RESEARCH REPORT

EXAMINING LONG RUN RELATIONSHIP BETWEEN GOLD PRICE, INFLATION AND EXCHANGE RATES FOR MALAYSIA: VECM APPROACH

SABARIAH NORDIN
DR. ZAEMAH ZAINUDDIN
NORHAFIZA NORDIN
PROF. MADYA DR. ANGAPPAN A/L REGUPATHI

UNIVERSITI UTARA MALAYSIA

2012

PENGAKUAN TANGGUNGJAWAB (DISCLAIMER)

Kami, dengan ini, mengaku bertanggungjawab di atas ketepatan semua pandangan, komen teknikal, laporan fakta, data, gambarajah, ilustrasi, dan gambar foto yang telah diutarakan di dalam laporan ini. Kami bertanggungjawab sepenuhnya bahawa bahan yang diserahkan ini telah disemak dari aspek hakcipta dan hak keempunyaan. Universiti Utara Malaysia tidak bertanggungan terhadap ketepatan mana-mana komen, laporan, dan maklumat teknikal dan fakta lain, dan terhadap tuntutan hakcipta dan juga hak keempunyaan.

We are responsible for the accuracy of all opinion, technical comment, factual report, data, figures, illustrations and photographs in the article. We bear full responsibility for the checking whether material submitted is subject to copyright or ownership rights. UUM does not accept any liability for the accuracy of such comment, report and other technical and factual information and the copyright or ownership rights claims.

Ketua Penyelidik:

____

Nama: SABARIAH NORDIN

Ahli-ahli:

____

Nama: DR. ZAEMAH ZAINUDDIN

____

Nama: NORHAFIZA NORDIN

____

Nama: PROF. MADYA DR. ANGAPPAN A/L REGUPATHI

ACKNOWLEDGEMENT

We would like to express our gratitude to all those who gave us the possibility to complete this research. Especially we are obliged to Dr. Zahiruddin Ghazali and Dr. Lim Chee Chee for the constructive comments and suggestions. Lastly but not least, the financial support from RIMC, Universiti Utara Malaysia is greatly acknowledged. All remaining shortcomings are our own responsibility.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SYNOPSIS

This paper is intended to examine the relationship between gold price, inflation and exchange rates. In investment, inflation is always identified as a “mean” that demolishes the value of an asset. In spite of just observing the short run and long run relationships that exist among the underlying variables, this paper is intended to propose an investment alternative which may resolve the negative effect of inflation. To achieve the objectives, this paper employs a cointegration technique of VECM based on three underlying variables of gold price, Malaysian consumer price index (CPI) and exchange rates of RM/US$ for yearly data of 1970 to 2009.

The results of the study indicate that there is a cointegration relationship that exists among the three variables. In other words, the three variables are moving towards a long run equilibrium relationship. Both variables, inflation and exchange rates, are found to be the significant determinants of the gold price in the long run. As expected, there is a significant positive relationship that exists between the CPI and the gold price. Results indicate an increase in the CPI by 1 percent will be reflected in an increase in the gold price by 2.5 percent. In other words, this result suggests that holding gold should be considered as a potential hedging strategy to hedge against the inflation. The rise in the gold price will be able to offset the negative effect of the inflation since the value of gold increases more than an increase in the inflation.

On the hand, results obtained are not able to show any short run relationship between the variables. Nevertheless, the short run adjustment of the error correction term (ect) is negative as supposed to, even though not significant. In short, results imply that gold is suitable for the long run investment rather than short run, particularly may be because of the huge fluctuations in its price in the short run.

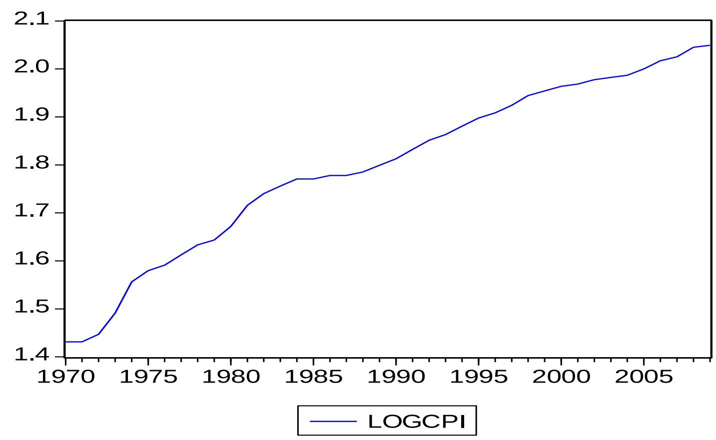
CHAPTER 1
INTRODUCTION

For ages, gold has been extensively used in jewelry industry. Its acceptance is highly due to the value that it carries with it. In addition to that, gold is also used for investment purposes. The demand for gold is not only confined to jewelry and investment purposes as it has been acknowledged as an effective hedging tool against inflation (Worthington & Pahlavani, 2006; Narayan, Narayan & Zheng, 2010; Wang & Lee, 2010). There has been a close relationship between gold price and inflation. It is not something uncommon to observe that the price of gold rises along with the rate of inflation. Since inflation is known to demolish the value of an asset, the rise of the price of an asset, particularly gold, would act as a hedging tool to counteract the effect of inflation.

Figure 1, Figure 2 and Figure 3 below illustrate the movement of Malaysian Consumer Price Index (CPI) which denotes the rates of inflation for Malaysia, gold prices (based on US dollar per troy ounce) and exchange rates of RM against US dollar within the years studied, which is between 1970 until 2009. Based on Figure 1, even though the Malaysian inflation rate is considered not to be too high, the CPI has been showing an increasing trend. That means prices have been steadily going up during those years. As price goes up, there will be an indication of positive inflation rate since inflation = (CPI_t –

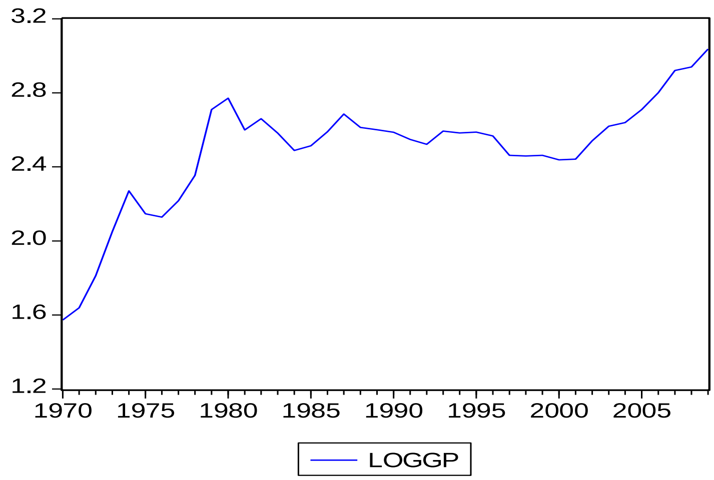
CPI_{t-1}) / CPI_{t-1}). Even during the crises, for example 1984-1985 crisis and 1997-1998 Asian financial crisis, it can be hardly seen a turning point for the CPI.

