3 \text{USD}_t + \hat{\beta}_4 \text{CRD}_t$

Where,

$\widehat{GOLD}_t$ = Gold Price (USD/Ounce)

INF_t = World Consumer Price Index (Year 2005=100)

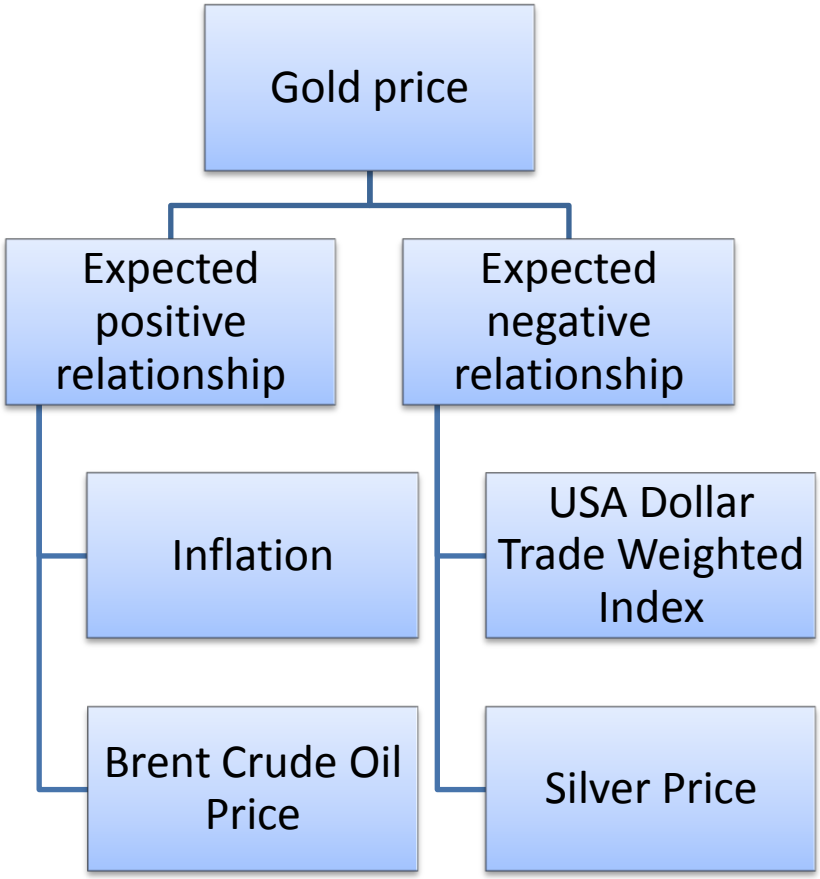
SIL_t = Silver Price (US cents/ Troy Ounce)

USD_t = USA Dollar Trade Weighted Index (Year 1975-1976=100)

CRD_t = Brent Crude Oil Price (USD/ Barrel)

As noted above, GOLD was the price of the gold, measured in USD per ounce; INF was the world inflation as a proxy of Consumer Price Index (CPI), measured using year 2005 as a base year; SIL was the silver price, measured in US cents per troy ounce; USD was the USA Dollar Trade Weighted Index, measured using year 1975-1976 as the base year, while CRD was the Brent crude oil price, measured in a unit of USD per barrel.

Figure 2 : Proposed model



The above figure illustrated the determinants of gold price which using inflation, silver price, USA dollar trade weighted index and Brent crude oil price as factors input. It was hypothesized that there were positive relationship between gold price and inflation, gold price and Brent crude oil price. While, negative relationships were expected between gold price and USA dollar trade weighted index, gold price and silver price. The positive relationship between gold price and inflation can be explained as when there was inflation, consumers or investors tend to demand more gold, which able to give protective cushion against the declined purchasing power. This trend was based on the rationale of the gold‘s property which served as an inflationary hedge. Positive relationship between gold price and crude oil price was related to the rationale of gold mining. A large portion of gold mining was closely related to crude oil energy. In other words, when the cost of oil used for gold mining

increased, the gold price would tend to increase as well, as the cost of production tend to drive the gold price upwards. On the other hands, gold and USA dollar trade weighted index were inversely related as the rationale stated that gold acts as dollar hedge. It meant that, when the US Dollar depreciated against other currency, it would give an upward pressure to the demand of gold thus gold price increased. Gold price and silver price was negatively related. Silver and gold was often treated as close substitute's goods to each other (Tully & Lucey, 2006; Ferretti & Gonzalo, 2010; Lee & Lin, 2010). Thus, the price of silver was negatively correlated with the gold price. When gold price increased, the demand of silver was increased as investors chose to invest in silver commodity which was more affordable.

2.4 Hypothesis Development

2.4.1 Gold Price and Inflation

H_0: $\beta_1 = 0$ (There is no relationship between inflation and gold price)
H_1: $\beta_1 \neq 0$ (There is a relationship between inflation and gold price)

Consumer price index, (CPI) is the most widely used proxy for inflation rate. The reason of CPI serves as the proxy for inflation is because it is a broad measurement and commonly uses to calculate the average price change in goods and services.

Inflation rate was one of the main factors in affecting gold market (Tully and Lucey, 2007). Conventional wisdom suggested that there was a positive correlation between gold price and inflation. When inflation happened, gold price would trend at increasing pattern. This is because during inflation, gold became a better option for investors. In times of economy uncertainties, for example inflation, when the cost of living increased, investor would prefer to hold gold as a hedge against inflation since

gold serve as a store of value. Therefore, there was a positive relationship between gold price and inflation rate.

According to Dempster and Carlos (2010), gold was likely to outperform in financial assets when the economy experienced resurgence in inflation. Since gold acted as inflationary hedgers, when inflation rate increased, gold tend to increase in value. Therefore, positive relationship between gold price and inflation was established.

2.4.2 Gold Price and Silver Price

H_0: $\beta_2 = 0$ (There is no relationship between silver price and gold price)

H_1: $\beta_2 \neq 0$ (There is a relationship between silver price and gold price)

Since 1792, silver assumed as a key role in the United States monetary system and used for the nation's coinage until 1965 (Champ, 2007). Approaching to 20th century, silver was identified as an important economic function which served as industrial raw material. The revolution of economics had made silver functioned as industrial commodity and one of the most appealing investment precious metals.

Referring to the silver's role in an economic, both gold and silver was found to exhibit similar properties as precious metals, with high economic investment value. Gold and silver were often treated as substitute's goods to reduce similar risks in portfolios (Tully & Lucey, 2006; Ferretti & Gonzalo, 2010; Lee & Lin, 2010). Hence, the substitution features between gold and silver had proposed a negative relationship.

On the other hand, when the gold price increased, the purchasing power of investors would decrease and caused the demand for gold to decrease. At this high gold price situation, those investors would shift the investment portfolio to silver commodities, since silver was often referred as the "poor's man gold" as silver was much more

affordable and the characteristics of being substitute goods to gold. When gold price are too high, the demand of silver sought to increase. Thus, the silver tend to increase in value. On the other hands, gold price would drop in value. As conclusion, as gold and silver were mutual substitutability, thus an increase in gold price, led the silver price to soar high.

Since silver often went along with gold as a safe haven asset to hedge against any economic, political, or currency crises, this phenomenon had caused those investors to seek silver that had similar characteristics like gold as alternative goods to invest. With the reasons stated above, a negative relationship was assumed to exist between gold price and silver price.

2.4.3 Gold Price and USA Dollar Trade Weighted Index

H_0: $\beta_3 = 0$ (There is no relationship between USA Dollar Trade Weighted Index and gold price)

H_1: $\beta_3 \neq 0$ (There is a relationship between USA Dollar Trade Weighted Index and gold price)

The USA Dollar Trade Weighted Index was a measurement of USD value against the other currencies especially G-10 countries. An increased in USA Dollar Trade Weighted Index meant the appreciation of USD against other currencies and vice versa. USD and gold price were closely related to each other since most of the transactions of gold across the countries are priced in USD.

Over the years, gold used to hedge against devaluation of currencies and USA Dollar Trade Weighted Index believed to has predictive power over gold market. Since gold price was generally denominated in U.S. dollars and this implied that the exposure gained from trading gold was influenced by changes in the dollar's exchange rate. In

other words, everything else being equal, weakness in the US dollar led to an increase in gold price, as investors demanded compensation for the currency loss. As US dollar depreciated, the investors would pull out the foreign investment in US dollar because the fear of the investment return would be depreciated. In order to secure the investment value, investors chose to invest in gold which acted as safe haven asset and a store of value. When dollar depreciated against another currency (appreciation of another currency), this reduced the gold price to investors outside of dollar bloc. Dollar bloc countries were the countries that used US dollar as main exchange currencies. If US dollar depreciated against another currency, thus, the gold would be relatively cheap for those investors who were outside of US areas. Therefore, demand of gold would increase in these non-dollar markets, indirectly led to an increase in gold price. In conclusion, gold price and US dollar were assumed to trend in an opposite direction or negatively related in this research.

When dollar's exchange values weaken, more dollars were taken to buy gold, increasing the value of US dollar gold. Meanwhile, when dollar's exchange value strengthened against another currency, the US dollar gold price would usually dropped. As a result, when US dollar depreciated against another currency, it would drive up the gold value.

2.4.4 Gold Price and Brent Crude Oil Price

H_0: $\beta_4 = 0$ (There is no relationship between Brent crude oil price and gold price)

H_1: $\beta_4 \neq 0$ (There is a relationship between Brent crude oil price and gold price)

Both crude oil and gold played a similar role as the limited resources in an economy. Crude oil played a significant role in industrial field while gold played an important role in monetary system of a country. Besides that, the usage of crude oil in excavating and refining the gold had made crude oil became one of the production

costs for gold. According to Polyus (2003), crude oil was used to replace diesel fuel as a power generation to produce heat during the production of gold mining. So, when Brent crude oil price increased, the cost to mine gold also increased. Therefore, gold would be sold at a higher price. In conclusion, with the reasons stated above, there was positive correlation between gold price and crude oil price.

