

## Gold Value Movement and Macroeconomics

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**Abstract:** What will happen if American investors fail to manage their portfolios as a result of plunge in their assets' value and global imbalance? Domino effects to the other industries and/ or to the rest of the world may occur as the US is the world largest economy. This research mainly aims to explore relationship on the movement of gold value and dynamic macroeconomic variables, specifically in the United States. There are five macroeconomic variables used in this research. Those comprise of inflation rate of the United States, US real GDP, value of US dollar, money supply level 2 of the United States ("US M2") and real interest rate in the US. The findings find that the percentage change of US dollar index is the perfect factor to explain movement of gold fix. Value of gold goes well even value of money drops. Movement of gold value and percentage change of US dollar index have mirror effects to each other. In Thailand, buying and selling price of a unit gold fund is determined by mark-to-market at the end of each day trade. Thai investors, who are willing to invest in gold through gold fund, can decide to buy such fund when US dollar spot drops heavily. They can collect cheap gold for their investment by predetermination when dollar spot rate is weak.

**Key words:** gold value; dynamic; macroeconomics; investment; movement

**JEL codes:** E44, F62, G00

### 1. Introduction

Inflation is a consequence of the products price increment that causes reduction in value of the money (Schwert, 1981). After the financial crisis in 2007 had revealed by IMF (2010), various governments and investors worried about inflation which was resulted from global imbalance of money flow. According to a study of IMF (2010), the sub-prime crisis slowed down the global economy's growth. US stock index dropped affected from uncertainty in economy as well as corporate revenue also declined from consumer's demand reduction. The reduction also affected real gross domestic product of the United States (US real GDP) and dropped its dollar value that caused people prefer to save more than to spend. In that period, the Federal Reserve and the US central bank tired to stimulate economic and consumers' spending with the policy of reducing interest rate. Simultaneously, they launched the program of money quantitative expansion to stimulate such economic status of the US. Since then, it might accelerate the increasing of inflation rate. Several studies of IMF (2010) showed that, consumer demand, US real GDP, money supply, real interest rate, and value of money are linked to inflation fear. Furthermore, some studies on linkage between inflation and gold by Harmston (1998) and Dempster (2009) also

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mentioned that, quantity of money flow in the system and inflation linked to gold and one attribute of gold is an inflation hedge. During mid 2007 to 2009, a period of sub-prime crisis; value of gold still remained its value. Especially in 2008, the gold price hit above USD 1,000/ounce, while bond's yield and world stock market indices fluctuated and finally dropped rapidly. As stated in the above paragraph, people became aware of inflationary after the time of subprime crisis and comprise of a statement which Harmston (1998) and Dempster (2009) stated that gold acts as an inflation hedge. The above reasons inspire to this study of how those dynamic macroeconomic indicators link to an increasing in the value of gold.

During the first phase of the crisis in September to December 2007, the stock market faced in recession when it plunged in mid 2007. An explicit critical situation since then revealed. Later to a collapse of US's economy, US dollar devalued as an uncertainty of the country's economy. A study of an inflation issue by Artigas (2010) presented that inflationary was being concerned after the US government had injected money paper to the business cycle. The worst situation had not stopped in that year but still remained until 2009 and expanded across the world. Such advanced countries like US and UK started to reduce their policy interest rates. Then, EU countries and Japan followed reducing their policy interest rates while; emerging and developing countries maintained their interest rates higher than the advanced ones. Interest gap then existed. IMF (2010) suggested the interest rate gap caused foreign investors to search out a higher return in emerging markets. Until the second half of year 2008; many countries, especially emerging and developing countries realized the surge of fund flow and a declining demand from the recent crisis. They began to ease their monetary conditions by reducing their policy interest rate as well. What will happen if American investors fail to manage their portfolios as a result of plunge in their assets' value and global imbalance? Domino effects to the other industries and/ or to the rest of the world may occur as the US is the world largest economy. Since there is an arising concern of inflation as well as unstable global economy which Harmston (1998) cited that; gold acts as an inflation hedge as well as the last resort of asset allocation, then, the question comes up whether should we invest gold. Appropriated time to collect gold into investors' portfolio shall be determined by which macroeconomic determinants. This research mainly aims to explore relationship on the movement of gold value and dynamic macroeconomic variables, specifically in the United States. There are five macroeconomic variables used in this research. Those comprise of inflation rate of the United States, US real GDP, value of US dollar, money supply level 2 of the United States and real interest rate in the US. The study will be discussed through production of various proxies which are percentage change of London PM Gold fix, as a proxy of movement of gold value would be dependent variable in this study. Other proxies would be then described in scope of the study section.

