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Is gold a hedge or a safe haven？Evidence from inflation and stock market

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Abstract

Gold with special nature has always been regarded as a safe asset. This paper examine whether gold serves as a hedge for stock or/and inflation in China mainland market. Employing improved classic methods, and some new methods, such as quantile regression and binary probit model, our empirical results show, for short-term investors, that gold always cannot hedge stock and inflation risk. But it is actually a good hedge for stock or inflation if you would hold gold for a long time. However, it is regrettable that gold is not a safe haven when investors face with stock and inflation risk in china capital market anyway.

Keywords: Hedge, Safe haven, Gold, Inflation, Stock

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1. Introduction

There is a saying in China, "Collecting antique in times of prosperity, while buying gold in times of troubled". The meaning of the saying is that gold is often referred to as a safe haven and a store of value in financial crisis and social turmoil. At present, it is interesting that prices for both antique and gold are at record highs, so from this perspective, China is neither in the times of prosperity nor in troubled times. And in recent decades, financial instruments have grown steadily, which has raised the risks of the system. So, even in stable age, the investors need a safe haven to avoid the risks yet.

Gold with its special nature has always been regarded as a safe asset. Gold has been used as a store of value and a means of exchange for thousands of years. It has been said gold as wealth "at all times and all places". Gold also has characteristics of a financial asset. In times of uncertainly, because of investors' unwillingness to trade, asset values become ambiguous, the activities of gold may increase due to the relative simplicity of gold market. So gold might become an attractive investment, especially during periods of financial market turbulence (Baur and McDermott, 2010). For instance, since the beginning of the financial crisis in July of 2007, the nominal gold price has risen more than 200%. In addition, unlike other financial assets, the value of gold tends to rise in response to negative market shocks. The beauty of gold is, it loves bad news.[1]

Baur and Lucey (2010) point out that gold is usually referred to as a safe asset, one major explanation is that it was one of the first forms of money and traditionally used as an inflation hedge. Another explanation could be gold is said to be uncorrelated with other types of assets. Additionally, because gold is priced in dollars, gold also can act as a hedge against exchange-rate risk for investor with dollar holdings. In this paper, we mainly focus on the former two aspects, studying whether gold can act as a hedge or a safe haven or not when facing the risk of inflation and the impact from the stock market.

There exists massive literature assessing the hedging potential of various assets. One strand examines which asset or the extent to which can hedge inflation .See, e.g. Reilly et al. (1970), Johnson et al (1971), Jaffe et al. (1976), Fama and Schwert (1977), Ely and Robinson (1997), Alagidede and Panagiotidis (2010) for stock; Park et al. (1990), Kiat-Ying Seah (2011) for REITs; Fama and Schwert (1977), Liu et al. (1997), Dee (2012) for direct investments in real estate; Laura and Zaghum (2010) for commodities; Despite this large body of literature, there is just few papers (See e.g. Ghosh et al,2002; McCown and Zimmerman, 2006) to discuss about gold as a hedge against inflation. Another strand examines the hedging potential between difference assets. See e.g. Baur and McDermott (2010), Virginie and Helene (2011) between gold and stock; Baur and Lucey (2010) between stock, bonds and gold; Ciner et al. (2010) for stocks, bonds, oil, gold and dollar; Wang and Lee (2011) between gold and exchange rate.

In these existing literatures, researches relevant to gold hedging against inflation and stock usually are separated, except for McCown and Zimmerman (2006). The theoretical foundation of hedging to stock is Arbitrage Pricing Model (APM) of Ross (1976). In fact, there are several relative theories to study hedging properties of an asset. For hedging against inflation, Fisher hypothesis (Fisher, 1930) is used mainly. Under

[1] See "Harry 'Rabbit' Angstrom" Rabbit is Rich, John Updike, the Economist, February 26th 2009.

this theoretical framework, Jaffe et al. (1976) regresses real and nominal stock index returns on ex post inflation, as well as on proxies of expected and unexpected inflation during inflationary and non-inflationary periods. Short-term returns are negatively related to contemporaneous, anticipated and unanticipated inflation, implying a bad hedge. However, for long-term returns the relation turns out positive. Fama and Schwert (1977) translate the Fisher hypothesis into a regression framework. They test the hedging capacity of stocks, bonds, T-Bills, residential real estate and labor income, and conclude that residential real estate is the only complete hedge against expected and unexpected inflation. Alagidede and Panagiotidis (2010) apply Fisher equation to examine the hedging potential of stock in Africa. Gold as a more excellent asset, these methods could be used to study its properties of hedging against inflation. However, studies relevant to this issue are relatively scarce.