Figure 1
Malaysian Consumer Price Index



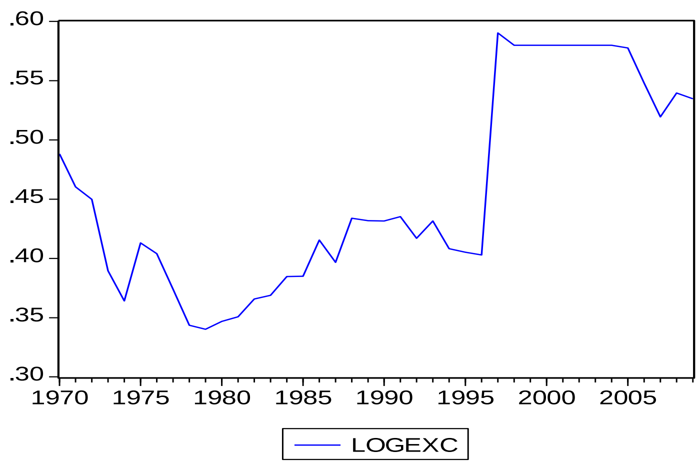
The main point here is that once there is inflation, it will erode our purchasing power. If we were to hold an asset, any kind of asset, at any particular point in time, and then there has been an increase in the inflation rate, given that the price of our asset does not change, the value of the asset that we are holding will depreciate. That is why the Fisher Effect theory states that the nominal interest rates should be equal to the real rate of return plus expected inflation. Therefore, if we want to maintain the value of our investment, in this case the asset that we are holding, we will have to make sure that its price will increase and we will be able to compensate for the expected inflation rate. In this case, the asset will only act as a hedge against inflation if it offers a certain degree of 'immunization' against the rise in the price level (Spierdijk & Umar, 2010). Due to that, we would like to examine gold as a potential investment which will hedge against the inflation scenario. In addition, gold price is also considered to be a good criterion of the inflationary trend in the future (Wang & Lee, 2010). Figure 2 illustrates the general rising prices of gold. Based on Figure 2, we can conclude that there has been an increasing trend for the price of gold in the long run despite a lot of short term fluctuations going on especially during the crises.

Figure 2
Gold Price (US Dollar per troy ounce)



In addition to the data on CPI and the gold price, we are going to include another variable which we believe to have a potential effect on the gold price. The variable is the exchange rates of Malaysian ringgit versus US dollar (RM/US$). Figure 3 demonstrates the volatility of the RM against US dollar. Prior to the 1997 Asian financial crisis, the average of Malaysian exchange rate had been around RM2.50/US$, however, during and after the crisis, ringgit had been depreciated to more than RM3/US$ until we adopted the fixed exchange rate regime of RM3.80/US$ from 1998 until 2004. After 2004, RM has been left floating again based on a basket of currencies. Since we are using US dollar to represent the price of the gold, we would expect that a depreciation of the US dollar would positively affect the gold price. Besides, since we incorporate exchange rates of RM/US$ as one of the underlying variables, and we know that the exchange was highly affected by the 1997 Asian financial crisis, we would also consider the 1997 crisis as a potential dummy variable to denote the structural break that may affect our results during the period of study. Based on Figure 2, it seems like the 1997 Asian financial crisis had a negative impact on the price of gold.

Figure 3
Exchange Rates of RM/US$



Empirical studies have shown that gold price is a good indicator or predictor for inflation rate, thus making gold an effective tool to hedge against deflation and inflation (See for example Worthington & Pahlavani, 2006; Wang & Lee, 2010). Since Malaysia has different regulations and surrounded by different economic and political environments, the impact of gold as a good hedge tool against inflation or the general trend between gold and inflation as being reported in previous studies might not be the same for Malaysia. For that reason, this study attempts to examine the long run relationship between the gold price, the Malaysian Consumer Price Index to represent Malaysian inflation rate and the exchange rate of RM/US$ using yearly data from 1970 to 2009. To achieve the goal, we will conduct cointegration tests of Johansen-Juselius and Vector Error Correction Model (VECM) technique to test for the long run and short run relationships. Having identified the cointegration relationship among the underlying variables, we are going to proceed with the determination of the error correction term (ECT) which indicates the short run adjustment towards long run equilibrium relationship. In addition, we will also proceed with causality and accounting innovation techniques to further justify the characteristics of the underlying series.

Objectives of the Study

Basically, there are four main objectives that we would like to achieve for this study:

1. To examine long run relationship between gold price, Malaysian Consumer Price Index (CPI) and exchange rates of RM/US$.
2. To examine short run relationship between gold price, Malaysian CPI and exchange rates of RM/US$.
3. To examine causality between the underlying variables in the case where there is a short run relationship.
4. To determine the short run adjustments (error correction term) towards long run equilibrium in the case where there is a long run equilibrium relationship between the underlying variables.

Significance of the Study

This study provides a platform for investors in Malaysia to find an alternative to secure their investment. Since inflation generally does exist, and its existence will demolish the value of an asset, it is important for an investor to invest in “something” which can hedge against the negative impact of inflation. As the price of gold generally rise in the long run, we would like to suggest gold as an alternative for potential investment which will help investors to protect the value of their investment.

Besides helping the investors in widening their choice of potential investment, findings of this study may also potentially help regulators in deriving expected inflation based on the scenario of the gold price movement. If the gold price were found to have a long run equilibrium relationship with the CPI, probably by observing the movements of the gold price, regulators or decision makers were able to estimate future inflation. By being able to estimate expected inflation, many things which are considered to be uncertain can be predetermined and secured such as the determination of nominal interest rate, real gross domestic product (GDP) and expected exchange rates. Nevertheless, there are still other factors that need to be considered before the gold price can be fully taken as a predictor of an expected inflation rate, and this study would initially function as the first step towards the objective.

CHAPTER 2
LITERATURE REVIEW

Due to the importance of preserving the value of investment, a number of studies have been conducted to assess the relationship between gold price and inflation (Worthington & Pahlavani, 2006; Narayan *et al.*, 2010; Wang, Wang & Huang, 2010). Even though some of the studies provide evidence of long run relationship between gold price and inflation (Worthington & Pahlavani, 2006; Levin & Wright, 2006; Ghosh, Levin, MacMillan & Wright, 2004), quite a number of studies also prove the opposite (Mahdavi & Zhou, 1997; Blose, 2010; Shafiee & Topal, 2010). Furthermore, we could not find any of this kind of study focusing specifically on Malaysia.

Worthington and Pahlavani (2006) examine the long run relationship between the gold price and inflation rate in the United States from 1945 to 2006 and from 1973 to 2006. They report evidence of a cointegrating relationship between gold price and inflation rate, thus support the idea that gold is a good tool against inflation. A more recent study by Narayan, Narayan and Zheng (2010) support the view by providing evidence that gold and oil futures prices are cointegrated using daily data from 1995 to 2009. They conjecture that the rise in oil price usually generates inflation, and inflation leads to a rise in gold price. Therefore, the existence of long-run relationship between gold and oil futures prices implies that gold can be used as a hedge against inflation. Likewise, Wang, Wang and Huang (2010), using daily data of 2006 until 2009, also discover cointegration relationships between oil price, gold price, exchange rates of the dollar versus other currencies and the stock markets in Germany, Japan, Taiwan and

China. However, they do not discover any cointegration relationship among the underlying variables with the US stock market. In addition, for the Taiwan group, they manage to show that gold and oil prices mutually affect each other in a two-way feedback relationship (Granger causality).

