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**The relationship between Gold Futures Price and Stock Price
of Gold Mining Companies**

Evidence from Hong Kong Market

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Abstract

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By

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August 20, 2014

This paper describes the relationship between gold futures and gold stocks with the data from the Hong Kong market and its change before and after the U.S subprime mortgage crisis, and after October 2, 2013, when NYSE Arca Gold Miners Index added these three Hong Kong gold stocks. The historical data on its three stocks and gold futures were collected through January 2, 2004 to July 31, 2014. The methodologies used include correlation and regression analysis. According to my research, we find the gold futures and gold stocks have a cointegration relationship and they have strong correlation before the U.S subprime mortgage crisis. Additionally, we find the fluctuations in gold futures heavily dominated fluctuations in gold stocks.

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Chapter 1

Introduction

1.1 Background

Since ancient times, gold is one of the most popular and sought after precious metals in our world, mainly due to the fact that it is a non-renewable resource, has fine chemical stability, versatile in its application and appealing in its characteristics. Besides its widespread usage as currency, gold has many realistic uses as a commodity, such as in electronics and jewelry. Like many of the other precious metals, scarcity made gold a symbol of wealth and as a result there has been a never ceasing demand for gold as an accessory. It wasn't until recently with the boom of the digital age that gold was used much in the practical sense; in CPU chips, electronic devices etc. Thus with the development of our economy and society, the demand of gold has become higher and higher. According to a World Gold Council (See surest at al 2014) report, there was a 44.7 billion dollars demand value in the first quarter in 2014 alone (p.1).

As we know, gold is an important part of foreign reserves. The gold investment market is a global investment market, and no one or group have enough money or power to control it. We all think the gold investment market is an open and fair market.

With the global economic downturn, the gold investment market has developed quickly since 2007. The U.S subprime mortgage crisis soon developed into a global financial disaster. Inevitably, this financial crisis affected the world quickly and dramatically. Many famous companies became bankrupt as a result of the economic crisis, for example Lehman Brothers Holding Inc., Washington Mutual and General Motors. With the sudden decrease in stock values and unemployment rapidly rising, many people lost confidence in the global economy. Many investors transferred their funds from banks and stocks to invest in other markets including to gold investment. Gold also can protect investor's property against inflation and serve as a buffer against an economic crisis. In a recent study, Worthington & Pahlavani (2007) described gold investments as effective inflationary hedges (p.261).

The Hong Kong stock market is one of the most important global stock markets today. The foreign investors in the Hong Kong stock market caused Hong Kong to become a premier international financial center. I believe the Hong Kong stock market is a healthy and fair market, from Zhu (1997), data shows there were only 253 companies listed in 1986, with a total market value around 420 billion HKD. By 1990, there were 299 companies, the total market value around 650 billion HKD and 528 companies the total market value around 3451.9 billion HKD in 1996 (p.38). According to these data, we can observe the rapid growth of the Hong Kong stock market with investors brimming with hope and faith.

1.2 Purpose of study

Stock and futures markets are integral parts of the international financial system. There are only a few studies that research the relationship between these markets, even less that study the relationship between the stock market and the precious metal futures market. This paper will fill this lacuna and to determine whether or not there is correlation, and if they have a correlation, how gold futures prices influence gold stock price in different periods, particularly before and after the economic crisis and other significant events.

This paper uses the dynamics of gold futures prices and gold stocks price to study their relationship. Using daily data from January, 2 2004 to July 31, 2014, three gold stocks, Zhaojin Mining Industry Co. Led. (1818.HK), Zijin Mining Group Co. Led. (2899. HK) and G-Resources Group Limited (1051. HK) were selected. According to Eric (2013), these three gold stocks were added in NYSE Arca Gold Miners Index in September, 2013(p.1). Meaning the market strategy and the performance of the equity markets of these three Hong Kong gold stocks have been approved. The daily data were divided into three parts:

1. January 2, 2004 to December 29, 2006, that is before the U.S subprime mortgage crisis.

2. January 2, 2007 to September 30, 2013—— after the U.S subprime mortgage crisis, and

3. October 2, 2013 to July 31, 2014 —— after the NYSE gold stocks index added these three Hong Kong gold stocks

This paper will compare data from different periods and discuss the correlation and influence between each other. Specifically, utilising correlation analysis and regression analysis will help investors to understand the change at different times and make better investment decisions in the future, especially concerning gold stock and gold future markets.