## 2. Literatures Related

Dubey, Geanakoplos & Shubik (2003) and Lowrence (2003) said that gold is independently, unique and indestructible. Gold has maintained its real purchasing power especially in the time of great depression (Dubey et al., 2003). A study on the volatility of gold by Wozniak (2008) on twenty years historical data stated that real rate of return of gold value is inflexible to economic situation comparing to other commodities such as oil and metal. Demspster (2009) also found that during inflationary, the movement New York spot gold price independently moved from commodity index, real estate investment index and US treasury inflation-protected security index (TIPS). Empirical study by Lowrence's (2003) conducted the gold price from other financial assets mainstreams and found that movement in macroeconomic indicators have a much stronger impact on other commodities than

they do on gold. Randson (2005a) and Randson (2005b) confirmed as well that gold is a better inflation indicator than oil price and other financial assets.

Time series and excess risks of return, a theory by (Sharpe, 1964) were derived for exploration by Jaffe (1989) on an average return of portfolios in which average return of portfolios would be increase when adding gold and gold stocks into portfolios. Gold is perceived as a better store of value than paper money in times of crisis (Harmston, 1998). Even Jaffe (1989), Harmston (1998), Randson (2005a), Randson (2005b), confirmed investment in gold is a good strategy under financial crisis, Saidi & Scacciavillani (2010) found a sudden dropped in gold price after union the Euro in 1999. At that time, central bank of United Kingdom and central bank of Switzerland released some gold from their international reserve to maintain their appropriate proportion of the Euro international reserve as a whole. Concern and expectation of gold price reduction occurred since then.

Diewert (1999) and Pollak (1980) mentioned about inflation that, inflation or cost of living index or consumption deflator is measured by Consumer Price Index (CPI). CPI for All Urban Consumers (CPI-U), a proxy of inflation in this research, is one of multi macroeconomic variables describing percentage change of London PM gold fix. Inflation rate is a measure of an average change between any two time periods of prices of consumer goods and services spent by all household in the US. Gillingham (1974) defined an annualized percentage change of inflation. A study of (Dubey et al., 2003) about the attribute of the gold is a store in its value. Whenever there is an expectation of inflation, people will turn to hold more gold. Gold has been counted as Inflation Hedge (Harmston, 1998). Numerous papers talking about investing in gold had been issued so far. Harmston (1998), Ranson (2005a), Ranson (2005b), Levin & Wright (2006) and Dempster (2009) argued gold is a well diversified portfolio when there is a fear of inflation. Their studies found the correlation between the gold price and inflation. Also, Levin & Even Lowrence (2003) under the Vector Auto Regressive (VAR) model found a positive correlation between gold price and inflation but, his investigation found insignificant relationship between the real rate of return of gold price and inflation rate under Ordinary Least Square (OLS) method. This outcome was consistent with a study of Jaffe (1989). Jaffe (1989) examined movement of gold value using Capital Asset Pricing Model (CAPM). He suggested that gold is not a good inflation hedge as his significant outcomes suggested that the beta of gold is nearly zero.