For hedging among various assets, the main idea comes from portfolio theory, such as capital asset pricing model (CAPM, See Shap, 1964 and Lintner, 1965) and Arbitrage Pricing Model. They provide theoretical foundation for following empirical analysis.

The econometric approach is mainly based on a regression model in which gold returns are regressed on inflation or other assets[2]. Taking into account the asset lagged effect and volatility clustering features, on the basis of return regression, Capie et al. (2005) and Baur and Lucey (2010b) also add lagged terms and assume the error term to exhibit conditional autoregressive heteroskedasticity modeled via a GARCH process. Return model tell us only the short-run relationship. In order to investigate the long-run relationship of variables, we should carry out Johansen's (1995) co-integration test or apply Error Correction Model (ECM). Generally speaking, we assume that the price of gold does not influence other assets' prices, however there is a causal relation running from gold to such as stock markets. Researchers apply VAR or VEC models (See e.g. Ely and Robinson, 1997; Anari and Kolari, 2001; Alagidede and Panagiotidis, 2010) to reflect this feedback mechanism.

Mulyadi and Anwar (2012) proceed in a very different way and discuss gold hedge by Probit model. If the above is from deterministic point of view, then they are from the uncertainty probability. At the same time, they provide a new method to define "hedge", which is very different from what based on Fisher theory and CAPM. The following will give relative details.

The above literatures focus on "hedge". Hedge means one asset co-moves with inflation or the gold is not relative with other assets. Baur and McDermott (2010) extend this analysis by showing that gold is a "safe haven" during periods of turmoil on the stock. They point out that a hedge is defined as an asset that is uncorrelated or negatively correlated with another asset or portfolio on average. But a safe haven is defined as an asset that is uncorrelated or negatively correlated with another asset or portfolio in times of market stress or turmoil. The two conceptions differ in market environment. In fact, in earlier studies, Jaffe and Mandelker (1976) also test Fisher hypothesis during inflationary and non-inflationary periods. Baur and McDermott (2010) add dummy variables to capture falling market. Apart from dummy variables, quantile regression also is a good method to solve this issue. It can discover some new relationship that general regression does not. Dee (2012) applies this method to find real estate can hedge against inflation in extreme

[2] In case of the two variables, a simple measure for quantifying the hedging potential of an asset is the Pearson correlation.

high or low quantile for Chinese mainland. Some researches divide sample into subsamples according to bull and bear markets or expansion and recession (Virginie and Helene, 2011).

This paper makes three key contributions: first, from econometric point of view, we apply quantile regression to examine gold hedging and safe haven properties in extreme conditions. Second, the paper provide a new definition of hedge definitely according to Mulyadi et al. (2012)'s studies. Third, we examine the hedging potential of gold in China, emerging market for the first time. Using daily and monthly data, we find that gold can hedge against inflation and stock risk for the long term, rather than short term, and it is not a safe haven for inflation and stock in China.

The remainder of this paper is organized as follows. Section 2 briefly introduces relative theories and research methodology. Section 3 sets out the definitions of the hedge and safe haven and describes how to use the former methods to test for hedge and safe haven. Section 4 contains the econometric analysis and comments on them, while Section 5 concludes.

2. Theoretical basis and econometric methods

2.1. Fisher equation and co-integration

In classical Theory of Interest, Fisher (1930) postulates that the ex ante nominal interest rate incorporates the anticipated rate of inflation. At the same time, he emphasizes the independence of the real and monetary sectors, precluding the ex ante real rate of interest is assumed constant. The proposition that ex ante nominal asset returns contain the market's perception of anticipated inflation rates can be applied to all assets. This means economic agents will require a nominal return that will compensate for the decline in the purchasing power of money. Therefore, the Fisher equation is expressed in its most simple form[3] as