1.3 Statement of problem

This paper will be developed in five parts. Chapter 1 has presented the introduction. Chapter 2 will provide a review of the literature. The methodology and data will be introduced in Chapter 3. Chapter 4 will discuss the results and the last chapter will present the conclusion.

Chapter 2

Literature Review

2.1 Volatility between Future Market and Stock Market

According to Edwards' (1988) research, market volatility in the S&P 500 in the period 1973-1982 were greater than futures trading open in 1982-1986, He argued that the futures market attracted more investors to the cash market, although there were a few irrational investors who prefer to get more benefits from the short-run in these new investments. As a result, the cash market will be more liquid and that can explain why market volatility in the S&P 500 in 1982-1986 was less than before. However, while there were a few reasons that can lead to decreased market volatility (p.69), the author only talked about the liquidity of the cash market.

Schwert (1990) explained the many reasons which lead to influence the market volatility, for example volatility of bond returns, inflation rates, money growth and industrial production growth (p.23-33).

Van et al. (2002) explained that futures markets can get obtain more investments when investors lose confidence in the stock market (p.223-234). In my opinion, the

futures market was a new free trade market in 1982-1986; and as a result, it should attract many investors from the stock market. Another very important reason why investors transfer their money from stock markets to futures markets is investors lose confidence in the stock market. As we know, the price of stock shows not only the price, but an assessment of a firm's performance and strategy. With decreasing investors in the stock market, the supply and demand forces of stock market will also decrease, and the market volatility will decrease as a result.

2.2 Financial Crisis on the Stock Market

A financial crisis is always a focal point amongst economists. This is because a financial crisis has so much influence on the worldwide economy, and it sometimes even threatens to destroy the current financial system. A large source of financial crises come from factors such as a financial market bubbles, lack of a government monitor, and war. According to Wadhvani (1999), he states that the American stock market and its global economy are interconnected with each other in a way no one has an exclusive benefit. As time goes on, with the daily rising uncertainty and rapidly changing global economy, it leads to the growth of the American stock market (p.103).

Yang et-al. (2003) shows that every stock market will be more merged become more integrated after a financial crisis than before (p.485). After the recent financial

crisis, all of the investors looked for the best strategy to cover their losses. Then the source of the market will be more liquid; every parts of the market become connected more closely.

2.3 Gold and the financial crisis

Whenever a financial crisis happens, investors tend to transfer money from the risky stock market to a less risky market such as the futures gold market. This action is known as finding a gold haven. In most cases the gold haven is useful in western developed countries as it has a strong effect in decreasing the investor's loss in uncertain economic environment such as the aforementioned financial crisis. However, if investors want to trade in the energy market, the gold haven effect turns from the strong form to weak form (Baur and McDermott 2008).

Northcott (2011) explained people will still search for the best means of investment, so when the U.S. economy took a sharp nose-dive during the recent economic crisis, gold was the world's most famous precious metal, and gold investment became increasing popular. According to the history of gold and silver, writers think precious metals such as gold and silver are direct indices of the current economy. Precious metals investment will protect an investor's wealth with low risk in their investment portfolio (p.253).

2.4 Price Discovery Theory

Price discovery is not only one of core functions in futures markets, but the basis of future market development as well. Through the large volume of futures trading, the market participants will figure out the relationship between demand and supply and this represents the determination of price. According to Garbade and Silber (1983), the impact of futures markets to spot markets is more significant than the influence of spot markets to future markets. 75% of the evidence shows that the futures markets reacted more quickly to news releases than spot markets. This research is very important to the investors, since the investors can predict the change of spot markets by observing the future markets. They can make rational decision regarding their investment plans (p.297). The volatility of futures market and stock market can be very high so it is very hard to pinpoint every increase or decrease because of particular reasons or news.