Furthermore, the oil price volatility had a large impact in influencing world's economic growth. According to Roubini (2004), oil price shocked had an effect on the macro-economy by slowing down the rate of growth or reduced the output level and thus caused economy recession. During economic recession, financial panics would induce among the financial securities markets, caused the stocks and bonds to lose in value. Thus, investors would shift the investment to alternative gold investment. When there was an oil shock, the crude oil price would spike at high pace, and thus, dragging down the stock and bond returns. Therefore, demand of gold would increase and led to an increase in gold price. As conclusion, crude oil was indirectly affected the gold price, and the positive relationship between gold price and crude oil price was assumed in this study.

2.5 Conclusion

In conclusion, a number of researches had been done on gold price. It should be noted that the previous studies had put more effort in examining the interaction of solely one factor on dependent variable, gold price. In practice, gold price was not solely determined by a variable; in fact it could be affected by several reasons at once. In this case, the model in determining the gold price might not be as comprehensive as the model that captures more factors in influencing the dynamics of gold price. In this study, the weakness could be overcome by including more variables in determining the factors affecting gold price.

CHAPTER 3: METHODOLOGY

3.0 Introduction

This research methodology was designed to examine the hypotheses which developed from the previous chapter. In this chapter, the flow of analysis would be simple and multiple linear regression models would be constructed to examine the relationship between the four selected independent variables and gold price. In this study, Ordinary Least Square (OLS) procedure was employed in the entire regression models constructed in the study. The analysis was then followed by diagnostic checking to ensure the model was free from economic problem. Lastly, log-log model was constructed if there was any economic problem existed in the model.

3.1 Data Description

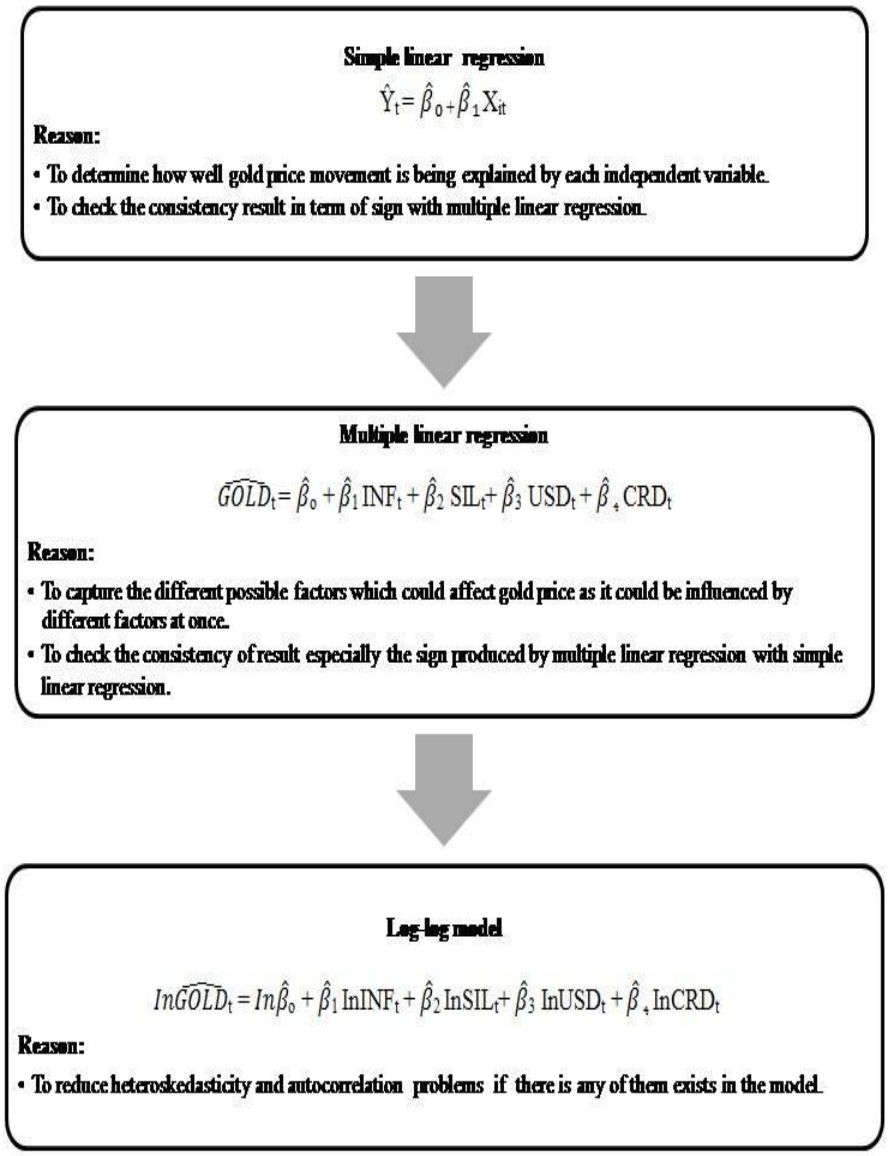
In this research, time series data of gold price, silver price and world consumer price index were employed starting from 1st quarter 1971 to 1st quarter 2011 with total observations of 161 for each variable from International Financial Statistics (IFS). On the other hand, the data of USA dollar trade weighted index and Brent crude oil price for the same period were obtained from Global Financial Data (GFD).

In the research, gold price (PGOLD), measured in US Dollar per ounce was the dependent variable. On the other hand, inflation (world consumer price index, (CPI) for year 2005 as the base year served as the proxy for inflation); Brent crude oil price (CRD) measured in US Dollar per barrel; silver price (SIL), measured in US cents per troy ounce; and USA dollar trade weighted index (USD), (1975-1976 as the base year) were the selected independent variables in the study. According to Global Financial Data (GFD), USA dollar trade weighted index was defined as the measurement of

USD against other currencies from G-10 countries. The G-10 countries included United Kingdom, Switzerland, Sweden, Netherlands, Japan, Italy, Germany, France, Canada and Belgium.

3.2 Flow of Analysis

Figure 3 : Flow of methodology analysis



3.3 Simple linear regression

3.3.1 General Equation

$\hat{Y}_t = \hat{\beta}_0 + \hat{\beta}_1 X_{it}$

Where,

$\hat{Y}_t$ = Gold price (USD/ Ounce)

t = quarterly period (1971 -2011)

i = 1, 2, 3, 4…

X_1 = World Consumer Price Index (Year 2005=100) as a proxy of inflation

X_2 = Silver price (US cents/ Troy Ounce)

X_3 = USA dollar trade weighted index (Year 1975-1976=100)

X_4 = Brent crude oil price (USD/ Barrel)

3.3.2 Reasons of using simple linear regression

The reason of running simple linear regression for each independent variable was to determine how well the gold price movement could be explained by different independent variables such as inflation, silver price, USA dollar trade weighted index and Brent crude oil price. Besides, another reason to construct simple linear regression was to check the consistency result in terms of expected sign with multiple linear regression.

3.3.3 Assumptions lying under simple linear regression

Assumption 1: Conditional mean of disturbance term was zero. Gujarati and Porter (2004), and Dougherty (2007) stated the expected value of disturbance term, *ui* was

zero in conditional for any independent variables set. By given the value of X, the mean value of disturbance term was zero, symbolically, $E\ (ui\ |Xi) = 0$. When the regression line passed through all the conditional means of Y, $E(Y \mid Xi)$, it implied that the expected value of disturbance term was zero. Disturbance term with zero mean also implied there would be no specification bias in empirical analysis.

Assumption 2: According to Gujarati and Porter (2004), the number of observations, n must be greater than the number of parameters estimated, (n>k). In other terminology, the number of observations must be greater than the number of explanatory variables, X. Four explanatory variables were adopted in this research, such as inflation, Brent crude oil price, silver price and USA dollar trade weighted index which employed quarterly data from Year 1971 to Year 2011. Thus the study had fulfilled this assumption of classical linear regression model.

Assumption 3: The regression model was linear. The parameter must be linear in regression model (Gujarati & Porter, 2004). For example, $E(Y \mid Xi) = \beta_1 + \beta_2 Xi$, was a linear regression model as the two parameters, β_1 and β_2, was linear. On the other hand, the model $E(Y \mid Xi) = \beta_1 + \beta_2{}^2 Xi$ showed that it was a nonlinear regression model as the parameters existed nonlinear relationship, and it did not satisfy the classical assumptions of linear regression model (Dougherty ,2007).

Assumption 4: According to Gujarati and Porter (2004), X variables were assumed to be fixed in repeated sampling. In this sense, there were no correlation between X and disturbance term. There were few reasons of why X values were assumed to be non-stochastic. First, it was to make the regression analysis simple and introduced to the readers to the complexities of regression analysis gradually. Second, it could be realistic to assume X values were fixed in the context of experimental. Lastly, the statistical result of linear regression based on the case of fixed regressors was valid even the X values were fixed.

Assumption 5: According to Gujarati and Porter (2004) and Dougherty (2007), X values must be varying in regression model. The X values in the study must not all be constant or fixed. Technically, var (X) must be a finite positive number. And, there was no outlier in X values; otherwise the regression result might be bias or inaccurate.

Assumption 6: There was no serial correlation or autocorrelation existed between the disturbance terms (Gujarati & Porter, 2004 and Dougherty, 2007). The disturbance terms were uncorrelated across the observations. In other words, for i ≠ j the disturbance terms were independent of one another. Symbolically,

$$\text{Covariance } (ui, uj \mid Xi, Xj) = E\{[ui - E(ui)] \mid Xi\}\{[uj - E(uj)] \mid Xj\}$$
$$= E(ui \mid Xi)(uj \mid Xj)$$
$$= 0$$ ----------Gujarati and Porter (2004)

Assumption 7: Homoskedasticity: According to Gujarati and Porter (2004) and Dougherty (2007), the variance of the disturbance term was equal and constant across the X values. In other words, the variation around the regression line (the line of average relationship between Y and X) was the same across the explanatory X values. Symbolically,

$$\text{Variance } (ui \mid Xi) = E[ui - E(ui \mid Xi)]^2$$
$$= E(ui^2 \mid Xi) \text{ because of Assumption 1}$$
$$= \sigma^2$$ ----------Gujarati and Porter (2004)

The equation above stated that the variance of the disturbance term (the conditional variance of disturbance term) was the same for all values of the independent variables, X.

