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HEDGING STOCK MARKET, INFLATION AND EXCHANGE RATE RISKS: PRECIOUS METALS

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Abstract

This paper explores the adequacy of precious metals i.e., gold, silver and platinum in hedging risks associated with adverse movements in stock market, decreasing purchasing power of local currency i.e., inflation and depreciating local currency against the US dollar in the US, UK and China for the sample period covering Jan 1990 to Jan 2015. The hedge and safe haven properties of precious metals are studied under the framework of EGARCH model using Baur and Lucey (2010) approach. To investigate the sensitivity of hedging potential for various bearish and bullish conditions of precious metal market we employ the quantile regression approach as proposed in Iqbal (2017). The analysis reveals that gold, silver and platinum can serve as hedge and safe haven against local currency in the UK in all the bearish and bullish scenarios of metal markets. Metals are also found as a safe haven against the Chinese Yuan. We found that the three precious metals do not play the role of safe haven for China against Chinese stock market risk. There is evidence suggesting that platinum hedges inflation risk in the US in various bearish and bullish conditions.

I. Introduction

The financial and academic literature has been well documented about the characteristics of precious metals. The markets of gold and silver have changed dramatically after the collapse of Breton wood agreement as metal prices are now freely determined by demand and supply forces. Research interest in metal market is has grown due to the increasing use of precious metals in production process and jewelry industry. The financial crises (the Asian financial crisis of 1997-98, financial crises in Russia and Brazil in 1998-99 and recent global financial crisis 2007-08) have enhanced the need for alternative venues for investment for investment risk diversification for which precious metals can be profitably employed. Jaffe (1989) reveals that precious metals should be added in the investment portfolios as they their inclusion reduces the variance and increases the average of intelligently selected portfolios. Similarly, Chua, et al. (1990) found that gold can benefit investors in portfolio diversification.

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Understanding safe haven property and hedging abilities of precious metals e.g., gold, silver and platinum is of immense importance for several reasons. Hillier, et al. (2006) found that the portfolio containing precious metal performs better than traditional equity portfolios. Gold is shown to serve as a safe haven for stocks in the US, the UK and Germany [Baur and Lucey (2010)].The observed negative association of price of gold with the depreciation of currency has motivated to test the hedging ability of gold. Capie, et al. (2005) shows that gold is indeed a hedge against sterling-dollar and Yen-dollar. Gold is found to have better inflation-hedging ability as compared to silver as revealed by McCown and Zimmerman (2006).

This paper builds on this background and aims to explore the investment implications of precious metals by extending the work of Baur and Lucey (2010) and Baur and McDermott (2010) in numerous ways. We investigate the hedging ability of gold, silver and platinum against the adverse movement of stock prices, exchange rate and consumer prices for the US, the UK and China. In addition, we also investigate whether this hedging ability is limited to normal conditions of the precious metal markets they could be used to hedge risks in extreme conditions as well. The regression approach of Baur and Lucey (2010) and Baur and McDermott (2010) consider only extreme conditions of the markets against which gold is to serve as hedge. We incorporate the hedging potential of various bearish and bullish conditions of gold, silver and platinum markets themselves by adopting the framework of quantile regression proposed by Iqbal (2017). Quantile regression as a statistical technique has several advantages over usual regression analysis as it can not only explains the average of the dependent variable but can also be used to explain various quantiles of their probability distributions. Therefore quantile regression provides a more complete picture of the relationship. The study aims to investigate that hedging potential of precious metals against stock market, exchange rate and inflation risks in the US, the UK and China by examining whether precious metals are negatively correlated with equity returns and positively related with their exchange rate and consumer price indexes. The paper also investigates the safe haven property of the metals against risks associated with the adverse of these variables. Our study aims to provide more comprehensive evidence on hedging potential of precious metals as most other studies focus only on gold. It has been well known that bulk of the gold is reserved by the central banks to back currency and remaining gold holds by private investors. Silver market is considerably smaller than gold market as Hillier, at al. (2006) pointed out that demand for silver is relatively lower than gold. However silver serves more industrial purpose than gold. Platinum is also being used many industries although it financial implications are not greatly known to investors.

In this study we consider the mature markets of the US and UK along with emerging market of China. The three countries have been selected due to their peculiar nature related to precious metal markets. The US holds the largest over the ground reserve in the form of central banking reserve. China has recently replaced India as the largest consumer of gold as reported by the World Gold Council. London is the largest market for gold in the world and New York is the main exchange-traded future market for gold.

II. Review of Literature

Plenty of research has been done to explore the hedging potential of precious metals against stock markets of various developed countries. Baur and McDermott (2010), and Baur and Lucey (2010) are the first who formally defined the safe heaven or hedge properties of assets. Baur and Lucey (2010) studied the relationship between the US, the UK and German stocks, bond and gold returns. They employed GARCH models in which mean equation contained dummy variables for extreme quantiles of stock and bond returns on daily prices from November 30, 1995 to November 30, 2005. They found that gold serves as a hedge against stock on average and safe haven in market turmoil. In order to assess the validity of their results obtained from full sample they partitioned their sample period into bull and bear market periods. After examining the peaks and troughs of the markets for full sample they selected a bull market regime until March 2000, a bear market regime from March 2000 until March 2003 and a bull market regime from March2003 until November 2005. They concluded that gold exhibits the properties of a safe haven asset in falling stock markets in the US, the UK and Germany.

Following the approach of Baur and Lucey (2010) Baur and McDermott (2010) employed daily world index, gold returns and stock returns indices of G7 countries and Brazil, Russia, India and China (BRIC) along with Australia (small developed country) and Switzerland (small European and non-Euro market) from 1979 to 2009. The GARCH framework of Baur and Lucey (2010) with the addition of strong and weak safe haven concept was used to study the relationship of gold and stock returns. They employed dummy variables to capture extreme negative returns in order to investigate the hedging performance of gold to stock markets in different conditions of the market. Thus they wanted to see if there are some non-linearities in the gold–stock index return relationship. The study concluded that gold is both a safe haven and a hedge for major European equity markets and the US but not for BRIC countries. They further showed that apart from Asian countries gold possesses the safe haven property and a hedge in most developed markets in economic stress.

The role of gold and other precious metals relative to volatility index as a hedge and safe haven were evaluated by Hood and Malik (2013) using data from the US stock market from November 1995 to November 2010. They used the regression model proposed by Baur and McDermott (2010) to estimate the relationship between each asset and the stock returns. They also considered dummy variables that capture extreme stock market declines i.e. if the stock market crosses a certain threshold of tenth, fifth and first percentiles of the return distribution of stock market. By applying the above model they concluded that volatility index is a superior hedging tool and serves as a better safe haven than gold. In a more recent study of Arouri, et al. (2015), the bivariate VAR-GARCH model was used as a baseline model to examine the diversification and hedging effectiveness of a portfolio involving the gold assets and stocks in China for the time spanning from 2004 through 2011. By employing VAR-GARCH model they found significant volatility transmission between the Chinese stock market and world gold market. Moreover they also applied CC-GARCH, DCC-GARCH, diagonal BEKK-GARCH, scalar BEKK-GARCH and full-BEKK-GARCH models in comparison of VAR-GARCH model and found that the VAR-GARCH is the best performing model in terms of both diversification and hedging effectiveness. Time period of global financial crisis was also taken into account in this study and concluded that stock investors in China should hold more gold than stocks in their diversified portfolios.

The early studies revealed weak relationship between gold and inflation rate. Jaffe (1989) examine Toronto stock exchange and South African gold-mining stocks for 17 years of time period ranging from September 1971 to November 1987 through regression analysis and concludes that gold is not a good hedge against inflation. McCown and Zimmerman (2006) investigated whether the stochastic movement of the prices of metals (gold and silver) and CPI of the US have a common trend so they can be cointegrated. This issue was explored by using data from the US market from 1970 to 2003.The estimates of CAPM revealed that gold can be a useful investment for the US investors while silver is not. Similarly the estimates of Arbitrage Pricing Model also favored gold for investment and it can hedge against inflation in the long run. With the help of cointegration tests again the hedging property of gold is verified. Thus they concluded that in the class of precious metals, gold has more inflation-hedging ability as compared to silver.

Beckmann and Czudaj (2013) examined four developed economies of the UK, USA, the Euro Area and Japan. This study covered the period from December 1969 to December 2011. They applied the Markov-switching error correction model (MS-VECM) to assess the relationship between the price of gold, CPI and PPI. The study found that gold is partially able to hedge inflation in the long-run especially for the US and UK as compared to Japan and the Euro area. The deterministic trend is present in prices of gold, CPI and PPI, thus they considered the two trends specification for each model. The first configuration had restricted trend and the second setting had unrestricted constant in the cointegration space. Moreover they utilized the Johansen cointegraton approach to estimate the cointegration relationship and found that the gold price is not significant although they considered the time varying coefficients for gold prices which revealed that gold is partially able to hedge future inflation in the long-run for US and UK as compared to Japan and the Euro Area. They estimated the MS-VECM model for each setting and established the cointegrating relations with a restricted trend for those countries whose trend is significant (USA and Euro Area) and used the unrestricted constant for insignificant trend (Japan and UK).The transition probabilities were highly significant for the four countries thus regimes are generally persistent in each case and concluded that gold can effectively be used to hedge against inflation. Shahbaz, et al. (2014) utilized quarterly data set of consumer price index, gold price and industrial production index of Pakistan from 1997 till 2011. They applied the ARDL bounds testing approach to co-integration for the long run, and innovative accounting approach (IAA) to see the direction of causality in consumer price index, gold price and industrial production index. They concluded from their analysis that gold can serve as a hedge against inflation in long as well as in short run.

Gold can serves as a hedge against sterling-dollar and yen-dollar exchange rates as suggested by implementing an EGARCH (1, 2) model in the study of Capie, et al. (2005). They established two models one for sterling and the other for yen exchange rates. The estimates of mean equation of both model showed that gold is indeed a hedge against exchange rate changes and is also inelastic in the short-run with respect to both exchange rates. The conditional error variance equation modeled as an EGARCH (1, 2) implied that an unanticipated increase in the price of gold will have a greater influence than unanticipated fall in price. Sari, et al. (2010) considered daily time series from January 1999 to October 2007 of four precious commodities (gold, silver, platinum and palladium) closing spot prices, oil spot prices and USD (Euro exchange rates). They utilized the VAR framework and show that there is no cointegration among precious metals and oil prices. Similarly their work also revealed positive correlation between platinum and oil prices. They estimated the generalized forecast error variance decompositions suggesting that most of the variations in each of the four metal prices, oil prices and exchange rate are due to own innovations and there is a strong bidirectional relationship between the oil price return and that of silver and impulse response function reveals the initial impacts of gold, silver, platinum and palladium prices on oil spot prices are positive and significant respectively. Hence concluded that there seem not to be long-run equilibrium relationships between these spot prices returns and changes in the exchange rate returns and they may be closely related in the short run.

