The relationship between the prices of gold and oil and macroeconomic variables: Malaysian evidence

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Abstract:

This paper attempts to find out the relationship between the prices of gold and oil and macro-economic variables. The methods applied are the standard time series techniques which involve testing their theoretical relationship and discerning their causality. Malaysia is taken as a case study. The findings revealed that in Malaysia, gold plays an important role leading the oil price and selected macro-economic variables. Oil is not regarded as a major determinant that influences the economy because it is heavily subsidized by the government. Oil price is driven by gold and inflation rate and followed by exchange rate and stock markets. Therefore, as per our findings, movement of gold price becomes the most important focus for the policy makers.

Keywords: gold price, oil price, macroeconomic variables, VECM, VDC, Malaysia

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1. INTRODUCTION: THE ISSUE MOTIVATING THE PAPER

Gold and oil are two strategic commodities which have received much attention, partly due to the surges in their prices and the increases in their economic uses. Gold has been an important metal for many centuries and plays a special role as a store of values in times of political and economic uncertainties. Gold is not only an industrial commodity but also an important investment asset which is commonly known as a "safe haven" to manage the increasing risk in the financial markets such as inflation, changes in exchange rates, interest rate and stock market performance. While crude oil is the world's most commonly traded commodity of which the price is the most volatile and may lead the price spill over in the commodity market so as influencing the overall economy.

The motivation of the study is utmost important for Malaysia being an oil importer and the practice of oil subsidy given by its government. Generally, Malaysia is having fiscal budget deficit since the occurrence of Asian currency crisis in 1997 which pose medium-term risks to the economy and threaten investors trust. However, the Current Account of Malaysia's Balance of Payment is still on the moderation surplus though at a narrowing pace. Amongst major contribution to this deficit is due to the oil expenses that government has to bear via oil subsidy and oil sales tax exemption. These commitments are making the price of Malaysian oil import more expensive. Being a consumption and crude oil importer Malaysia need to manage its risk and exposure due to the escalating oil prices. One of the established well-known choices is gold. Can gold be used as hedging device for the case of Malaysia. Given that gold and oil are major commodities and their price movements have important implications for the real economy and the financial markets, we are interested to know the relationship of prices of gold, oil and macro-economic factors in Malaysia.

2. OBJECTIVE OF RESEARCH

The purpose of this study is to examine the relationship of the price of gold, oil and macro-economic factors in Malaysia. It also seeks to find empirical evidence whether based on the theoretical background that price of oil play major influence on the economic activities thus macro-economic factors and gold acts as hedging tool on most investments. Finally among the price of gold, oil and selected macro-economic variables used in the study, which is the most influential?

Formally, this study has three research questions, namely:

a) Theoretically, there is a positive cointegrating relationship between the price oil and gold and oil acts as the one of determining factor of the price of gold amongst other common factors that moves the price of gold and oil. What is the relationship of the studied variables for the case of Malaysia? The result might be different than theoretical foundation due to distinguish factors unique to Malaysia.

b) Based on the cointegration relationship, can gold be used as hedging tool against oil shocks?

c) Based on the results, which variable is the most influential that is important to policy maker in handling the specific oil subsidy issue that contributes to Malaysia's budget deficit?

The data consists of monthly observations of gold price Gold (UK), 99.5% fine, London afternoon fixing quoted in Malaysian Ringgit per Troy ounce as the focus variable. Core variable of crude oil price from Crude Oil (petroleum), Dated Brent, light blend 38 API, fob U.K. quoted in Malaysian Ringgit per Barrel. We used Brent because it is a reference for determining the price of other light crudes in the USA and is closely related to other crude oil marker such as those for WTI, Maya and Dubai. Selection of controlled variables consist of Consumer Price Index (CPI) which is the most frequently used indicator of inflation, the Kuala Lumpur Composite Index (BURSA FTSE) in measuring the health of national economy, base lending rate represents the short term interest rate capturing the monetary policy instruments, and Exchange Rate Malaysia, an important transmission channel in an open economy, quoted against the US dollar.

The sample period running from January 1997 till September 2013 covers a total of 201 observations for all six series of variables. Both gold and oil prices were sourced from Mundi Index while all controlled variables data were abstracted from Datastream International.

The balance of the paper is organized as follows. Section 3 reviews the literature on the price of gold, oil and macro-economic variables relationships. Section 5 discusses conclusions and Section 6 discusses limitations and suggestions for future research.