M2 was applied as one determinants of real rate of return of gold in a study by Lowrence (2003). The money supply is important to economists for understanding how policies will affect interest rates. It is a tool of monetary policies for the policy makers. IMF (2010) suggested that huge volume of money supply injects to the economic system especially in the US revealing the fear of inflation and fear of inflation will indicate the monetary policy of the government. IMF (2010) found strongly positive link between money supply and asset prices. Artigas (2010) also studied on the linkage of money supply to inflation and hence the effect to the gold price as huge amount of money supply flowing in the economic system will make booming of asset price, especially gold, and increasing of such asset's price will be a signal of inflationary. Lowrence (2003) found real rate return on gold did not significantly related to money supply.

One role of US dollar is accumulation of wealth. Every government and financial institution holds US dollar as a major reserve currency. A study of (IMF, 2010) found US dollar tends to be depreciating continually since Bretton Woods system which is a system of fixed exchange rate has been aborted. Capie, Mills & Wood (2004) suggested even before or after the Bretton Wood system, the gold value has been linked with the dollar value. An abortion of the Bretton Woods system in 1971, exchange rates of US dollar floated and US dollar has become varies upon economic situation and some macroeconomic indicators since then (Loretan, 2005). Hence, investors

looked for currencies which they could rely on as an asset hedge against investor's portfolios (Dempster, 2009). However, as Ranson (2005b) explained investment by relying only on US dollar is somehow danger as US dollar's move in accordance with the situation of the US. Since Ranson (2005b) found changes in US dollar value and effect to the gold value changes, he suggested an alternative way to hedge investor's portfolios by investment in gold. Proportion of gold reserve by each central bank is arising while holding US dollar is reducing (Saidi & Scacciavillani, 2010) due to gold has been proved itself as the store of value asset (Dempster, 2009). Though its price fluctuates sometimes, its real purchasing power has not been declined (Harmston, 1998). Recently, sub-prime crisis affects the confidence of US economy; value of US dollar thus keeps continually declining. Every single of a country's currency evolved with gold. Dempster (2008) and Capie et al., 2004 also suggested that; since gold moves in the opposite direction to US dollar, whenever individuals lose some confidence in the nation's currency, they will move their desires to hold the gold instead. However, a study of Lowrence (2003) found movement of US dollar does not change the gold value significantly.

The study by (Abel, Bernake, & Croushore, 2008) stated about real GDP that, it is one primary indicator used to examine the health of a country's economy or it could be said as the size of the economy indicator. GDP is a major impact to every business sector, from household sector to the large corporations and governments sector (Abel et al., 2008). Most investors concern of negative GDP growth and it is one of the factors that the economists use to determine whether an economy is in a recession. Growing in economic was one main factor effects to a sudden increase in gold price. India and China have rapid and high economic growth rates level. Both of them are the nations where consume high proportion of gold in the world. Demand of gold for ornament industry in India and China was approximated 51% of global demand in 2010. In 2010, the world demand of gold for jewelry and technology increased from 2009 by 17% and 12% respectively but the demand for investment reduced from previous year by 2% (Saidi & Scacciavillani, 2010). World Gold Council (2011) suggested the gold price will not increase as much as expected from an increasing concern in budget deficit of the US government and declining demand of gold for ornament and industrial production sectors. Real GDP growth usually has a significant effect on the stock market but found none significant impact directly on value of gold. However, demand boom encourages an increasing rate of real GDP and sometimes arouse inflation (IMF, 2010) in which Dempster (2009) concluded gold as a strategic inflation hedge. Lowrence (2003) found insignificant relationship between growth rate of US real GDP and real rate return of gold and later conclusion by Dempster (2008) that US recession has no impact to the gold price movement.

