

How the US Dollar Index Affects Gold Prices

By

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Abstract

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This paper tests how the US dollar index affects global gold prices. The data on US dollar index and gold prices was collected from the period 1995 to 2014. To examine how the US dollar affects the gold prices, this paper mainly employs the Augmented Dickey Fuller test, the Cointegration Test and the Error-Correction Model. The results of the empirical study show that the US dollar index is negatively related to global gold prices both before and after the 2007 financial crisis.

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Chapter1: Introduction

1.1 Purpose of the Study

Since the gold investment market has been increasingly active in recent years, investors have begun to pay more attention to changes in gold price than before, but compared with previous research, the analysis for changes in gold prices is still scarce. Generally, investors believe that there are some factors that would influence the price of gold in the market such as changes in the US dollar, the flexible policy, inflation, gold output, the price of crude oil and so on. Changes in the US dollar index also reflect the change of US dollar. Similarly, any changes in the US dollar index will be directly reflected in the price of gold, so it is important to pay attention to trends of the US dollar index in order to understand how the US dollar index influences gold prices. This is especially important for investors who wish to benefit from the gold market.

The US dollar index is obviously influencing gold prices; therefore the focus of this paper will be on finding the correlation between US dollar index and gold prices. Through the research, we can find the US dollar index changes have

significant influence on gold prices, and these changes are important signals for gold investors. I will also give some suggestions for these gold investors.

1.2 Background

Established in 1944, the Bretton Woods System asked to use the US dollar as the main international reserve currency. The US Dollar is directly linked to gold, currencies are pegged to the US dollar. Specifically, \$35 US dollars is the official price of one ounce of gold in the United States. This is what we commonly know as the "gold standard", that means all currencies are based on gold as a fundamental standard. However, the Renaissance led to a large number of US dollar arbitrages in gold especially in Europe and Japan. In addition, due to the Vietnam War in the 1960s the US experienced a severe economic recession. The Bretton Woods System eventually collapsed due to these events.

In August 1971, US President Richard Nixon announced the policy that stopped gold and dollar exchange. This is commonly referred to as the "Nixon shock". Before this announcement, gold was the standard currency, but this

event ended the fixed exchange rates of major currencies, and replaced it with a floating exchange rate system which began to be widely used in the world. In current society, gold can be used as a kind of commodity to embody its value, but gold also embodies its value in currency.

Gold has long been an important investment tool. It has high value and also it is a kind of independent resource. It is not limited to any country or trade markets. As gold has a good function of value maintenance and capital appreciation, gold can be used as a risk hedging tool. Many gold owners believe that they can invest gold to hedge against inflation. Economist Martin Feldstein (26 Dec 2009) however does not believe that gold is a good hedge against inflation or currency depreciation. However, when the economy is not stable, or when economic depression and recession happens, more and more investors prefer to invest in gold to avoid these problems. Gold investment means investment in gold bars, gold coins, and even pure gold.

The US Dollar Index (USDIX) is an index (or measure) of the value of the United States dollar relative to a basket of foreign currencies (Investopedia. Retrieved 23 March 2013). It is the comprehensive reflection of the exchange rate in the international foreign exchange market indicators, which is used to

measure the dollar against a basket of currencies' exchange rate changes. Chentao's report regarding the origin and the composition of the dollar index (June 7, 2005) explained the US dollar index as the comprehensive rate by computing the dollar and selecting a basket of currencies. Besides, it measures the degree of the power of the dollar, and indirectly reflects the changes of the competitive ability in the export and import costs. For example, when the US dollar index goes up, the exchange rate between the US dollar and other currencies also increases, which is the US dollar appreciation. As the international major commodities are denominated in dollars, the corresponding commodity prices should fall. The US dollar appreciation can improve the value of its own currency, by increasing purchasing power. But for some industries, the US dollar appreciation will give them the reverse impact. For import and export industries, when the currency appreciates it will raise the price of export commodities, which affects the number of company's export commodities and vice versa.

As we know, the gold market is a global market. Currently, the major gold markets of the world are in London, Zurich, New York, Hong Kong, among other places, while the largest gold markets are located in London and New York. The price in the London gold market will influence the world's gold

market. The operation of the gold market is similar to other investment markets and the stock market.

Western economist John Maynard Keynes vividly outlined the role of gold in the monetary system, he said: "the gold is one of the important role in our system, it serves as the final guard and reserves of emergency when needed, don't have any other better thing can replace it".