Joy (2011) found negative relationship between prices of gold (US dollar per troy ounce) and 16 US dollar exchange rate pairings with the help of weekly data set extends from January 1988 to August 2008. By applying the model adequacy tests he found that the GARCH (1, 1) is the most suitable one. In order to generate the consistent standard errors he used the quasi maximum likelihood method. The GARCH process showed a high degree of persistence and the estimated DCC parameters express persistent correlation. The basic objective of his study was to find the main features of the relationship between the price of gold and the US dollar. His result based on a multivariate GARCH model of dynamic conditional correlations concluded that the conditional correlation between the changes in the price of gold and changes in the US dollar exchange rates is negative. The role of gold as an investment hedge against the US dollar is strong and durable. He further analyzed quantile correlations and concluded that gold's role as a safe haven from the US dollar movement is negligible and it does not act as an effective safe haven in extreme market conditions.

By using copulas Reboredo (2013) revealed that gold can act as a hedge and an effective safe haven against USD rate movements. He employed weekly data from January 7, 2000 until September 21, 2012 of gold prices, USD rates along with exchange rates of Australian dollar, the Canadian dollar, the euro, the British pound, the Japanese yen, the Norwegian krone and the Swiss franc. He formulated two hypotheses to assess the hedge and safe haven properties of gold. With the help of copulas framework their hypothesis is not rejected and he finally concluded that gold can act as a hedge and an effective safe haven against USD rate movements. Quantile regression (QR) is extremely useful in assessing the tail behavior of financial data. Fin, et al. (2009) revealed that quantile regression is more effective than OLS in analyzing the extremes of the distributions. They considered 43 Australian daily stocks of S&P/ASX 50 spanning from 2006 through 2008.They explained graphically that when the distribution reaches extremes, the market factor behaves differently from that in or around median observations, slope of the regression changes across the quantiles and relationship between beta (systematic risk) and return is clearly not constant. Furthermore they utilized quantile regression to compare the coefficients across quantiles, called inter-quantile regression. It is used to find that how beta effects vary from the 95 to 5 per cent quantile levels. Chiang, et al. (2010) utilized QR in comparison of conventional least squares method to test the behavioral relation between stock return dispersions and aggregate market movements with different quantile distributions. They used the daily data on stock prices and turnover ratios for all firms listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange from 1996 till 2007. These listed companies are classified into A-share and B-share markets. After applying the QR approach they concluded that herding behavior is more prevalent at the median and lower tails of the quantile distributions of the returns dispersions and this holds for Chinese aggregate stock market.

III. Methodology

To investigate the hedge and safe haven property of precious metals we extend the econometric model of Baur and Lucey (2010) by specifying the models for stock, inflation and exchange rate. We assume that the prices of precious metals are dependent on changes in the stock prices, inflation and exchange rates of the US, the UK and China. The following model is estimated to study the role of gold, silver and platinum in times of stress or extreme stock market decline of three selected countries.

$$R_p = c + \beta_t R_{stock} + \mu_t \quad (1)$$

$$\beta_t = \pi_0 + \pi_1 D(R_{stockq10}) + \pi_2 D(R_{stockq5}) + \pi_3 D(R_{stockq1}) \quad (2)$$

$$\log(h_t) = \rho_0 + \rho_1 \log(h_{t-1}) + \rho_2 \left|\frac{\mu_{t-1}}{\sqrt{h_{t-1}}}\right| + \rho_3 \frac{\mu_{t-1}}{\sqrt{h_{t-1}}} \quad (3)$$

where R_p represents the returns of precious metals i.e. gold, silver and platinum and R_{stock} shows the stock return. Equation (1) describes the relationship of the price of gold, silver and platinum with stock return and μ_t is an error term; while Equation (2) incorporates with terms $D(R_{stockq10})$, $D(R_{stockq5})$, and $D(R_{stockq1})$, representing the dummy variables having value 1 if the stock return is less than the 10 per cent, 5 per cent and 1 per cent quantile, respectively. If we find any one of the parameters π_1, π_2 and π_3 are significantly different from zero than the relationship between precious metal and stock market is linear. If π_0 is negative and significant than precious metals behaves as a hedge against stock market. To access the safe haven characteristic of gold, silver and platinum against stock the sum of parameters π_1, π_2 and π_3 at the 1 per cent, 5 per cent, and 10 per cent quantiles have analyzed through standard Wald F-Statistics. Metals can be viewed as a safe haven against the stock if the sum of π_0, π_1, π_2 and π_3 is less than or equal to zero i.e. when the market returns are in the lowest 1 per cent and the three metals possess negative relation with the stock market returns. Similarly, the sum of π_0 and π_2 point out the haven property at 5 per cent quantile, while the sum of π_0 and π_1 shows that precious metals keep safe haven property at 10 per cent quantile respectively. In order to capture the asymmetric shocks we consider an EGARCH (1, 1) model with student t error distribution as shown in Equation (3). To identify that whether three precious metals under studied can act as hedge or safe haven against the exchange rate risk we estimate the following econometrics model.

$$R_p = c + \beta_t R_{exhange\ rate} + \mu_t \quad (4)$$

$$\beta_t = \varphi_0 + \varphi_1 D(R_{exhange\ rate,q90}) + \varphi_2 D(R_{exhange\ rate,q95})\ \varphi_3 D(R_{exhange\ rate,q99}) \quad (5)$$

$$\log(h_t) = \delta_0 + \delta_1 \log(h_{t-1}) + \delta_2 \left|\frac{\mu_{t-1}}{\sqrt{h_{t-1}}}\right| + \delta_3 \frac{\mu_{t-1}}{\sqrt{h_{t-1}}} \quad (6)$$

where, the same EGARCH (1, 1) model has employed to allow asymmetric response of shocks to the volatility. The dummy variables possess the value 1 if the exchange rate return is greater than 90 per cent, 95 per cent and 99 per cent quantile and 0 elsewhere. Our aim is to study the role of precious metals in high inflation rate i.e. the time of stress, thus we consider the upper quantiles of currency returns such as 90 per cent, 95 per cent and 99 per cent. The relationship between precious metals and exchange rate risk is non-linear if one of the parameters φ_1 , φ_2 and φ_3 is significantly different from zero. The study test $H_0 : \varphi_i \leq 0$ versus $H_1 : \varphi_i > 0$, this right tail test is used to observe the hedge and safe haven characteristics of gold, silver and platinum. The metals call as hedge against exchange rate risk if φ_0is positive and significant. If sum of φ_0 , φ_1 , φ_2 and φ_3 is greater than or equal to zero than the three precious metals act as a safe haven asset against extreme movement of currency i.e., at 99 per cent quantile. Moreover, if precious metals are to be used as hedge their prices must also increase so metals returns should also have a positive relationship with currency.

The assessment of inflation hedging potential of gold, silver and platinum is carried out by estimating the following extended version of Baur and Lucey (2010) model.

$$R_p = c + \beta_t R(_{\text{inflation rate}}) + \mu_t \tag{7}$$

$$\beta_t = \alpha_0 + \alpha_1 D(R_{\text{inflation rate},q90}) + \alpha_2 D(R_{\text{inflation rate},q95}) + \alpha_3 D(R_{\text{inflation rate},q99}) \tag{8}$$

$$\log(h_t) = \gamma_0 + \gamma_1 \log(h_{t-1}) + \gamma_2 \left| \frac{\mu_{t-1}}{\sqrt{h_{t-1}}} \right| + \gamma_3 \frac{\mu_{t-1}}{\sqrt{h_{t-1}}} \tag{9}$$

The above equations are estimated by maximum likelihood method with EGARCH (1, 1) structure. The Dummy variables $D(R_{\text{inflation rate},q90})$, $D(R_{\text{inflation rate},q95})$ and $D(R_{\text{inflation rate},q99})$ accounts for extreme shocks. These terms take value 1 if the inflation return is greater than 90 per cent, 95 per cent and 99 per cent quantile and 0 elsewhere. The relationship between precious metals and log return of consumer price index (CPI) is non-linear if one of the parameters α_1, α_2 and α_3 is significantly different from zero. The increasing price of metals has motivated their hedge property as inflation decreases the purchasing power of investors. We use a right tail test to examine the hedge and safe haven property of gold, silver and platinum. The metals can serve as hedge against inflation rate if α_0 is positive and significant. Similarly, if sum of α_0, α_1, α_2 and α_3 is greater than or equal to zero than precious metals act as a safe haven asset against high inflation.

To assess sensitivity of the hedging potential of three selected precious metals to various quantiles of the distribution of the precious metal distributions we employ the quantile regression approach proposed by Iqbal (2017). Traditional method of regression is based on linking average of the dependent variable with a set of covariates. The regression analysis is therefore useful in explaining the average behavior of the dependent variable. The quantile regression, on the other hand, explains different quantiles of the dependent variable i.e. the behavior of the dependent variable at low, say 5 per cent, and high, say 95 per cent quantiles. Fin, et al. (2009) reported that the usual regression analysis cannot capture the upper and lower quantiles of distributions, adequately. Thus, the semi parametric quantile regression approach is very suitable in testing the hedging ability of gold, silver and platinum and whether this ability of gold, silver and platinum is limited to their average conditions or they serve hedging in extreme conditions of these markets as well. Quantile regression is an extension of classical least squares estimation formally introduced by Koenker and Basset (1978) and is especially relevant for modeling dependent variables that are fat tailed. For a random variable Y with probability distribution function F(y) = P(Y≤y) the τth conditional quantile of Y given X = x is defined as:

$$(Y|x) = \{y{:}F(y|x) \geq \rho\}, \qquad 0 < \rho 1 \tag{10}$$

Similarly the quantile regression is defined as:

$$Q_\rho\,(Y|x) = x'\,\beta(\rho) \tag{11}$$

where β(ρ) is the vector of coefficients attached with variable x associated with ρthquantile. The Least Absolute Deviation (LAD) approach yields the parameter estimates as:

$$\hat{\beta}(\rho) = \operatorname{argmin}_\beta \textstyle\sum_{i=1}^{n} \tau_\rho\,(yi - x'\beta) \tag{12}$$

where τ_ρ is the asymmetric weighted absolute valued function.

Under various bearish and bullish conditions of precious metals we assess their hedge and safe haven property against the extreme movement of equity markets. For this purpose we formulate the following model.

$$\begin{aligned} Q_\rho(Y|x) = {} & \beta_{0(\rho)} + \beta_{1(\rho)}\, R_{stock} + \beta_{2(\rho)}\, R_{stock}\, D(R_{stockq10}) + \beta_{3(\rho)}\, R_{stock}\, D(R_{stockq5}) + \\ & \beta_{4(\rho)}\, R_{stock}\, D(R_{stockq1}) + \mu_t \end{aligned} \tag{13}$$

here Q_ρ (Y|x) are the conditional quantiles of gold, silver and platinum at different values. The Dummy variables are included in the model and take value 1 if the percentage change of stock return is less than 10 per cent, 5 per cent and 1 per cent quantile respectively. For examining the hedging potential of gold, silver and platinum at particular quantile we observe the sign and significance of the coefficient β_1. Similarly the sum of coefficients β_2, β_3 and β_4 will help us to judge the safe haven characteristics of precious metals.