3. LITERATURE REVIEW AND THEORETICAL FRAMEWORK

There are numerous empirical works been done to study the relationship of gold and oil price. There are either direct comparison of highly cointegrated movement of gold and oil price or

research works considering other common factors that might have indirect influence on the cointegration of both commodity prices. Sujit et. al. (2011) explore the extent of linkages of crude oil price, stock market returns price and exchange rate on gold prices using Vector Autoregression (VAR) and cointegration technique. The authors use daily data of gold price in dollar and various other currencies (in index), crude oil price from Cushing, OK WTI Spot Price FOB (dollars per barrel) and Europe Brent Spot Price FOB (dollars per barrel) which also converted in index, Trade Weighted Exchange, major currencies as a proxy of exchange rate and S&P Stock market index. The result shows that exchange rates have a direct influence on gold prices; oil prices and stock market index. The variance decomposition implies that the largest portions of total variations in exchange rate comes from innovation in Gold index, WTI and S&P stock market index. The dynamic effects of the impulse response also suggest the same in terms of the relationship of exchange rate with respect to gold prices, oil prices, stock market index returns and inflation. The study also found the presence of a weak long run relationship among variables in one of the models.

Another explanation in the literature regarding similar study is by T.H Le et al. (2011). They employ the bounds testing approach to cointegration (or autoregressive distributed lag (ARDL)) to investigate the long run and short run relationships and dynamic interactions between the prices of two strategic commodities: gold and oil and the financial variables (interest rate, exchange rate and stock price) of Japan. They collected monthly data spanning from Jan-1986 to Feb-2011, which consists of 302 observations for each series. The variables are crude oil price (quoted in US dollar) as a representative of world oil price, the monthly average of the London afternoon (pm) fix (quoted in US dollar) is selected as a representative of world gold. While data of Japanese macro-economic variables including consumer price index (CPI), interest rate, exchange rate (JPY/USD) and stock price index are obtained from CEIC data sources. The money market rate is chosen as a representative for the short term interest rate in Japan. The results suggest that in the long run, gold price and the Japanese stock price have significantly positive impacts on the Japanese interest rate. The results from error correction approach indicate that movements in gold price to predict fluctuations in interest rates in Japan. This suggests that the price of gold and stock, among others, can help form expectations of higher inflation over time. In the short run, only gold price impacts the interest rate in Japan. Overall the findings of this study could benefit both the Japanese monetary authority and investors who hold the Japanese yen in their portfolios.

From the two literatures, different relationship of the price of gold, oil and macro-economic variables in different countries may be due to so many factors that is unique only to that particular country or economy. Thus, different relationship is expected that is uniquely for Malaysia.

4. RESEARCH METHODOLOGY, RESULTS AND INTERPRETATION

Time series technique is employed, particularly cointegration, error correction model and variance decomposition for the purpose of finding the empirical evidence of the relationship between gold prices and oil prices in Malaysia. The following discussions explain why time series analysis is more favoured compared to regression technique.

Firstly, regression technique assumes that variables are stationary in terms of mean, variance and covariance. However, this technique did not check for stationarity which opposed by time series technique. This means that running regression on the variable will lead to misleading results as statistical tests such as t-stat and F-stat are not statistically valid when applied to non-stationary variables. This is due to the variances of these variables are changing and the relationship estimated will be spurious. Furthermore, when first differenced variables are used in a regression, the long term trend is effectively removed capturing only short term information. In other words, regression is not testing theoretical relationship. To address the shortcomings of spurious and not testing theory, in 1987, Engle and Granger invented the concept of cointegration i.e. to keep the variable in level form and if there is cointegration, that shows the variables are theoretically related.

Secondly, in regression technique, relative exogeneity and endogeneity of variables is pre-determined based on prevailing theoretical foundation. However, in this paper, there is no specific established theory explaining the relationship of gold prices and oil prices. Therefore, in time series, data will determine variables exogeneity or endogeneity. In particular, variance decompositions will determine the ranking of the most exogenous to the weakest endogenous.