1.3 Outline of the Paper

This paper includes five chapters. The introduction in the previous chapter described the background and the purpose of the study which is used to explain some concepts or significance, along with a general explanation of the relationship between gold prices and the US dollar index. The second chapter contains a literature review, which introduces some existing literature about gold price fluctuations and the US dollar index change, as well as some analysis of the relationship between gold prices and the US dollar index. Chapter 3 provides the data source, methodology and some models that I will use to test the theory. Chapter 4 will discuss the results, separated into two

parts: pre- financial crisis and post- financial crisis. In chapter 5, I will provide my conclusion.

Chapter 2: Literature Review

2.1 The Factors Affecting Gold Prices

Gold is considered to be an effective hedging tool, when a financial crisis comes, it will help investors to reduce loss. From the Yahoo finance web page and Bloomberg data, we can easily see gold prices reaching up to \$500 an ounce when 1987 financial crisis happened; also the price hit a new high level in nearly five years at that time. In 2007 the US subprime mortgage crisis triggered the financial crisis. In August, gold prices reached \$700 per ounce and in March 2008, gold prices rose to \$1,032 per ounce.

In Haubrich, Joseph G's report Gold Prices (Mar 1, 1998), they believed the price of gold depended on their demand and supply, and at the same time that the change in gold price and the inflation rate had a close relationship.

From the report of Determination of Factors Affecting the Price of Gold: A Study of MGARCH Model by Toraman, Cengiz; Basarir, Çagatay; Bayramoglu, Mehmet Fatih (Feb 4, 2011), the author used the MGARCH model to analyze if

the real interest rate, oil price, the US dollar exchange rate, and the US inflation rate affected gold prices. According to the test, the author found a high degree of correlation between gold prices and the US dollar exchange rate, but no obvious correlation between the price of oil and real interest rate.

2.2 Volatility of Gold Prices

Gold has the same market risk as other currencies and commodities. Compared with other currencies, the volatility of gold price change is low. However, in recent years, due to increased speculation, the volatility in gold prices has increased.

“The Price of Gold and the Exchange Rates” by Larry A. Sjaastad* (1996), discussed the empirical inspection and test of major currencies’ exchange rates and the circulation of commodities. Larry A. Sjaastad put forward the major currencies exchange rate movements which became the main factors influencing the international gold price fluctuations after the collapse of the Bretton Woods system. The Chicago Board of Trade (CBOT) is one of the most famous commodity trading markets in the world. Whenever any change

of the exchange rate happens, it will cause commodity prices to adjust immediately in the CBOT.

According to Sopipan Nop; Sattayatham Pairote; Bhusana Premanode (Feb 2012) "Forecasting Volatility of Gold Price Using Markov Regime Switching and Trading Strategy", they use the GARCH model which was built based on R. Engle (Nov 4,1982), the EGARCH model proposed by D. B. Nelson (Nov2,1991), the GJR-GARCH model, which was introduced independently by Glosten, Aganathan, and Runkle (Nov5,1993) and the Markov Regime Switching GARCH (MRS-GARCH) model to forecast the volatility of gold prices and compare their performance.

They found that with the lapse of time, the volatility does not keep a constant number. Also, with a change in asset prices, the volatility also changes. The big asset price change led to a great fluctuation change, and vice versa.

By using the Augmented Dickey- Fuller test (D. A. Dickey and W. A. Fuller 1979), the result is that the gold price log returns and serial log returns of gold price are stationary. However, the serial correlation in the gold price is

non-stationary. Serial correlation in the squared returns suggests conditional heteroskedasticity. From the result, it is easy to find that almost all parameter estimates in GARCH models are highly significant at 1%, most parameter estimates in MRS-GARCH are at 95% confidence level, these results are significantly different from zero. The cumulative returns will be higher if the Markov Regime Switching GARCH-N (MRS-GARCH-N) model and the GJR-N model are used. All models show that the range from 0.965 to 0.974 is very strong and durable, unless the EGARCH model is very low. Thus, the volatility arises, the gold prices volatility will remain at a relatively high level in a given period of time. By using the result of price volatility they estimated, they believe they can predict the gold prices in the future.