Similarly, Levin and Wright (2006), using cointegration techniques to analyze data from January 1976 to August 2005, find that there is a long term relationship between the gold price and the US price level. To substantiate the belief that gold is the long term hedge against inflation, their results show that a one percent increase in the general US price level leads to a one percent increase in the price of gold. Based on their findings, they also discover that there is a slow reversion towards the long term relationship, and it roughly takes around five years to eliminate two-third of the deviation from the long run relationship. A research done by Ghosh, Levin, MacMillan and Wright (2004) emphasize similar results. Using monthly data of January 1976 to December 1999, they confirm some evidence of long run relationship between the retail price index in the United States and the nominal price of gold. Their results agree that gold can be regarded as a long run inflation hedge. They also suggest that movements in the nominal price of gold are dominated by short run influences.

Wang, Lee and Thi (2011), employing monthly data from January 1971 to January 2010, examine short-run and long-run inflation hedging effectiveness of gold in the US and Japan. In the long-run, their results indicate the rigidity of gold price characterized by market disequilibrium causes the price of gold to be unable to response to the changes in the CPI. While in the short-run, only during high momentum regimes, the gold return is found to be able to hedge against inflation in the US. Even their causality test reports that the gold return could be hedged against inflation in the short-run, and an increase in the gold return is followed by a rise in inflation. While in Japan, the gold is found not to fully hedge against inflation. Based on their results, they suggest two major factors that influence the inflation hedging ability of gold investor; 1) the rigidity adjustment between gold price and CPI, and 2) the price adjustment within high momentum regime. The determination of the momentum regime is done through the comparison between the momentum of the error correction term (ΔECT) and the threshold value.

In addition, Baur and McDermott (2010) show that gold is a hedge and a safe haven for major European stock markets and the US, but not for Australia, Canada, Japan and other large emerging markets. Using a sample of a 30 years period from 1979 to 2009, they argue that gold may act as a stabilizing force to reduce losses of negative market shocks, especially during the peak of the recent financial crisis. Correspondingly, Wang and Lee (2010) investigate the causality between the gold return and yen depreciation rate using threshold vector autoregressive model for the period from 1986 to 2007. The result of their study reveals that gold is a good tool for hedging against yen depreciation. However, the effectiveness depends on the depreciation of the yen. In particular, they find that gold can be used to avoid depreciation loss when yen depreciates greater than 2.62 percent. Meanwhile, Tkacz (2007), using monthly data for 14 countries over the period of 1994 to 2005, finds that gold contains significant information for future inflation for several countries.

On the hand, Mahdavi and Zhou (1997) do not find any cointegration relationship between gold price and CPI, but they do suggest a cointegrating relationship between commodity prices and CPI. To conduct their study, they use quarterly data of 1970 through 1994. Using unexpected changes in the CPI (calculated based on the subtraction of expected change from the actual change) as a proxy for changes in expectations regarding future inflation and using monthly data from March 1988 through February 2008, Blose (2010) indicates that gold prices do not change as a result of unexpected changes in the CPI. Shafiee and Topal (2010) also do not find any significant relationship between gold price and inflation. Similarly, Gunes, Guler, Ozkalay and Laaganjav (2010) analyze the impact of changes in oil price, Eurodollar parity, and interest rate on gold price. They find no evidence of cointegration between gold price and Eurodollar parity as well as the interest rate.

CHAPTER 3
METHODOLOGY

Prior to estimating cointegration relationship among the underlying series, the data will be exposed to unit root tests. The purpose is to identify the order of integration of each variable, or in other words, to test the stationarity of each variable. By simply looking at Figure 1, Figure 2 and Figure 3, the generalization that we can make is that all of the series are showing some kind of an increasing trend in the long run. If that the case, their means have been changing depending on time. Normal regression assumes that the mean of a series has to be zero and its variance has to be constant, in which they are time-invariant and it is considered to be stationary. If a regression is applied on a non-stationary series, most probably, the results will be spurious. Therefore, it is important for us to identify the stationarity of each series first before pursuing the cointegration test.

For the cointegration test, this study will employ Johansen-Juselius cointegration test. This technique will only allow variables that have been identified as *I(1)* or integrated of order one to be tested. The intuition of cointegration is that time series integrated of order *1* with a long-run equilibrium relationship cannot drift too far apart from the equilibrium because in the long run the variables will converge towards the equilibrium. Besides, the existence of a cointegrating relationship among the variables means there is an ability to forecast future movement in the variables.

In order to test for the cointegration relationship, this study will apply Johansen's method of maximum likelihood estimator of the so-called reduced rank model. The coefficients will be determined by the Vector Error Correction Model (VECM) estimates. We begin with a VAR specification for the n x 1 vector of *I(1)* variables:

(1)

where the error term, , is assumed to be an independent and identically distributed Gaussian process. Rewriting equation (1) as a Vector Error Correction Model (VECM) which represents the short-run and long-run responses to the changes in the variables:

(2)

where

j = 1,..., k

Δ denotes changes in the variables, is a vector of variables integrated of order 1, μ is vector of constants, *k* is a lag structure, and is a vector of white noise error terms. Long-run information in is determined by the long-run impact matrix of Π, and it is the rank of this matrix that decides on the number of cointegrating vectors. The result of implies no cointegration. is a matrix that indicates short-term changes among variables given equations and *j* lag. Under the null hypothesis of r cointegrating vectors, Π can be transformed into αβ, where α and β are $n \times r$ matrices.

Since Π denotes the long run equilibrium impact, α can be construed as a "speed of adjustment towards long run equilibrium" and can be determined from the error correction equations. A larger α indicates a faster convergence towards long-run equilibrium which is due to the short run deviations. Meanwhile, β is considered as the asymptotically efficient estimates of the cointegrating vectors. is known as an error correction term (ECT), and it is used to measure the long-run relationships of the variables. To rewrite the equation for :

(3)

For the order of cointegration, *r*, Johansen and Juselius propose two likelihood ratio test statistics to determine the rank of Π which include:

(4)

(5)

The Trace test will determine the number of maximum cointegrating relationships, while the (maximum Eigenvalue) test is used to test specific alternative hypotheses. Models where Π is in full rank are rejected since is stationary, and there would be no error-correction (Maysami & Koh, 2000).

Data

For this study, we are going to employ three main variables; namely gold price (GP), consumer price index (CPI) and exchange rates (EXC). Data on gold price is extracted from the World Gold Council's website (www.gold.org). The gold price is in US dollar, and the price is based on US dollar per troy ounce of gold. The Malaysian consumer price index (CPI) is obtained from the database of UNDATA, and it will represent the Malaysian inflation rate. For the exchange rate, we will use the exchange rate of RM/US$; depreciation in RM will be symbolized by an increase in the amount and vice versa. However, we have to take note that the gold price is in US dollar, so, we assume that the effect of the exchange rate on the gold price is much on the volatility of the US dollar relative to ringgit. All data will be converted into logarithm to reduce or normalize their scales. The period of study for this research is between 1970 and 2009, which consists of 40 observations. Appendix 1 provides descriptive statistics on the data and the correlation between them.