From the New York commodity Exchange (2014), we know there were many different products traded in COMEX, for example agriculture, metals energy, equity index, interest rates and weather (p.1). All news can influence at least two different aspects. A lot of factors can influence the future market at the same time. We cannot keep other factors same when we research the possible influences. The other very

important reason for the change of price are actions of the irrational investors who wanted to earn more short-term benefits.

Gold is a special commodity with multiple attributes, therefore the spot price of gold is not completely dominated by the futures market price. There are many other factors which can also affect the tendency of current gold price, such as the uncertainty of extreme government political and economic environment, inflation, government policies, and the supply and demand of gold (n.d). Firstly, gold has two key attributes: it is a commodity and quasi currency. Under an uncertain economic environment, gold is more likely to reflect the store of value, raising the difficulty in determining the price of gold. Secondly, since gold also is a “currency”, then as with its slope of value function, when the inflation rise, the price of gold also increase. Thirdly, government auctions can manipulate the gold price (Abken, 1980).

In general, monitoring the futures market movement will help an investor to predict the gold stock price. However, as described reaction, the gold stock does not just depend on the futures market. We should consider all these factors in coming to a decision and Darst (2013) confirm this. (p98).

Chapter 3

Data and Methodology

3.1 Empirical Data

To decrease the research deviation, I choose three stocks from the Hong Kong stock market that were added to the NYSE gold stock index. The entirety of the daily stock prices data were chosen with the close its prices and adjusted for dividends and splits and denoted in US dollars. All data in this paper were collected from Bloomberg from January 2, 1994 to July 31, 2014, in order to provide real, reliable and effective data.

The weighted average price of the three gold stocks were used and the trading volume was the weight. The weighted average price is continuous and representative of the price change of gold stocks in the Hong Kong market.

3.2 Gold Futures Price and Gold Stock Price

The following figures (3.1-3.2) describe in more detail the change of gold futures prices and gold stock prices from January 2, 2004 to July 31, 2014 and we can easily find the difference between gold futures price and gold stock prices.

Figure 3.1 The historical prices of gold future 2004-2014.



Figure 3-2 The historical prices of gold stocks 2004-2014.



From the Figures 3.1 and 3.2, we can determine that the volatility of gold stocks is bigger than gold futures prices. The similarity from the two figures is apparent as the top points and lower points occurred almost at the same time and the trend looks broadly to be the same.

Figure 3.3 Ps/Pf ratio



From Figure 3.3, we find the change of Ps/Pf ratio was very small with the value in the range 0 to 0.002 and the volatility of Ps/Pf ratio from 2007 to 2010 was bigger than the other periods. As a result we can predict there is a relationship between these two variables.

Because the prices of gold futures are much more than the gold stock prices, this paper used the natural logarithm to decrease the disparity.

The formula is:

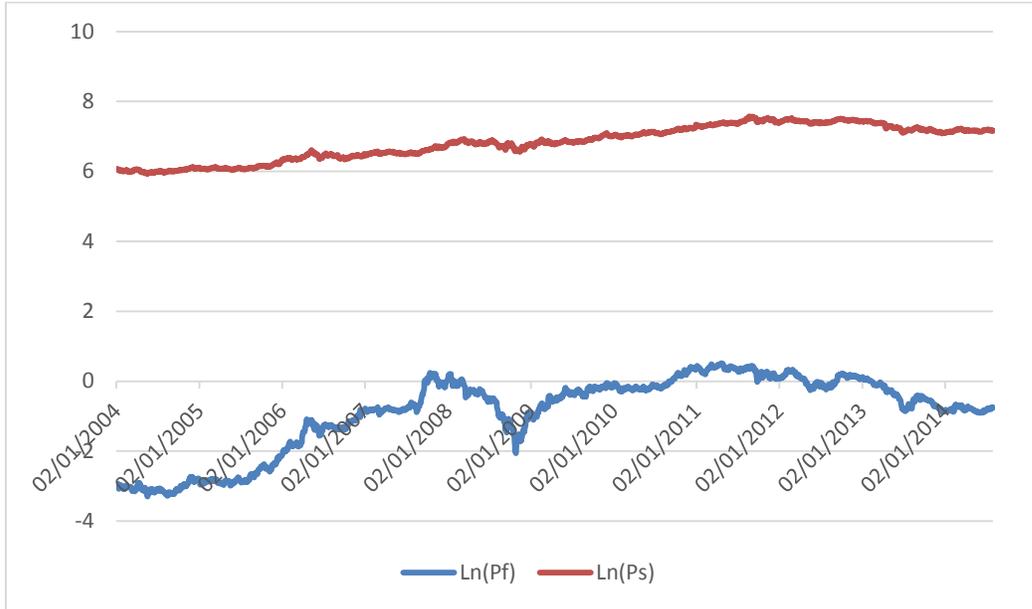
$$\ln (Pf) \dots\dots\dots 3.1$$

Pf = Price of Gold Futures

$$\ln (Ps) \dots\dots\dots 3.2$$

P_s = Price of Gold stock

Figure 3.4 Natural Logarithm of Price



Using the natural logarithm we can easily find the two figures have a matching trend.

But we can note that the trend of Ln (Pf) was smoother than Ln (Ps).

3.3 Correlation Analysis

The correlation coefficient is one of the basic statistical methods to measure the linear relationship between two variables. It can be divided into many parts.

$$r = \frac{\sigma_{xy}}{\sigma_x \sigma_y} \dots\dots\dots 3.3$$

$$r = \frac{\sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})}{\sqrt{\sum_{i=1}^n (x_i - \bar{x})^2 \cdot \sum_{i=1}^n (y_i - \bar{y})^2}}$$

$$= \frac{n \sum_{i=1}^n x_i y_i - \sum_{i=1}^n x_i \cdot \sum_{i=1}^n y_i}{\sqrt{n \sum_{i=1}^n x_i^2 - (\sum_{i=1}^n x_i)^2} \cdot \sqrt{n \sum_{i=1}^n y_i^2 - (\sum_{i=1}^n y_i)^2}} \dots\dots\dots 3.4$$

r = Correlation Coefficient

x= Gold Futures Price

y= Gold Stock Price

\bar{x} = Average of Gold Futures Price

\bar{y} = Average of Gold Stock Price

The value of correlation coefficient is between -1 to 1, where 0 means there is no correlation, 1 means they have the total positive correlation and -1 means they have a total negative correlation.

From the Figure 3.3, we can find the two lines have the same trend. It represents a possible linear relationship between gold futures and gold stock price. The correlation coefficient will be used to measure the linear relationship between the two variables in different periods.

3.4 Distributed Lag Model and Regression Analysis

Let us set the price of gold futures as the dependent variable and stock price as the independent variable. Suppose that the gold futures price and gold stock price have a linear relationship following a distributed lag model:

$$Y_t = C + B_0X_t + B_1X_{t-1} + \dots + B_kX_{t-k} + u \dots \dots \dots 3.5$$

Y = the price of gold futures

X = the price of gold stock

C = constant

T = time

u = error

k = constant

The coefficient of determination (R^2) is one of very important test tools to explain how the data fit in a model. In the linear relationship model, R^2 is equal to the square of the correlation coefficient. We know the value of correlation coefficient is between -1 to 1 then value of R^2 is between -1 to 1, where the highest R^2 can explain more correlation with the model. If we find gold futures prices and gold stock price have a linear relationship, we can use the coefficient of determination to test our formula. Thus R^2 will show how much the data can explain our functional relationship.

Chapter 4

Results and Analysis

4.1 Correlation analysis

Table 4.1 Basic Statistics

	period	stock (USD)	gold price	gold future price(USD)
Mean	Jan 2, 2004~ July 31, 2014		0.62635	1022.09908
	Jan 2, 2004~ Dec 29, 2006		0.12489	494.01884
	Jan 2, 2007~ Sep 30, 2013		0.74	1224.77
	Oct 2, 2014~ July 31, 2014		0.27	1290.95
Standard deviation	Jan 2, 2004~ July 31, 2014		0.43659	603.16208
	Jan 2, 2004~ Dec 29, 2006		0.10493	93.26218
	Jan 2, 2007~ Sep 30, 2013		0.25727	377.76961
	Oct 2, 2014~ July 31, 2014		0.09814	39.07462
Max	Jan 2, 2004~ July 31, 2014		1.67	1951.80
	Jan 2, 2004~ Dec 29, 2006		0.45	742.80
	Jan 2, 2007~ Sep 30, 2013		1.67	1951.80
	Oct 2, 2014~ July 31, 2014		0.49	1380.50
Min	Jan 2, 2004~ July 31, 2014		0.04	378.30
	Jan 2, 2004~ Dec 29, 2006		0.04	378.30
	Jan 2, 2007~ Sep 30, 2013		0.12	635.80
	Oct 2, 2014~ July 31, 2014		0.19	1197.40