Hirshleifer (1969) stated about the real interest rate that it is an inflation adjustment rate that aims to remove the effects of inflation to reflect the real cost of funds to the borrower, and the real rate of return to the lender. In term of an investment, it would be calculated as the amount by which the nominal interest rate is higher than the inflation rate. Therefore, real interest rate is the important fact to be concerned. The results of recession recently arising from subprime crisis have an impact to various countries need to reconsider their monetary policies. One of such effective tools to fight with the recession period is the reduction in policy interest rate, especially, in advanced countries like USA, UK and Japan (IMF, 2010). The long-term government bonds, long-term corporate bonds and Treasury bill (T-bill) yield as proxies of real interest rate, were also tested to estimate their relationship with bullion gold price and gold stock prices (Jaffe, 1989). Only yield on one-month T-bill was significantly negatively related to monthly return on gold price. Lowrence (2003) showed a negative correlation of -0.17 of the three-month real interest rate to the gold price movement. However, Lowrence (2003) also found insignificant relationship between the gold price movement and short term real interest rate.

Rather than the simple equilibrium model to predict the excess return of dependent variable by using one factor (market risk) called Capital Asset Pricing Model (CAPM), a theory by (Sharpe, 1964), the Arbitrage Pricing Theory (APT) is used to explore the relationship of multiple variables. Burmeister, Roll & Ross (2003) included macroeconomic factors to control the portfolio's risks. Chen, Roll & Ross (1986), Fama & French (1992), Flannery & Protopapadakis (2002), Kyereboah-Coleman & Agyire-Tettey (2008) and Mohammad, Hussain, & Ali (2009) suggested that there are several primary sources of risk which affect the stock returns. Those risks comprising of an investor confidence, interest rates, inflation, real business activity and a market index. APT is an instrument used to analyze the asset price (Roll & Ross, 1980). One of APT's characteristics is that, it allows more than one factor describe the model. In other words, APT is used as the same fashion as multi-factor model. Roll & Ross (1980) APT's process is performed under the assumption that the asset returns follow a multivariate normal distribution. Benefit of APT enables the researcher to describe the asset's contribution more general than using CAPM. This means the asset's price can be affected beyond one factor together with riskless asset. An empirical work by Roll & Ross (1980, 1984) fellow by an empirical study of Chen, Roll & Ross (1986) constructed APT given larger samples and a risk free asset generated the process. APT was thus, so far proved as a linear regression.

### 3. Methodology

This research mainly aims to find out determinants of movement of London PM gold fix. This chapter will discuss on the different data acquired from different sources and will explain definitions of each variable. The research hypotheses and methodologies used for achieving objectives of this research will be also described. Those methodologies to be discussed comprised of Ordinary Least Square (OLS) and correlation analysis. OLS would be used to explore the factors contributing to the movement of the gold fixing. Another method is correlation analysis used to explore correlation between each observed predictors and dependent variables.

This research will determine whether macro economic factors have effect to the change of gold price real rate of return. In each ordinary least square regression equation, the standard t-test and F-statistic test will be performed. Process to transform nominal data into useful information and method to describe the validity of data series such as Augmented Dickey-Fuller, it is used to test whether there is any unit root in an autoregressive model. Next is using Pearson correlation as a tool to explore such correlations. However, this paper intends to explore macroeconomics indicators as determinants of the movement of gold value. The VAR method is used to study the correlation of the gold price (Lowrence, 2003). Ordinary Least Square (OLS) Method will be applied in order to determine the effective factors jointly impact to the movement of the gold value. The result by Ordinary Least Square Method will be presented in following.

### 4. Discussion of results

As mentioned previously, the joint distribution percentage change of particular data series and its lag is stationary when there is no unit root. Table 1 showed the statistic result from Augmented Dickey-Fuller test.

Under autoregressive model, the t-stat of percentage change of London PM gold fixing, inflation rate, percentage change of US dollar index, percentage change of money supply level 2, growth rate of US real GDP, and real interest rate change are -11.7320 (p-value = 0.0000), -3.8232 (p-value = 0.0179), -9.7315 (p-value = 0.0000), -7.1413 (p-value = 0.0000), -8.2068 (p-value = 0.0000) and -11.2383 (p-value = 0.0000); respectively. Their p-values of constant and drift are less than 5% significant level, hence; reject null hypothesis where

covariance of each variables with their lags are different from zero at 95% confident interval. The results revealed that, all variables have no unit root. In another word, all data series are stationary. The information used in this research is reliable and it does not conflict with OLS assumptions.