Estimation Technique

As mentioned earlier, we have decided to conduct cointegration test relationship among the underlying series using Johansen-Juselius (1990) cointegration test and the estimates will be derived from Vector Error Correction Model (VECM) technique. This technique requires that all variables tested should be integrated of order *1* or *I(1)*. The general model of the test will be as follow:

$$LOGGP_t = \beta_0 + \beta_1 LOGCPI_t + \beta_2 LOGEXC_t \quad (6)$$

Where,

$LOGGP_t$ = Logarithm of gold price at time t

$LOGCPI_t$ = Logarithm of Malaysian consumer price index (CPI) at time t

$LOGEXC_t$ = Logarithm of exchange rate of RM/US$ at time t

Prior to testing for the unit root of each variable, we first estimate the optimal lag length based on the suggested VAR lag order selection criteria. Table 1 below highlights the suggested optimal lag length based on sequential modified LR test statistic, Final Prediction Error (FPE), Akaike Information Criterion (AIC), Schwarz Information Criterion (SIC) and Hanna-Quinn Information Criterion (HQ) of the underlying variables of gold price (LogGP), CPI (LogCPI) and exchange rates (LogEXC). Based on the results from the table, all criteria suggest lag 1. As a result, lag 1 will be used as the basis to conduct the unit root and also the cointegration tests. It is important to note here that VECM is very sensitive to the selection of the lag length.

Table 1
VAR Lag Order Selection Criteria Based on Underlying Series of Gold Price, Consumer Price Index and Exchange Rates

Lag	LogL	LR	FPE	AIC	SC	HQ
0	100.8699	NA	1.01e-06	-5.290266	-5.159651	-5.244218
1	234.6433	*238.6228**	*1.19e-09**	*-12.03477**	*-11.51231**	*-11.85058**
2	242.1700	12.20549	1.31e-09	-11.95514	-11.04083	-11.63280
3	249.2885	10.38908	1.49e-09	-11.85343	-10.54728	-11.39295

* indicates lag order selected by the criterion

After estimating the optimal lag, selected variables, in this case the gold price (GP), CPI and exchange rates (EXC) will be exposed to unit root tests. The purpose of testing the unit root of each variable is to determine whether the underlying variable is stationary or not. Stationary variables or *I(0)* variables signify that the mean variances and auto-covariances of the variables are time-invariant at various lags. Regression of time series data normally assumes that the underlying variables are stationary, however, if the underlying variables are not stationary as expected, results are considered to be spurious. Spurious results are particularly observed when the adjusted coefficient of determination (R^2) exceeds the Durbin-Watson statistic (*D-W*). In order to solve the problem, the underlying variables will be first differenced to make them stationary. That is why it is important for us to identify the order of integration of the underlying variables series first before proceeding with the cointegration test. Besides, as mentioned above, since we are pursuing the VECM technique, it is important for us to make sure that the underlying variables series are integrated of order 1.

To test for the unit root or the stationarity of each variable, we will employ the Augmented Dickey-Fuller (ADF) test. However, since the ADF test is often criticized for low statistical power, we will complement the results of the ADF with the results estimated by the Phillips-Perron (PP) test. Table 2 below provides the results of the two unit root tests for the underlying variables series. Based on the results shown in Table 2, given that the significance level accepted is 5 percent, all variables (GP, CPI and EXC) are considered to be integrated of order 1 or *I(1)* in the criteria of "intercept and trend". Figure 4 illustrates the stationarity of the first differenced data of the three variables.

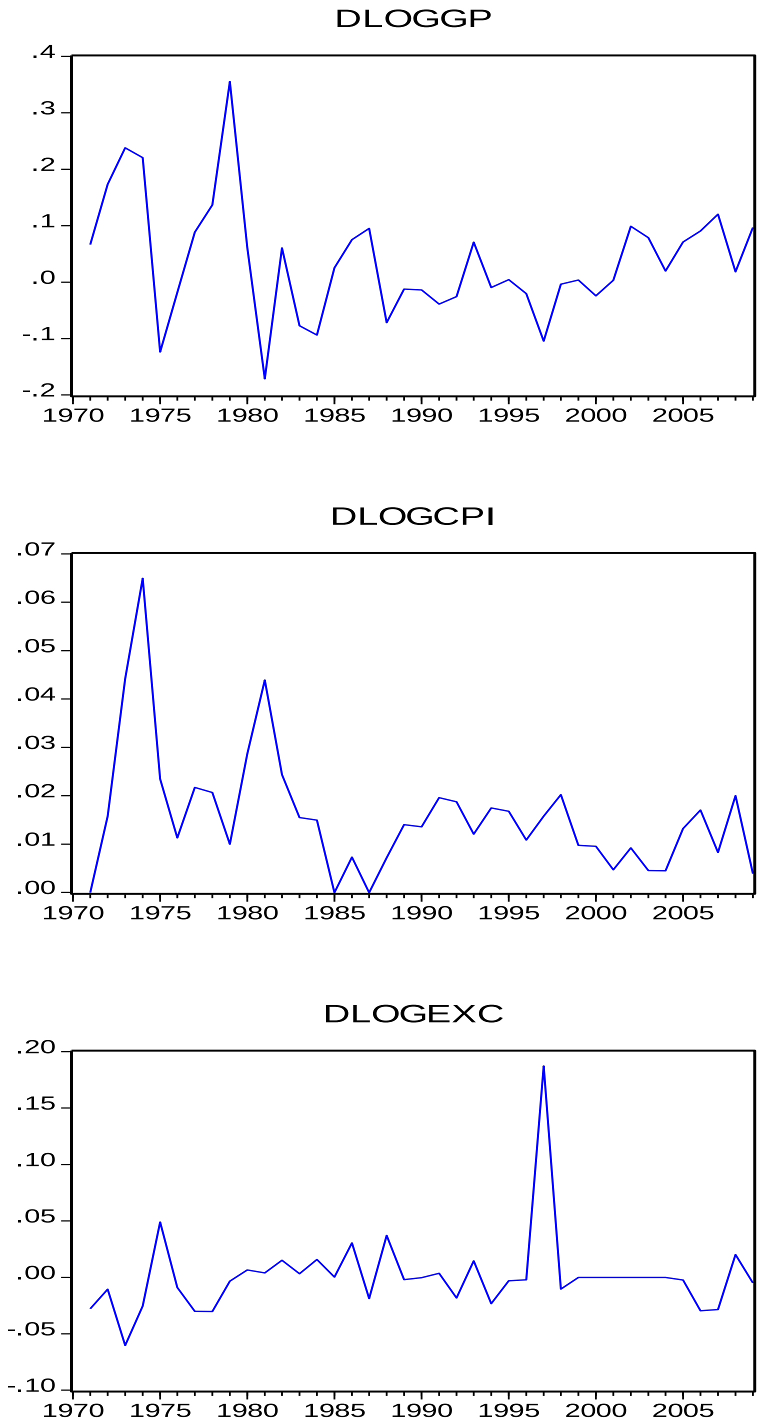
Table 2
Results of Unit Roots Tests Based on Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) Tests

	ADF		PP	
	Intercept and Trend		Intercept and Trend	
	Level	First Difference	Level	First Difference
LogGP	-3.205293	-4.278827**	-2.671121	-4.191759*
LogCPI	-3.425387	-5.202376**	-1.703829	-4.494149**
LogEXC	-2.903909	-6.273738**	-2.888360	-6.312984**

*Notes: *,** denote significance at 5% and 1% significant levels respectively.*

Since the three variables of the underlying series are *I(1)*, we will proceed with the cointegration test of Johansen and Juselius (1990). The idea of testing the cointegration test is to observe any equilibrium long run relationship that may exist between the underlying variables. Cointegration implies that those variables are related to each other in a systematic way. Once we found that there is a cointegrating relationship between the underlying variables in the series, we will proceed with estimating coefficients of the cointegrating vectors using the VECM approach. The VECM will help us determine the long run and short run adjustment processes in which the variables will converge towards their long run cointegrating relationship while allowing for short run adjustment process.