$$R_t = E_{t-1}(r_t) + E_{t-1}(\pi_t) + u_t \qquad (1)$$

where R_t is the nominal interest rate, $E_{t-1}(r_t)$ and $E_{t-1}(\pi_t)$ are the ex-ante real interest rate and the expected inflation, respectively. u_t is error term. Under rational expectations, if define the ex-post real interest rate is r_t , and the actual inflation rate is π_t , the relationship between the real and the expectant values can be written as

$$r_t = E_{t-1}(r_t) + v_{1t} \qquad (2)$$

[3] Furthermore, Jaff and Mandelker (1976), Fama and Schwert (1977) distinguish between expected and unexpected inflation when they tested the Fisher hypothesis empirically, $r_t^{(k)} = \mu + \alpha E_t(\pi_t^{(k)}) + \gamma(\pi_t^{(k)} - E_t(\pi_t^{(k)}))$.

$$\pi_t = E_{t-1}(\pi_t) + v_{2t} \qquad (3)$$

where v_{1t} and v_{2t} are stationary zero mean forecast errors. Now substitute equation (2) and (3) to (1), obtaining

$$R_t = r_t + \pi_t + w_t \qquad (4)$$

where $w_t = u_t - v_{1t} - v_{2t}$. We can regress nominal asset returns on ex-post inflation rates, yielding the regression model[4]

$$R_t = \alpha + \beta\pi_t + e_t \qquad (5)$$

For gold market, the Fisher hypothesis postulates that the nominal gold return reflects market expectations about the real gold return and inflation. Moreover, in equation (5), also following equation (8) and (9), it is important to analyze the dynamic link and higher moment between the assets return via adding lagged return and conditional autoregressive heteroskedasticity process.

Using gold returns and inflation tell us only about the short-run solution. However, several studies use the concept of co-integration to define a long-term inflation hedge, called the long-run Fisher effect (See Ely and Robinson, 1997; Anari and Kolari, 2001). In my paper, for single equation, we apply Engel and Granger cointegration test (called E-G two step method) to investigate the long-run relationship between gold price (G_t) and consumer prick (P_t). Let the vector $y_t = (G_t, P_t)^T$, each of which is known to be I(1). If these time series are cointegrated, there exists a vector α such that the stochastic process $z_t = (1, y_t)^T \alpha$ is I(0). So one step is to run the cointegrating regression[5]

$$G_t = \alpha_0 + \alpha_1 P_t + u_t, \qquad (6)$$

thus obtaining a vector of coefficients $\hat{\alpha}$. Next step is calculates $\hat{z}_t = (1, y_t)^T \hat{\alpha}$, and tests to see if $\hat{z}_t$ is I(1) using Unite root test. If one rejects z_t is I(1), one concludes that G_t and P_t are cointegrated. And if the coefficient is more than one, then they have long-run Fisher effect.

[4] Although Jaff and Mandelker (1976), Fama and Schwert (1977) regressed nominal asset returns on proxies of expected and unexpected inflation, Boudoukh and Richardson (1993) noticed that the estimate of α is also informative about the influence of unexpected inflation on nominal asset returns. The OLS estimates in Equation (5) can be viewed as existing measurement errors. Usually, this bias is downward, resulting in an estimate of the Fisher coefficient that understates the true value of α.

[5] In the right of equation (7), we can also add lag terms of G_t and P_t such as $G_t = \sum_{i=1}^{k} \beta_i G_{t-i} + \sum_{i=0}^{k} \alpha_i P_{t-i} + u_t$, then long-term coefficient is $\hat{\theta} = \sum_{i=0}^{k} \hat{\alpha}_i \Big/ (1 - \sum_{i=1}^{k} \beta_i)$.

2.2. Capital and asset pricing model and arbitrage pricing model

The Capital Asset Pricing Model (CAPM) of Sharp (1964) and Lintner (1965) is listed in equation (7):

$$R_{gt}\text{-}R_{ft}=\alpha+\beta\left(R_{st}\text{-}R_{ft}\right)+\varepsilon_t \qquad (7)$$

The CAPM is limited in usefulness as a tool for investment analysis because it lumps all sources of risk into one set. To evaluate multiple sources of risk, we use the arbitrage pricing theory of Ross (1976). It provides a framework with which to evaluate an asset's potential to multiple sources of risk simultaneously by running the following regression:

$$R_{gt}\text{-}R_{ft}=\alpha+\beta_1\left(R_{st}\text{-}R_{ft}\right)+\beta_2\pi_t+\varepsilon_t \qquad (8)$$