4.1 TESTING STATIONARITY OF VARIABLES

To begin with, unit root test is performed to ensure that variables are I(1) i.e non stationary at level form and stationary at differenced form. This test is important in order to proceed with test for cointegration. The level form is created by transforming the original data into natural logarithm, to achieve stationary in variance except for variable that is already in percentage

form. For example, LCPI=LOG(CPI). Then, the differenced form for each variables are created by taking difference of their log forms, for example, DEXR=LEXR-LEXR(-1). Upon creating variables in log and differenced form, Augmented Dickey-Fuller (ADF) is conducted to test for the stationary and non stationary variables. Table below summarizes the result. For details, please refer to Appendix 1A to 1L for details.

TABLE 1: Unit Root Test in Level and Differenced Form

Variable	Test Statistics	Critical Value	Implication
Variables in Level Form			
LCPI	-3.0572	-3.4387	Variable is non-stationary
LEXR	-2.7335	-3.4387	Variable is non-stationary
INT	-2.4968	-3.4387	Variable is non-stationary
LGOLD	-2.2813	-3.4387	Variable is non-stationary
LOIL	-3.0567	-3.4387	Variable is non-stationary
LFTSE	-3.4987 (AIC)	-3.4387	Variable is stationary
	-3.2254 (SBC)	-3.4387	Variable is non-stationary
Variables in Differenced Form			
DCPI	-6.5627 (AIC)	-2.8798	Variable is stationary
	-7.0463 (SBC)	-2.8798	Variable is stationary
DEXR	-4.4634 (AIC)	-2.8798	Variable is stationary
	-9.5758 (SBC)	-2.8798	Variable is stationary
DINT	-5.9145	-2.8798	Variable is stationary
DGOLD	-9.7251	-2.8798	Variable is stationary
DOIL	-7.7621	-2.8798	Variable is stationary
DFTSE	-6.128 (AIC)	-2.8798	Variable is stationary
	-8.6261 (SBC)	-2.8798	Variable is stationary

In addition to ADF test, Phillips Perron is performed to further test the unit root of the variables. Table 2 below summarizes the result. For details, please refer to Appendix 1M to 1T for details.

TABLE 2 : Phillips Perron Test

Variable	Test Statistics	P value	Implication
Variables in Level Form			
DCPI	0.5835	0.560	Variable is non-stationary
DEXR	-.95935	0.339	Variable is non-stationary
DINT	-1.4840	0.140	Variable is non-stationary
DGOLD	-.50403	0.551	Variable is non-stationary
DOIL	-3.0567	0.199	Variable is non-stationary
DFTSE	-.25366	0.800	Variable is non-stationary
Variables in Differenced Form			
D2CPI	-6.5814	0.000	Variable is stationary
D2EXR	-13.7764	0.000	Variable is stationary
D2INT	-4.9804	0.000	Variable is stationary

D2GOLD	-13.5466	0.000	Variable is stationary
D2OIL	-7.7621	0.000	Variable is stationary
D2FTSE	-10.0305	0.000	Variable is stationary

Based on the ADF test, all the variables to be used for this analysis are I(1) except for the case of variable FTSE.[1] Its AIC is indicating that FTSE is stationary at level form while SBC indicating it is non stationary. Taking a lower order may lead to the effects of serial correlation. However, serial correlation diagnostic test for FTSE has proven there is no serial correlation. Therefore, SBC result is applied. Unit root test of Phillips Perron which corrects both autocorrelation and heteroskedasticity will be used to further test the stationarity of the variables.[2] The results show that all the variables used are I(1). Based on this, variable FTSE is further justified to be used in the next time series steps.

4.2 DETERMINATION OF ORDER OF THE VAR MODEL

Upon confirming the variables are I(1) variables, the vector auto regression (VAR), that is, the number of lags to be used need to be determined. The result in Table 3 shows that AIC recommends order of 1 while SBC offers zero lag. For details, please refer to Appendix 2A for details.[3]

TABLE 3 : Order of VAR

	Choice Criteria	
	AIC	SBC
Optimal Order	1	0

[1] Null hypothesis for ADF test: The variable is non-stationary. At level form, when the T stat is less than its critical value, we are not able to reject the null, therefore the variable is non-stationary. At differenced form, when the T stat is more than critical value, we are able to reject the null, therefore the variable is stationary.

[2] Null hypothesis of Phillips Perron : The variable is non stationary. At level form, when the p-value is more than 0.05, we are not able to reject the null therefore the variable is non stationary. Whereas, in differenced form, when the p-value is less than 0.05, we are able to reject the null indicating that the variables are stationary at differenced form.

[3] Order VAR of 6 is used.