Following is the quantile regression model use to explore the hedge and safe haven behavior of gold, silver and platinum against the depreciation of currency risk.

$$Q\rho\ (Y|x) = \beta_{0(\rho)} + \beta_{1(\rho)}\ R_{\text{exchange rate}} + \beta_{2(\rho)}\ R_{\text{exchange rate}}\ D(R_{\text{exchange rateq90}}) + \beta_{3(\rho)}\ R_{\text{exchange rate}}\ D(R_{\text{exchange rateq95}}) + \beta_{4(\rho)}\ R_{\text{exchange rate}}\ D(R_{\text{exchange rateq99}}) + \mu_t \quad (14)$$

here Q_ρ (Y|x) represents the behavior of metals at different quantiles while $D(R_{\text{exchange rateq90}})$, $D(R_{\text{exchange rateq95}})$ and $D(R_{\text{exchange rateq99}})$ are dummy variables having value 1 if the currency return is greater than the defined quantiles. The inflation-hedging ability of gold, silver and platinum at different quantiles is examined through the following model.

$$Q\rho\ (Y|x) = \beta_{0(\rho)} + \beta_{1(\rho)}\ R_{\text{inflation rate}} + \beta_{2(\rho)}\ R_{\text{inflation rate}}\ D(R_{\text{inflation rateq90}}) + \beta_{3(\rho)}\ R_{\text{inflation rate}}\ D(R_{\text{inflation rateq95}}) + \beta_{4(\rho)})\ R_{\text{inflation rate}})\ D(R_{\text{inflation rateq99}}) + \mu_t \quad (15)$$

The conditional distribution Q_ρ (Y|x)of gold, silver and platinum is studied at various quantiles while dummy variables represents as 1 if the inflation rate return *s* greater than 90 per cent, 95 per cent and 99 per cent quantile and 0 elsewhere.

IV. Data Description and Descriptive Statistics

We collected daily data on gold, silver and platinum prices expressed in US dollar. To determine metal prices in the UK and China we multiplied dollar designated metal prices by their local currencies at the exchange rate prevailing on close of that day. Daily stock prices and exchange rate for the US, the UK and China along with the metal prices are taken from January 19, 1990 to January 19, 2015. Monthly inflation rate extends from January 1990 to Dec 2014. We use S&P 500 Index, FTSE Index and Shanghai A-share Index to represent the US, the UK and China stock markets respectively. In order to achieve stationary time series, each series is taken as a natural log returns by using the following formula:

$$r_t = ln\left(\frac{p_t}{p_{t-1}}\right) \times 100$$

where p_t :closing value of metal prices, stock market index and consumer price index of the current day or month and p_{t-1}:closing value of metal prices, stock market index and consumer price index of the previous day or month. Table 1 presents the summary statistics of precious metals returns, inflation and stock index returns for the three countries. The average return of equity markets of developed markets i.e. the US and the UK is lower than the emerging market of China. Similarly the standard deviation of China is greater than the standard deviation of the US and the UK which indicates that higher risk is associated with higher returns. Similarly the average returns of gold, silver and platinum in China is higher than the US and the UK.

TABLE 1

Summary Statistics of Log percentage change of Metal Prices, CPI and Stock Market of US, UK and China

	Variable	Obs	Mean	Median	Standard Deviation	Minimum	Maximum
US	Gold	6536	0.017	0	0.996	-10.162	7.382
	Silver	6536	0.018	0.000	1.74	-12.981	13.664
	Platinum	6536	0.014	0.000	1.356	-17.277	11.728
	S& P 500 returns	6536	0.027	0.021	1.121	-9.469	10.957
	Inflation	300	0.203	0.1973	0.335	-1.933	1.214
UK	Gold	6536	0.016	0.024	1.265	-10.507	11.137
	Silver	6536	0.017	0.000	1.962	-13.322	18.099
	Platinum	6536	0.013	0.039	1.547	-16.432	11.433
	FTSE returns	6536	0.015	0.000	1.102	-9.264	9.384
	Inflation	300	0.208	0.234	0.424	-0.972	3.318
China	Gold	6013	0.023	0.001	1.130	-10.244	41.192
	Silver	6013	0.027	0.000	1.846	-12.962	40.623
	Platinum	6013	0.024	0.000	1.460	-17.357	40.434
	Shenzen A-Share returns	6013	0.040	0.000	2.437	-18.427	74.517
	Inflation	300	-0.009	0	0.725	-2.607	2.245

Figure 1 present the time series plots of gold prices versus stock indexes and Consumer Price Index (CPI) for the US, the UK and China. The left panel of figure portrays the price changes of gold, silver and platinum versus stock markets of the US, the UK and China. After a historical lower price in February 2001, the gold price generally showed an increasing trend reaching the peak on August 2011. Since then gold has been generally declining. The US stock market has been more volatile than the gold with altering bullish and bearish periods. Unlike the gold trend, stock has been generally increasing since 2011 showing an inverse relationship and possible role of gold in hedging stock market risk. The UK stock market and gold prices also show negative direction among them, FTSE 100 index has seen a gradual and steady rise by the end of Global financial crisis while gold prices falling during this period. Similarly Chinese stock market appears to indicate stable condition during most of the sample period except a price hike October 2007 when the index was all time high. In 2005 the Chinese stock market appears at its lowest point while it regained its target and became one of the fastest growing stock companies around the globe. After the 2008 crisis it achieves stable position and maintains it till the end of 2014. As shown in figure the Chinese stock market is consistent at the end of sample period when gold prices are falling. Generally similar trend in gold prices prevail when expressed in British Pound and Chinese Yuan. The right panel of the figure shows time trend in CPI of the US, the UK and China. Consumer prices in the US and the UK have shown a consistent increasing trend over the sample period under study. Apparently, no relationship with gold price is visible in the two countries. Although the CPI of China is moving with rise and fall over the entire sample period, but there might be no clear indication of relationship with gold prices.

Figure 2 present the time series plots of silver prices versus stock indexes and Consumer Price Index (CPI) for the US, the UK and China. The left panel of the figure presents the time trend of silver prices versus stock of the US, the UK and

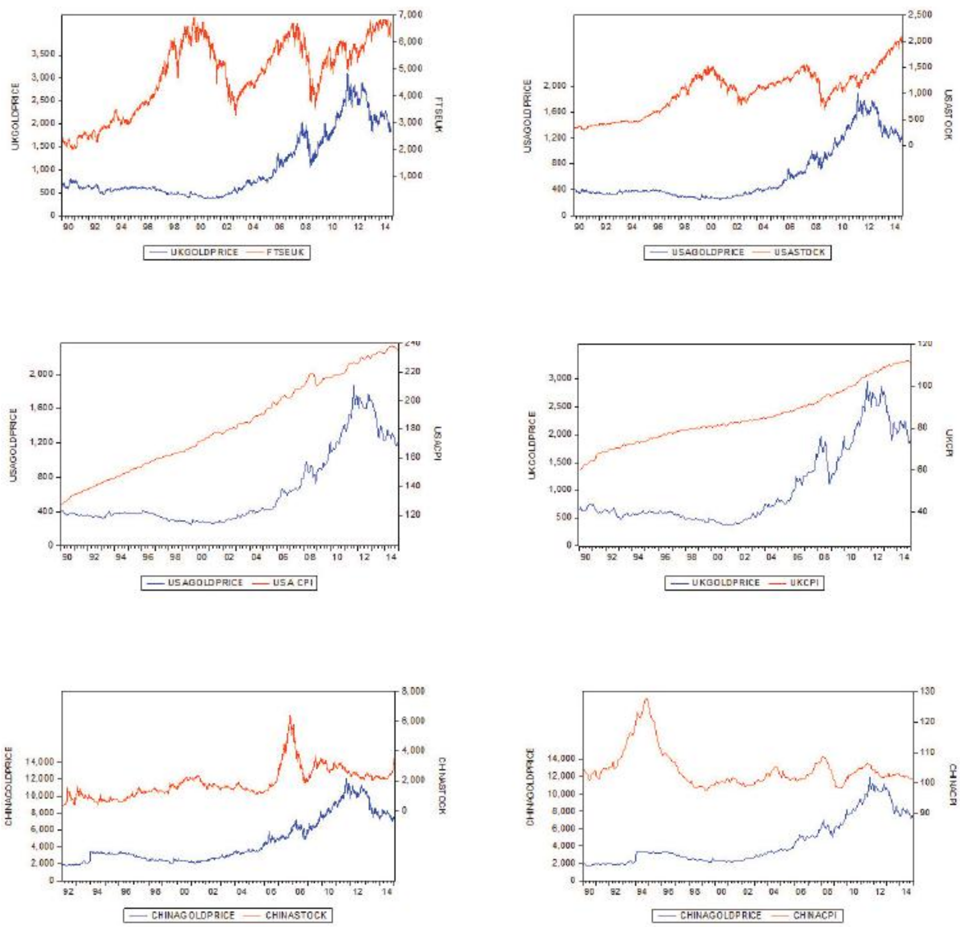


FIGURE 1

Time Series Plot of Gold prices, Stock Indices and CPI for US, UK and China

China. Silver prices are showing consistent movement in the beginning of the sample period followed by a rise in prices between 2006 and 2007. Sharp decline in prices of silver has observed in 2008 with a rapid increase in 2011. Like gold, silver prices are also declining after 2011. The stock prices of the US are growing after 2011 indicating that silver may be hedge the US market. The UK stock market is growing after 2011 showing the opposite relation with the prices of silver while Chinese stock market is quite stable and move with consistent behavior after 2011 followed by an increase by the end of 2014. The right panel of figure shows the CPI of the three countries. There appears to be no indication of clear relationship between CPI of the three countries with silver.