2.3. Binary dependent variable models

In this class of models, the dependent variable Y_t, may take on only two values. Y_t is a dummy variable representing the occurrence of the event (See, Agresti, 1996). In this paper, Y_t represents whether increase in gold return and stock return, respectively, They are 1 if return is higher than previous time, 0 otherwise. Binary model suppose that there is an unobserved latent variable Y_t^* that is linearly related to explanatory variables. R_s and R_g are daily return of stock and gold, respectively.

$$Y_{gt}^*=\beta_0+\sum_{i=1}^{k}\beta_i R_{s,t\text{-}i+1}+u_{gt}$$

$$Y_{gt}=\begin{cases}1 & if\ Y_{gt}^*>0\\ 0 & if\ Y_{gt}^*\le 0\end{cases}$$ [6]

$$P(Y_{gt}=1|R_s,\beta)=P(Y_{gt}^*>0)=P(u_{gt}>\text{-}(\alpha_0+\sum_{i=1}^{k}\alpha_i R_{s,t\text{-}i+1}))=1-F(\text{-}(\alpha_0+\sum_{i=1}^{k}\alpha_i R_{s,t\text{-}i+1}))$$ Similarly,

$$Y_{st}^*=\alpha_0+\sum_{i=1}^{k}\alpha_i R_{g,t\text{-}i+1}+u_{st}$$

$$Y_t=\begin{cases}1 & if\ Y_{st}^*>0\\ 0 & if\ Y_{st}^*\le 0\end{cases}$$

$$P(Y_{st}=1|R_g,\beta)=P(Y_{st}^*>0)=P(u_{st}>\text{-}(\beta_0+\sum_{i=1}^{k}\beta_i R_{g,t\text{-}i+1}))=1-F(\text{-}(\beta_0+\sum_{i=1}^{k}\beta_i R_{g,t\text{-}i+1}))$$

[6] In this case, the threshold is set to zero, but the choice of a threshold value is irrelevant, so long as a constant term is included in regression.

where F is the cumulative distribution function of u . Common models include probit (standard normal), logit (logistic) specifications for the F function.

Binary dependent variable models can be used to test whether the probability of gold return (stock return) increasing is relative with stock return (gold return).

2.4. Quantile regression

For non-normal variables, it is meaningful to study quantile relationship between these variables. "While the great majority of regression models are concerned with analyzing the conditional mean of a dependent variable, there is increasing interest in methods of modeling other aspects of the conditional distribution" (Quantitative Micro Software, 2007). Quantile regression (See Koenker and Bassett, 1978) permits a more complete description of the conditional distribution than conditional mean analysis alone, for example, to describe how the 10th or 95th percentile of the response variable, are affected by regressors. Moreover, it offers a robust method of modeling these relationships. In reality, financial time series are usually non-normal distribution, and have peak and fat tail characteristics.

Examining higher quantile and lower quantile is useful to analyze extreme risk of financial variable. In this paper, we employ quantile method to consider the quantiles of distribution function of R_{gt} (gold return) given R_{rt} (stock return) or π_t (inflation rate). Suppose that we have the linear regression

$$R_{gt} = \beta' x_t + u_t ,$$

where β is a κ-dimensional vector of parameters and x_t is a vector of predictors. For a given probability p, the pth quantile of R_{gt} is obtained by

$$\hat{x}_p = argmin_{\beta} \sum_{i=1}^{n} \rho_p \left(R_{gt} - \beta x_t \right) \tag{9}$$

where $\rho_p(z)$ is a loss function, defined by

$$\rho_p(z) = \begin{cases} pz & \text{if } z \geq 0, \\ (p-1)z & \text{if } z < 0. \end{cases}$$

3. Definitions

This section discusses three methods for quantifying the hedging potential of an asset, based on the theories discussed in Section 2. The first approach is based on Fisher equation and co-integration. Actually, CAPM and ATM are the transformation of Fisher equation. So they belong to this category. These are usually used. The second approach is based on Binary dependent variable models. It is really not different from common method, is from probability point of view. The third one is based on quantile regression and dummy variable. It is used to examine the potential of safe hedge in extreme condition.