Given this conflicting of recommendation of AIC and SBC, serial correlation check for each variable is required.[4] The result is as depicted in Table 4.

TABLE 4 : Serial Correlation Test

Variable	Chi-Sq p-value	Implication (at 10%)
DFTSE	0.170	There is no serial correlation
DCPI	0.012	There is a serial correlation
DEXR	0.019	There is a serial correlation
DGOLD	0.155	There is no serial correlation
DOIL	0.064	There is a serial correlation
DINT	0.675	There is no serial correlation

Given the results above, out of 6 variables, there is 3 autocorrelation. If lower order is adopted, the effects of serial correlation may be faced. Since a series of 164 observations is used in this analysis, over-parameterization is not a huge concern. In this case, 1 order of lag is not recommended as Microfit will not be generating full result at the stage of Vector Error Correction Model. Therefore, for the purpose of obtaining optimum result at a later stage, order number of lag 2 will be used in the test of cointegration.

4.3 TESTING COINTEGRATION

Upon establishing that the variables are I(1) and optimal VAR order as 2, test of cointegration will be performed. According to Table 5 and Table 6, there is one cointegrating vector indicated by Maximal Eigenvalue and SBC, three cointegrating vectors by AIC and HQC while two cointegrating vectors by Trace. For details, please refer to Appendix 3A.[5]

TABLE 5 : Johansen Test - Multiple Cointegration Vectors

H_0	H_I	Statistics	95% critical Value	90% Critical Value
Maximum Eigenvalue Statistics				
r = 0	r = 1	57.79	43.61	40.76
r<=1	r = 2	34.57	37.86	35.04
Trace Statistics				

[4] Null hypothesis for serial correlation: there is no serial correlation. When the p-value is more than the confidence level e.g 10%, we are not able to reject the null, therefore there is no serial correlation.

[5] In the case of Eigenvalue and Trace, the test statistics for null of r = 0 is greater than 95% critical value whereas for other null hypothesis, statistic is less than the critical value. Highest value of AIC, SBC and HQC is obtained for number of cointegrating vectors.

r = 0	r >= 1	145.06	115.85	110.60
r<=1	r >= 2	87.2728	87.17	82.88
r<=2	r >= 3	52.7033	63.00	59.16

TABLE 6 : Cointegration Test - Overall

Criteria	Number of cointegrating vectors
Maximal Eigenvalue	1
Trace	2
AIC	3
SBC	1
HQC	3

Based on various literatures and also intuition, it is an understanding that there is at least one cointegrating vector that moves the prices of gold, oil and the macro-economic variables. In general, these two commodities are directly affected by other common factor namely inflation rate. And indeed inflation rate also directly relate to interest rate. The effect of these two variables will be reflected in stock prices too. Value of Ringgit Malaysia through exchange rate is also affecting prices of gold and oil as these commodities are mostly traded in US$. In general, variables are cointegrated in various ways. Therefore, there is a possibility of having more than one cointegrating vectors in explaining the relationship of the data as suggested by Trace, AIC and HQC. However, for the purpose of this study, the existence of only one cointegrating vector is assumed.

Based on the assumption above, the evidence of cointegration in the error term is required to further test that the variables are not spurious. For this purpose, Engle-Granger Cointegration method is applied. The result is depicted in the table below.

TABLE 6 : Engle-Granger Cointegration

Variable	**Test Statistics**	**Critical Value**	**Implication**
Variables in Level Form			
LCPI	-3.6254 (AIC)	-4.8129	Error term is non stationary
	-2.6102 (SBC)	-4.8129	Error term is non stationary
LEXR	-3.7795	-4.8129	Error term is non stationary
INT	-3.1120	-4.8129	Error term is non stationary
LGOLD	-4.2744 (AIC)	-4.8129	Error term is non stationary
	-3.3594 (SBC)	-4.8129	Error term is non stationary
LOIL	-4.1566 (AIC)	-4.8129	Error term is non stationary
	-3.4541(SBC)	-4.8129	Error term is non stationary
LFTSE	-3.1389	-4.8129	Error term is non stationary

At this stage, we are looking for evidence of cointegration of the error term. Statistic explanation on stationary error term is that the variables are moving together in a long term. This means that the six variables are not spurious or just moving together by chance. This conclusion has a very important implication for policy maker. Since all variables are cointegrated, possibility of obtaining abnormal gain for example purchasing gold from various countries is limited. This is due to the characteristics of a cointegrated market that in a long term will eventually realign its movement back to equilibrium.