According to Poole & O'Farrell (1970), if the variance of disturbance term was not constant, but was independence of X values, then the estimates of the regression coefficients were unbiased. However, the usual methods of statistical inference were invalid. Meanwhile, if the variance of disturbance term was unequal and correlated with X values, the estimates of the regression coefficients were biased and thus did not have valid inference.

Assumption 8: According to Gujarati and Porter (2004), disturbance terms were normally distributed in terms of:

Mean : E (ui) = 0

Variance : E [ui - E (ui)] ^{2} = E(ui ^{2}) = σ^2

cov(ui , uj): E{ [(ui - E(ui)][uj- E(uj)]} = E(ui uj) = 0 for i ≠ j

Symbolically, the assumptions could be denoted as

$$ui \sim N (0, \sigma^2)$$

The equation stated that the disturbance terms were normally distributed, with zero covariance or zero correlation.

3.3.4 Properties of least-squares estimators (simple regression model)

According to Gauss-Markov Theorem, by given the assumptions of Classical Linear Regression Model (CLRM), there were few properties which posed by the least-squares estimators, $\hat{\beta}$. If the conditions stated below were hold, the OLS estimator, $\hat{\beta}$ was said to be BLUE, best linear unbiased estimator.

1. It was linear, that was a linear function of a random variable, such as the dependent variable Y in the regression model.

2. It was unbiased, that the expected value, was equal to its true value.Symbolically,

$$E(\hat{\beta}_2) = \beta_2$$

3. It had minimum variance in all classes of linear unbiased estimators. An estimator with the least variance was known as efficient estimator.

3.3.5 Hypothesis Testing

3.3.5.1 Gold price and inflation

H_0: $\beta_1 = 0$ (There is no relationship between inflation and gold price)

H_1: $\beta_1 \neq 0$ (There is a relationship between inflation and gold price)

Decision rule: Reject H_0 if t-statistic is larger than positive critical value or smaller than negative critical value, otherwise do not reject H_0.

3.3.5.2 Gold price and silver price

H_0: $\beta_2 = 0$ (There is no relationship between silver price and gold price)

H_1: $\beta_2 \neq 0$ (There is a relationship between silver price and gold price)

Decision rule: Reject H_0 if t-statistic is larger than positive critical value or smaller than negative critical value, otherwise do not reject H_0.

3.3.5.3 Gold price and USA dollar trade weighted index

H_0: $\beta_3 = 0$ (There is no relationship between USA dollar trade weighted index and gold price)

H_1: $\beta_3 \neq 0$ (There is a relationship between USA dollar trade weighted index and gold price)

Decision rule: Reject H_0 if t-statistic is larger than positive critical value or smaller than negative critical value, otherwise do not reject H_0.

3.3.5.4 Gold price and Brent crude oil price

H_0: $\beta_4 = 0$ (There is no relationship between Brent crude oil price and gold price)

H_1: $\beta_4 \neq 0$ (There is a relationship between Brent crude oil price and gold price)

Decision rule: Reject H_0 if t-statistic is larger than positive critical value or smaller than negative critical value, otherwise do not reject H_0.

3.4 Multiple linear regression

3.4.1 General Equation

Gold Price=f (Inflation, Silver Price, USA Dollar Trade Weighted Index, Brent Crude Oil Price)

$\widehat{GOLD}_t = \hat{\beta}_o + \hat{\beta}_1 INF_t + \hat{\beta}_2 SIL_t + \hat{\beta}_3 USD_t + \hat{\beta}_4 CRD_t$

Where,

$\widehat{GOLD}_t$ = Gold Price (USD/ Ounce)

INF_t = World Consumer Price Index (Year 2005=100)

SIL_t = Silver Price (US cents/ Troy Ounce)

USD_t = USA Dollar Trade Weighted Index (Year 1975-1976=100)

CRD_t = Brent Crude Oil Price (USD/ Barrel)

3.4.2 Reasons of using multiple linear regression

The reason to construct multiple linear regression in this research was to capture the possible different factors which could affect gold price at once. The multiple linear

regression that consisted of four independent variables could provide a clearer picture on several factors which could influence gold price movement. Also, the consistency of the result especially the expected sign produced by multiple linear regression were compared to simple linear regression. In other words, the study would examine the changes on the solely impact of each independent variable on dependent variable if more independent variables were taken into account in the multiple linear regression model.

3.4.3 Assumptions lying under multiple linear regression

On top of the 8 assumptions underlying the simple linear regression, the additional 2 assumptions were needed to fulfill by multiple linear regression model in order to produce best linear unbiased estimator (BLUE) result (Gujarati & Porter, 2004).

Assumption 1: No specification bias. The model used in regression analysis must correctly specified and zero error (Gujarati & Porter, 2004). Specification problem might incurred if the important explanatory variables were left out, including unnecessary variables and employing the wrong functional form of the relationship between explanatory variable X and explained variable Y.

Assumption 2: Besides that, Poole and O'Farrell (1970) also assumed that there was no perfect multicollinearity incurred at linear regression model. The independent variables (X_1i, X_2i... X_ni) were not random. Also, no linear relation existed among explanatory variables. This assumption was added when two-variable model and multiple linear regression model, which containing several regressors in a model were considered. This was because the closer the linear correlation between the independent variables, there more uncertain to identify the coefficients (Poole & O'Farrell, 1970).

For example, if the model contained the variables X_1, X_2, and X_3, then this assumption ruled out a case such as $X_3i = \beta_0 + \beta_1 X_1 i + \beta_2 X_2 i$, for i = 1, 2, 3, ..., n. Note that if X_3 could be perfectly explained in terms of X_1 and X_2, then the variable X_3 would provide no information as that information was already included in the variables X_1 and X_2. In such a case, the separate effect that X_3 had on the dependent variable was unable to examine. As a practical matter, it was safe to assume that this assumption was not violated.

3.4.4 Hypothesis Testing

$\widehat{GOLD}_t = \hat{\beta}_o + \hat{\beta}_1 INF_t + \hat{\beta}_2 SIL_t + \hat{\beta}_3 USD_t + \hat{\beta}_4 CRD_t$

Where,

Dependent Variable

$\widehat{GOLD}_t$ = Gold price (USD/Ounce)

Independent Variable

INF_t = World Consumer Price Index (Year 2005=100)

SIL_t = Silver price (US cents/ Troy Ounce)

USD_t = USA Dollar Trade Weighted Index (Year 1975-1976=100)

CRD_t = Brent Crude Oil (USD/ Barrel)

3.4.4.1 Test on the significance of individual independent variable (t-test)

T-test statistic was carried out to test for the significance of the four selected individual independent variables on gold price. The hypothesis testing for t-test in

each of the individual independent variable was similar to the simple linear regression model that we had discussed earlier.

3.4.4.2 Test on the overall significance of Multiple Linear Regression Model (F-test)

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

H_1: at least one β is not equal to zero

Decision rule: Reject H_0 if F-statistics is larger than critical value, otherwise do not reject H_0.

In order to test for the overall significance of the model, F-test statistic was obtained from the estimation output to identify the model was significant enough in explaining the gold price movement.

3.4.5 Diagnostic Checking

After the multiple linear regression was carried out, diagnostic checking was performed in order to detect the existence of four economic problems such as multicollinearity, autocorrelation, heteroscedasticity and model mispecification in the model. The reason of having the diagnostic checking was to ensure the Classical Normal Linear Regression Model (CNLRM) was fit in analyzing the gold price.

3.4.5.1 Multicollinearity

Multicollinearity meant the existence of linear relationship among the independent variables. There were no formal tests to detect the presence of multicollinearity

problem in the model. However, one of informal methods was to check whether there was high R-square with few significant t-ratios from the estimation generated. If the condition above was achieved, serious multicollinearity problem might existed in the model. On the other hand, VIF (variance inflation factor) was another method to detect multicollinearity problem. If multicollinearity problem existed in the model, the highly correlated pair of independent variables was to regress again in order to determine the VIF (Gujarati & Porter, 2004). The formula to compute VIF was stated as ($VIF = \frac{1}{1-R^2}$). If the calculated VIF was larger than 10, the result concluded there was serious multicollinearity problem existed in the model. However, if the calculated VIF was less than 10, the result showed there was no serious multicollinearity problem existed in the model. As a result, the model could retain without any modification. In order to remedy the problem, the less significant variable among the highest correlated pair had to be eliminated. Also, redesigned the model was the other remedy for multicollinearity.

3.4.5.2 Heteroskedasticity

Heteroskedasticity meant the variance vary with independent variables and it also known as the variance was not constant (Gujarati & Porter, 2004). Autoregressive conditional heteroskedasticity ARCH test was used to detect the heteroskedasticity problem by evaluating the p-value of F-statistic. White heteroscedasticity consistent covariance coefficient test could be the remedy of heteroskedasticity problem if existed in the regression. The hypothesis testing for heteroskedasticity was stated as following:

H_0: There is no heteroskedasticity problem in the model.
H_1: There is heteroskedasticity problem in the model.
Decision rule: Reject H_0 if p-value of the F- test statistics is smaller than α (0.05), otherwise do not reject H_0.