3.1. Hedge

For the capability of gold against inflation, Fama and Schwert (1977) say that an asset is a complete hedge against expected inflation if the Fisher coefficient in a regression of nominal asset returns on the expected inflation rate is not statistically different from unity, just as equation (5). The asset is a perverse hedge for $\beta \leq 0$, a partial hedge for $0<\beta<1$, and a more than complete hedge for $\beta \geq 1$. These are the contemporaneous relation between gold return and inflation, Moreover, using the variables in their first-differences (return) may throw away significant information about their long-run relationships. Cointegration allows us to analyze the long-run relationship with gold price and consumer price. In equation (6), given that the variables are expressed in logarithms, the coefficient α_1 is the elasticity of gold price with respect to consumer prices. If variables are not stationary and exist cointegration relationship, possible outcomes will include $\alpha_1>0$ (partial hedge), $\alpha_1=1$ (co-move relationship, full hedge) and $\alpha_1>1$ (gold performance a good hedge). [7]

For the hedge property of gold against stock, the empirical research is based on CAPM. In equation (7), a hedge is defined as an asset that is uncorrelated or negatively correlated with stock on average, that is, the coefficient β is not different from zero statistically. Considering investor holding stock as well as facing inflation, employ ATM is appropriate. In equation (8), the coefficients β_1 and β_2 represent marginal effect. If both the coefficients β_1 and β_2 are not significant, gold cannot only hedge stock risk but also inflation risk. If one of them is zero, gold can only hedge one of the risks. We can also research long-run hedge characteristic, just as equation (6), when there is no co-integration among logarithmic gold price, logarithmic stock price and logarithmic inflation, gold can efficiently hedge stock and inflation risk over long time horizon.

For the hedge property of gold against stock, there is a special method used by Mulyadi and Anwar (2012) at first. They realize the rise in probability of gold return is increasing while the stock return is decreasing, so they think gold is a hedge to stock. In our paper, we expand this research. Employ Binary dependent variable models, we define probable hedge as the rise in probability of gold return is uncorrelated or negatively correlated with the stock return.

[7] However, when the income from stocks is subject to taxes, the rate of return on common stocks should exceed the inflation rate at least. Therefore, the size of the coefficient could, in fact, exceed unity.

3.2. Safe haven

Baur and Lucey (2010) think "a hedge does not have the (specific) property of reducing losses in times of market stress or turmoil since the asset could exhibit a positive correlation in such periods and a negative correlation in normal times with a negative correlation on average." So, they define a safe haven as "an asset that is uncorrelated or negatively correlated with another asset or portfolio in times of market stress or turmoil". In their paper, dummy variables are included in order to keep track of falling stock market, such as

$$R_{gt} = \alpha_0 + \alpha_1 R_{st} + \alpha_2 D_{sq} + \alpha_3 D_{sq} \times R_{st} + \varepsilon_t \qquad (10)$$

D_{sq} is a dummy variable, if the return is larger than the $q\%$ quantile of stock return, its value is zero. If the sum of α_1 and α_3 is nonpositive, gold serves as a safe haven asset for stock.

The key point of a safe haven is whether there are hedge phenomena in extreme market condition. Adding dummy variable is one method, another way is subsample. For instance, Virginie and Helene (2011) examine gold hedge property during business cycle (expansion or recession) and stock market cycle (bull or bear markets). However, this is subjective somewhat and is incomplete, because recession and bear term cannot catch all falling market information. Quantile regression can overcome this problem.

Using quantile regression method, we can define a safe haven as the higher quantile, rather than lower quantile. For hedging stock, the coefficient is not significant in equation (9), while for inflation risk in equation (5) coefficient is significant positive. Notice that we focus on the higher quantile, because lower gold return usually is not along with depress economy. Economic and social turbulence usually company with higher gold price.

4. Empirical analysis

4.1. Data

The data consists of daily, monthly gold price and stock price provided by RESSET database and monthly Consumer Price Index (CPI) taken from the National Bureau of Statistics of China, which is seasonally adjusted data by Tramo/Seats tool.[8] Monthly price of gold is the arithmetic mean of the daily price of gold within every month. The returns are calculated by prices as following formula:

$$R_i = (\ln P_{i,t} - \ln P_{i,t-1}) \times 100$$

[8] The specific method of calculation as follow, firstly, use month-on-month figures after January 2001, published by the National Bureau of Statistics of China, to calculate data based on January 2001. Secondly, according to the CPI year-over-year data compute forward, obtain monthly data based on January 2001. Finally, we convert them to the CPI monthly data based on January 1990.

i =gold price, stock price and CPI. The growth rate of CPI is also called inflation rate. The daily data cover almost 10 year period from October 31, 2002 to April 6, 2012, a sample size of 2272 observations. The monthly data include 113 observations from December, 2002 to March, 2012.