The above table indicates that none of the variables shows that error term is stationary indicating lack of evidence of cointegrating vector. However, the analysis will proceed using the Johansen test given the superiority as it employs the maximum likelihood approach when identifying the cointegrating vector.

4.4 CUSUM and CUSUM SQUARE

To test the structural stability, CUSUM and CUSUM Squared are used. There is no structural break found in mean and variance.

4.5 LONG RUN STRUCTURAL MODELLING (LRSM)

Now, the statistical findings need to be compared against the expectation of theoretical relationship or even based on intuitive thinking. This is done by applying Long Run Structural Modelling (LRSM) in Microfit where the interest variable that is GOLD is normalized. For details, please refer to the table below for the exact identifying result. T-ratios are then calculated manually. The result is shown in Table 7.

TABLE 7 : LRSM Exact-identifying

Variable	Coefficient	Standard Error	t-ratio	Implication[6]
LGOLD	-	-	-	-
INT	0.30537	0.12041	2.5361	Variable is significant
LCPI	-3.3842	2.6363	1.2837	Variable is insignificant
LOIL	-.85188	0.28831	2.9547	Variable is significant
LEXR	4.7223	1.5815	2.9860	Variable is significant
LFTSE	0.18264	0.29489	0.6193	Variable is insignificant

[6] Variables are significant when the t-ratio is more than 2 and vice versa.

Referring to Table 7, LCPI and LFTSE are insignificant though these two variables have been amongst core variables when analysing gold and oil relationship. Therefore, (one by one) over-identifying restriction will be performed in order to verify the significance of the variables. And Table 8 confirmed the earlier findings that variables INT, OIL and EXR are significant.

TABLE 8 : LRSM Over-identifying (one by one)

Variable	Chi-Sq p-value	Implication (10%)
LGOLD	-	-
INT	0.002	Variable is significant
LCPI	0.242	Variable is insignificant
LOIL	0.000	Variable is significant
LEXR	0.000	Variable is significant
LFTSE	0.539	Variable is insignificant

TABLE 9 : LRSM Over Identifying (Insignificant Variables Only i.e LCPI AND LFTSE)

Variable	Chi-Sq p-value	Implication
LCPI and LFTSE	0.387	Restriction is correct.

Over-identifying of all insignificant variables at one time is performed as a comparison to the one by one variable restrictions imposed.[7] Intuitively, CPI and FTSE are significant in explaining the relationship of gold and oil as CPI represents period of inflation or deflation. LFTSE represents the health of an economy. Theoretically, the price of oil will be reflected in inflation rate, higher money in circulation thus increases in production activities. While gold is used mainly to hedge investment activities. Intuitively, it can be assumed that these two variables are important in explaining the relationship of the variables studied in this paper.

From the above analysis, the following cointegrating equation (number in parentheses is standard deviation) is as follows:

$$\underset{}{\text{GOLD}} + \underset{(0.12)}{0.31\text{INT}} - \underset{(2.64)}{3.38\text{CPI}} - \underset{(0.29)}{0.85\text{OIL}} + \underset{(1.58)}{4.72\text{EXR}} + \underset{(0.29)}{0.18\text{FTSE}} \rightarrow I(0)$$

[7] The null hypothesis for over-identifying: the restriction is correct. We are not able to reject the null, therefore the restriction is correct and confirmed our earlier intuition that LCPI and LFTSE are indeed significant.

4.6 VECTOR ERROR CORRECTION MODEL (VECM)

At this stage, it is known that all six variables are cointegrated to a significant level i.e. GOLD, INT, CPI, OIL, EXR and FTSE. However, the cointegration did not revealed causality i.e. which variables are exogenous or which are endogenous. These two types of variables class play different functions and therefore it will provide different implications for policy maker or investors. Specifically, policy maker would be interested to know which variable is exogenous as any impact or shocks applied on exogenous variable will cause impact on other endogenous variables. Therefore, the exogenous variable is the variable of interest to the policy maker.

With the knowledge of there is a cointegrating vectors among the six variables, VECM will be used to determine which variables are exogenous and which are endogenous. At this stage, principle of Granger Causality where the extent to which the change of one variable is caused by another variable in the previous period. The error correction term, e_{t-i} for each variable is examined and checked whether it is significant. It was found that there is only one exogenous variable i.e. GOLD. The result is tabulated in Table 10.