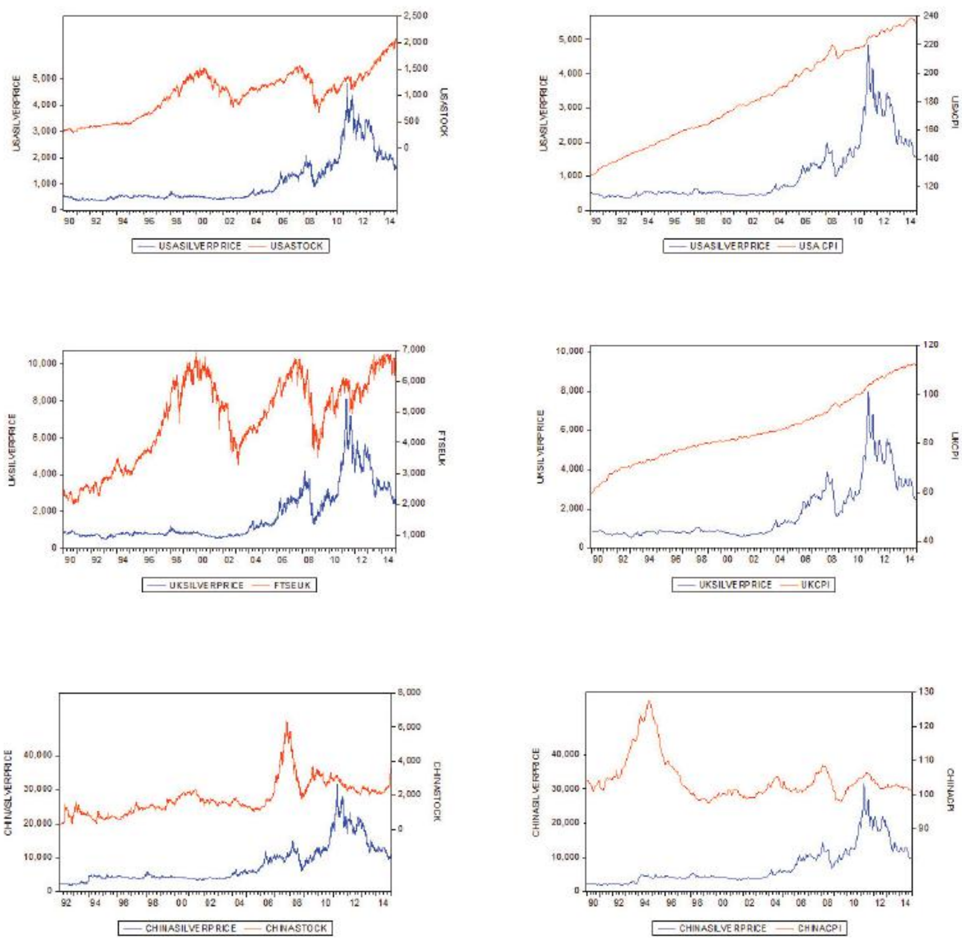


FIGURE 2

Time Series Plot of Silver Prices, Stock Indices and CPI for US, UK and China

Figure 3 present the time series plots of platinum prices versus stock indexes and Consumer Price Index (CPI) for the US, the UK and China. Prices of platinum are more volatile than gold and silver prices. The prices of platinum rise around 2007 with the gradual movement from the start of sample period. After a sharp decline in 2008 the prices climb up and consistently moving at the end of 2014. The same movement of prices of platinum has observed when expressed in the British pound and Chinese Yuan. The US stock prices and the UK stock show an increase

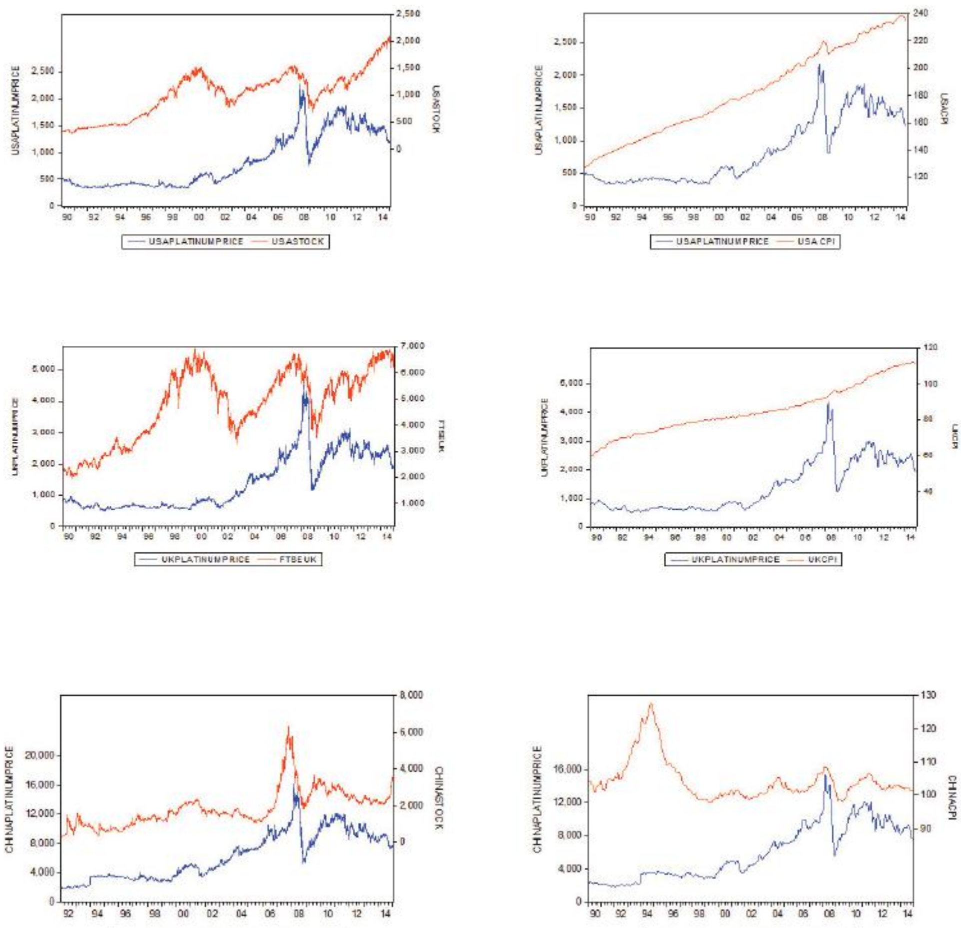


FIGURE 3

Time Series Plot of Platinum Prices, Stock Indices and CPI for US, UK and China after 2011 while the platinum prices are consistent within this period. The China stock market is somehow shows same movement with platinum prices after 2011.

Figure 4 portrays the time series plot of gold, silver and platinum prices and of exchange rate for the UK and china. The exchange rate of the UK shows more volatility after the year 1992.The gold and platinum prices and exchange rate of the UK moves in the same direction after the global financial crisis of 2007. Moreover the figure does not show any relationship between Chinese Yuan and metal prices.

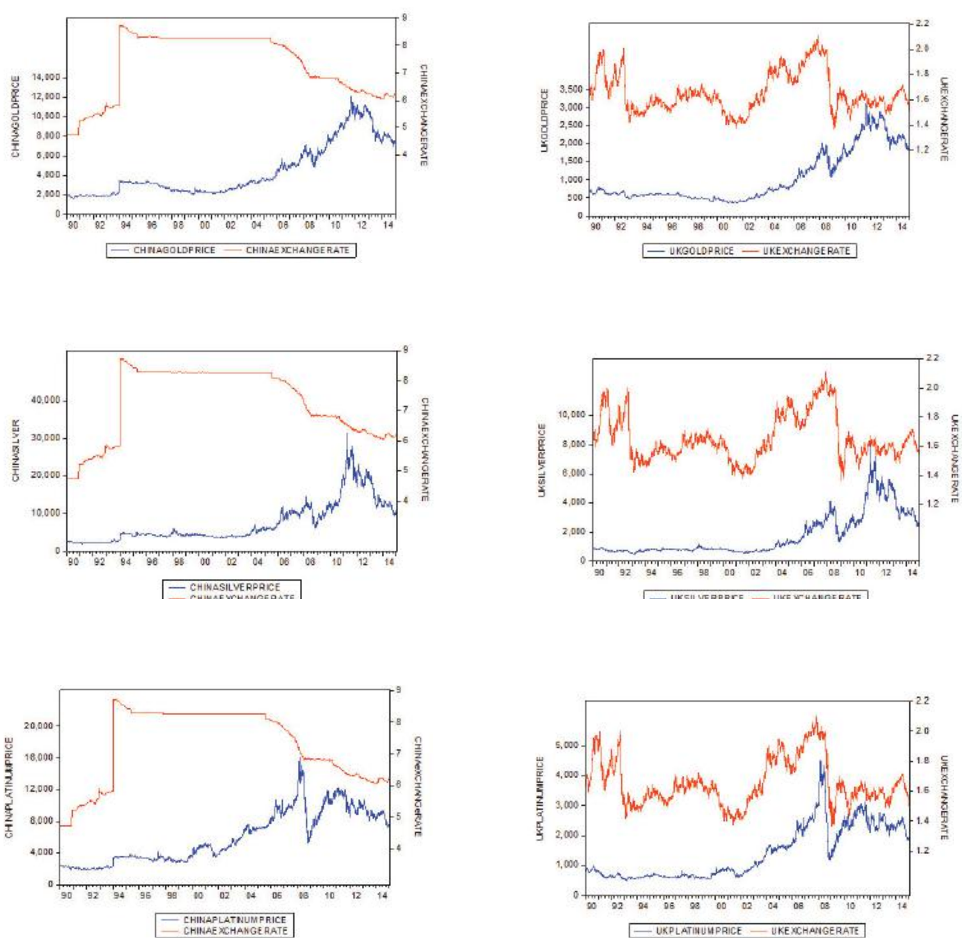


FIGURE 4

Time Series Plot of Gold Prices, Silver Prices and Platinum Prices and of Exchage Rate for UK and China

V. Results and Empirical Analysis

This section is divided into two parts, First part discuss the results estimated the econometric modeling framework adapted by Baur and Lucey (2010) and second part explains the result obtained by the quantile regression approach proposed by Iqbal (2017).

1. Econometric Analysis

To access the hedge and safe haven property of gold, Equations (1), (2) and (3) has been estimated using the EGARCH model. For the USA the evidence of gold acting as hedge is convincing but the gold is seen to hedge stock risk only when the stock market falls extremely i.e., below 1 per cent quantile as the sum of coefficients is negative but significant at 1 per cent quantile of stock market in the US. The results from Table 2 indicate that gold appears to act as hedge and safe have against stock in the UK as the associated coefficients are significantly negative In case of the UK the sum of coefficients are negative and significant

TABLE 2

Estimates of Relationship between Gold Returns (%) and Stock Market (%) for US, UK and China

Gold Return	US			UK			China		
	Coef	SE	t-stat p value	Coef	SE	t-stat p value	Coef	SE	t-stat p value
π_0 (hedge)	-0.043	0.010	-4.261**	-0.115	0.014	-7.829**	-0.001	0.004	-0.416
			0.000			0.000			0.677
$\Sigma\pi_1$ - 10%	-0.019	0.025	-0.776	-0.120	0.036	-3.332**	0.042	0.014	2.974
			0.218			0.000			0.998
$\Sigma\pi_2$ - 5%	-0.023	0.018	-1.271	-0.067	0.025	-2.625**	0.009	0.008	1.144
			0.101			0.004			0.873
$\Sigma\pi_3$ - 1%	-0.064	0.023	-2.696**	-0.062	0.031	-1.949**	0.002	0.007	0.391
			0.003			0.025			0.652
	Conditional Volatility			Conditional Volatility			Conditional Volatility		
ρ_0	-0.078	0.006	-11.68**	-0.069	0.006	-10.403**	-0.053	0.004	-12.021**
			0.000			0.000			0.000
ρ_1	0.113	0.010	11.213**	0.096	0.009	10.346**	0.077	0.006	11.410**
			0.000			0.000			0.000
ρ_2	0.036	0.007	5.413**	0.022	0.005	3.833**	-0.006	0.005	-1.185
			0.000			0.000			0.236
ρ_3	0.995	0.001	801.653**	0.995	0.001	705.281**	0.995	0.001	971.217**
			0.000			0.000			0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

for 10 per cent, 5 per cent and 1 per cent quantile of stock returns which shows that when the stock market of the UK falls below of the specified quantile gold acts as safe haven to safeguard investors. This result is consistent with Baur and Lucey (2010) who also findsgold a hedge and safe haven asset against stock market risk in the UK. Our results are similar to Baur and McDermott (2010) for the case of China as we also find the inability of gold to hedge Chinese stock market risk. This might indicate that Chinese investors do not consider gold for investment purpose to hedge stock market risk.