4.2. Is gold a hedge or a safe haven to inflation?

Table 1 shows the estimates for daily data. The table contains three panels. The top panel is contemporaneous or short relationship based on Fisher equation, containing conditional volatility function. For model 1, the coefficient of volatility is significant, and $Q(10)$, $Q^2(10)$ show the model is designed appropriately. However, the coefficient estimate for inflation rate is 0.02, which is not significant. That means the return of gold is not increase along with inflation rate increasing. That is, gold is not a hedge against inflation in the short term. However, for the long run, we find out gold performs as a good hedge against inflation. For model 2 in middle panel , gold price and CPI have a long co-integration relation via E-G two step method, since both gold price and CPI[9] are I(1) and E-G residual is I(0). Considering the lag term, the long-run coefficient is obtained through formula $\alpha/(1-\beta)$, whose value is 8.696. That is, if CPI increases one unit, gold price will increase 8.696 unit. For comparison, we also estimate the same model for the log values. The long-run coefficient 4.668 is the elasticity of gold price with respect to CPI and is greater than 1, which means gold is a good hedge against inflation in the long term.

We apply two methods to examine save haven. The results are showed in bottom panel. The first method is quantile regression introduced in section 2. We show nine quantile estimated coefficients. In the 10 percent and 20 percent quantile of gold return, the coefficients are significantly positive, 0.032 and 0.023 respectively, however they are very small, that mean when the gold return is very low, gold return can hedge just a little inflation risk. We also recognize the coefficients such as 0.8 and 0.9 quantile are significantly negative. One possible explanation is high inflation is associated with a depressed economy and thus nominal returns will tend to be lower when inflation is high. Another possible interpretation is gold market investors incorrectly discount real cash flows with nominal discount rates. This mispricing error is exacerbated in inflationary environments. As a result, when inflation is high, gold are undervalued. The second method is adding dummy variables to Fisher equation, just as model 5, d is a dummy variable, if the return is larger than inflation rate 6%, its value is 1. However, the coefficients are zero, that is, gold do not serves as a safe haven asset for higher inflation. To sum up, gold is not a safe haven asset for inflation risk.

4.3. Hedge or safe haven to stock?

This section provides empirical results about gold serves as hedge or safe haven to stock. In Table 2, short term relation coefficient is 0.053, if stock return increases a unit, gold return increases 0.053 unit accordingly. That implies the two are moving in the same direction, gold is not a hedge to stock in the short run. However, Johansen Cointegration Test tells us there is no a co-integration relation between logarithms gold price and logarithms stock price, that is, there is no same trend for the long term. So gold is a good hedge to stock for long-run.

[9] The result of unite root test will be available upon request.

Table 1. Estimation Results for Gold to Inflation

contemporaneous relation				
model 1		β		0.020(1.222)
		γ_1		0.212(1.678*)
		$Q(10)$		6.318
		$Q^2(10)$		3.808
long-run relation				
		model 2		model 3
α		0.567(1.703*)		0.537(2.086**)
β		0.934(22.208***)		0.884(16.745***)
long coefficient		$\alpha/(1\text{-}\beta)$ =8.696		$\alpha/(1\text{-}\beta)$ =4.668
R-squared		0.987		0.985
E-G residual unite root test		ρ = -0.050(-0.518)		ρ = -0.136(-1.433)
Extreme condition				
model 4	quantile (Coeff.est)	0.1 (0.032***)	0.2 (0.023**)	0.3 (0.006)
		0.4 (-0.006)	0.5 (-0.008)	0.6 (-0.021)
		0.7 (-0.013)	0.8 (-0.019*)	0.9 (-0.020**)
model 5		β_1		0.025 (1.498)
		β_2		-0.022(-0.011)
		β_3		0.005(0.003)
		γ_1		0.204(1.719*)
		$Q(10)$		6.335
		$Q^2(10)$		3.781