Table 4.1 shows some basic statistics from three different periods. We can clearly find that the maximum price and minimum price of gold stock and gold futures occurred in the same period. To each if there is any relationship between gold future and gold stocks we can calculate the correlation coefficients.

Table 4.2 The Correlation Coefficient

	Jan 2, 2004~ July 31, 2014	0.84597
correlation	Jan 2, 2004~ Dec 29, 2006	0.93665
coefficient	Jan 2, 2007~ Sep 30, 2013	0.59412
	Oct 2, 2014~ July 31, 2014	-0.06129

Table 4.2 describes the correlation coefficient at different periods. The correlation coefficient was 0.85 from January 2, to July 31, 2014. This number shows there is a very positive correlation between the two variables we researched. Before the U.S subprime mortgage crisis, the correlation coefficient was 0.94, which was the highest correlation. From January 2, 2007 to September 30, 2013, the correlation coefficient decreased from 0.94 to 0.57. After September 30, 2013, the correlation coefficient declined further from 0.59 to negative 0.06. That means the correlation between two variable we researched decreased after the economic crisis. We know the correlation was not the only standard to research the relationship between two variables, we will use the regression analysis to research the relationship between gold futures and gold stocks in different stages.

4.2 Regression Analysis of Pre- Crisis

Table 4.3 The variance-comparison tests

group (group 1 group2 group3)	Summary of price		
	Mean	Std. Dev.	Freq.
1	.2749052	.0981431	205
2	.74093038	.25727058	1664
3	.12489582	.10493938	743
Total	.52911995	.3552486	2612

W0 =	285.68097	df(2, 2609)	Pr > F = 0.00000000
W50 =	312.48327	df(2, 2609)	Pr > F = 0.00000000
W10 =	302.45220	df(2, 2609)	Pr > F = 0.00000000

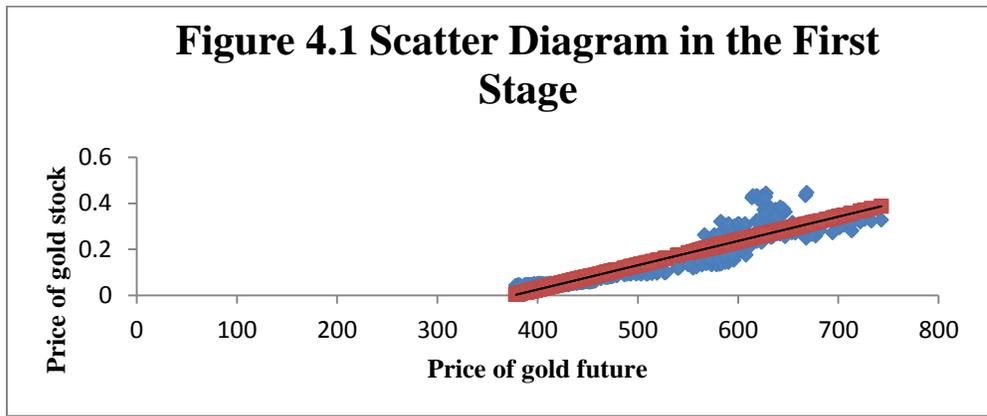


Table 4.4 Regression Analysis in the First Stage

	SS	df MS	Number of obs	743	
		F(1, 741)	5299.51		
Model	7.16874237	1 7.16874237	Prob > F	0	
Residual	1.00236423	741 .001352718	R-squared	0.8773	
		Adj R-squared	0.8772		
Total	8.1711066	742 .011012273	Root MSE	0.03678	
price	Coef.	Std. Err.	t	P>t	[95% Conf. Interval]
gold	0.0010539	.0000145	72.80	0	0.0010255 0.0010824
_cons	-0.3957681	.0072784	-54.38	0	-0.4100567 0.3814794

According to Figure 4.1 and Table 4.4, it's easy to find there is a strong linear relation between gold futures and gold stocks. I added a red line to predict the

relationship. The regression function was $Y = -0.3957681 + 0.0010539x$, R-squared was 0.8773 and adjusted R-squared was 0.8772 in the first stage which was January 2, 2004 to December 29, 2006. To increase the veracity, I used $100\% * R\text{-squared} = 87.73\%$. Therefore 87.73% data were explained by the regression function.