3.4.5.3 Autocorrelation

On the other hand, autocorelation could define as correlation between the variables. Breusch-Godfrey Serial Correlation LM Test was carried out to detect whether autocorrelation existed in the model. The generated p-value of F-statistic from the estimation was compared with α at significant level at 5%. The hypothesis testing for autocorrelation was stated at below:

H_0: There is no autocorrelation problem in the model.
H_1: There is autocorrelation problem in the model.
Decision rule: Reject H_0 if p-value of the test statistics is smaller than α (0.05), otherwise do not reject H_0

3.4.5.4 Model Misspecification

The model misspecification problem included ommission of important variables, inclusion of irrelavent variable, adopting the wrong functional form and incorrect specification of the stochastic. The model misspecification could be detected by Ramsey RESET test (Gujarati, 2004). The generated p-value of F-statistic from the estimation was compared with α at significant level of 5%. The hypothesis testing for model misspecification was stated at below:

H_0: There is no model misspecification problem in the model.
H_1: There is model misspecification problem in the model.
Decision rule: Reject H_0 if p-value of the test statistics is smaller than α (0.05), otherwise do not reject H_0

3.5 Log-Log Model

3.5.1 General Equation

$\widehat{InGOLD}_t = In\hat{\beta}_o + \hat{\beta}_1 \text{InINF}_t + \hat{\beta}_2 \text{InSIL}_t + \hat{\beta}_3 \text{InUSD}_t + \hat{\beta}_4 \text{InCRD}_t$

Where,

$\widehat{InGOLD}_t$ = logarithm of Gold price (US/oz)

InINF_t = logarithm of Inflation (Consumer Price Index, Year 2005= 100)

InSIL_t = logarithm of Silver price (US cents/ Troy Ounce)

InUSD_t = logarithm of Trade weighted US dollar index (Year 1975-1976= 100)

InCRD_t = logarithm of Brent Crude Oil (USD/ Barrel)

3.5.2 Reasons of using log-log model

The log-log model was constructed if there were heteroskedasticity or autocorrelation problems existed in the model. In order to reduce the problem of heteroscedasticity and autocorrelation, all the variables were transformed into logarithm (log-log) form. Therefore, all the variables were being expressed in percentage term in log-log model.

Since this research obtained quartely data from the sample period of 1971-2011 which contained 161 number of observations. When the number of observations were increased, the data may contained many information about the regression model over a long period of time. Therefore, the residuals might had inconsistent variance that would lead to heteroskedasticity problem in the case of CNLRM was applied in the

study. However, log-log model could help to remedy the heteroskedasticity and autocorrelation problems (Baser, 2007).

3.5.3 Hypothesis Testing and Diagnostic Checking

In the case that log-log model was constructed due to the existance of autocorrelation and heteroskedasticity problems, the hypothesis testing and diagnostic checking were being repeated again. The process was similar to multiple linear regression which we had discussed earlier.

3.6 Conclusion

In this chapter, EViews 6 had selected in running the statistical tests like simple linear regression, multiple linear regression and log-log model. Besides that, diagnostic checking was carried out to detect the four economic problems which might occur in the model. In the following chapter, the statistical results would obtain and to prove the consistency with the hypothesis stated above.

CHAPTER 4: DATA ANALYSIS

4.0 Introduction

This chapter illustrated the results and interpretations of the relationship between gold price and four variables employed in the study. The selected variables were inflation (CPI), silver price, Brent crude oil price and USA dollar trade weighted index. Eviews was the main statistical software to analyze and estimate the regressions model in this study. In this research, t-test was used to examine the significance relationship between independent X's and dependent Y variables. In the mean time, F-test was used to test the significance of the overall regression model. In addition, 5% significance level was applied in the study to test the significance results. Moreover, several tables were constructed to explain the statistical results in an effective manner.

4.1 Simple Linear Regression Model Result

$\hat{Y}_t = \hat{\beta}_o + \hat{\beta} X_{it}$

$\hat{Y}_t$ = gold price

t = quarterly period (1971-2011)

i = 1, 2, 3, 4…

X_1 = World Consumer Price Index (Year 2005=100) as a proxy of inflation

X_2 = Silver price (US cents/ Troy Ounce)

X_3 = USA dollar trade weighted index (Year 1975-1976=100)

X_4 = Brent crude oil price (USD/ Barrel)

Table 1: Determinants of gold price using simple linear regression model

Independent Variables	Coefficient	t-statistics	F-statistics
INF	3.677380	10.04098*	100.8213*
SIL	0.407812	19.67427*	387.0768*
USD	-7.548351	-6.762986*	45.73798*
CRD	8.931207	20.45119*	418.2510*

For estimation output, please refer to Appendix 4.1

* significant at 0.01 level ** significant at 0.05 level *** significant at 0.1 level

Notes: Critical values are cited from Black (2007) Student T-distribution table, n = 161; number of regressor, k = 4. F-critical value = 2.44; Critical value= ±2.576 at the 1% significant level (*); critical value = ±1.96 at the 5% significant level (**); critical value = ±1.645 at the 10% significant level (***).

4.1.1 Results Interpretations and Hypothesis testing

The regression results of simple linear regression model were presented in Table 1. The Ordinary Least Squares (OLS) procedure had been used to estimate the regression models in this study. From the estimation result, the positive sign of coefficient 3.677380 implied that when there was an additional one unit increased in INF, on average, gold price would increased by USD 3.677380 per ounce. Thus, the result concluded that there was positive linear relationship between gold price and inflation. This indicated gold price increased as inflation increase and vice versa. Besides, t-statistic test was used to identify the significance relationship between gold price and independent variables. From the estimation results shown, it showed that t-stat for inflation, generated from Eviews (10.04098) is exceeded the tabulated t-statistic critical value (1.96) at 5% of significance level. Thus, null hypothesis was rejected. Therefore, there was significance relationship between gold price and INF. On the other hand, the F-statistic value for inflation, (100.8213) was larger than the F-

statistics critical value 2.44, 5% of significance level. Thus, the null hypothesis was rejected. The study could conclude that the overall model was statistically significant. As a whole, the positive relationship existed between gold price and inflation was consistent with the study expected sign.

Next, the positive coefficient of silver price 0.407812 indicated when there was an additional one US cent increased in silver price, on average, gold price would increased by USD 0.407812. In other words, silver price was positively related to gold price. Since the t-statistic (19.67427) was larger than the t-critical value (1.96) at 5% of significance level, thus, null hypothesis was rejected and this result concluded that gold and silver prices are statistically significant at 5 % significant level. On the other hand, the F-statistic value of silver price (387.0768) was larger than the F-statistics critical value (2.44), 5% of significance level**.** Thus, the null hypothesis was rejected. The study concluded that the overall model of silver and gold price was statistically significant. However, the positive relationship found between gold price and silver price was contradicted with the study expected sign.

In addition, the negative coefficient of -7.548351 indicated when there was an additional one unit increased in USA dollar trade weighted index, on average, gold price would decreased by USD -7.548351. The results signified when US dollar depreciated against other currencies, eventually it drove up on gold demand, thus led to the gold price increased. Therefore, negative relationship was found between gold price and USA dollar trade weighted index. Besides, the t-statistic generated, (-6.762986) was smaller than critical t-value (-1.96). Thus the result concluded the significant relationship was found between gold price and USA dollar trade weighted index. On the other hand, this model was overall significant as the F-statistic value for USA dollar trade weighted index (45.73798) was larger than the F-statistics critical value (2.44), at 5% of significance level. In conclusion, the negative relationship existed between gold price and USA dollar trade weighted index was consistent with the study expected sign.

Lastly, the positive coefficient of 8.931207 implied when Brent crude oil price increased by additional USD 1 per barrel, gold price would increased by USD 8.93 per ounce in gold price on average. In other words, an increased in crude oil price will led to an increased in gold price. Therefore, the estimation results above showed the Brent crude oil price had a strong positive linear relationship towards gold price. Moreover, the t-statistic (20.45119) was larger than the critical t-value (1.96). This result proved that Brent crude oil price was statistically significant to gold price at 5% of significance level. On the other hand, the F-statistic value of Brent crude oil price (418.2510) was larger than the F-statistics critical value (2.44), at 5% of significance level. Therefore, the finding showed that the model was overall significant to explain on gold price. Similarly, the positive relationship found between gold price and Brent crude oil price was consistent with the study expected sign.

4.2 Multiple Linear Regression Model Result

$\widehat{GOLD}_t = \hat{\beta}_o + \hat{\beta}_1 INF_t + \hat{\beta}_2 SIL_t + \hat{\beta}_3 USD_t + \hat{\beta}_4 CRD_t$

Table 2: Determinants of gold price using multiple linear regression model

Independent Variables	Coefficient	t-statistic
INF	1.454130	5.401838*
SIL	0.270983	10.53060*
USD	-1.441313	-2.532661*
CRD	2.261491	3.288069*

For the estimation output, please refer to Appendix 4.2

R-square= 0.850568

Notes: Critical values are cited from Black (2007) Chi-square table, n = 161; number of regressor, k = 4.

d.f = n-k-1; thus d.f= 161-4-1 = 156 observations

Number of observation, n= 161 k=4 $d.f_1$ = k =4 $d.f_2$ = n-k-1= 156

F-critical value = 2.44; Critical value= ±2.576 at the 1% significant level (*); critical value = ±1.96 at the 5% significant level (**); critical value = ±1.645 at the 10% significant level (***).

The relationship of inflation, silver price, USA dollar trade weighted index and Brent crude oil price on gold price were observed in multiple linear regression model. This regression model with four selected independent variables was regressed by OLS estimation procedure. The estimation output for multiple linear regression model were presented in Table 2.

4.2.1 Results Interpretations

4.2.1.1 Gold price and inflation

The estimated coefficients of the variables suggested the relationship existed between gold price and the selected independent variables in the study. Table 2 indicated an increased in inflation had a significant positive impact on gold price at significant levels of 5%. This positive coefficient of inflation implied an additional 1 unit increased in the price index, on average, gold price was to increase by USD 1.454130 per ounce, holding other variables constant. In other terminology, when inflation rate moved upward, gold price had followed in the same direction and vice versa. From the results shown in Table 2, the t-statistic value for inflation was 5.401838. Since the t-statistic (5.401838) had exceeded the critical value (1.96) at 5% significant level. Thus, the null hypothesis was rejected and implied there was significant relationship between gold price and inflation. As a whole, the significant positive relationship found between gold price and inflation was consistent with the result shown in simple linear regression model as well as the study expected sign.