Figure 4
Multiple Line Graphs of First-Differenced Data



CHAPTER 4
RESULTS AND DISCUSSION

Table 3 below highlights the cointegration results of Johansen-Juselius for the underlying variables of gold price, consumer price index and exchange rates. Results based on Trace Statistic indicate one cointegrating relationship among the underlying variables. Due to the small sample size, the statistics have been adjusted using the formula suggested by Ahn and Reinsel (1990).

Table 3
Results of Johansen-Juselius Test

	Trace statistic	Max. Eigenvalue Statistics
r = 0	31.9754**	17.49880
r = 1	14.47656	13.40414
r = 2	1.07242	1.07242

*Note: ** indicates a significant level at 5%. The Trace and Max. Eigenvalue statistics have been adjusted based on T-kn/T where T=number of effective observations, k=lag length, n=number of independent variables*

Given that there is a cointegrating relationship among the underlying variables, we proceed to estimating long run coefficients using the VECM approach. Referring to Table 4, VECM results indicate that there is a highly significant positive relationship between the Malaysian CPI and the gold price and a negatively significant relationship between the exchange rates and the gold price. An increase in the CPI by 1 percent will be reflected in an increase in the gold price by 2.5 percent. In other words, this result suggests that holding gold should be considered as a potential hedging strategy to hedge against the inflation. Nevertheless, we should never forget that there are also other factors that contribute towards the gold price. One of them is the exchange rates. The negative relationship of RM/US$ indicates that the depreciation of the US dollar would result in an increase in the gold price. The coefficient based on the VECM result indicates a 1 percent increase in the RM (indicates the depreciation of RM) will be reflected in a decrease in the gold price by 1.86 percent. Not to forget that the price of the gold has normally being stated in US dollar ever since the Bretton Wood. This result also signifies that an appreciation of our currency would result in paying a higher price for the gold.

Table 4
Long-run Equilibrium Coefficients for VECM

LOGGP = -1.222056 +	2.532911*LOGCPI* -	1.858392*LOGEXC*
	(0.24432)	(0.47661)
	[10.3673]	[-3.89920]

Note: The values in ( ) and [ ] represent standard errors and t-statistics respectively.

In the short run, the VECM results (refer to Table 5) do not indicate any favorable correlation except for the lagged of the first differenced of gold price but at a very low significance level. Even the result for the dummy variable of 1997-1998 Asian financial crisis which has been included in the model to denote a structural break does not indicate any significant relationship, although the sign is as expected. In addition, results in Table 6 do not indicate any favorable short run relationship except that the gold price is found to Granger-cause the exchange rate at the 10 percent significance level. Since there is hardly any short run relationship between the gold price and the CPI, these results imply that gold is more suitable to be used for the long term investment rather than short term. As mentioned by Keran and Penzer (1974), gold is unlikely to be a good short term hedge against inflation because of the wide monthly price fluctuations. Furthermore, given that our inflation rates are considered not to be too high, this may be one of the reasons why the effect is hardly seen in the short run.

Table 5
Short-run VECM Results

Dependent Variable: LOGGP					
	Coefficient estimates of				
Lag	ECT	ΔLOGGP	ΔLOGCPI	ΔLOGEXC	C97
	-0.054888 (-0.41925)				
1		0.312600 (1.45048)	-0.989822 (-0.67210)	-0.211455 (-0.31477)	-0.057310 (-0.57437)
Diagnostic Tests: R^2 = 0.154839; Normality Skewness, χ^2=2.106937[0.5505], Kurtosis, χ^2=0.848535[0.8378], JB, χ^2= 2.955472[0.8144]; Serial Correlation $\chi^2(1)$ = 13.72721[0.1324]; Heteroscedasticity χ^2 = 64.36156[0.1580]					

*Note: ( ) and [ ] denote t-statistics and probabilities respectively. *, **, and *** indicate 10%, 5% and 1% significant levels respectively.*

Having identified the cointegrating vector using the Johansen-Juselius technique, it would be crucial to investigate the dynamic process of short run adjustment towards equilibrium. This is done through the establishment of the error correction term (ECT) derived from ordinary least square (OLS) by estimating lagged variables. It involves regressing the first differenced of the dependent variable onto lagged values of the first differenced of independent variables of the cointegrating vector plus the lagged value of the error correction term (Miller, 1991). The ECT is generated from the coefficients derived from the VECM log run results. Results (from Table 5) show that the coefficient of the error correction term for the estimated logarithm of gold price is with the correct negative sign but not significant. The idea is if the actual condition is higher than the equilibrium, the error correction term will tend to reduce it and if it is below the equilibrium, the error correction term will raise it. Any deviations from the long run equilibrium will be corrected gradually through a series of partial short run adjustment dynamics. However, for our results, our ECT is not significant. Even previous studies that find their ECT to be negatively significant, their short run adjustment is very low (refer to Levin & Wright, 2006). Given that the Malaysian market is not that huge and our inflation rate is relatively low, these may contribute towards the result.

Table 6
Temporal Causality/Block Exogeneity Wald Test Results

Dependent Variables	ΔLOGGP	ΔLOGCPI	ΔLOGEXC
ΔLOGGP		0.451716 (0.5015)	0.099080 (0.7529)
ΔLOGCPI	0.408336 (0.5228)		2.529425 (0.1117)
ΔLOGEXC	2.999478 (0.0833)*	0.070651 (0.7904)	

Note: The values in ( ) are probabilities. * denotes significance at 10% significant level.

Since the short run results do not indicate any significant relationship, there is nothing much that we can say about the causality effect. Table 6 summarizes temporal causality results, and generally, results indicate that most of the variables are independent, except for the exchange rates where the gold price is found to Granger-cause it but at a very low significance level. In order to enable us to distinguish the relative importance of the underlying variables and further clarify the causality test, we adopt the variance decomposition technique that explains the forecast error in each variable that can be attributed to innovations in other variables. Based on Table 7 of ten-year error variance, the innovation of the gold price is mainly due to its own innovation as it roughly shows that more than 98 percent of its innovation is explained by its own variation. On average, less than 2 percent of the variations are explained by the variations in both CPI and EXC. This indicates the exogeneity[1] of the gold price. On the other hand, changes in the CPI are mainly explained by the variation in the gold price, followed by CPI and by a small percentage by the EXC. Even its explanation on its own variation has been significantly decreasing from 98 percent to 11 percent over the ten-year period. This indicates the endogeneity[2] of the CPI, in which it depends on others to explain its variation. In the meantime, less than half of the variation in EXC is explained by its own variation. Roughly, on average 45 percent and 25 percent of the variations in exchange rates are explained by variations in the gold price and CPI respectively. This also indicates the endogeneity of exchange rates. The conclusion that can be made here is that the gold price is not just important in explaining its own variation but also in explaining variations in the CPI and EXC. This result is consistent with the one showed in Table 6 where the GP is found to Granger-cause the EXC.