January 2, 2004 to December 29, 2006 is before the U.S subprime mortgage crisis. The main function of gold was a world currency and the price of gold futures became a standard to measure to value gold companies. That was why 87.83% data can explained with same regression equation. In other words, there was an obvious linear relationship between two variables we researched in the first stage.

4.3 Regression Analysis of Post- Crisis

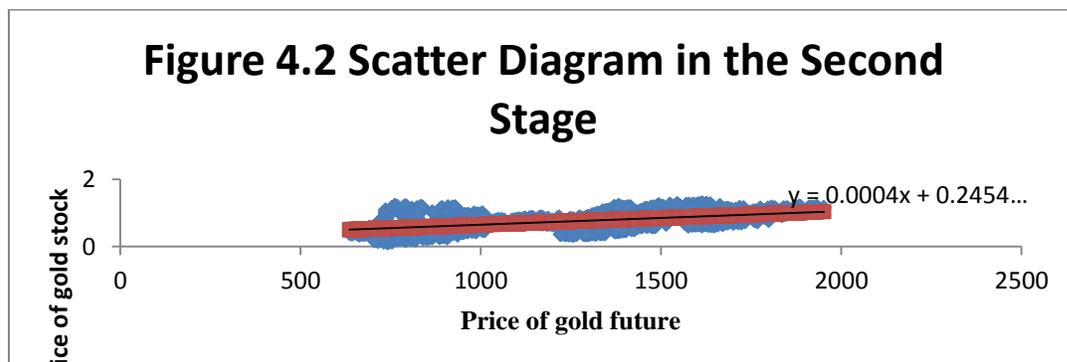


Table 4.5 Regression Analysis in the Second Stage

Source	SS	df MS	Number of obs	1664	
		F(1, 1662)	906.71		
Model	38.8532166	1 38.8532166	Prob > F	0	
Residual	71.2176766	1662 .042850588	R-squared	0.353	
		Adj R-squared	0.3526		
Total	110.070893	1663 .06618815	Root MSE	0.207	
price	Coef.	Std. Err. t	P>t	[95% Conf.	Interval]
gold	0.0004046	.0000134 30.11	0	0.0003783	0.000431
_cons	0.2453705	.017222 14.25	0	0.2115914	0.2791496

From Figure 4.2, we find the scatter diagram was very cluttered. The red line I added was not explained by the change between the two variable we researched very well. Table 4.5 shows the R-squared was 0.353, which means only 35.3% data can be covered in the equation $Y=0.2453705+0.0004x$. From January 2, 2007 to December 31, 2013, the U.S subprime mortgage crisis happened and spread its economic influence everywhere. Inflation always happens, as caused by government investing more money into the economy. Not surprisingly, inflation occurs in this case as well. They started to look for some good investment opportunities. Since people were not able to make enough money for their lives, they started to think maybe investment is an efficient way to add some wealth. Gold investment is still one of the highly effective inflationary hedge tools. With the decrease in the stock index and rise in unemployment, many people lost confidence in the global economy. So many investors entered in to gold investment. Day by day the demand of the gold and the price of gold grows higher. The price of gold stock shows not

only the price of the gold, but also a firm's performance. That is why we find some different trends between the gold futures market and the gold stock market. Compared with Table 4.2, we know the cointegration relationship between gold futures and gold stocks decreased and was caused by different trends after the U.S subprime mortgage crisis.