The result produced from the study could be explained by inflation rate was one of the important macroeconomic variables which could influenced the gold market. The

positive relationship found between inflation and gold price in this research was consistent with the earlier studies by previous researchers. The positive correlation coefficient existed between the inflation and gold price indicated a positive linear relationship between inflation and gold price. For example, when inflation happened in an economy, gold price would be at increasing trend. The above phenomenon well explained gold had become a better option for investors during inflation. In times of inflation, overall price for goods and services increased, therefore investor would preferred to hold gold as a hedge against inflation. The purpose of holding gold was to safe guard the investment value from having losses due to inflation. Therefore, the positive relationship could be observed between gold price and inflation.

The findings were further confirmed by the other researches in the past. According to Kaufmann and Winter (1989), gold price was expected to group with parameter inflation. An increased in inflation would pushed up the gold demand in the market. Thus the overall gold price was increased due to an increased in demand. This was due to the main role of gold which served as a store of value. Besides, Ismail et al. (2009) also found the similar findings on the existence of a linear relationship between gold price and inflation.

In addition, the positive relationship was further supported by Worthington and Pahlavani (2006), who had done their research on examine the role of gold as the protection against inflation based on monthly data from 1945 to 2006. The result produced from the study showed there was positive long-term relationship existed between gold price and inflation. Consequently, this finding suggested gold could act as an instrument to hedge against inflation especially during the post-war and post 1970s period. Besides, the authors also concluded that investment in gold, both physical and paper holding were allowed investor to protect themselves against inflation.

4.2.1.2 Gold price and silver price

Based on the estimation output in Table 2, significant positive relationship was observed between gold price and silver price at 5% significant level. When there was an additional one US cent increased in silver price per troy ounce, on average, gold price would increased by USD 0.273769 per ounce, holding other variables constant. Since the t-statistic value for silver price (10.53060) was exceeded the critical value (1.96) at 5% significant level. Thus, null hypothesis was rejected. The result concluded there was significant relationship existed between gold price and silver price. The significant positive relationship found between gold price and silver price was consistent with the result shown in simple linear regression model but the finding was contradicted with the study expected sign.

From the findings above, significant positive relationship was observed between silver price and gold price. This positive relationship indicated that silver price and gold price generally moved in the same direction. The positive finding had suggested silver and gold did not act as substitute goods in the study. Thus the result was contradicted with the expected sign. However, the positive relationship was supported by Solt and Swanson (1981). According to Solt and Swanson (1981) who studied the efficiency of both gold and silver markets, the study finding stated there was positive relationship existed between silver price and gold price. In addition, the paper also declared the importance for investors to understand on the relevant information set which reflected by the gold and silver price at every single of time in order to predict each other accurately.

4.2.1.3 Gold price and USA dollar trade weighted index

Based on the estimation output stated in Table 2, USA dollar trade weighted index possessed negative relationship towards gold price. The coefficient indicated that when the USA dollar trade weighted index increased by 1 unit, on average, gold price

would decreased by USD 1.441313 per ounce, holding other variables constant. It also implied when US dollar depreciated against other currencies, gold price would increase and vice versa. Since the t-statistic value for USA dollar trade weighted index (-2.532661) was smaller than critical value (-1.96) at 5% significant level. Therefore, the null hypothesis was rejected. This result concluded there was significant relationship existed between gold price and USA dollar trade weighted index. As a whole, the significant negative relationship between gold price and USA dollar trade weighted index was consistent with the result shown in simple linear regression model as well as the study expected sign.

From this research, negative correlation was observed between USA dollar trade weighted index and gold price. This negative correlation indicated that USA dollar trade weighted index and gold price generally moved in the opposite direction. The negative relationship from the study findings was consistent with study expected sign. This could be explained when investors chose to hold gold during currency crisis. This was because gold served as the protection of investments value and its ability to hedge in against depreciation of US dollar. As a result, when US dollar depreciated against other currencies over an extended period, it would lead to gold price increased. In contrary, if US dollar appreciated against other currencies over an extended period, eventually gold price would fell.

The result finding was consistent with Kaufmann and Winter (1989), who stated their findings of significant inverse relationship between US dollar and gold price. Gold price should fluctuate inversely with the value of US dollar in relation to other currencies. Besides, the negative relationship was further supported by Tully and Lucey (2007). The authors confirmed that US dollar was the sole macroeconomic variable which influenced gold. Gold and US dollar were statistically significant in the study and it could serve as the “anti-dollar”. Correspondingly, the negative correlation was found between changes in gold price and changes in US dollar exchange rate (Joy, 2011). All the above findings had once again proved the

increased gold price tended to be associated with the depreciation of US dollar against other currency.

4.2.1.4 Gold price and Brent Crude oil price

From the result shown in Table 2, the estimated coefficient for Brent crude oil price, 2.261491 illustrated that when crude oil price increased by USD 1 per barrel, on average, gold price would increased by USD 2.261491 per ounce, holding other variables constant. The result had suggested positive relationship between Brent crude oil price and gold price as the positive coefficient generated from the estimation. The t-statistic value for Brent crude oil price (3.288069) exceeded the critical value (1.96) at 5% significant value. Thus, null hypothesis is rejected. The result had concluded there was significant relationship existed between Brent crude oil price and gold price. In conclusion, the significant positive relationship produced in the study was consistent with the results shown in simple linear regression model as well as the study expected sign.

The positive findings had been supported by Narayan et al. (2010) who study the long run relationship between gold and oil spot and future price at different level of maturity. The findings showed increased in oil price would led to an increased in gold price. Therefore, the authors found that oil market could used to predict gold price. The positive relationship was further supported by Shafiee and Topal (2010), who identified there was positive correlation between gold and crude oil price. In the study findings, the correlation between gold and crude oil price was extremely high. This meant both crude oil price and gold price were moved in the same direction. Moreover, Soytas et al. (2009) also indicated gold price had significant positive elasticity with respect to oil price in short run.

4.2.2 Is the model significant?

Based on the Chi-square table, we obtained the critical F-value, 2.44, k=4; F-statistic critical value, 2.44. Since F-statistic (221.9889) was larger the F-critical value (2.44) at 5% significant level, thus null hypothesis was rejected. Therefore, the result concluded that the overall multiple linear regression model was significant to explain on gold price. There were at least one independent variable was significantly affected gold price. Besides, adjusted R-square of 0.846737 observed from the estimation indicated that approximately 84.67 percents of the variation in gold price can be explained by the model at 95% confidence interval (5% significant level). In other words, this illustrated that the selected independent variables such as inflation, silver price, USA dollar trade weighted index and Brent crude oil price were sufficient to explain the variation in gold price.

4.2.3 Diagnostic Checking

The diagnostic checking was used to ensure the model was free from the four economic problems such as multicollinearity, heteroskedasticity, autocorrelation and model misspecification problems. If any of these problems incurred in the model, it might led to biased and inaccurate result. In this research, we had performed covariance analysis test on multicollinearity problem, ARCH test tested on heteroskedasticity, Ramsey Reset test tested on model misspecification problem and Breusch-Godfrey Serial Correlation LM Test tested on autocorrelation problem. The diagnostic checking result for multiple linear regression were discussed as followed:

Since there were no formal way to detect the presence of multicollinearity in a model, observed at the R-square and t-ratio from estimation output would be one of the ways to detect multicollinearity problem. For example, when there was high R-square with few significant t-ratios in the model, this result indicated that multicollinearity problem might exist in the model. However, high R-square and high significant t-

ratios were showed in the estimation result of this study. Consequently, this result indicated the model did not suffer from serious multicollinearity problem. Apart from that, VIF (variance inflation factor) was another way to detect the multicollinearity problem in the model. If the calculated VIF was less than 10, there was no serious multicollinearity problem indicated in the model. From the covariance analysis result showed in table 4, Brent crude oil price and silver price was the highly correlated pair among the independent variables. As a result, VIF of the highest correlated pair was calculated to ensure no serious multicollinearity existed in the model. Since the calculated VIF (2.5693) was less than 10, therefore the result concluded there was no serious multicollinearity problem in the model.

Next, Ramsey Reset test was conducted to ensure the model was free from model misspecification problem. Since the p-value for F-statistic (0.8811) is larger than p-value (0.05), thus the null hypothesis was not rejected. The result showed there was insufficient evidence to conclude that model misspecification problem was existed in the model.

However, the estimation generated form ARCH and Breusch-Godfrey Serial Correlation LM test had showed the model was suffering from heteroskedasticity and autocorrelation problems. Since the p-value of F-statistic for both ARCH and Breusch-Godfrey Serial Correlation LM test (0.0000) were smaller than p-value (0.05), thus null hypothesis were rejected. The result concluded that heteroskedasticity and autocorrelation problems existed in the model.

On the other hand, White Heteroskedasticity-Consistent Standard Errors & Covariance test was constructed in order to reduce heteroskedasticity and autocorrelation problems. The variance of standard errors would be adjusted during the test. After White test was run, t-statistic for INF, SIL, and USD was significant at all level which were 1%, 5% and 10% significant level. While Brent crude oil price only significant at 10% significant level. There was high R-square and significant t – ratios. Thus, White Heteroskedasticity-Consistent Standard Errors & Covariance test

was one of the remedies to treat heteroskedasticity and autocorrelation problems in regression model.

4.3 Log-log model

$\widehat{InGOLD}_t = In\hat{\beta}_o + \hat{\beta}_1 \text{InINF}_t + \hat{\beta}_2 \text{InSIL}_t + \hat{\beta}_3 \text{InUSD}_t + \hat{\beta}_4 \text{InCRD}_t$

Table 3: Determinants of gold price using log-log model

Independent variables	Coefficient	t-statistic
LINF	0.193578	10.59948*
LSIL	0.771766	11.55288*
LUSD	-0.18263	-1.364065
LCRD	0.039631	0.666438

For the estimation output, please refer to Appendix 4.4

R-square= 0.899823

Notes: Critical values are cited from Black (2007) Chi-square table, n = 161; number of regressor, k = 4.

d.f = n-k-1; thus d.f= 161-4-1 = 156 observations

Number of observation, n= 161 k=4 $d.f_1$ = k =4 $d.f_2$ = n-k-1= 156

F-critical value = 2.44

Critical value= ±2.576 at the 1% significant level (*); critical value = ±1.96 at the 5% significant level (**); critical value = ±1.645 at the 10% significant level (***).