To further reveal the dynamic causal relationships between the GP, CPI and EXC, we adopt the impulse response function. The first line of Figure 5 illustrates impulse responses to a shock in GP. The graph clearly shows that the impact of the shock on GP itself is positive and strong, which means it depends very much on its past values as indicated by the error variances provided by the variance decomposition. Nevertheless, the effect is increasing only up to the second period before starting to slowly decrease.

[1] In general, exogenous variables are the equivalent of the X variables or regressors. In other words, it represents the ability of the variable to explain others (Gujarati, 2003, p.701)
[2] Endogeneous variables are the equivalent of the dependent variable in the single equation model (Gujarati, 2003, p.701).

Table 7
Variance Decomposition Percentage of Ten-Year Error Variance

Variance Decomposition of LOGGP:

Period	S.E.	LOGGP	LOGCPI	LOGEXC
1	0.102494	100.0000	0.000000	0.000000
2	0.167957	99.85989	0.052561	0.087552
3	0.213162	99.78982	0.117533	0.092645
4	0.246019	99.74089	0.090524	0.168588
5	0.270373	99.67713	0.091596	0.231271
6	0.289989	99.47956	0.187133	0.333308
7	0.306368	99.20979	0.362840	0.427369
8	0.320901	98.84272	0.620951	0.536334
9	0.334048	98.44920	0.915180	0.635621
10	0.346333	98.02795	1.235697	0.736357

Variance Decomposition of LOGCPI:

Period	S.E.	LOGGP	LOGCPI	LOGEXC
1	0.009310	2.238733	97.76127	0.000000
2	0.016281	20.10119	79.81930	0.079503
3	0.022432	39.79372	60.09348	0.112802
4	0.028819	56.32506	43.52616	0.148779
5	0.035072	67.76062	31.94431	0.295075
6	0.041245	75.45793	24.15571	0.386356
7	0.047130	80.58325	18.92164	0.495115
8	0.052745	84.12546	15.30803	0.566508
9	0.058040	86.62770	12.73714	0.635165
10	0.063051	88.46979	10.84649	0.683714

Variance Decomposition of LOGEXC:

Period	S.E.	LOGGP	LOGCPI	LOGEXC
1	0.026200	39.87972	23.50146	36.61882
2	0.030355	48.62150	21.04051	30.33799
3	0.039013	48.39803	21.38764	30.21432
4	0.042689	49.77873	21.52705	28.69422
5	0.048042	47.98846	22.84859	29.16296
6	0.051368	47.23789	23.89377	28.86833
7	0.055427	45.47623	25.27909	29.24469
8	0.058542	44.31373	26.43050	29.25577
9	0.061955	42.89538	27.59749	29.50713
10	0.064879	41.82318	28.59009	29.58674

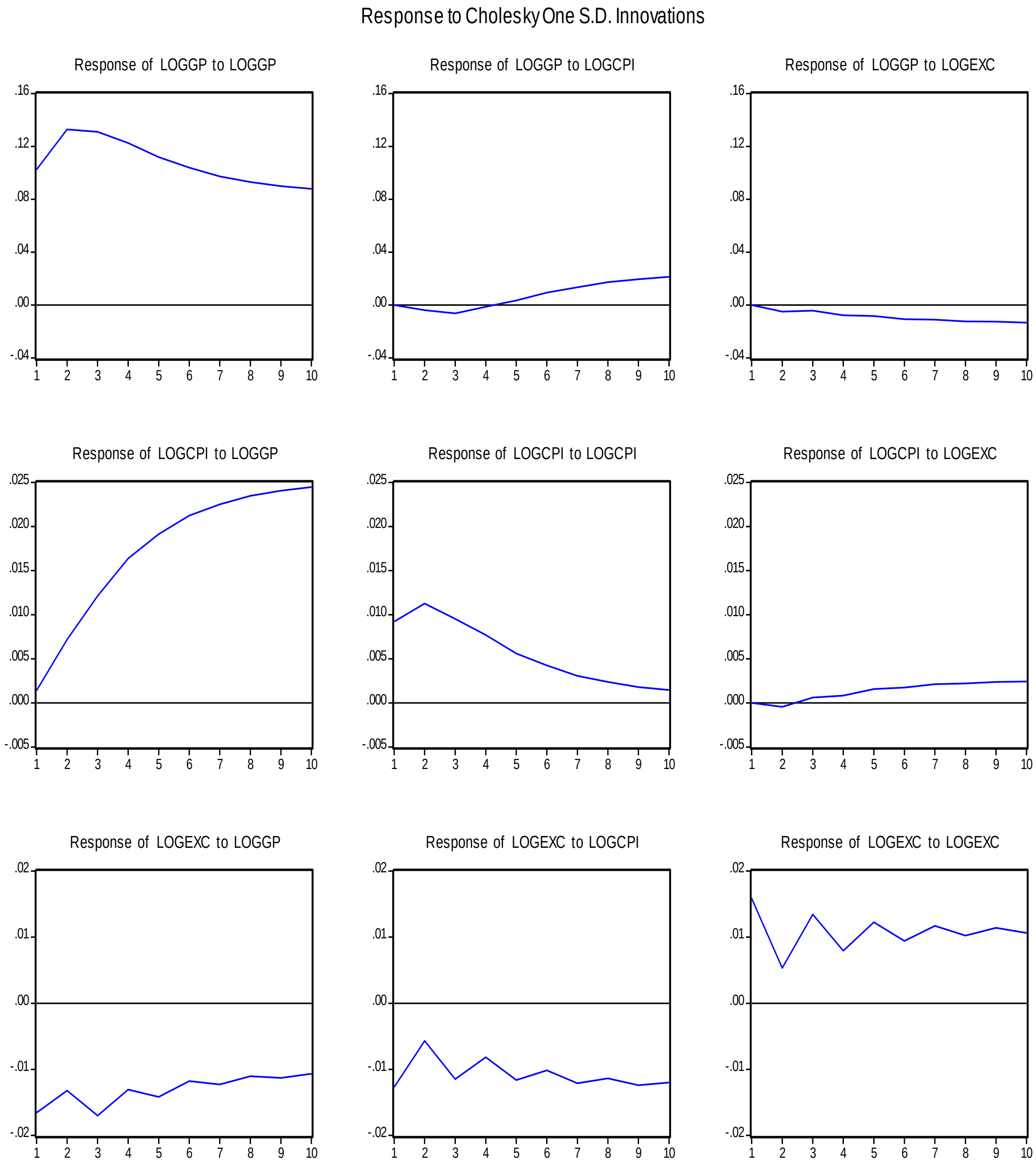
Even though the shock of CPI on GP is positive, it is not significant. Even the shock of EXC does not show significant effect on GP.

The second line of Figure 5 illustrates impulse responses to a shock in CPI. GP has been showing a positive and significant effect on the CPI. Similar to the results provided by variance decomposition, shock in the CPI is mainly due to changes in the GP. Even though shock in CPI has been showing a positive effect in explaining its own values, the effect has been decreasing and starting to lose its significance over time. The shock in EXC is showing a positive effect on the CPI but not significant.