TABLE 10 : VECM

Variable	ECM(-1) t-ratio p-value	Implication
LGOLD	0.744	Variable is exogenous
INT	0.007	Variable is endogenous
LCPI	0.018	Variable is endogenous
LOIL	0.001	Variable is endogenous
LEXR	0.001	Variable is endogenous
LFTSE	0.000	Variable is endogenous

From the test, it was found that only GOLD is exogenous while INT, CPI, OIL, EXR and FTSE are endogenous. Prior explaining further on this findings, it is obvious that the result contradicts the theoretically foundation. Instead of oil being the exogenous, the VECM results shows that GOLD is the most and the only exogenous among all the variables studied. This could be due to the effect of oil subsidy by the government of Malaysia. When oil is subsidized, the real price is not reflected as it is under controlled. Hike in oil price is absorbed by the government. In other words, the price of oil does not have the influence on other variables therefore in this case, oil is endogenous.

Baes on table 10, policy maker is interested to monitor the prices of GOLD, being the exogenous, any market shocks imposed on GOLD prices, will lead to transmission of effect

to the other variables including oil prices. Therefore, amongst others, policy maker will be eyeing for the information of supply and demand of gold, US inflation rates as most gold are traded using US$ and thus the U.S's inflation will be transmitted to gold prices. Any impact of US currency value will also affect the world gold price. Policy maker would also be monitoring the world economy as a whole because it is known that gold is used as last resort during crisis which will lead to disposing of more gold in the market that will affect the gold supply therefore the gold price.

Additionally, VECM produces a statistics that is also important to policy maker. The coefficient of e_{t-i} tells how long does it takes for the variable to get back to equilibrium when it is shocks.[8] For example, when gold is shocked, it would take an average of 169 months to get back to equilibrium. Table 11 details out on how long the variable will get back to equilibrium upon shocked.

TABLE 11 : Time to equilibrium when variable is shocked

Variable	Coefficient	Equilibrium
LGOLD	0.0059	169 months
INT	-0.1013	10 months
LCPI	-0.0042	238 months
LOIL	0.1341	7 months
LEXR	-0.0221	45 months
LFTSE	0.0949	10 months

4.7 VARIANCE DECOMPOSITIONS (VDCs)

From VECM, it is derived that GOLD is the only exogenous variable. However, it is not known to us the ranking of remaining variables. Which is the strongest and the weakest? Relative endogeneity can be determined using the following way. VDC decomposes the variance of forecast error of each variable into proportions attributable to shocks from each variable in the system including its own. The results are computed in tables below.

[8] Number of months to get back to equilibrium is derived by dividing one by the coefficient value (1/coefficient)

Table 12 : Orthogonalized VDCs (Forecast horizon = 12 months)

	GOLD	INT	CPI	OIL	EXR	FTSE
GOLD	97.17%	1.01%	0.85%	0.07%	0.07%	0.83%
INT	4.33%	73.31%	5.25%	8.57%	8.51%	0.03%
CPI	0.62%	0.97%	86.98%	8.49%	1.52%	1.40%
OIL	7.21%	5.27%	10.94%	63.45%	9.33%	3.79%
EXR	2.21%	16.12%	2.60%	14.68%	64.33%	0.07%
FTSE	0.59%	4.23%	8.39%	18.09%	3.80%	64.90%

Table 13 : Orthogonalized VDCs (Forecast horizon = 36 months)

	GOLD	INT	CPI	OIL	EXR	FTSE
GOLD	97.38%	1.03%	0.52%	0.17%	0.05%	0.85%
INT	4.47%	68.03%	6.97%	10.53%	9.95%	0.04%
CPI	0.75%	1.43%	84.42%	24.66%	5.44%	4.64%
OIL	13.17%	5.77%	5.16%	48.41%	22.99%	4.51%
EXR	3.61%	15.71%	5.98%	26.22%	48.35%	0.13%
FTSE	0.95%	2.76%	13.65%	25.38%	5.97%	51.29%

For the above two tables, the diagonal line of matrix (highlighted) represents the relative exogeneity. Referring to results in Table 12 and 13, the ranking of the variables according to the degree of exogeneity is as depicted in Table 14.