The estimation results of Equations (1), (2) and (3), for silver are reported in Table 3. The significant and negative hedge coefficients for both the US and the UK silver appears to hedge while the safe haven property is not observed by the estimated results. Like gold, silver also does not appear to hedge and be safe haven in the case of China. Most of the coefficients in EGARCH (1, 1) model are significant indicating time varying volatility. However the evidence of asymmetric behavior of volatility is not observed. Table 4 shows the estimation results of platinum for the three countries the US, the UK and China. In case of the US the hedge coefficient is positive and significant at conventional level of signifi-

TABLE 3

Estimates of Relationship between Silver returns (%) and Stock Market (%) for US, UK and China

Silver Return	US			UK			China		
	Coef	SE	t-stat p value	Coef	SE	t-stat p value	Coef	SE	t-stat p value
π_0(hedge)	-0.048	0.017	-2.712**	-0.081	0.021	-3.737**	-0.000	0.009	-0.033
			0.006			0.000			0.973
$\Sigma\pi_1$ - 10%	0.014	0.041	0.349	-0.068	0.052	-1.303*	0.048	0.029	1.636
			0.636			0.096			0.949
$\Sigma\pi_2$ - 5%	0.024	0.029	0.851	0.055	0.037	1.468	0.010	0.017	0.580
			0.802			0.929			0.719
$\Sigma\pi_3$ - 1%	0.075	0.036	2.070	0.056	0.044	1.287	0.012	0.014	0.922
			0.980			0.901			0.821
	Conditional Volatility			Conditional Volatility			Conditional Volatility		
ρ_0	-0.056	0.005	-9.573**	-0.054	0.005	-9.041**	-0.049	0.005	-9.193**
			0.000			0.000			0.000
ρ_1	0.091	0.009	9.698**	0.084	0.008	9.419**	0.081	0.008	9.337**
			0.000			0.000			0.000
ρ_2	0.030	0.006	4.488**	0.022	0.005	3.814**	0.016	0.006	2.775**
			0.000			0.000			0.005
ρ_3	0.995	0.001	793.7**	0.995	0.001	748.647**	0.995	0.001	824.483**
			0.000			0.000			0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

cance i.e., at 0.05. The sum of coefficients is significantly positive for 1 per cent quantile of stock returns of the US which indicates that when the stock market falls below of the 1 per cent quantile platinum prices increases thus it became safe haven for the US investors. Results show that for the investors of the UK and China, platinum does not shine. It neither hedge nor safe haven against any bearish and bullish condition of the stock markets of the UK and China.

The estimation results reported through Tables 5 to 7 are to observe the hedge and safe haven property of gold, silver and platinum, respectively. Table 5 shows that among the three countries only the US has significantly positive hedge coefficient. This finding is consistent with the results of McCown and Zimmerman (2006) who found that gold is more hedging ability for the US investors. The results also find that gold appears to be a safe haven asset against inflation in the US as gold market progresses in high inflationary circumstances particularly when inflation rate is more than 90 per cent quantile. Moreover the insignificant coefficients for the UK show the negligible relationship between gold and inflation. Since the establishment of relationship between inflation and gold returns is difficult to hold for emerging economies thus our results show that for China

TABLE 4

Estimates of Relationship between Platinum Returns (%) and Stock Market (%) for US, UK and China

Platinum Return	US			UK			China		
	Coef	SE	t-stat p value	Coef	SE	t-stat p value	Coef	SE	t-stat p value
π_0(hedge)	0.048	0.015	3.066**	-0.017	0.018	-0.949	0.007	0.005	1.306
			0.002			0.342			0.191
$\Sigma\pi_1$ - 10%	0.034	0.037	0.907	0.032	0.045	0.707	0.061	0.023	2.656
			0.817			0.760			0.996
$\Sigma\pi_2$ - 5%	-0.006	0.029	-0.216	0.037	0.033	1.119	0.001	0.013	0.080
			0.414			0.868			0.532
$\Sigma\pi_3$ - 1%	0.078	0.032	2.420	0.078	0.039	1.970	0.010	0.012	0.879
			0.992			0.975			0.810
	Conditional Volatility			Conditional Volatility			Conditional Volatility		
ρ_0	-0.109	0.009	-12.672**	-0.092	0.008	-11.497**	-0.075	0.006	-12.184**
			0.000			0.000			0.000
ρ_1	0.160	0.012	12.450**	0.133	0.011	11.707**	0.111	0.009	12.151**
			0.000			0.000			0.000
ρ_2	0.024	0.007	3.1273**	0.016	0.006	2.506**	0.002	0.006	0.305
			0.001			0.012			0.759
ρ_3	0.984	0.002	342.755**	0.988	0.002	386.421**	0.986	0.002	407.649**
			0.000			0.000			0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

gold cannot play the role of hedge and safe haven. The recent study of Dee, et al. (2013) also reveals that investors in china must be cautious as gold is not acting as a hedge and safe haven against high inflation periods. Table 6 and Table 7 show the estimation results for silver and platinum respectively. For silver it is evident clearly that all the hedge and safe haven coefficients are insignificant for both developed and emerging market. Similarly the EGARCH (1, 1) equations result the significant coefficient for silver. Platinum results in Table 5.6 indicate that like gold, platinum also serve as hedge for the US investors while the UK and China shows insignificant hedge coefficients. The sum of coefficients is significantly positive for 90 per cent and 95 per cent quantile of inflation for the US and the UK respectively. Thus platinum acts as a safe haven when inflation is increasing especially at its 90 per cent and 95 per cent quantile for the US and the UK economy.

Table 8 present the estimated results by using the extended version of Baur and Lucey (2010) model. The model is estimated to identify the hedge and safe haven property of gold against the exchange rate risk of the UK and China. The results are in favor of hedge property of gold for both the UK and China. It shows

TABLE 5

Estimates of Relationship between Gold Returns (%)
and Inflation Rate (%) for US, UK and China

Gold Return	US			UK			China		
	Coef	SE	t-stat p value	Coef	SE	t-stat p value	Coef	SE	t-stat p value
α_0(hedge)	1.385	0.748	1.851*	-0.607	0.894	-0.678	0.772	0.417	1.849
			0.064			0.497			0.064
$\Sigma\alpha_1$ - 90%	-0.141	1.760	-0.080	-0.379	1.775	-0.213	0.086	0.923	0.093
			0.532			0.584			0.462
$\Sigma\alpha_2$ - 95%	3.783	1.772	2.1348**	0.876	1.742	0.503	- 1.194	0.752	-1.588
			0.016			0.307			0.943
$\Sigma\alpha_3$ - 99%	2.423	2.915	0.831	-1.762	1.869	-0.943	- 0.550	1.482	-0.371
			0.203			0.827			0.645
	Conditional Volatility			Conditional Volatility			Conditional Volatility		
γ_0	0.097	0.156	0.624	0.104	0.169	0.617	0.630	1.599	0.394
			0.532			0.536			0.109
γ_1	0.278	0.116	2.386**	0.239	0.108	2.201**	0.502	3.037	0.165**
			0.017			0.027			0.002
γ_2	0.112	0.066	1.681	0.091	0.068	1.328	0.102	0.969	0.106
			0.092			0.184			0.332
γ_3	0.889	0.065	13.53**	0.910	0.061	14.909**	0.670	4.834	0.138**
			0.000			0.000			0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

that when Chinese Yuan and British pound moves toward depreciation against Dollar, gold prices climbs up. Thus gold and local currencies of the UK and China possess positive relationship among them. Gold is also playing a role of safe haven for the UK and China having positive and significant coefficients against unfavorable circumstances of their exchange rates. Thus these results are quite useful for the investors who generally want to invest in emerging economy as well as mature markets like the UK. To access the hedge and safe haven property of silver for the UK and China, the model has been estimated and results are reported in the Table 9. The estimation leads us to the same conclusion that silver also can hedge and safe the investors like gold in bad times i.e. when their local currency devaluates. Thus the results conclude the positive relationship between silver and exchange rate risk for both countries. Platinum can serve as hedge and safe haven for the UK as results shown by Table 10. It shows that when local currency of the UK reaches at its minimum against Dollar, the precious metal platinum grows. It also plays the role of safe haven against the extreme conditions of currency in the UK as measured by upper quantiles of exchange rate returns. Thus these findings are one of the important one as no one has found the hedging

TABLE 6

Estimates of Relationship between Silver Returns (%) and Inflation Rate (%) for US, UK and China

Silver Return	US			UK			China		
	Coef	SE	t-stat p value	Coef	SE	t-stat p value	Coef	SE	t-stat p value
α_0(hedge)	1.788	1.358	1.315	- 1.734	1.467	-1.181	0.643	0.643	1.000
			0.188			0.237			0.317
$\Sigma\alpha_1$ - 90%	-3.753	2.276	-1.648	1.699	2.868	0.592	0.523	1.801	0.290
			0.949			0.276			0.385
$\Sigma\alpha_2$ - 95%	-2.180	2.580	-0.844	- 0.149	1.718	-0.086	0.541	1.189	0.455
			0.800			0.534			0.324
$\Sigma\alpha_3$ - 99%	6.514	6.259	1.041	0.070	2.919	0.024	4.568	2.025	2.254
			0.149			0.490			0.012
	Conditional Volatility			Conditional Volatility			Conditional Volatility		
γ_0	0.159	0.171	0.928	0.124	0.153	0.808	0.170	0.150	1.131
			0.352			0.418			0.258
γ_1	0.329	0.113	2.908**	0.259	0.099	2.602	0.343	0.116	2.941**
			0.003			0.009			0.003
γ_2	0.126	0.061	2.040**	0.068	0.051	1.330	0.111	0.066	1.689
			0.041			0.183			0.091
γ_3	0.896	0.047	18.837**	0.924	0.041	22.185	0.894	0.039	22.443**
			0.000			0.000			0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

ability of platinum earlier for the UK. In case of China platinum can acts as hedge with significantly positive coefficient and also it is safe haven investment against extreme conditions in forex market measured by upper quantiles of exchange rate returns.