The third line of Figure 5 illustrates impulse responses to a shock in EXC. The graph shows that the EXC has been consistently explained by its own past values. Meanwhile, GP and CPI have been showing a negative effect on EXC, and both variables seem to move in the same direction. The peaks and troughs of EXC are almost always at the opposite positions of GP and CPI.

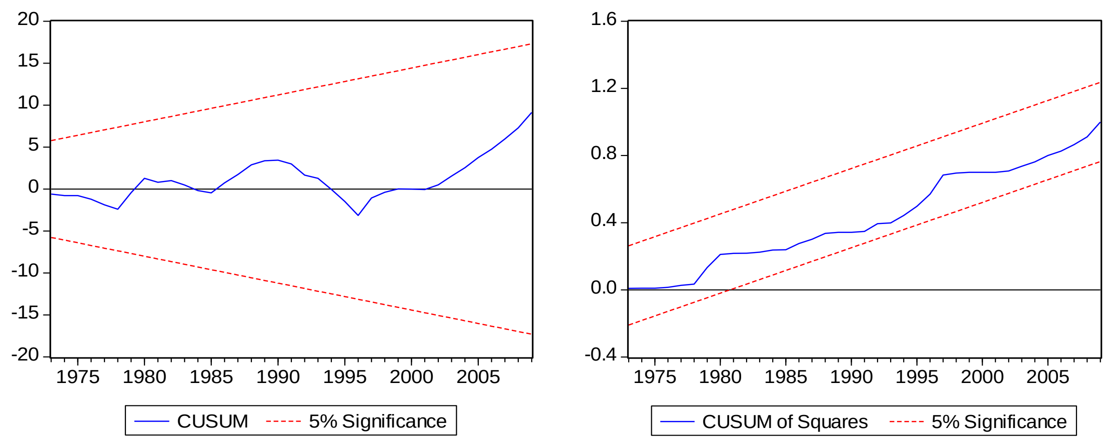
The results provided by the impulse response function are similar to the results highlighted by the variance decomposition and Granger causality test. GP seems to depend a lot on its past values rather than affected by the changes in CPI and EXC. On the other hand, CPI and EXC are found to be affected by the changes in the GP; the effect of the GP on CPI is positive, while the effect of the GP on EXC is negative, and these results are as expected. Besides, these results also confirm the short run VECM results where none of the variables are found to affect the gold price in the short run. Hence, this indicates the importance of using gold to hedge against inflation in the long run (as indicated by the long run VECM results), but not in the short run.

Figure 5
Impulse Response Function



Diagnostic tests highlight in Table 5 indicate that the VECM estimation is adequately specified. Tests on normality, serial correlation and heteroscedasticity cannot be rejected, implying that the specification does not exhibit those problems. The cumulative sum (CUSUM) and cumulative sum of squares (CUSUMQ) plots as depicted in Figure 6 indicate that the coefficients over the sample period is highly stable.

Figure 6
CUSUM and CUSUM square tests



CHAPTER 5
CONCLUSION

Results obtained for this study, in general, confirm the general norm of the ability of gold to hedge against the inflation scenario as indicated by a number of previous studies (Ghosh *et al.*, 2004; Worthington & Pahlavani, 2006; Narayan *et al.*, 2010). In addition, we did not find any study on similar objective focusing on Malaysian market. Therefore, our study can be regarded as value added information for the Malaysian market. Our results also propose that gold is suitable for long term investment, but not for the short run. Reasons that we may conclude which could have affected our results are the size of the Malaysian market that is considered to be relatively small and the low inflation rate compared to other countries inherited by Malaysia. Furthermore, our innovation accounting results of variance decomposition and impulse response reveal the exogeneity of the gold price and the endogeneity of the CPI and the exchange rates.

References

Ahn, S.K. & Reinsel, C.G. (1990). Estimation of Partially Nonstationary Multivariate Autoregressive Models. *Journal of American Statistical Association*, 85, 813-823.

Baur, D.G. & McDermott, T.K. (2010). Is Gold a Safe Haven. *Journal of Banking & Finance*, 34, 1886-1898.

Blose, L.E. (2010). Gold Prices, Cost of Carry, and Expected Inflation. *Journal of Economics and Business*, 62, 35-47.

Ghosh, D., Levin, E.J., MacMillan, D. and Wright, R.E. (2004).'Gold as an Inflation Hedge?'*Studies in Economics and Finance*, 22, 1-25.

Gujarati, D. N. (2003). *Basic Econometrics* (fourth ed.). Singapore: McGraw-Hill Education.

Gunes, H., Guler, F., Ozkalay, M. A., & Laaganjav, B. (2010). *Effects of Oil Price, Interest Rate and Dollar Price of Euro on Gold Price.* Paper presented at the 6thInternational Student Conference, Izmir University of Economics, Izmir, Turkey.

Johansen, S., & Juselius, K. (1990). Maximum Likelihood Estimation and Inference on Cointegration - with Applications to the Demand for Money. *Oxford Bulletin of Economics and Statistics, 52*, 169-210.

Keran, M.W. & Penzer, M. (1974-1975). Gold as a Private Hedge Against Inflation. *Business Review, Federal Reserve Bank of San Francisco*, Special Issue: Gold. Winter.

Levin, E.J. & Wright, R.E. (2006). Short-run and Long-run Determinants of the Price of Gold. *World Gold Council*, Research Study No. 32.

Mahdavi, S. & Zhou, S. (1997). Gold and Commodity Prices as Leading Indicators of Inflation: Tests of Long-Run Relationship and Predictive Performance. *Journal of Economics and Business*, 49, 475-489.

Maysami, R. C., & Koh, T. S. (2000). A Vector Error Correction Model of the Singapore Stock Market. *International Review of Economics and Finance*, 9, 79-96.

Miller, S.M. (1991). Monetary Dynamics: An Application of Cointegration and Error-Correction Modeling. *Journal of Money, Credit and Banking*, 23, 139-154.

Narayan, P. K., Narayan, S., & Zheng, X. (2010). Gold and Oil Futures Markets: Are Markets Efficient? Retrieved December 1, 2011, from http://ideas.repec.org/p/dkn/econwp/eco-2010_13html.

Shafiee, S. & Topal, E. (2010). An Overview of Global Gold Market and Gold Price Forecasting. *Resources Policy*, 35, 178-189.

Spierdijk, L. & Umar, Z. (2010). Are Commodities a Good Hedge Against Inflation? A Comparative Approach. *Netspar Discussion Papers*, 11/2010-078.

Tkacz, G. (2007). Gold Prices and Inflation. *Bank of Canada Working Paper* 2007-35.

Wang, K-M. & Lee, Y-M. (2010). Could Gold Serve as an Exchange Rate Hedge in Japan?. *Inzinerine Ekonomika-Engineering Economics*, 21, 160-170.

Wang, M-L., Wang, C-P. & Huang, T-Y. (2010). Relationships among Oil Price, Gold Price, Exchange Rate and International Stock Markets. *International Research Journal of Finance and Economics*, Issue 47, 80-89.

Wang, K-M., Lee, Y-M. & Thi, T-B. N. (2011). Time and Place Where Gold Acts as an Inflation Hedge: An Application of Long-Run and Short-Run Threshold Model. *Economic Modelling*, 28, 806-819.