4.4 Regression Analysis in the Third Stage.

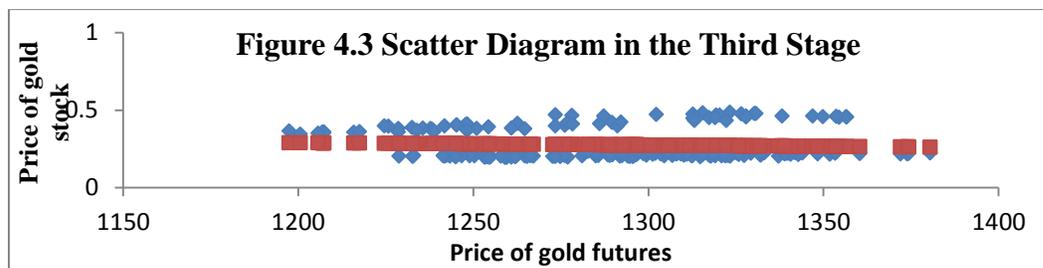


Table 4.6 Regression Analysis in the third Stage

Source	SS	df MS	Number of obs	205	
		F(1, 203)	0.77		
Model	0.007382327	1 .007382327	Prob > F	0.3826	
Residual	1.95755959	203 .009643151	R-squared	0.0038	
		Adj R-squared	-0.0012		
Total	1.96494191	204 .009632068	Root MSE	0.0982	
price	Coef.	Std. Err. t	P>t	[95% Conf.	Interval]
gold	-0.000154	.000176 -0.87	0.383	-	0.000193
_cons	0.4736494	.2272507 2.08	0.038	0.0255749	0.921724

Figure 4.3 and Table 4.6 shows there was not a linear relationship between the two variables we researched. With a R-squared was 0.0038 and the scatter diagram became more and more complicated. From the beginning of 2012, the price of gold futures started to decrease, with the global stock market already returning back to its normal levels. We can report on a very interesting observation on the correlation coefficient: it is -0.06 from October 2, 2014 to July 31, 2014. What caused the large discrepancy in the correlation coefficient? With the development of electronics and jewelry, gold has expanded its areas of application. The demand of gold futures has decreased caused by economic recovery, then the gold futures price has also decreased. However, the price of gold stock increased. We now find the correlation between gold future and gold stock is very low.

Chapter 5

Conclusion

This paper researches the relationship between gold futures and gold stocks and how gold futures influenced gold stocks before and after the U.S subprime mortgage crisis, and after October 2, 2013, when the NYSE Acra Gold Miners Index added these three Hong Kong gold stocks. The historical data on three gold stocks and gold future are collected through January 2, 2004 to July 31, 2014 from the Hong Kong market. The main finding from this paper can be summarized as follows:

1. The gold futures and gold stock have a cointegration relationship and the fluctuation in gold futures dominated fluctuations in gold stocks was weaker than before.

2. In the pre-crisis stage from January 2, 2004 to December 29, 2006, the gold futures and gold stocks have a very strong positive correlation. The regression analysis indicates that the fluctuation in gold futures heavily dominated fluctuations in gold stocks, the price of gold futures was a most important standard to estimate the price of a gold stock.

3. In the post-crisis stage from January 2, 2007 to September 30, 2013, the correlation between gold future and gold stock decreased to a significant positive correlation. The regression analysis shows that the fluctuation in gold futures cannot dominates fluctuation in gold stocks. The price of gold futures was one of important standards to estimate the price of gold stock, but there more variables can influence the

price of gold stocks. For example a weak world economy, bad firm's performance, inflation and so on.

4. After the NYSE Arca Gold Miners index added these three Hong Kong gold stocks we researched. The correlation between gold futures and gold stocks decreased to -0.06, which means they did not have a relationship. The regression analysis describes that the fluctuation in gold futures cannot dominates fluctuation in gold stocks, because the currency function of gold was replaced with U.S. dollars and the euro. Additionally the industry and jewelry function of gold developed rapidly. As a result currency function of gold cannot dominates the performance of a gold company. Also the demand of gold decreased as economic recovery look worse and inflation reduced. The price of gold futures will decrease when the demand decreases, however the price of gold stocks will increase with economic recovery given the consumer demand.

There is no doubt that there are a lot of limitations the affect my research. For example the number of gold stocks, short period and other variables' influence the Hang Seng index, NYSE Arca Gold Miners index, U.S. dollar index and the euro.

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