Note:

* *Statistical significance at the 10% level.*

** *Statistical significance at the 5% level.*

*** *Statistical significance at the 1% level. If no special notes, it is t-statistic value in parenthesis. The following table notes are similar.*

model 1: $R_t = \alpha + \beta\pi_t + e_t \quad h_t = \gamma_0 + \gamma_1 e_{t-1}^2$

model 2: $GP = c + \alpha CPI + \beta GP(-1) + \varepsilon_t$

model 3: $\ln(GP) = c + \alpha \ln(CPI) + \beta \ln(GP(-1)) + \varepsilon_t$

model 4: quantile regression $R_{gt} = \beta\pi_t + u_t$

model 5: $R_t = \alpha + \beta_1\pi_t + \beta_2 d + \beta_3 d \times \pi_t + e_t \quad h_t = \gamma_0 + \gamma_1 e_{t-1}^2$

Table 2. Estimation Results for Gold to Stock

		contemporaneous relation		Extreme condition
		model 6		model 8
β		0.053 (3.228***)		0.067 (4.089***)
β_1		/		0.001 (0.899)
β_2		/		-0.060 (-1.633)
γ_1		0.079 (17.879***)		0.080 (17.794***)
γ_2		0.913 (185.871***)		0.912 (186.618***)
$Q(10)$		9.5592		9.4396
$Q^2(10)$		11.991		12.056
long-run relation				
				Trace Statistic
Johansen Cointegration Test		none of CE		3.924093
		At most 1 CE		0.624287
Extreme condition				
model 7	quantile (Coeff.est)	0.1(0.078***)	0.2(0.073***)	0.3(0.059***)
		0.4(0.038***)	0.5(0.039***)	0.6(0.048***)
		0.7(0.053***)	0.8(0.051***)	0.9(0.032)

Note: model 6: $R_{gt}-R_{ft}=\alpha+\beta\left(R_{st}-R_{ft}\right)+\varepsilon_t$, $h_t=\gamma_0+\gamma_1 e_{t-1}^2+\gamma_2 h_{t-1}$

model 7: quantile regression $R_{gt}-R_{ft}=\beta(R_{st}-R_{ft})+u_t$

model 8: $R_{gt}=\alpha+\beta(R_{st}-R_{ft})+\beta_1 d+\beta_2 d\times(R_{st}-R_{ft})+e_t$, $h_t=\gamma_0+\gamma_1 e_{t-1}^2+\gamma_2 h_{t-1}$

We test whether the probability of gold rising return is relative with stock return via binary dependent variable model. The results are provided in Table 3. We assume that gold and stock returns are between -10% and 10% (here only report -5%~5%). Under assumption of -5% stock return there is only 39.6% probability that gold return will increase, while in 5% stock return we have greater probability (60.6%). At the meanwhile the probability of increase in gold return more and more lower while stock return is decreasing. It can be concluded that when stock investment is negative return, then the probability of increase in gold return becomes lower, gold is not a good hedge to stock from view of probability. Above result is based on daily data. To test its robustness, we use lower frequency data, monthly frequency, the result is very different. Along with decreasing stock return, the probability of gold return is increasing. In fact, it is not surprised at all. This result is consistent with co-integration test.

Table 3. Estimation Results for Gold to Stock (Binary Logit Model)

Daily frequency				
Regression equation				
β_1		8. 296 (3.368***)		
The probability of increase in gold return				
-5%	-4%	-3%	-2%	-1%
0.396	0.417	0.437	0.4585	0.479
1%	2%	3%	4%	5%
0.520	0.541	0.562	0.583	0.606
Monthly frequency				
Regression equation				
β_1		-0.875 (-0.398)		
The probability of increase in gold return				
-3%	-2.5%	-2%	-1.5%	-1%
0.610	0.595	0.582	0.571	0.563
1%	1.5%	2%	2.5%	3%
0.539	0.509	0.497	0.445	0.420

Note: *model 9: Binary Logit* $Y_{gt}^{*}=\beta_0+\beta_1 R_{st}+u_{gt}$, $F(Y_{gt}^{*})=\frac{1}{1+e^{-(\beta_0+\beta_1 R_{st})}}$