Worthington, A.C. & Pahlavani, M. (2006). Gold Investment as an Inflationary Hedge: Cointegration Evidence With Allowance for Endogenous Structural Breaks. *University of Wollongong, School of Accounting and Finance Working Paper Series*, No. 06/05.

Appendix 1

Descriptive Statistics

	LOGGP	LOGCPI	LOGEXC
Mean	2.486623	1.796774	0.455145
Median	2.574919	1.806127	0.431605
Maximum	3.036429	2.049218	0.590162
Minimum	1.572639	1.431364	0.340246
Std. Dev.	0.311665	0.180640	0.085158
Skewness	-1.227943	-0.504503	0.427153
Kurtosis	4.708886	2.245693	1.679898
Jarque-Bera	14.91945	2.645118	4.120846
Probability	0.000576	0.266453	0.127400
Sum	99.46493	71.87097	18.20582
Sum Sq. Dev.	3.788268	1.272607	0.282824
Observations	40	40	40

Correlation Matrix

	LOGGP	LOGCPI	LOGEXC
LOGGP	1		
LOGCPI	0.78584409372539	1	
LOGEXC	0.133014868480869	0.641324304699745	1

VAR Lag Order Selection Criteria
Endogenous variables: LOGGP LOGCPI LOGEXC
Exogenous variables: C
Sample: 1970 2009
Included observations: 37

Lag	LogL	LR	FPE	AIC	SC	HQ
0	100.8699	NA	1.01e-06	-5.290266	-5.159651	-5.244218
1	234.6433	238.6228*	1.19e-09*	-12.03477*	-11.51231*	-11.85058*
2	242.1700	12.20549	1.31e-09	-11.95514	-11.04083	-11.63280
3	249.2885	10.38908	1.49e-09	-11.85343	-10.54728	-11.39295

* indicates lag order selected by the criterion
Sample (adjusted): 1972 2009
Included observations: 38 after adjustments
Trend assumption: Linear deterministic trend
Series: LOGGP LOGCPI LOGEXC
Exogenous series: C97
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.393449	34.71611	29.79707	0.0125
At most 1 *	0.318170	15.71741	15.49471	0.0463
At most 2	0.030176	1.164340	3.841466	0.2806

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None	0.393449	18.99870	21.13162	0.0969
At most 1 *	0.318170	14.55307	14.26460	0.0450
At most 2	0.030176	1.164340	3.841466	0.2806

Max-eigenvalue test indicates no cointegration at the 0.05 level

1 Cointegrating Equation(s):	Log likelihood	270.2248

Normalized cointegrating coefficients (standard error in parentheses)

LOGGP	LOGCPI	LOGEXC
1.000000	-2.532911	1.858392
	(0.24432)	(0.47661)

Vector Error Correction Estimates
Sample (adjusted): 1972 2009
Included observations: 38 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LOGGP(-1)	1.000000
LOGCPI(-1)	-2.532911
	(0.24432)
	[-10.3673]
LOGEXC(-1)	1.858392
	(0.47661)
	[3.89920]
C	1.222056

Error Correction:	D(LOGGP)	D(LOGCPI)	D(LOGEXC)
CointEq1	-0.054888	0.036642	0.022805
	(0.13092)	(0.01189)	(0.03347)
	[-0.41925]	[3.08117]	[0.68146]
D(LOGGP(-1))	0.312600	0.012510	-0.095412
	(0.21552)	(0.01958)	(0.05509)
	[1.45048]	[0.63901]	[-1.73190]
D(LOGCPI(-1))	-0.989822	0.276348	-0.100065
	(1.47274)	(0.13378)	(0.37647)
	[-0.67210]	[2.06572]	[-0.26580]
D(LOGEXC(-1))	-0.211455	-0.097050	-0.707616
	(0.67178)	(0.06102)	(0.17172)
	[-0.31477]	[-1.59042]	[-4.12072]
C	0.044826	0.010381	-0.000134
	(0.03058)	(0.00278)	(0.00782)

	[1.46585]	[3.73696]	[-0.01717]
C97	-0.057310	0.020809	0.153799
	(0.09978)	(0.00906)	(0.02551)
	[-0.57437]	[2.29584]	[6.02992]
R-squared	0.154839	0.527790	0.562082
Adj. R-squared	0.022783	0.454007	0.493658
Sum sq. resids	0.336162	0.002774	0.021966
S.E. equation	0.102494	0.009310	0.026200
F-statistic	1.172521	7.153289	8.214615
Log likelihood	35.90758	127.0580	87.74152
Akaike AIC	-1.574083	-6.371471	-4.302185
Schwarz SC	-1.315517	-6.112905	-4.043619

VEC Granger Causality/Block Exogeneity Wald Tests

Dependent variable: D(LOGGP)

Excluded	Chi-sq	df	Prob.
D(LOGCPI)	0.451716	1	0.5015
D(LOGEXC)	0.099080	1	0.7529
All	0.479065	2	0.7870

Dependent variable: D(LOGCPI)

Excluded	Chi-sq	df	Prob.
D(LOGGP)	0.408336	1	0.5228
D(LOGEXC)	2.529425	1	0.1117
All	5.528671	2	0.0630

Dependent variable: D(LOGEXC)

Excluded	Chi-sq	df	Prob.
D(LOGGP)	2.999478	1	0.0833
D(LOGCPI)	0.070651	1	0.7904
All	2.999508	2	0.2232

Null Hypothesis: LOGGP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic based on SIC, MAXLAG=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.205293	0.0986
Test critical values:	1% level	-4.219126	
	5% level	-3.533083	
	10% level	-3.198312	

Null Hypothesis: D(LOGGP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.278827	0.0086
Test critical values:	1% level	-4.219126	
	5% level	-3.533083	
	10% level	-3.198312	

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.671121	0.2534
Test critical values:	1% level	-4.211868	
	5% level	-3.529758	
	10% level	-3.196411	

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.191759	0.0107
Test critical values:	1% level	-4.219126	
	5% level	-3.533083	
	10% level	-3.198312	

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.703829	0.7305
Test critical values:	1% level	-4.211868	
	5% level	-3.529758	
	10% level	-3.196411	

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.494149	0.0050
Test critical values:	1% level	-4.219126	
	5% level	-3.533083	
	10% level	-3.198312	

Null Hypothesis: LOGEXC has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.903909	0.1724
Test critical values:	1% level	-4.211868	
	5% level	-3.529758	
	10% level	-3.196411	

Null Hypothesis: D(LOGEXC) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic based on SIC, MAXLAG=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.273738	0.0000
Test critical values:	1% level	-4.219126	
	5% level	-3.533083	
	10% level	-3.198312	

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-2.888360	0.1771
Test critical values:	1% level	-4.211868	
	5% level	-3.529758	
	10% level	-3.196411	

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

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.312984	0.0000
Test critical values:	1% level	-4.219126	
	5% level	-3.533083	
	10% level	-3.198312	

Null Hypothesis: LOGCPI has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic based on SIC, MAXLAG=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.425387	0.0630
Test critical values:	1% level	-4.219126	
	5% level	-3.533083	
	10% level	-3.198312	

Null Hypothesis: D(LOGCPI) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 1 (Automatic based on SIC, MAXLAG=1)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.202376	0.0008
Test critical values:	1% level	-4.226815	
	5% level	-3.536601	
	10% level	-3.200320	