2.3 Relationship between Gold Prices and Exchange Rates

From the report of the Relationship between Commodity Prices and Exchange Rate in Light of Global Financial Crisis: Evidence from Australia by R, Omar K M; Kabir, Sarkar Humayun (Oct 2013), researchers use the Augmented Dickey Fuller (ADF) and Phillips Perron (PP) unit root tests to verify if time series data of Australian/US dollar exchange rate and commodity prices are stationary and co-integrated. Then they use the Granger causality test to find commodity

prices such as the gold price and exchange rate to determine whether each affects the other. The Global Financial Crisis in 1998 and in 2007 would impact on commodity prices.

The report “Can Exchange Rate Forecast Commodity Prices” (2008) by Chen Y, Rogoff K, Rossi discusses the dynamic relationships between commodity price fluctuations and the changes of exchange rates. Surprisingly, the test results indicate that exchange rates and the future commodities price have a causal explanation relationship, which is significant to the prediction of the future commodity prices change and exchange rate.

The finance report “Cross Correlation between Gold Prices and Exchange Rate finance essay” fromUKessays.com includes two main econometric analyses; the Granger causality test and cross tests. According to Granger’s causality test, it finds the international price of gold and the US dollar index has obvious causality. In the investigation of cross-correlation, it suggests that the US dollar was significantly correlated with the price of gold.

2.4 Objective

From the literature review, we see that there is a close relationship between the fluctuation of the gold prices and the exchange rate. Now the gold market is denominated in dollars, so we are curious what relationship exists between the price of gold and the US dollar index changes, and how the US dollar index affects gold price fluctuations. Therefore, we will use a series of tests to get the answers.

Chapter3: Methodology

3.1 Data Source

The London gold market is associated with other important gold trading markets worldwide and it is one of the world's most important markets. To find how the US dollar index affects gold prices. We obtain the data from Bloomberg, the daily data gold price basis of the London Gold Market Fixing Limited and the US dollar index announced day by day. This article selects the June 30, 1995 to July 1, 2014 data of time, in days.

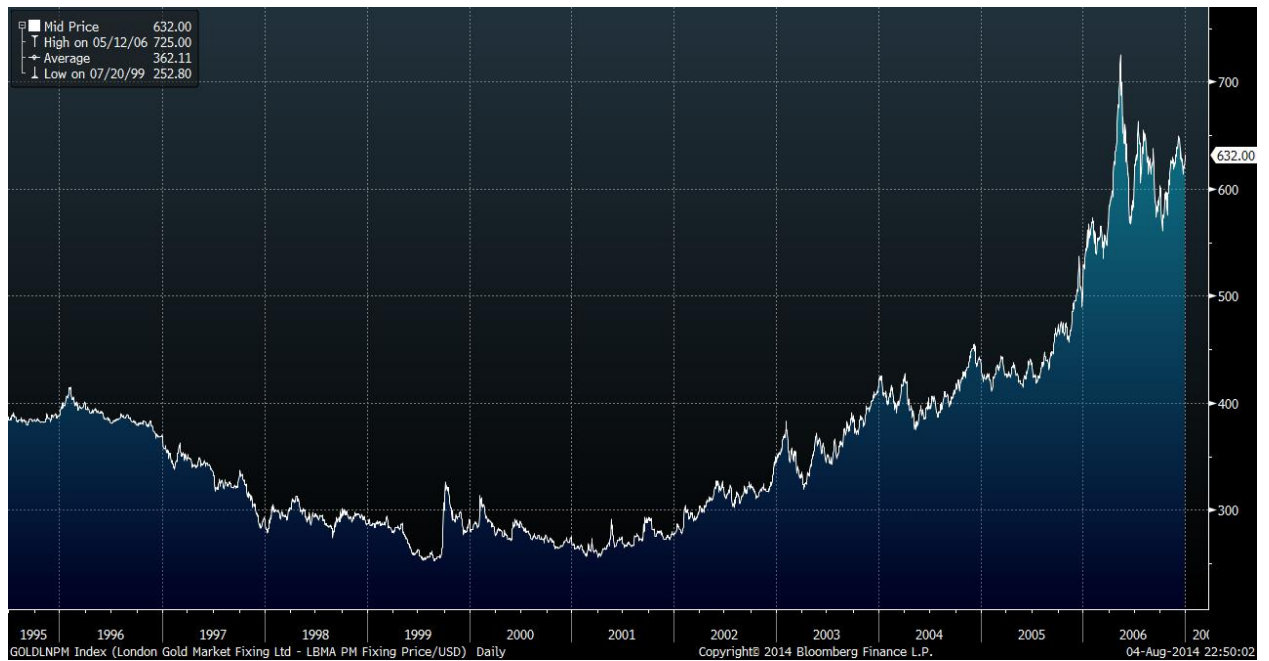
The gold price charts and the US dollar index change figure before and after the 2007 financial crisis are shown in below.