2. *Quantile regression Analysis*

Table 11 shows the estimation results for the quantile regression model for the US and also Baur and Lucey (2010) estimates for comparison purpose. The results show that gold is hedge against stock market of the US when it is in bearish condition i.e. at its lowest quantiles. These results are quite same as Baur and Lucey (2010) model also concludesthat on average gold can hedge in the US market. It is observed from the results that during bearish conditions in gold market (represented by 75th and 90th quantile) it has a negatively significant affiliation with stock market of the US in its various bearish conditions. Thus the safe haven characteristics of gold keep on perfect when gold is in bullish mood.To see the hedging power and safe haven property of silver quantile regression model has

TABLE 7

Estimates of Relationship between Platinum Returns (%) and Inflation Rate (%) for US, UK and China

Platinum Return	US			UK			China		
	Coef	SE	t-stat p value	Coef	SE	t-stat p value	Coef	SE	t-stat p value
α_0(hedge)	3.452	1.210	2.852**	1.254	1.028	1.219	1.492	0.589	2.529
			0.004			0.222			0.011
$\Sigma\alpha_1$ - 90%	1.568	1.883	0.832	6.688	2.282	2.929	0.760	1.168	0.650
			0.202			0.001			0.257
$\Sigma\alpha_2$ - 95%	4.141	1.650	2.508**	-1.667	1.846	-0.902	0.238	0.988	0.241
			0.006			0.816			0.404
$\Sigma\alpha_3$ - 99%	0.907	5.356	0.169	-1.981	2.180	-0.908	0.304	4.333	0.070
			0.432			0.818			0.472
	Conditional Volatility			Conditional Volatility			Conditional Volatility		
γ_0	0.318	0.308	1.032	0.353	0.276	1.278	0.932	0.583	1.597
			0.301			0.201			0.110
γ_1	0.402	0.119	3.365**	0.308	0.113	2.731**	0.359	0.136	2.639*
			0.000			0.006			0.008
γ_2	-0.001	0.066	-0.023	-0.084	0.063	-1.319	-0.130	0.094	-1.384
			0.981			0.187			0.166
γ_3	0.815	0.096	8.464**	0.839	0.079	10.540**	0.673	0.167	4.025**
			0.000			0.000			0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

employed and results are displayed in Table 12. It is evident from the results that silver can hedge against the US market in various bearish conditions of silver. The bullish condition of silver measured by 90th quantile possess negative and significant coefficient corresponding to the 1 per cent quantile of stock returns showing the safe haven property of silver. Thus it has been concluded that silver hedges and became safe haven when it is in bullish attitude. From Table 13 the hedging power of platinum is evident as results show its hedging ability in various bearish and bullish conditions. The safe haven property of platinum reveals by significant coefficients corresponding to the 75th and 90th quantile of platinum as stock markets is at its lowest 1 per cent quantile.

Table 14 to 16 results obtained presents the hedging ability and safe haven property of gold, silver and platinum estimated by quantile regression model for the UK. Gold and silver both possess hedging ability as reported by Baur and Lucey (2010) model as well as by quantile regression approach. Gold can acts as hedge in both bearish and bullish conditions while only bullish conditions of silver favor its hedging ability. Also when stock market returns falling in their 10

TABLE 8

Estimates of Relationship between Gold Returns (%) and Exchange Rate (%) for UK and China

Gold Return	UK			CHINA		
	Coef	SE	t-stat pvalue	Coef	SE	t-stat pvalue
φ_0 (hedge)	1.208	0.016	73.190**	0.606	0.134	4.511**
			0.000			0.000
$\Sigma\varphi_1$ (90%)	1.288	0.042	30.084**	0.775	0.293	2.642**
			0.000			0.004
$\Sigma\varphi_2$ (95%)	1.277	0.032	39.522**	0.773	0.340	2.222**
			0.000			0.013
$\Sigma\varphi_3$ (99%)	1.213	0.034	34.746**	1.016	0.039	25.563**
			0.000			0.000
	Conditional Volatility			Conditional Volatility		
δ_0	-0.080	0.007	-11.482**	-0.078	0.006	-11.581**
			0.000			0.000
δ_1	0.114	0.010	11.127**	0.112	0.010	11.148**
			0.000			0.000
δ_2	0.039	0.006	5.715**	0.037	0.006	5.588**
			0..000			0.000
δ_3	0.994	0.001	721.826**	0.995	0.001	802.05**
			0.000			0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

per cent or less of its quantile gold is found to be safe haven. These results are consistent with the study of Baur and Lucey (2010) who also finds gold a hedge and safe haven for the UK stock market. Moreover the insignificant coefficients corresponding to all bearish conditions of stock market confirm the absence of safe haven characteristics of silver for the UK market. It has been observed from Table 16 that platinum only hedges when it keeps on bullish attitude. The bullish mood of platinum measured by 90th quantile get negative and significant coefficient only when the stock returns are in bearish condition.

Table 17 shows the estimation results of gold by quantile regression model for China. The results look different from Baur and Lucey (2010) model showing that gold can hedge against stock market of Chinawhen it is in bullish condition; also it is observed that gold plays the role of safe haven during bearish conditions of stock market i.e. at its lowest 1 per cent of quantile silver and platinum when gold is at its 10 per cent of quantile. Baur and McDermott (2010) examined BRIC countries from 1979 to 2009 and finds that gold does not hedge against stock markets of BRIC countries. The same quantile regression model has estimated

TABLE 9

Estimates of Relationship between Silver Returns (%)
and Exchange Rate (%) for UK and China

Silver Return	UK			CHINA		
	Coef	SE	t-stat pvalue	Coef	SE	t-stat pvalue
φ_0 (hedge)	1.375	0.030	44.781**	0.521	0.267	1.949*
			0.000			0.051
$\Sigma\varphi_1$ (90%)	1.417	0.081	17.410**	1.223	0.530	2.304**
			0.000			0.010
$\Sigma\varphi_2$ (95%)	1.439	0.061	23.317**	1.290	0.623	2.071**
			0.000			0.019
$\Sigma\varphi_3$ (99%)	1.130	0.075	14.951**	1.009	0.052	19.247**
			0.000			0.000
	Conditional Volatility			Conditional Volatility		
δ_0	-0.058	0.006	-9.610**	-0.056	0.005	-9.619**
			0.000			0.000
δ_1	0.095	0.009	9.739**	0.092	0.009	9.718**
			0.000			0.000
δ_2	0.028	0.006	4.113**	0.029	0.006	4.388**
			0.000			0.000
δ_3	0.994	0.001	710.569**	0.995	0.001	794.563**
			0.000			0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

for silver as well as for platinum. Table 18 and 19 shows the estimated results and concludes that both metals can hedge against stock market of China when they are in various bearish conditions. Similarly the lack of safe haven property can be seen by the insignificant coefficients correspond to all bearish and bullish conditions of silver and platinum respectively.

Tables 20, 21 and 22 display the estimation results of gold, silver and platinum for the US against inflation. On average the relationship between gold and inflation rate is negligible as noted by Baur and Lucey (2010) model while at its lowest quantile i.e., at 10 per cent quantile, it can hedge inflation risk of the US. The relationship remains positive and significant so gold is found to be a safe haven against high inflation only in bearish scenario of gold market. Beckman and Czudaj (2013) employed the MS-VECM approach to consider the different regimes and finds that gold is partially able to hedge against inflation for the US and the UK. From Table 21 it has observed that the silver at its lower quantile i.e. at 10 per cent and 25 per cent of its quantile it appears to hedge inflation of the US. Similarly in the bearish condition of silver it appears to act as a safe haven

TABLE 10

Estimates of Relationship between Platinum Returns (%)
and Exchange Rate (%) for UK and China

Platinum Return	UK			CHINA		
	Coef	SE	t-stat pvalue	Coef	SE	t-stat pvalue
φ_0 (hedge)	1.224	0.026	45.928**	0.235	0.077	3.039**
			0.000			0.002
$\Sigma\varphi_1$ (90%)	1.212	0.068	17.597**	-0.568	0.363	-1.562
			0.000			0.940
$\Sigma\varphi_2$ (95%)	1.230	0.056	21.782**	-0.645	0.447	-1.441
			0.000			0.925
$\Sigma\varphi_3$ (99%)	1.253	0.065	19.188**	0.995	0.147	6.766**
			0.000			0.000
	Conditional Volatility			Conditional Volatility		
δ_0	0.008	-12.635**	-0.114	0.008	-12.805**	-9.619**
		0.000			0.000	0.000
δ_1	0.013	12.416**	0.168	0.013	12.566**	9.718**
		0.000			0.000	0.000
δ_2	0.008	2.952**	0.026	0.008	3.217**	4.388**
		0.003			0.001	0.000
δ_3	0.002	328.271**	0.983	0.003	322.588**	794.563**
		0.000			0.000	0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 11

Quantile Regression of Gold versus Stock for US

Gold	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	-0.043	-4.261**	-0.142	-4.237**	-0.084	-5.086**	-0.014	-1.272	-0.006	-0.306	0.100	3.852**
		0.000		0.000		0.000		0.203		0.759		0.000
$\Sigma\beta_2$ (10%)	-0.019	-0.776	0.271	2.820	0.083	1.218	-0.041	-1.335	-0.135	-3.306**	-0.139	-1.951**
		0.218		0.997		0.888		0.090		0.000		0.025
$\Sigma\beta_3$ (5%)	-0.023	-1.271	0.131	2.303	0.043	0.909	-0.040	-1.871	-0.114	-2.903**	-0.139	-2.245
		0.101		0.989		0.818		0.031		0.001		0.012
$\Sigma\beta_4$ (1%)	-0.064	-2.696**	0.384	7.101	0.176	8.982	-0.095	-3.443**	-0.198	-3.903**	-0.385	-11.472*
		0.003		1.000		1.000		0.000		0.000		0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 12

Quantile Regression of Silver versus Stock for US

Silver	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	-0.048	-2.712**	-0.095	-1.969**	-0.063	-2.061**	0.000	0.000	0.063	1.293	0.151	2.526**
		0.006		0.049		0.039		1.000		0.195		0.011
$\Sigma\beta_2$ (10%)	0.014	0.349	0.494	2.538	0.262	2.615	0.000	0.000	-0.041	-0.551	0.017	0.104
		0.636		0.994		0.995		0.500		0.290		0.541
$\Sigma\beta_3$ (5%)	0.024	0.851	0.370	3.214	0.211	2.885	0.000	0.000	0.027	0.492	0.022	0.352
		0.802		0.999		0.997		0.500		0.688		0.637
$\Sigma\beta_4$ (1%)	0.075	2.070	0.666	6.090	0.292	7.083	0.134	1.721	-0.096	-0.825	-0.226	-4.323**
		0.980		1.000		1.000		0.956		0.204		0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 13