4.4. Is gold a hedge or a safe haven to stock and inflation simultaneously?

Investors usually face with not only stock risk but also inflation risk in some periods. We use monthly frequency data[10] to examine these marginal effects. From table 4, we can find these results are according with the previous analysis. In model 10, the coefficient of stock β_1 is still not significant, that is, gold is a good hedge to stock for a longer period. The coefficient of inflation β_2 is also still significant, but it implies gold is not a good hedge against inflation. As far as probability hedge, model 11 tell us, along with stock return decreasing, the probability of the gold return growth is increasing. So gold can serve as a good hedge to stock from a view of probability. However, the effect of inflation rate is not certain. In model 12' result, we can see the coefficient of stock return in every quantile are zero statistically, that is, for a longer period, facing inflation and stock risk, gold still is a good hedge and save haven to stock. While the coefficient of inflation is significant just in lower quantile, so we also conclude that gold can hedge inflation risk only when the gold return is lower.

[10] One reason is CPI data is obtained with just monthly or quarterly data.

Table 4. Estimation Results for Gold to Stock and Inflation

model 10	β_1		-0.012 (-0.204)		
	β_2		0.020 (1.198)		
	γ_1		0.217 (1.669)		
	$Q(10)$		5.4041		
	$Q^2(10)$		3.7186		
model 11					
Regression equation					
	β_1		-0.575(-0.414)		
	β_2		0.043(0.131)		
The probability of increase in gold return					
Stock return	-3%	-2.5%	-2%	-1.5%	-1%
	0.588	0.579	0.571	0.564	0.562
	1%	1.5%	2%	2.5%	3%
	0.520	0.503	0.499	0.490	0.488
inflation rate	-4%	-3%	-2%	-1.5%	0
	0.536	0.534	0.513	0.547	0.536
	1.5%	3%	5%	7%	10%
	0.533	0.557	0.542	0.588	0.573
model 12	β_1 quantile (Coeff.est)	0.1(-0.051)	0.2(-0.039)	0.3(-0.032)	
		0.4(-0.044)	0.5(-0.026)	0.6(0.035)	
		0.7(0.084)	0.8(0.088)	0.9(0.065)	
	β_2 quantile (Coeff.est)	0.1(0.050***)	0.2(0.038***)	0.3(0.022**)	
		0.4(0.017)	0.5(0.006)	0.6(0.005)	
		0.7(-0.003)	0.8(-0.010)	0.9(-0.022)	

Note: *model 10:* $R_{gt}-R_{ft}=\alpha+\beta_1\left(R_{st}-R_{ft}\right)+\beta_2\pi_t+\varepsilon_t$, $h_t=\gamma_0+\gamma_1 e_{t-1}^2$

model 11: $Y_{gt}^*=\beta_0+\beta_1 R_{st}+\beta_2\pi_t+u_{gt}$, $F(Y_{gt}^*)=\frac{1}{1+e^{-(\beta_0+\beta_1 R_{st}+\beta_2\pi_t)}}$

model 12: quantile regression $R_{gt}-R_{ft}=\alpha+\beta_1(R_{st}-R_{ft})+\beta_2\pi_t+u_t$

5. Conclusion and direction for further research

This paper analyzes whether gold serves as a hedge tool for stock or/and inflation in China mainland market. Our empirical results show, for short-term investors, that gold always cannot hedge stock and inflation risk. But it is actually a good hedge for stock or inflation if you would hold gold for a long time. However, it is regrettable that gold is not a safe haven when investors face with stock and inflation risk in china capital market anyway. Baur and McDermott (2010) think unlike developed markets gold was a strong safe haven for most during the peak of the recent financial crisis, the safe haven asset plays a relatively minor role in emerging markets. We think possible reasons are capital market is imperfect and investors are more irrational, so that they are suffering losses in emerging market stocks, rather than seeking an alternative haven asset to readjust their portfolios. It should be cautious to say gold is a hedge or safe haven in China. Our empirical researches suggest investors not pursuing gold blindly.

In research methods, we improve classic methods, and employ new methods, such as quantile regression and binary probit model to examine. Nevertheless, there is some methods can be used to further studies, such as time-varying coefficient in return equation and time-varying in volatility function. And almost all existing researches focus on return hedge, we can consider higher moment hedge, for instance, volatility and skewness. We can also combine these ideas with binary probit model to examine bigger risk hedge of gold.

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