As Table 2 presented below, only inflation rate has a positive correlation with percentage change of London PM gold fix. Meanwhile, growth rate of US real GDP, changes in real interest rate, percentage growth rate of M2, and percentage of change of US dollar index have negative correlation with percentage change of London PM gold price fix. Inflation rate and percentage change of US dollar index have the strongest positive and negative correlation of 0.1980 and -0.3905, respectively.

**Table 1 Augmented Dickey-Fuller Test Statistic**

Variable	t-stat	p-value
GOLDP	-11.7320	0.0000
INFG	-3.8232	0.0179
USDG	-9.7315	0.0000
M2G	-7.1413	0.0000
RGDPG	-8.2068	0.0000
RINTX	-11.2383	0.0000

**Table 2 Correlation Matrix**

	INFG	M2G	RGDPG	RINTX	USDG
GOLDP	0.1980	-0.0013	-0.0953	-0.0456	-0.3905
INFG		0.0401	0.0261	0.0299	-0.0304
M2G			-0.0754	0.1587	0.1332
RGDPG				-0.0139	-0.0087
RINTX					0.0990

The result also shows that, only percentage of US dollar growth moves in the opposite direction with inflation rate, meanwhile, the rest of variables move in the same direction with inflation rate. Percentage change of money supply is the strongest positively correlated with inflation rate at 0.0401. This may imply that when there is a larger quantity of money supply inject into economy, it stimulates the rate of inflation. As a consequence, the central bank has a necessity to increase real interest rate in order to slow down the increasing of inflationary. This action will also stimulate people's saving as well as decelerate their lending and borrowing. Even change of real interest rate positively correlated with inflation rate and percentage change of money supply, it moves in the opposite direction with growth rate of US real GDP. The growth rate of US real GDP negatively correlated with the percentage change of US dollar index as well, but it slightly negative co-move to the change of real interest rate and percentage of US dollar index at -0.0139 and -0.0087, respectively. Furthermore, according to Table 3 showed above, expansion of money flow in the United States reflects an appreciation in US dollar index as well.

As explained previously, regression of percentage change of London PM gold price fix is explained its fit by Ordinary Least Square. An estimation results in following equation:

*Estimated Regression:*

$$\text{GOLDP} = 0.7561 + 2.0268 \cdot \text{INFG} - 1.3738 \cdot \text{USDG} - 0.0321 \cdot \text{RINTX} + 0.4123 \cdot \text{M2G} - 1.1643 \cdot \text{RGDPG}$$

(0.6721) (0.0121) (0.0000) (0.7875) (0.6110) (0.1745)

Recall that; GOLDP is percentage change of London PM gold price fix, INFG is an inflation rate, USDG is US dollar index growth rate, RINTX is change of real interest rate, M2G is percentage change of M2 and RGDPG

is real GDP growth rate. Each coefficient of each factor could be clarified as follow:

(1) Holding unchanged in percentage change of M2, unchanged in real interest rate, no growth in real GDP and no growth of US dollar, 1% increasing in inflation rate results in 2.03% returning in global gold price.

(2) If US dollar index falls by 1%, it increases in percentage change of London PM gold fixing by 1.37%. Given coefficient of the rest variables equal to zero.

(3) 1% reduction in real interest rate will yield 0.03% returning on global gold price, holding the rest equal to zero.

(4) A percentage increase in M2 results in 0.41% increasing in percentage change of London PM gold price fix, given the rest constant.

(5) If the constant rate of inflation rate, M2 growth rate, real interest rate and US dollar growth are zero, one percentage growth of US real GDP decreases the gold price fix by 1.16%.