Quantile Regression of Platinum versus Stock for US

Platinum	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	0.048	3.066**	-0.094	-2.181**	0.009	0.370	0.019	1.046	0.117	3.834**	0.174	4.328**
		0.002		0.029		0.710		0.290		0.000		0.000
$\Sigma\beta_2$ (10%)	0.034	0.907	0.197	1.513	0.124	2.052	0.001	0.026	-0.091	-1.176	-0.110	-1.366
		0.817		0.934		0.979		0.510		0.120		0.086
$\Sigma\beta_3$ (5%)	-0.006	-0.216	0.235	2.881	0.067	1.490	0.000	0.030	-0.077	-1.475*	-0.074	-0.729
		0.414		0.997		0.931		0.512		0.070		0.233
$\Sigma\beta_4$ (1%)	0.078	2.420	0.351	18.363	0.394	8.878	0.109	1.030	-0.041	-0.889	-0.210	-2.815**
		0.992		1.000		1.000		0.848		0.187		0.002

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 14

Quantile Regression of Gold versus Stock for UK

Gold	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	-0.115	-7.829**	-0.157	-4.595**	-0.129	-5.349**	-0.068	-3.393**	-0.018	-0.678	0.101	2.619**
		0.000		0.000		0.000		0.000		0.497		0.008
$\Sigma\beta_2$ (10%)	-0.120	-3.332**	0.235	2.248	0.033	0.551	-0.072	-1.537	-0.191	-2.642**	-0.218	-2.825**
		0.000		0.987		0.709		0.062		0.004		0.002
$\Sigma\beta_3$ (5%)	-0.067	-2.625**	0.394	5.470	0.123	2.030	-0.053	-1.277	-0.179	-4.241**	-0.365	-4.370**
		0.004		1.000		0.978		0.100		0.000		0.000
$\Sigma\beta_4$ (1%)	-0.062	-1.949**	0.511	5.311	0.114	1.368	-0.016	-0.204	-0.214	-5.055**	-0.237	-5.692**
		0.025		1.000		0.914		0.418		0.000		0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 15

Quantile Regression of Silver versus Stock for UK

Silver	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	-0.081	-3.737**	-0.039	-0.543	-0.025	-0.745	-0.011	-0.409	0.128	2.814**	0.406	7.272**
		0.000		0.586		0.456		0.682		0.004		0.000
$\Sigma\beta_2$ (10%)	-0.068	-1.303	0.617	2.554	0.275	1.475	-0.070	-0.876	-0.017	-0.258	-0.022	-0.198
		0.096		0.994		0.929		0.190		0.397		0.421
$\Sigma\beta_3$ (5%)	0.055	1.468	0.896	8.247	0.428	4.093	0.118	1.391	0.051	0.754	-0.019	-0.239
		0.929		1.000		0.999		0.917		0.774		0.405
$\Sigma\beta_4$ (1%)	0.056	1.287	1.175	7.085	0.592	8.877	0.303	3.085	0.064	0.711	-0.017	-0.189
		0.901		1.000		1.000		0.998		0.761		0.424

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 16

Quantile Regression of Platinum versus Stock for UK

Platinum	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	-0.017	-0.949	-0.098	-2.075	-0.052	-1.667	0.005	0.203	0.089	2.979**	0.309	7.041**
		0.342		0.038		0.095		0.839		0.002		0.000
$\Sigma\beta_2$ (10%)	0.032	0.707	0.424	2.415	0.236	3.020	-0.029	-0.477	-0.056	-0.886	-0.033	-0.307
		0.760		0.992		0.998		0.316		0.187		0.379
$\Sigma\beta_3$ (5%)	0.037	1.119	0.471	3.096	0.243	4.118	0.082	1.200	-0.021	-0.332	-0.166	-2.316**
		0.868		0.999		0.999		0.884		0.369		0.010
$\Sigma\beta_4$ (1%)	0.078	1.970	1.216	13.754	0.401	3.935	0.150	2.445	0.000	0.004	0.010	0.259
		0.975		1.000		0.999		0.992		0.501		0.602

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 17

Quantile Regression of Gold versus Stock for China

Gold	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	-0.001	-0.416	0.014	0.594	0.005	1.760	-0.001	-0.849	-0.008	-4.047**	-0.016	-10.633**
		0.677		0.551		0.078		0.395		0.000		0.000
$\Sigma\beta_2$ (10%)	0.042	2.974	0.214	4.929	0.087	4.342	0.031	1.801	0.071	2.951	0.132	2.810
		0.998		0.999		0.999		0.964		0.998		0.997
$\Sigma\beta_3$ (5%)	0.009	1.144	0.055	1.119	0.012	0.615	0.001	0.205	0.000	0.028	0.007	0.386
		0.873		0.868		0.730		0.581		0.511		0.650
$\Sigma\beta_4$ (1%)	0.002	0.391	-0.032	-4.348**	-0.007	-0.521	-0.002	-0.565	0.020	2.515	0.043	1.638
		0.652		0.000		0.301		0.285		0.994		0.949

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 18

Quantile Regression of Silver versus Stock for China

Silver	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	0.000	-0.033	0.024	9.144**	0.021	2.864**	0.000	0.246	-0.012	-3.388**	-0.011	-0.172
		0.973		0.000		0.004		0.805		0.000		0.862
$\Sigma\beta_2$ (10%)	0.048	1.636	0.035	0.470	0.032	0.688	0.002	0.080	0.063	1.090	0.047	0.671
		0.949		0.680		0.754		0.532		0.862		0.748
$\Sigma\beta_3$ (5%)	0.010	0.580	0.263	2.963	0.072	1.285	0.000	0.032	0.058	1.736	0.021	0.224
		0.719		0.998		0.900		0.513		0.958		0.588
$\Sigma\beta_4$ (1%)	0.012	0.922	0.016	0.227	-0.004	-0.136	-0.009	-0.897	0.051	4.717	0.092	2.036
		0.821		0.590		0.445		0.184		0.999		0.979

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 19

Quantile Regression of Platinum versus Stock for China

Platinum	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	0.007	1.306	0.019	8.782**	0.008	3.715**	0.002	0.609	0.021	1.909	0.016	0.446
		0.191		0.000		0.000		0.541		0.056		0.655
$\Sigma\beta_2$ (10%)	0.061	2.656	0.092	1.872	0.103	2.216	0.007	0.342	0.073	2.172	0.135	2.728
		0.996		0.969		0.986		0.634		0.985		0.996
$\Sigma\beta_3$ (5%)	0.001	0.080	0.165	2.184	0.049	2.128	0.001	0.078	0.006	0.395	0.049	1.291
		0.532		0.985		0.983		0.531		0.653		0.901
$\Sigma\beta_4$ (1%)	0.010	0.879	0.019	0.991	0.002	-0.131	0.013	1.058	0.022	1.706	0.029	2.302
		0.810		0.839		0.447		0.855		0.956		0.989

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 20

Quantile Regression of Gold versus Inflation Rate for US

Gold	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	1.385	1.851*	4.730	7.006**	3.712	1.714*	1.717	1.245	-1.194	-0.783	-0.794	-0.612
		0.064		0.000		0.087		0.214		0.434		0.541
$\Sigma\beta_2$ (90%)	-0.141	-0.080	-0.912	-0.211	1.094	0.625	-0.949	-0.564	-2.681	-1.319	1.791	0.395
		0.532		0.583		0.266		0.713		0.905		0.346
$\Sigma\beta_3$ (95%)	3.783	2.135	5.655	3.241**	4.566	2.452**	5.017	2.837	2.438	1.512*	2.043	0.887
		0.016		0.000		0.007		0.002		0.065		0.187
$\Sigma\beta_4$ (99%)	2.423	0.831	5.815	4.870**	4.055	2.706**	3.168	1.710**	3.489	1.256	0.621	0.329
		0.203		0.000		0.003		0.044		0.104		0.371

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 21

Quantile Regression of Silver versus Inflation Rate for US

Silver	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	1.788	1.315	10.146	3.757**	8.946	2.712**	2.298	0.681	0.304	0.238	2.836	2.545**
		0.188		0.000		0.007		0.495		0.811		0.011
$\Sigma\beta_2$ (90%)	-3.753	-1.648	0.004	0.001	-1.885	-0.595	-4.657	-1.338	-1.544	0.209	8.668	0.801
		0.949		0.499		0.724		0.909		0.582		0.211
$\Sigma\beta_3$ (95%)	-2.180	-0.844	-3.853	-1.353	-4.674	-1.022	-1.160	-0.416	-6.735	-2.638	-0.749	-0.082
		0.800		0.911		0.846		0.661		0.995		0.532
$\Sigma\beta_4$ (99%)	6.514	1.041	11.830	3.503**	8.576	1.705**	8.838	2.818**	5.145	2.169	0.100	0.063
		0.149		0.000		0.044		0.002		0.015		0.474

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 22

Quantile Regression of Platinum versus Inflation Rate for US

Platinum	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	3.452	2.852**	7.192	5.225**	6.832	5.172**	3.001	1.620	4.056	2.257**	4.332	2.145**
		0.004		0.000		0.000		0.106		0.024		0.032
$\Sigma\beta_2$ (90%)	1.568	0.832	-3.682	-0.589	-0.659	-0.165	0.865	0.194	1.788	0.744	-0.241	-0.127
		0.202		0.721		0.565		0.423		0.228		0.550
$\Sigma\beta_3$ (95%)	4.141	2.508**	5.079	2.305**	3.522	1.686**	2.335	0.812	4.585	0.493	8.659	2.572**
		0.006		0.010		0.046		0.208		0.311		0.005
$\Sigma\beta_4$ (99%)	0.907	0.169	6.103	4.200**	3.310	1.784**	0.897	0.387	3.329	0.840	1.033	0.385
		0.432		0.000		0.037		0.349		0.200		0.350

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 23

Quantile Regression of Gold versus Inflation Rate for UK

Gold	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	-0.607	-0.678	-3.594	-2.572	0.084	0.075	-0.804	-0.728	-0.426	-0.327	0.664	0.444
		0.497		0.010		0.939		0.467		0.743		0.657
$\Sigma\beta_2$ (90%)	-0.379	-0.213	-3.211	-1.105	-1.451	-0.522	-0.308	-0.057	2.012	0.763	1.727	0.304
		0.584		0.865		0.699		0.522		0.222		0.380
$\Sigma\beta_3$ (95%)	0.876	0.503	2.955	1.427	1.693	0.859	1.177	0.817	-0.339	-0.262	-3.164	-2.678
		0.307		0.076		0.195		0.206		0.603		0.996
$\Sigma\beta_4$ (99%)	-1.762	-0.943	-0.451	-1.027	-2.104	-0.847	-1.946	-2.240	-2.913	-4.408	2.220	0.549
		0.827		0.847		0.801		0.987		0.999		0.291