4.3.1 Results Interpretations and Hypothesis testing

There were heteroskedasticity and autocorrelation problems existed in the model after diagnostic checking for the multiple linear regression model had been carried out. According to Baser (2007), data transformation was one of the ways to reduce

heteroskedasticity and autocorrelation problems. Thus, log-log model was contructed with the aim to overcome these problems.

From the estimation results of log-log model showed in Table 3, gold price was significantly affected by LINF and LSIL. The result was consistent with the results obtained from multiple linear regressions model. However, the major difference between multiple linear regression and log-log model was the t-statistic for LUSD and LCRD had insignificant relationship with gold price. The insignificant relationships were proved when the t-statistic of LUSD (-1.364065) and LCRD (0.666438) did not fall in any of the rejection area at all significant level. Thus the null hypothesis was not rejected for both LUSD and LCRD. Therefore, the result concluded USA dollar trade weighted index and Brent crude oil price were not significant in affecting gold price.

From the Chi-square table, the F-critical value, 2.44, k=4, was obtained. Since the F-statistic generated (350.3102) was larger than F-critical value (2.44) at 5% significant level, thus the null hypothesis was rejected. The result concluded that the overall regression model was significant in explaining gold price. Besides, high adjusted R-square (0.897254) in the model indicated that approximately 89.73 percents of the variation in gold price can be explained by the model. The higher adjusted R-square in log-log model indicated the model had higher explanatory power compared to multiple linear regression model. On top of that, the coefficients obtained from log-log model were consistent with the expected sign in multiple linear regression model.

In conclusion, based on the observation from the estimation output in log-log model, only LINF and LSIL were statistically significant at all significant level. However, USA dollar trade weighted index and Brent crude oil price were not significant at all significant level. As compared with multiple linear regressions model, only LINF and LSIL were found to be significant in log-log model. Therefore, the log-log model might not be the best model in examined the variation of gold price in the study.

4.3.2 Which models to choose?

Table 4: Diagnostic checking

DIAGNOSTIC CHECKING	MULTIPLE LINEAR REGRESSION MODEL	LOG-LOG MODEL
Autocorrelation	0.0000	0.0000
Heteroskedasticity	0.0000	0.0000
Model Misspecification	0.8811	0.0000
Multicollinearity	VIF= 2.5693	VIF= 3.940

Note: The above figures were expressed in p-value except VIF.
For estimation output, please refer to Appendix 4.3 and Appendix 4.5

Data transformation was the alternative way to cure heteroskedasticity and autocorrelation problems (Baser, 2007). Therefore, log-log model was constructed to cure heteroskedasticity and autocorrelation problems which existed in multiple linear regressions model. The motivation of introducing the log-log model was to ensure the model was not suffering from the economic problems.

Similarly to the result of diagnostic checking obtained from multiple linear regression model, there was no serious multicollinearity problem detected in the log-log model. Since the calculated VIF (3.940) was smaller than 10, therefore the result concluded there was no serious multicollinearity problem existed in the model.

However, log-log model did not help much in minimizing the heteroskedasticity and autocorrelation problems in the study. Furthermore, the additional of model misspecification problem existed in the model after log-log model was constructed. Based on Table 4, the p-value for F-statistics generated from ARCH, Breusch-Godfrey Serial Correlation LM test and Ramsey RESET tests were 0.000. Since the

p-value for F-statistics (0.000) for the above three tests were smaller than the p-value (0.05), thus null hypothesis was rejected. The result concluded the model now was suffering from autocorrelation, heteroskedasticity and model misspecification problems.

In conclusion, the results generated above had indicated that multiple linear regression model with raw data had performed better than log-log model. This was because three economic problems existed in log-log model such as heteroskedasticity, autocorrelation and model misspecification problems. On the other hand, only heteroskedasticity and autocorrelation problems existed in multiple linear regression model. Therefore, multiple linear regression model should be chosen in this study.

4.4 Conclusion

In conclusion, there were two assumptions being violated among ten assumptions of CNLRM. Thus, the estimators produced in this study might not be the most efficient but still provide unbiased linear estimators. Besides, the larger the number of observations in the research, the error terms would not be constant. Therefore, heteroskedasticity problem would exist in the model if CNLRM was employed. As a result, CNLRM might not be the most appropriate model to be employed in this study.

CHAPTER 5: CONCLUSION

5.0 Introduction

This study had analyzed the possible factors that would affect gold price. In this study, four independent variables had been employed such as inflation, silver price, USA Dollar trade weighted index and Brent crude oil price to test whether there were significant relationship with gold price. The final chapter discussed the summary of this paper and findings. The layouts of this chapter were organized as follow. Firstly, summary of statistical analysis is presented in the chapter, followed by discussion on major findings, contributions of study, limitations of study and recommendations for future research.

5.1 Discussion of Major Findings

The main objective of this research was to examine the statistical relationship between the selected variables and gold price. Simple linear regression model and multiple linear regression model were carried out to investigate the relationship between the independent variables and gold price using Ordinary Least Square (OLS) procedure. There were 161 observations derived from the quarterly data from year 1971 to first quarter of 2011 which sourced from International Financial Statistics (IFS) and Global Financial Data (GFD).

In this research paper, a comprehensive empirical study had been conducted to investigate the relationship between Inflation (CPI), Silver Price, Brent Crude Oil Price and USA Dollar Trade Weighted Index with gold price using Ordinary Least Square (OLS) procedure. Firstly, t-test was carried out to test for the significant between each independent variable towards gold price in simple linear regression and

multiple linear regression model. Next, F-test was used to test the significance of the overall model. In addition, diagnostic checking was performed to detect the four economic problems such as autocorrelation, heteroskedasticity, multicollinearity and model misspecification in the model. The empirical results indicated that all the independent variables had significant relationship towards gold price. The results of our regression model were summarized as below:

5.1.1 Inflation and gold price

The table 1 and 2 indicated that there were positive and significant relationship between inflation (CPI) and gold price in both simple linear regression model and multiple linear regression model. The positive relationship implied that gold price and inflation were moving in the same direction. When there was an increase in inflation, it leads to an increase in gold price and vice versa. This had showed that gold served as the strong hedge against inflation.

5.1.2 Silver and gold price

The empirical results obtained from simple and multiple linear regressions showed that silver price was not consistent with the expected sign that we had assumed earlier in chapter 3. In study findings, silver price showed significant and positive relationship with gold price. The positive relationship found in this study was contradicted with the previous researchers who assumed silver and gold served as substitute goods for each other. In short, the positive relationship found in this study indicated silver and gold were complementary goods where both of them were move in the same direction.

5.1.3 USA Dollar Trade Weighted Index and gold price

From the estimation output from single and multiple linear regression model, USA dollar trade weighted index had showed significant and negative relationship with gold price. The negative relationship explained when US dollar depreciated against other currencies, gold price was moving to a higher level and vice versa. This relationship proved that gold played a vital role in hedged against USD exchange rate. Majority transactions of gold were in US dollar, thus when US dollar depreciated against other currencies, the US dollar gold price was increasing in its value. Therefore, gold can be used as the hedging tool against exchange rate risk.

5.1.4 Brent crude oil price and gold price

The empirical results obtained from simple linear regression and multiple linear regression indicated there was significant and positive relationship between Brent crude oil price and gold price. This finding was consistent with the previous researchers. The positive relationship indicated when there was an increase in crude oil price; it led to an increase in gold price. This relationship can be explained when crude oil price increased, the cost of gold mining also increased as crude oil served as the main cost in gold mining. Since the cost of gold mining had increased, thus gold was sold at higher price. This indicated crude oil market can be used to predict the gold price movement. Therefore, investors can expect a corresponding reaction in gold price by observing at crude oil price level.

5.1.5 Fitness of CNLRM in the study

Apart from that, the estimation output from multiple linear regression model was observed, the finding concluded that Classical Normal Linear Regression Model might not be the most appropriate in our study. This is because after diagnostic

checking was carried out, heteroskedasticity and autocorrelation problems were found in the regression model. The violation of the 2 assumptions in CNLRM had caused CNLRM estimators might not be the most efficient, but it still provide unbiased linear result. Therefore, CNLRM might not the best model to employ in the study of gold price movement.

5.2 Contributions of Study

Nowadays, there were varieties of gold investment products provided by the commercial banks. The hot trend of gold investment had been introduced in the recent years because of the gold characteristic as the hedge against economic uncertainty. This study could provide financial planners some hints of monitoring gold price movement. The relationship between inflation, silver price, USA dollar trade weighted index and Brent crude oil price with gold price were observed, the findings could facilitate financial planner to speculate on the gold price trend. For example, the negative relationship between US dollar exchange rate and gold price indicated the financial planners to invest in gold when the USD was appreciated against other currency due to buy low sell high concept. The negative relationship explained when USD was appreciated against other currencies; gold price was moving downward. This was due to the good US economy condition; majority of financial planners would allocate their investments in US securities market which could generate higher return. Thus, there would be lesser demand on gold as most of the financial planners shifted their investments to securities market. Therefore, gold speculators should invest at low gold price and sell at higher price when the situation was favour to them.

Besides, the relationship produced in the study findings could facilitate fund managers in decision making. Based on the research findings in the study, the rationale of gold price movement was provided. Therefore, with the findings provided by this study, the fund manager was able to hold better control in fund management. Besides, a well diversified fund were usually divided into different segments such as

equity funds, money market funds, gold market funds, stock funds and others. The relationship provided in the findings allowed fund managers to monitor better on fund performance. For example, the positive relationship existed between gold price with crude oil price and silver price indicated the fund managers should not allocate all their funds into the positively correlated variables. In the case of gold was selected into portfolio due to the ability to hedge against inflation, thus allocation fund into silver and crude oil market were not suggested. This was because the fund performance will be adversely affected if one of the variables collapsed due to the positive correlation with gold market. Therefore, the managers were recommended to allocate their fund into different segment which held negative correlation with gold in order to achieve fund performance stability.