2007/01/02~2014/06/30(gold prices)



Source from Bloomberg web page

1995/06/30-2006/12/28(gold prices)



Source from Bloomberg web page

1995/06/30-2006/12/28(US Dollar index)



Source from Bloomberg web page

2007/01/02-2014/06/30(US dollar index)



Source from Bloomberg web page

3.2 Stationary Unit Root Test

The regression analysis based on time series data implicitly assumed that the underlying time series are stationary. A stochastic process is said to be stationary if its mean, variance, and autocovariance are constant over time (Gujrati, 2003). To prevent the presence of spurious regression phenomenon, we are implementing a stationary test to the data. We used the Augmented Dickey Fuller (D. A. Dickey and W. A. Fuller 1979) to find if the time series data of gold prices and the US dollar index data is stationary.

To test the null hypothesis that $\phi = 1$ in:

$$\text{Gold}_t = \phi \cdot \text{Gold}_{t-1} + u_t \quad (3.1)$$

Gold_t : The gold prices in t-times

Gold_{t-1} : The gold prices in t-1 times

ϕ : Coefficient of gold prices in t-1 times

u_t : The residual in time series data of gold prices

To test the null hypothesis that $\phi = 1$ in:

$$\text{Dollar index}_t = \phi \cdot \text{Dollar index}_{t-1} + u_t \quad (3.1)$$

Dollar index_t : The US dollar index in t times

$\text{Dollar index}_{t-1}$: The US dollar index in t-1 times

ϕ : Coefficient of US dollar index in t-1 times

u_t : The residual in time series data of US dollar index

Hypothesis:

H_0 : Series constants a unit root

H_1 : Series is stationary

Usually, we also use the regression (Augmented DF test)

$$\Delta y_t = \psi y_{t-1} + \sum_{i=1}^p \alpha_i \Delta y_{t-i} + u_t$$

So that a test of $\phi=1$ is equivalent to a test of $\psi=0$ (since $\phi-1=\psi$).

3.3 Cointegration Test

We used the Johansen cointegration test (Johansen. S, 1991) to verify whether there is a long-term equilibrium relationship between US dollar index and gold prices. Known by the cointegration theory (1) for non-stationary time series variable, their linear combination may be stationary. (2) Cointegrating variables must have the same order number, for example, they should both be the first-order series or second-order series. There are two kinds of cointegration tests (1) based on the regression coefficients of cointegration and (2) based on the regression residuals of cointegration . In this paper, I will use the residual error test.

To test the cointegration of gold prices and the US dollar index, we must first estimate

Gold $= \beta_1 + \beta_2$ **Dollar index** $+ u_t$, get residual u_t .

Then test whether u_t are stationary

$$\Delta u_t = \pi u_{t-1} + v_t$$

Hypothesis:

$H_0: \pi = 0, u_t$ is not stationary

$H_1: \pi < 0, u_t$ is stationary

3.4 Error-Correction Model

We use the model to regress and find the US dollar index effect on the gold price changes in the short term and long term fluctuation

$$\Delta \text{Gold}_t = \alpha_1 + \alpha_2 \Delta \text{Dollar index}_t + \alpha_3 u_{t-1} + \varepsilon_t \quad (3.3)$$

α_2 : Short run effect on change gold prices and US dollar index

α_3 : Adjustment parameter

u_{t-1} : Disequilibrium error in the previous period

ε_t : Error term

Chapter 4: Result Analysis

4.1 Unit Root Test Result (for before 2007 financial crisis data)

According to Table 1, the observation dataset is from the December 28th, 1995 to the December 28th, 2006 time period, which is the period before the financial crisis of 2007. Through the ADF unit root test, we determine the price of gold and the US dollar index has a unit root by using two logarithmic variables (lnGP: log gold prices. lnUSR: log US dollar index). The test result is 0.878 and -1.841 which are the biggest in 1% critical value, 5% critical value and 10% critical value. Therefore neither time series data is stable, their change trend and time are closely linked.