Inflation rate, M2 growth rate, real GDP growth rate, real interest rate, and percentage change of US dollar are moderate predictors to explain the global gold price return. Measurement of the model fit ( $R^2$ ) equals to 20% which is in line with an adjusted  $R^2$  of 0.17%. This means that, the above regression is a moderate regression to explain the whole population. Even 20% indicate measure of fit of the regression, though an average mistake size made by the above regression is 8.83%. In addition, probability of F-Statistic (F-prob = 0.000004) which tested the joint hypothesis of whole population is nearly zero. Therefore, at least one of the population coefficients is not zero. Besides, by regression of each independent variable on the other ones showed that, an equation of the percentage change of London PM gold price fixing has no perfect multi co linearity. Their  $R^2$  results are weak to explain that each of them relies on each other.

Furthermore, t-stat results also shows that; p-value of percentage change of M2, US real GDP growth rate, and change in real interest rate, all fell to reject the null hypothesis (p-value > 0.05) at 95% confidence interval. F-test coincides to the t-test of each particular factor at 5% significant level that is the F-test of whole population reject null hypothesis at 5% significant level. On the other hand, it means that only inflation rate and US dollar growth rate are the factors to explain the percentage change of gold fixing significantly. Meanwhile, percentage change of US dollar index is negatively affects percentage change of gold fix; inflation rate is also a good factor to explain the positively impact to the percentage change of London PM gold fix at 5% significant level.

However, heteroskedasticity of the residuals and misspecification problem for an above estimated regression still persist. Testing under the White Heteroskedasticity, the result appeared that, p-value of F-test rejects the null hypothesis at 95% confidence interval. Seventeen percent measure of fit ensures that, there are omitted variables in the regression.

Apart from percentage change of money supply, change in real interest rate, and growth rate of US real GDP; inflation rate and US dollar index percentage of growth are the only two variables that significantly impact to the movement of percentage change of London PM gold price fix. Inflation rate moves in the same direction with London PM gold price fix whereas US dollar moves in the opposite direction.

## 5. Summaries of the Findings

The answer to the research questions are obtained from an analysis of Ordinary Least Square (OLS) method and correlation analysis. The analysis reveals a satisfactory result. Under OLS, all data series has no unit root. F-test shows at least one of whole population used in this research significantly impact to the movement of gold

fix. By t-test, inflation rate and percentage change of US dollar significantly affect the gold price at 95% confident interval. The movement of gold fix is positively impacted by inflation while it is negatively affected by percentage change of US dollar. Correlation analysis is used to justify correlation of percentage change of gold fix with five macroeconomic variables. Inflation rate positively correlated to percentage of gold fix whereas percentage growth rate of US real GDP, change of real interest rate, percentage growth of money supply and US dollar percentage change all move in opposite direction with return of global gold price.

Percentage change of US dollar index is the perfect factor to explain movement of gold fix. When the US dollar depreciates at 1% from previous quarter, gold price at present quarter increases by 1.3%. The global gold price with only US dollar percentage change accepts all Arbitrage Pricing Theory assumptions. No residual terms are omitted in this linear regression and the US dollar in this regression significant move independently from the residual terms. Value of gold goes well even value of money drops. In an ongoing euro crisis, to curb with mess sovereign debts in Euro zone; one possible outcome to cope such problem is printing out paper money for debt repayment. This solution is similar to what US had done several years ago. Such deleveraging effect, like heavily drop in global demand and devaluation of the currency may happen.

So far, gold is proved as an inflation hedge, investors should better collect gold as one asset in their portfolio to hedge such risks. While people's wallet size continually reduces, price of gold still keeps increasing in its value. Reasonable price of the gold can be predicted by the value of US dollar. Movement of gold value and percentage change of US dollar index have mirror effects to each other. In Thailand, buying and selling price of a unit gold fund is determined by mark-to-market at the end of each day trade. Thai investors, who are willing to invest in gold through gold fund, can decide to buy such fund when US dollar spot drops heavily. They can collect cheap gold for their investment by predetermination when dollar spot rate is weak.

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