Table 14 : Degree of Exogeneity

No.	Variable relative endogeneity	
	Forecast horizon = 12 months	**Forecast horizon = 36 months**
1	**Gold**	**Gold**
2	**CPI**	**CPI**
3	**INT**	**INT**
4	**FTSE**	**FTSE**
5	**EXR**	**OIL**
6	**OIL**	**EXR**

In comparison with the result in the previous VECM analysis, GOLD is still the most exogenous in orthogonalized. However, two considerations that need to be recognized are the limitations of orthogonalized VDCs. First, it assumes that when a variable is shocked, all other variables are switched off. Second, it did not produce a unique solution. For example, the first variable listed in the VAR order will appear to be the most exogenous. And if it is put at the last in the listing, it could be reported as the least endogenous.

Therefore, due to these limitations, Generalized VDCs which is invariant to the ordering of variables is applied. Please refer to Appendix 6F-6K for the details of the result including for 12 months, 36 months and 60 months test. In interpreting the numbers generated by generalised VDCs, additional computations need to be performed. This is because the numbers do not add up to 1 as in the case of orthogonalized VDCs. For a given variable, at a specified horizon, the number of the given row is added up and then the number for that variables (representing magnitude if variance explained by its own past) divided by the computed total. In this way, the number in a row is now added up to 1.0 or 100%. Note that for the purpose of making meaningful analysis, three different time horizon for the VDCs that is a 12 months, 36 months and 60 months test respectively. Tables below show the results of the generalised VDCs.

Table 15 : Generalized VDCs (Forecast horizon = 12 months)

	GOLD	INT	CPI	OIL	EXR	FTSE
GOLD	95.69%	0.66%	1.07%	1.37%	0.18%	1.02%
INT	3.60%	64.15%	4.37%	8.11%	15.92%	3.85%
CPI	0.52%	1.02%	72.43%	18.71%	3.70%	3.62%
OIL	6.64%	3.04%	10.27%	69.10%	7.08%	3.87%
EXR	1.99%	12.42%	2.28%	13.32%	67.12%	2.87%
FTSE	0.60%	3.86%	8.49%	22.32%	3.37%	61.35%

Table 16 : Generalized VDCs (Forecast horizon = 36 months)

	GOLD	INT	CPI	OIL	EXR	FTSE
GOLD	96.93%	0.56%	0.70%	0.81%	0.07%	0.94%
INT	3.66%	59.06%	5.72%	10.06%	17.36%	4.13%
CPI	0.52%	1.02%	72.43%	18.71%	3.70%	3.62%
OIL	12.96%	3.05%	5.22%	55.57%	19.99%	3.22%
EXR	3.31%	11.81%	5.34%	25.61%	52.18%	1.75%
FTSE	1.00%	2.32%	14.10%	32.56%	5.34%	44.67%

Table 17 : Generalized VDCs (Forecast horizon = 60 months)

	GOLD	INT	CPI	OIL	EXR	FTSE
GOLD	97.20%	0.54%	0.62%	0.68%	0.04%	0.92%
INT	3.68%	58.11%	5.98%	10.43%	17.62%	4.18%
CPI	0.52%	1.02%	72.43%	18.71%	3.70%	3.62%
OIL	15.02%	3.03%	3.60%	51.08%	24.29%	2.99%
EXR	3.63%	11.63%	6.10%	28.55%	48.61%	1.48%
FTSE	1.07%	2.04%	15.14%	34.42%	5.72%	41.60%

Table 18 : Degree of Exogeneity

No.	Variable relative endogeneity		
	Forecast horizon = 12 months	**Forecast horizon = 36 months**	**Forecast horizon = 60 months**
1	GOLD	GOLD	GOLD
2	CPI	CPI	CPI
3	OIL	INT	INT
4	EXR	OIL	OIL
5	INT	EXR	EXR
6	FTSE	FTSE	FTSE

Based on the results, the following observations can be made:

- The Generalized VDCs confirm the results of VECM and Orthogonalized VDCs that GOLD is the most exogenous variable contradicting the theoretical foundation that oil is exogenous.
- The relative ranking of the remaining variables are more stable for the long term indicating that the variables are moving together towards equilibrium. Whereas during the 12 months forecast, variables OIL, EXR and INT are switching places in their ranking.
- The difference in exogeneity between variables are increasingly substantial. During the 12 months horizon forecast, 34.34% separates the most and the least exogenous. It increases to 52.35% and 55.60% during the 36 months and 60 months horizon respectively.
- Intuitively, oil will be and endogenous as long as the government continues to subsidize the price. However, as the subsidy is gradually reduced to a certain level that the price is representing the real oil price, then probably the theoretical foundation is applicable in Malaysia.