Our findings showed the empirical behavior of gold price from 1971 to 2011 and provided a systematic examination on four independent variables towards gold price. The main drivers of gold price movement were discussed. This paper had enhanced previous researcher's work by developed a more comprehensive model to investigate the gold price movement. Also, the research findings indicated the positive relationship was once again established between inflation, silver price, Brent crude oil price with gold price while negative relationship existed between USA dollar trade weighted index and gold price. Besides, the study had used more frequent and recent data in the study in order to provide a clearer and accurate picture to researchers. The study could provide the researcher as an additional reference whenever gold related research papers were carried out.

5.3 Limitations of study

Although the study had tried to construct the research in a comprehensive manner, but some limitations would not be able to overcome during the research especially in designing the model and methodology wise.

In the research, time series data from 1971 to 2011 had been employed for all the variables. The characteristic of time series data which was in time sequence had the existence of correlation across observations. This was because the data was highly correlated across time. The first limitation the research faced was on methodology perspective. The advanced method such as time series analysis was required in the study. However this was beyond the knowledge which could obtain from bachelor degree. Therefore only Classical Normal Linear Model (CNLRM) was employed in determine the factors affecting gold price. However, CNLRM was found not fit due to the existence of heteroskedasticity and autocorrelation problems in the model after diagnostic checking was performed. Therefore, the estimators produced in the study might not be the most efficient but it still provides unbiased linear result. In conclusion, CNLRM might not be the most appropriate model to examine gold price, as it was unable to fulfill 2 of the CNLRM assumptions which were homoskedasicity and no existence of autocorrelation across the observations.

In associates with the limited knowledge obtained in time series analysis, this research could not differentiate factors that affect gold price in short run and long run. The reason to differentiate the factors in such a way was because some factors could affect gold price in long run but not necessary the same factor could have the same impact in short run. Therefore, it was important to identify the factors which influence gold price in both short run and long run. For example, one of the findings in this research indicated inflation held positive relationship with gold price in long run, but would the positive relationship remained in short run? The long run relationship impact might be different with short run due to the delayed effects of policy implementation. Usually the implemented policy needs to take some time before it took effect to the economy (Kilponen & Leitemo 2010). By studying the long and short run relationship of gold price with the determinants, financial planners could be provided with better picture on investment strategy. Also, the policymakers were provided with hints on implementation of policy related to the determinants. However, OLS procedure in this study could not differentiate the short and long run

relationship between the variables. Hence, this is one of the limitations in this research.

Besides, the gold price was not solely affected by the four independent variables as proposed in this research. There were others factors such as macroeconomic news announced; Treasury bill rate and money supply also engaged an important role in affecting gold price. The reason this study did not include the above variables in the model was due to some of the data were not readily available and hardly retrieved such as the macroeconomic news announced. Thus this research might left out some of the important variables which were significantly affect gold price.

Another limitation which could observed in this research was gold price was examined at general economic condition. This was because the various factors affecting gold price were examined in this study without the consideration of different economy situations. The relationship produced in this study only act as the guideline at general level but the findings might not be accurate at all economy situations. For example, the study only took the general economic situation. In fact, when the economy was in crisis or downturn, the factors which could affect gold price might not be the same as the one without crisis. Therefore, the relationship produced only served as the guideline for general economy condition.

5.4 Recommendations for Future Research

The increasing trend of gold price and the uncertainty of economic in recent years had triggered many researchers to do further research in gold related topic. Therefore, this research paper served as a reference for future researchers concerning with this issue. After comprehensive research had been done in this paper, there are few suggestions or recommendations provided for future researchers.

Firstly, since CNLRM might not be the most appropriate model to investigate time series data, future researchers were recommended to employ time series analysis in

examining the factors affecting gold price. With time series analysis was carried out, the four economic problems would be able to reduce. Hence the results produced will be better compared to CNLRM. Besides, time series analysis such as Error Correction Model (ECM) would be able to examine the short run relationship between variables while Vector Error Correction Model (VECM) was constructed to examine the long run relationship between gold price and the independent variables. Apart from that, ECM could overcome one of the limitations in our study as the CNLRM could not determine the short run effects. Also a bidirectional relationship between gold price and the four independent variables could be examined by VECM. This is because VECM treated gold price as both dependent and independent variable in the procedure, thus the bidirectional relationship could be determined. With that, the different types of relationship between the variables could be provided. Therefore, better decision could be made by the financial planners on their investment strategy based on the various relationships provided.

Secondly, despite of the determinants affecting gold price proposed in this paper, future researchers were encouraged to include others variables that significantly affect gold price. For example, Money Supply (M1); macroeconomic news announced; jewellery demand; gold lease rate and T-bill interest rate. By including other important factors in the model, more complete picture in factors affecting gold price could be captured. Besides, since gold had the characteristics of safe haven asset and investment tool instead of commodity, financial planners might need a more detailed framework to justify their investment decision. Therefore, future researchers were encouraged to take into considerations of examined gold in different context, such as the volatility of gold and gold return instead of gold price. According to Ross (1989), the study will be provided with additional and valuable insights into the price dynamics of individual assets and portfolios by studying the aspect of gold volatility structure. Therefore, better risk and portfolio management framework could be provided to the financial planners.

Lastly, future researchers were recommended to carry out the related issue in different economic conditions especially economy with crisis and economy without crisis. This was because different factors might be significantly affecting gold price at different economic condition. Thus, by carry out the research in this manner, the researchers were provided with more information on the factors affecting gold price at different economy situation. The respective factors captured in affecting gold price during different economic condition might provide the planners with a different decision aid in the investment strategy. Furthermore, the similar study on the different economic conditions was still not being discovered by the current researchers.

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Appendices

Appendix 4.1: Simple Linear Regression Model

Gold price and Inflation

Dependent Variable: GOLD
Method: Least Squares
Date: 02/20/12 Time: 23:36
Sample: 1 161
Included observations: 161

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPI	3.677381	0.366237	10.04098	0.0000
C	225.3604	22.49875	10.01657	0.0000

R-squared	0.388041	Mean dependent var	391.7622
Adjusted R-squared	0.384192	S.D. dependent var	246.0462
S.E. of regression	193.0809	Akaike info criterion	13.37644
Sum squared resid	5927556.	Schwarz criterion	13.41472
Log likelihood	-1074.803	Hannan-Quinn criter.	13.39198
F-statistic	100.8213	Durbin-Watson stat	0.041251
Prob(F-statistic)	0.000000		

Gold price and silver price

Dependent Variable: GOLD
Method: Least Squares
Date: 02/20/12 Time: 23:37
Sample: 1 161
Included observations: 161

Variable	Coefficient	Std. Error	t-Statistic	Prob.
SIL	0.407812	0.020728	19.67427	0.0000
C	94.02851	18.41697	5.105536	0.0000

R-squared	0.708832	Mean dependent var	391.7622
Adjusted R-squared	0.707001	S.D. dependent var	246.0462
S.E. of regression	133.1833	Akaike info criterion	12.63367
Sum squared resid	2820309.	Schwarz criterion	12.67195
Log likelihood	-1015.011	Hannan-Quinn criter.	12.64922
F-statistic	387.0768	Durbin-Watson stat	0.280249
Prob(F-statistic)	0.000000		

Gold price and USA dollar trade weighted index

Dependent Variable: GOLD
Method: Least Squares
Date: 02/20/12 Time: 23:37
Sample: 1 161
Included observations: 161

Variable	Coefficient	Std. Error	t-Statistic	Prob.
USD	-7.548351	1.116127	-6.762986	0.0000
C	1134.653	111.1762	10.20591	0.0000

R-squared	0.223398	Mean dependent var	391.7622
Adjusted R-squared	0.218513	S.D. dependent var	246.0462
S.E. of regression	217.5091	Akaike info criterion	13.61470
Sum squared resid	7522324.	Schwarz criterion	13.65298
Log likelihood	-1093.984	Hannan-Quinn criter.	13.63025
F-statistic	45.73798	Durbin-Watson stat	0.051540
Prob(F-statistic)	0.000000		

Gold price and Brent crude oil price

Dependent Variable: GOLD
Method: Least Squares
Date: 02/20/12 Time: 23:38
Sample: 1 161
Included observations: 161

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CRD	8.931207	0.436709	20.45119	0.0000
C	131.9805	16.29653	8.098689	0.0000

R-squared	0.724557	Mean dependent var	391.7622
Adjusted R-squared	0.722824	S.D. dependent var	246.0462
S.E. of regression	129.5371	Akaike info criterion	12.57816
Sum squared resid	2667999.	Schwarz criterion	12.61644
Log likelihood	-1010.542	Hannan-Quinn criter.	12.59370
F-statistic	418.2510	Durbin-Watson stat	0.344138
Prob(F-statistic)	0.000000		

Appendix 4.2: Multiple Linear Regression Model

Dependent Variable: GOLD
Method: Least Squares
Date: 02/20/12 Time: 23:38
Sample: 1 161
Included observations: 161

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPI	1.454130	0.269192	5.401839	0.0000
SIL	0.270983	0.025733	10.53060	0.0000
USD	-1.441313	0.569090	-2.532661	0.0123
CRD	2.261491	0.687787	3.288069	0.0012
C	204.1958	63.65533	3.207835	0.0016

R-squared	0.850568	Mean dependent var	391.7622
Adjusted R-squared	0.846737	S.D. dependent var	246.0462
S.E. of regression	96.32426	Akaike info criterion	12.00388
Sum squared resid	1447425.	Schwarz criterion	12.09958
Log likelihood	-961.3124	Hannan-Quinn criter.	12.04274
F-statistic	221.9889	Durbin-Watson stat	0.261242
Prob(F-statistic)	0.000000		