Table 2

. dfuller d.InGP

Dickey-Fuller test for unit root Number of obs = 259

	Test Statistic	Interpolated Dickey-Fuller		
		1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-22.568	-3.459	-2.880	-2.570

MacKinnon approximate p-value for Z(t) = 0.0000

. dfuller d.InUSR

Dickey-Fuller test for unit root Number of obs = 259

	Test Statistic	Interpolated Dickey-Fuller		
		1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-16.522	-3.459	-2.880	-2.570

MacKinnon approximate p-value for Z(t) = 0.0000

4.2 Cointegration Test Result (for before 2007 financial crisis data)

In the unit root test, we found that the price of gold and the US dollar index is a first-order stationary sequence; therefore we did a two variable cointegration test to verify the existence of a long-term equilibrium relationship between the two variables before running the regression. The result in Table 3 clearly identifies that in 1%, 5%, 10% significant levels all reject null hypothesis,

Table 4

```
. regress d.InGP d.InUSR l.uhat
```

Source	SS	df	MS			
Model	130.640093	2	65.3200465	Number of obs =	2326	
Residual	45.2917954	2323	.019497114	F(2, 2323) =	3350.24	
Total	175.931888	2325	.075669629	Prob > F =	0.0000	
				R-squared =	0.7426	
				Adj R-squared =	0.7423	
				Root MSE =	.13963	

D.InGP	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
InUSR						
D1.	-1.696976	.0227511	-74.59	0.000	-1.74159	-1.652361
uhat						
L1.	-.7190677	.0199681	-36.01	0.000	-.7582249	-.6799105
_cons	.0012542	.0028952	0.43	0.665	-.0044233	.0069317

4.4 Unit Root Test Result (for after 2007 financial crisis data)

The observation is from 2007 to 2014, the result is shown in Table 5, we used two variables' logarithmic (lnGP: log gold prices. lnUSR: log US dollar index). According to the ADF test, we get the price of gold has a unit root, but the US dollar index series is stationary. As we need both of them to be stationary, we try to test their first-order (d.InGP, d.InUSR) and find they are stationary in 1%,

5% and 10% significance levels because the test statistic result is the smallest in these significance levels and we cannot accept the null hypothesis. The results are illustrated in Table 6..

Table 5

. dfuller InUSR

Dickey-Fuller test for unit root Number of obs = 372

	Test Statistic	Interpolated Dickey-Fuller		
		1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-4.303	-3.450	-2.875	-2.570

MacKinnon approximate p-value for Z(t) = 0.0004

. dfuller InGP

Dickey-Fuller test for unit root Number of obs = 372

	Test Statistic	Interpolated Dickey-Fuller		
		1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-3.435	-3.450	-2.875	-2.570

MacKinnon approximate p-value for Z(t) = 0.0098

-0.7097155, its absolute value determines the speed of the recovery rate to equalization and it is similar with the data in before 2007 financial crisis.

Table 8

```
. reg d.InGP d.InUSR l.uhat
```

Source	SS	df	MS			
Model	69.7472067	2	34.8736033	Number of obs =	1477	
Residual	121.907218	1474	.082705033	F(2, 1474) =	421.66	
Total	191.654425	1476	.129847171	Prob > F =	0.0000	
				R-squared =	0.3639	
				Adj R-squared =	0.3631	
				Root MSE =	.28758	

D.InGP	Coef.	Std. Err.	t	P> t	[95% Conf. Interval]	
InUSR						
D1.	-.7011524	.1371667	-5.11	0.000	-.9702151	-.4320898
uhat						
L1.	-.7097155	.024811	-28.60	0.000	-.7583841	-.6610469
_cons	.0013756	.0074831	0.18	0.854	-.013303	.0160543

Chapter 5: Conclusion

With comprehensive testing and analysis of the above, we can see clearly that the US dollar index fluctuations has the opposite influence on international prices of gold. For example, when the US dollar index increases, it will cause a decline in gold prices. The decrease of the US dollar index will lead to the rise of gold prices. As the US dollar index is one of the most important financial factors, it would affect the volatility of gold prices; meanwhile the US dollar index often decreases in relation to inflation and the stock market downturn. Compared with the time period before and after the year of 2007, which was the world financial crisis, we find that before the financial crisis, gold price fluctuations were greatly influenced by the US dollar index change. However, the US dollar index against gold price volatility had a significantly reduced impact after the financial crisis in 2007. If the portfolio managers want to put commodities into their portfolios to hedge against inflation during the period of a financial depression, the conclusions we have drawn above may give them some helpful suggestions.

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