The above result shows that gold appears to be the most exogenous followed by CPI and INT. It is unexpected that OIL falls into lower category of the relative list of exogeneity due to its subsidized price. The increasing difference of exogeneity for the 60 months forecast indicates the reducing cointegration among variables in the long term.

Referring to the cointegration equation:

GOLD + 0.31INT - 3.38CPI - 0.85OIL + 4.72EXR + 0.18FTSE → I(0)

(0.12) (2.64) (0.29) (1.58) (0.29)

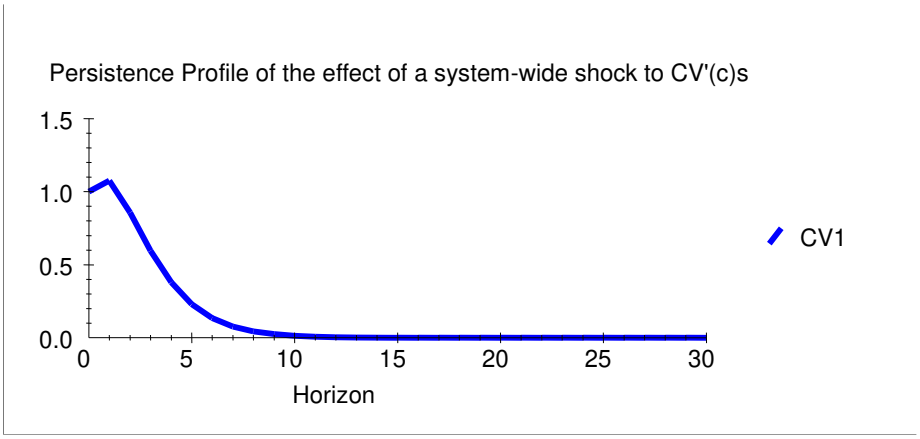
In order to answer one of the research questions whether gold can be used to hedge against the risk of oil import, the above equation is referred as the best effort of the author considering the lack of in depth knowledge on the time series analysis. Based on OLS explanation, holding other variables constant, certain percentage of change in OIL price will lead to reduce of certain varying degree in GOLD price. Thus OIL and GOLD is significantly negatively related. In other words, GOLD can be used as hedging tool against risk of increasing OIL price.

4.7 IMPULSE RESPONSE FUNCTIONAL (IRF)

The IRF produces the same information as the VDCs, except it is presented in graphical form.

4.8 PERSISTENCE PROFILE

The persistence profile illustrates the situation when the whole cointegrating equation is shocked. It also indicates the time taken for the relationship to get back to equilibrium. The focus here is on a system-wide shock on the long term relations as oppose to Orthogonalized and Generalized VDCs. The chart below shows the persistence profile for the cointegrating equation of this study.



The chart indicates that it would take approximately 10 months for the cointegrating relationship to return to equilibrium following a system-wide shock.

5. CONCLUSIONS

In conclusion, the three research questions posted at the onset of the paper is revisited. Based on the quantitative analysis, the answers found are as follows:

a) GOLD is found to be the most exogenous among all variables studied instead of OIL as per specified by theoretical foundation.

b) Due to the negative relationship between GOLD and OIL, GOLD can be used as hedging tool for Malaysian government in order to manage the impact of increasing OIL price plus the OIL related subsidy involved.

c) GOLD as the most exogenous is seen as the most influential variable compared to oil and major macro-economic variables as far as Malaysia is concerned.

6. LIMITATIONS AND SUGGESTIONS FOR FUTURE RESEARCH

The choices of variables are based on the author discretionary referring to limited literature as reference. Due to time constraint, the necessity of in depth research on specific related variables that significantly influence Malaysian market might lead to different results. For example, data of Malaysian gold reserve to support the hedging of risk in oil import. Data from major indices for gold and oil exchange counter mainly used by the Malaysian government in order to obtain most precise prices. Selective data on oil related subsidized expenses is also vital as core data in the studying.

There is no specific theory that relates the price of gold and oil directly. The relation is always driven by common macro-economic factors. As such this study might be seen as a mere number crunching. More research should be done to further establish the findings so far.

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