Appendix 4.3: Diagnostic Checking

Autocorrelation -LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	247.2174	Prob. F(2,154)	0.0000
Obs*R-squared	122.7633	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 02/20/12 Time: 23:39
Sample: 1 161
Included observations: 161
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPI	-0.016091	0.132328	-0.121599	0.9034
SIL	-0.022734	0.012664	-1.795184	0.0746
USD	-0.039548	0.279156	-0.141670	0.8875
CRD	0.244510	0.337902	0.723612	0.4704
C	13.92956	31.22951	0.446038	0.6562
RESID(-1)	0.936893	0.082824	11.31187	0.0000
RESID(-2)	-0.069181	0.083694	-0.826595	0.4097

R-squared	0.762505	Mean dependent var	-5.58E-15
Adjusted R-squared	0.753252	S.D. dependent var	95.11258
S.E. of regression	47.24598	Akaike info criterion	10.59112
Sum squared resid	343756.1	Schwarz criterion	10.72509
Log likelihood	-845.5849	Hannan-Quinn criter.	10.64552
F-statistic	82.40579	Durbin-Watson stat	1.800065
Prob(F-statistic)	0.000000		

Heteroskedasticity- ARCH Test

Heteroskedasticity Test: ARCH

F-statistic	48.57245	Prob. F(1,158)	0.0000
Obs*R-squared	37.62163	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/20/12 Time: 23:39
Sample (adjusted): 2 161
Included observations: 160 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4646.807	1352.908	3.434681	0.0008
RESID^2(-1)	0.485042	0.069596	6.969394	0.0000

R-squared	0.235135	Mean dependent var	9033.586
Adjusted R-squared	0.230294	S.D. dependent var	17266.26
S.E. of regression	15148.19	Akaike info criterion	22.10157
Sum squared resid	3.63E+10	Schwarz criterion	22.14001
Log likelihood	-1766.126	Hannan-Quinn criter.	22.11718
F-statistic	48.57245	Durbin-Watson stat	1.967536
Prob(F-statistic)	0.000000		

Heteroskedasticity-White Test

Dependent Variable: GOLD
Method: Least Squares
Date: 02/20/12 Time: 23:40
Sample: 1 161
Included observations: 161
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPI	1.454130	0.284072	5.118874	0.0000
SIL	0.270983	0.070267	3.856452	0.0002
USD	-1.441313	0.438724	-3.285236	0.0013
CRD	2.261491	1.351406	1.673435	0.0962
C	204.1958	52.85737	3.863148	0.0002

R-squared	0.850568	Mean dependent var	391.7622
Adjusted R-squared	0.846737	S.D. dependent var	246.0462
S.E. of regression	96.32426	Akaike info criterion	12.00388
Sum squared resid	1447425.	Schwarz criterion	12.09958
Log likelihood	-961.3124	Hannan-Quinn criter.	12.04274
F-statistic	221.9889	Durbin-Watson stat	0.261242
Prob(F-statistic)	0.000000		

Model Misspecification- Ramsey Test

Ramsey RESET Test:

F-statistic	0.022444	Prob. F(1,155)	0.8811
Log likelihood ratio	0.023311	Prob. Chi-Square(1)	0.8787

Test Equation:
Dependent Variable: GOLD
Method: Least Squares
Date: 02/20/12 Time: 23:40
Sample: 1 161
Included observations: 161

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CPI	1.437745	0.291345	4.934849	0.0000
SIL	0.265683	0.043792	6.066996	0.0000
USD	-1.416919	0.593650	-2.386791	0.0182
CRD	2.214108	0.758989	2.917181	0.0041
C	204.6107	63.91576	3.201257	0.0017
FITTED^2	1.55E-05	0.000103	0.149813	0.8811

R-squared	0.850590	Mean dependent var	391.7622
Adjusted R-squared	0.845770	S.D. dependent var	246.0462
S.E. of regression	96.62749	Akaike info criterion	12.01616
Sum squared resid	1447215.	Schwarz criterion	12.13099
Log likelihood	-961.3008	Hannan-Quinn criter.	12.06279
F-statistic	176.4827	Durbin-Watson stat	0.264796
Prob(F-statistic)	0.000000		

Multicollinerity

	GOLD	CPI	SIL	USD	CRD
GOLD	1.000000	0.622929	0.841922	-0.472650	0.851209
CPI	0.622929	1.000000	0.346462	-0.465764	0.653013
SIL	0.841922	0.346462	1.000000	-0.317936	0.781528
USD	-0.472650	-0.465764	-0.317936	1.000000	-0.416663
CRD	0.851209	0.653013	0.781528	-0.416663	1.000000

Appendix 4.4: Log Model

Multiple Linear Regression Model

Dependent Variable: LGOLD
Method: Least Squares
Date: 02/20/12 Time: 23:57
Sample: 1 161
Included observations: 161

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCPI	0.193578	0.018263	10.59948	0.0000
LSIL	0.771766	0.066803	11.55288	0.0000
LUSD	-0.180951	0.132656	-1.364065	0.1745
LCRD	0.039631	0.059467	0.666438	0.5061
C	0.933139	0.745899	1.251025	0.2128

R-squared	0.899823	Mean dependent var	5.775323
Adjusted R-squared	0.897254	S.D. dependent var	0.678833
S.E. of regression	0.217593	Akaike info criterion	-0.181818
Sum squared resid	7.386083	Schwarz criterion	-0.086122
Log likelihood	19.63634	Hannan-Quinn criter.	-0.142962
F-statistic	350.3102	Durbin-Watson stat	0.132362
Prob(F-statistic)	0.000000		

Appendix 4.5; Diagnostic Checking

Autocorrelation-LM Test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	425.3853	Prob. F(2,154)	0.0000
Obs*R-squared	136.3237	Prob. Chi-Square(2)	0.0000

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 02/21/12 Time: 00:00
Sample: 1 161
Included observations: 161
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCPI	-0.010746	0.007219	-1.488594	0.1386
LSIL	-0.047885	0.026419	-1.812553	0.0718
LUSD	-0.019053	0.052304	-0.364280	0.7161
LCRD	0.044580	0.023517	1.895614	0.0599
C	0.288107	0.294469	0.978395	0.3294
RESID(-1)	1.054255	0.079583	13.24719	0.0000
RESID(-2)	-0.141095	0.079782	-1.768493	0.0790

R-squared	0.846731	Mean dependent var	9.31E-17
Adjusted R-squared	0.840760	S.D. dependent var	0.214856
S.E. of regression	0.085738	Akaike info criterion	-2.032535
Sum squared resid	1.132056	Schwarz criterion	-1.898561
Log likelihood	170.6191	Hannan-Quinn criter.	-1.978136
F-statistic	141.7951	Durbin-Watson stat	1.660207
Prob(F-statistic)	0.000000		

Heteroskedasticity-ARCH Test

Heteroskedasticity Test: ARCH

F-statistic	324.4104	Prob. F(1,158)	0.0000
Obs*R-squared	107.5965	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/21/12 Time: 00:00
Sample (adjusted): 2 161
Included observations: 160 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.009283	0.002866	3.238431	0.0015
RESID^2(-1)	0.771467	0.042832	18.01140	0.0000

R-squared	0.672478	Mean dependent var	0.044563
Adjusted R-squared	0.670405	S.D. dependent var	0.046109
S.E. of regression	0.026472	Akaike info criterion	-4.413066
Sum squared resid	0.110718	Schwarz criterion	-4.374627
Log likelihood	355.0453	Hannan-Quinn criter.	-4.397457
F-statistic	324.4104	Durbin-Watson stat	1.706009
Prob(F-statistic)	0.000000		

Heteroskedasticity-White Test

Dependent Variable: LGOLD
Method: Least Squares
Date: 02/21/12 Time: 00:01
Sample: 1 161
Included observations: 161
White Heteroskedasticity-Consistent Standard Errors & Covariance

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCPI	0.193578	0.016944	11.42483	0.0000
LSIL	0.771766	0.076229	10.12429	0.0000
LUSD	-0.180951	0.107590	-1.681855	0.0946
LCRD	0.039631	0.065402	0.605967	0.5454
C	0.933139	0.687088	1.358105	0.1764

R-squared	0.899823	Mean dependent var	5.775323
Adjusted R-squared	0.897254	S.D. dependent var	0.678833
S.E. of regression	0.217593	Akaike info criterion	-0.181818
Sum squared resid	7.386083	Schwarz criterion	-0.086122
Log likelihood	19.63634	Hannan-Quinn criter.	-0.142962
F-statistic	350.3102	Durbin-Watson stat	0.132362
Prob(F-statistic)	0.000000		

Model Misspecification-Ramsey Test

Ramsey RESET Test:

F-statistic	44.33221	Prob. F(1,155)	0.0000
Log likelihood ratio	40.49918	Prob. Chi-Square(1)	0.0000

Test Equation:
Dependent Variable: LGOLD
Method: Least Squares
Date: 02/21/12 Time: 00:01
Sample: 1 161
Included observations: 161

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCPI	0.518862	0.051456	10.08351	0.0000
LSIL	2.165091	0.217448	9.956827	0.0000
LUSD	-0.718069	0.142407	-5.042389	0.0000
LCRD	0.073571	0.052854	1.391957	0.1659
C	-1.475181	0.752496	-1.960385	0.0517
FITTED^2	-0.153387	0.023037	-6.658244	0.0000

R-squared	0.922103	Mean dependent var	5.775323
Adjusted R-squared	0.919590	S.D. dependent var	0.678833
S.E. of regression	0.192495	Akaike info criterion	-0.420943
Sum squared resid	5.743391	Schwarz criterion	-0.306108
Log likelihood	39.88593	Hannan-Quinn criter.	-0.374316
F-statistic	366.9593	Durbin-Watson stat	0.135284
Prob(F-statistic)	0.000000		

Multicollinearity

	LGOLD	LCPI	LSIL	LUSD	LCRD
LGOLD	1.000000	0.689725	0.857274	-0.463531	0.880236
LCPI	0.689725	1.000000	0.365529	-0.438002	0.624986
LSIL	0.857274	0.365529	1.000000	-0.349221	0.863599
LUSD	-0.463531	-0.438002	-0.349221	1.000000	-0.389816
LCRD	0.880236	0.624986	0.863599	-0.389816	1.000000