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 24

Quantile Regression of Silver versus Inflation Rate for UK

Silver	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	-1.734	-1.181	-7.235	-4.465**	-4.209	-2.823**	-1.823	-1.297	-0.312	-0.154	0.977	0.357
		0.237		0.000		0.005		0.195		0.877		0.721
$\Sigma\beta_2$ (90%)	1.699	0.592	-36.660	-3.829	-9.088	-0.834	3.420	0.811	10.246	1.496	8.238	1.873**
		0.276		0.999		0.797		0.208		0.067		0.030
$\Sigma\beta_3$ (95%)	-0.149	-0.086	-2.385	-0.748	-0.953	-0.269	3.047	0.872	0.341	0.098	4.769	0.953
		0.534		0.772		0.606		0.191		0.460		0.170
$\Sigma\beta_4$ (99%)	0.070	0.024	2.107	3.261**	1.142	1.372*	-0.003	-0.003	-1.745	-2.073	-3.510	-5.098
		0.490		0.000		0.085		0.501		0.980		1.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 25

Quantile Regression of Platinum versus Inflation Rate for UK

Platinum	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	1.254	1.219	1.819	0.981	1.328	0.920	1.148	0.769	2.220	1.691*	3.076	2.554**
		0.222		0.327		0.358		0.442		0.091		0.011
$\Sigma\beta_2$ (90%)	6.688	2.929**	0.049	0.009	-0.053	-0.007	6.784	2.402**	4.756	2.040**	3.651	1.383*
		0.001		0.496		0.502		0.008		0.021		0.083
$\Sigma\beta_3$ (95%)	-1.667	-0.902	0.627	0.224	0.008	0.004	-2.121	-0.883	-0.283	-0.092	-0.216	-0.052
		0.816		0.411		0.498		0.811		0.536		0.520
$\Sigma\beta_4$ (99%)	-1.981	-0.908	0.003	0.006	-2.003	-1.596	-2.094	-2.284	-3.364	4.210	-1.323	-0.284
		0.818		0.497		0.944		0.988		0.999		0.612

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 26

Quantile Regression of Gold versus Inflation Rate for China

Gold	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	0.772	1.849*	0.985	0.562	0.697	0.974	0.735	1.756*	0.710	1.328	0.983	1.753*
		0.064		0.574		0.330		0.080		0.184		0.080
$\Sigma\beta_2$ (90%)	0.086	0.093	2.357	2.774**	0.376	0.365	0.873	0.826	-0.328	-0.337	-1.092	-0.808
		0.462		0.002		0.357		0.204		0.631		0.790
$\Sigma\beta_3$ (95%)	-1.194	-1.588	1.535	3.058**	-0.229	-0.407	-0.859	-1.117	1.125	1.178	-0.900	-1.346
		0.943		0.001		0.658		0.867		0.119		0.910
$\Sigma\beta_4$ (99%)	-0.550	-0.371	-0.101	-0.125	-1.480	-1.255	-0.361	-0.280	21.661	16.386**	19.941	21.625**
		0.644		0.550		0.894		0.610		0.000		0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 27

Quantile Regression of Silver versus Inflation Rate for China

Silver	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	0.643	1.000	-0.059	-0.039	- 0.282	-0.306	0.533	0.583	1.197	1.168	3.005	4.066**
		0.317		0.968		0.759		0.560		0.243		0.000
$\Sigma\beta_2$ (90%)	0.523	0.290	-0.034	-0.013	- 0.284	-0.139	-1.021	-0.369	-0.732	-0.292	1.016	0.202
		0.385		0.505		0.555		0.643		0.615		0.419
$\Sigma\beta_3$ (95%)	0.541	0.455	3.375	1.799	2.811	2.071**	1.291	0.651	1.417	0.546	1.794	0.964
		0.324		0.036		0.019		0.257		0.292		0.167
$\Sigma\beta_4$ (99%)	4.568	2.254**	6.084	4.542**	3.920	2.110**	4.596	1.559*	16.554	5.887**	14.095	7.450**
		0.012		0.000		0.017		0.059		0.000		0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 28

Quantile Regression of Platinum versus Inflation Rate for China

Platinum	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	1.492	2.529**	1.240	0.595	0.875	1.281	1.452	2.603**	1.765	2.029**	-1.165	-0.887
		0.011		0.551		0.201		0.009		0.043		0.375
$\Sigma\beta_2$ (90%)	0.760	0.650	0.884	0.196	1.075	0.637	1.735	1.028	0.364	0.269	0.635	0.319
		0.257		0.422		0.262		0.152		0.393		0.374
$\Sigma\beta_3$ (95%)	0.238	0.241	1.574	1.126	1.319	1.240	0.467	0.419	-0.292	-0.211	3.237	1.686**
		0.404		0.130		0.107		0.337		0.583		0.046
$\Sigma\beta_4$ (99%)	0.304	0.070	3.192	4.793**	1.344	1.586*	0.396	0.369	21.495	11.285**	20.154	14.329**
		0.472		0.000		0.056		0.355		0.000		0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 29

Quantile Regression of Gold versus Exchange Rate for UK

Gold	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	1.208	73.190**	1.728	27.313**	1.444	37.737**	1.242	44.257**	1.258	49.893**	1.269	27.162**
		0.000		0.000		0.000		0.000		0.000		0.000
$\Sigma\beta_2$ (90%)	1.288	30.084**	1.458	14.492**	1.369	24.048**	1.365	19.889**	1.594	10.631**	1.846	11.250**
		0.000		0.000		0.000		0.000		0.000		0.000
$\Sigma\beta_3$ (95%)	1.277	39.522**	1.141	10.494**	1.215	22.445**	1.336	19.632**	1.505	23.792**	1.770	9.256**
		0.000		0.000		0.000		0.000		0.000		0.000
$\Sigma\beta_4$ (99%)	1.213	34.746**	1. 181	15.666**	1.157	33.199**	1.323	3.548**	1.533	5.865**	2.374	51.134**
		0.000		0.000		0.000		0.000		0.000		0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 30

Quantile Regression of Silver versus Exchange Rate for UK

Silver	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	1.375	44.781**	2.287	16.954**	1.828	27.998**	1.402	30.787**	1.417	26.729**	1.336	21.430**
		0.000		0.000		0.000		0.000		0.000		0.000
$\Sigma\beta_2$ (90%)	1.417	17.410**	1.668	6.8276**	1.464	11.09**	1.538	13.318**	2.042	10.798**	2.748	5.584**
		0.000		0.000		0.000		0.000		0.000		0.000
$\Sigma\beta_3$ (95%)	1.439	23.317**	1.586	9.133**	1.508	18.993**	1.659	18.617**	1.986	11.919**	2.206	10.164**
		0.000		0.000		0.000		0.000		0.000		0.000
$\Sigma\beta_4$ (99%)	1.130	14.951**	1.448	19.716**	1.222	21.045**	1.285	6.285**	1.853	9.626**	2.876	33.014**
		0.000		0.000		0.000		0.000		0.000		0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 31

Quantile Regression of Platinum versus Exchange Rate for UK

Platinum	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	1.224	45.928**	1.523	28.449**	1.350	25.320**	1.212	34.967**	1.177	28.968**	1.065	15.540**
		0.000		0.000		0.000		0.000		0.000		0.000
$\Sigma\beta_2$ (90%)	1.212	17.597**	1.235	4.214**	1.297	10.837**	1.229	15.916**	1.418	13.884**	1.295	7.168**
		0.000		0.000		0.000		0.000		0.000		0.000
$\Sigma\beta_3$ (95%)	1.230	21.782**	1.297	12.102**	1.211	13.993**	1.346	17.047**	1.337	15.236**	1.526	9.476**
		0.000		0.000		0.000		0.000		0.000		0.000
$\Sigma\beta_4$ (99%)	1.253	19.188**	1.161	2.342**	1.157	9.579**	1.377	9.663**	1.792	23.555**	1.994	34.920**
		0.000		0.009		0.000		0.000		0.000		0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 32

Quantile Regression of Gold versus Exchange Rate for China

Gold	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	0.606	4.511**	1.141	1.555	0.580	7.587**	0.379	1.260	-0.931	-1.924*	-2.067	-3.357**
		0.000		0.119		0.000		0.207		0.054		0.000
$\Sigma\beta_2$ (90%)	0.775	2.642**	-3.814	-4.897	-2.090	-3.678	0.750	2.807**	1.135	1.952**	2.695	2.894**
		0.004		0.999		0.999		0.002		0.025		0.001
$\Sigma\beta_3$ (95%)	0.773	2.222**	-3.453	-3.377	-2.262	-3.697	0.764	2.548**	1.268	1.273	2.883	3.062**
		0.013		0.999		0.999		0.005		0.101		0.001
$\Sigma\beta_4$ (99%)	1.016	25.563**	1.037	658.392**	1.023	469.67**	1.014	358.952**	1.003	458.311**	0.989	652.334**
		0.000		0.000		0.000		0.000		0.000		0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 33

Quantile Regression of Silver versus Exchange Rate for China

Silver	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	0.521	1.949*	2.066	1.477	0.733	0.964	0.646	4.624**	-1.382	-1.649	-3.197	-1.960*
		0.051		0.139		0.335		0.000		0.099		0.049
$\Sigma\beta_2$ (90%)	1.223	2.304**	-7.603	-3.592	-2.948	-1.786	1.000	2.506**	2.153	2.241**	2.980	1.361*
		0.010		0.999		0.962		0.006		0.012		0.086
$\Sigma\beta_3$ (95%)	1.290	2.071**	-4.860	-1.874	-3.046	-1.744	1.000	2.171	2.312	2.171	3.358	1.53**
		0.019		0.969		0.959		0.014		0.014		0.062
$\Sigma\beta_4$ (99%)	1.009	19.247**	1.042	367.585**	1.016	262.894**	1.000	199.795**	0.980	254.830**	0.956	356.3**
		0.000		0.000		0.000		0.000		0.000		0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

TABLE 34

Quantile Regression of Platinum versus Exchange Rate for China

Platinum	Baur & Lucey		Quantile Regression									
			10th		25th		50th		75th		90th	
	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value	Coef	t-stat p value
β_1 (hedge)	0.235	3.039	-0.288	-3.714	0.302	0.972	0.320	2.043	-0.691	-1.292	-1.295	-1.403
		0.002		0.000		0.330		0.041		0.196		0.160
$\Sigma\beta_2$ (90%)	-0.568	-1.562	-4.400	-4.202	-2.688	-4.618	-0.500	-0.889	-0.681	-1.322	-0.181	-0.211
		0.940		0.999		0.999		0.813		0.906		0.583
$\Sigma\beta_3$ (95%)	-0.645	-1.441	-3.345	-2.718	-2.317	-3.367	-0.664	-0.893	-0.518	-0.973	0.541	0.621
		0.925		0.996		0.999		0.814		0.834		0.267
$\Sigma\beta_4$ (99%)	0.995	6.766	1.028	471.671	1.009	312.046	0.995	235.401	0.978	303.111	0.960	434.325
		0.000		0.000		0.000		0.000		0.000		0.000

***, **, * indicate statistical significance at the level of 0.01, 0.05 and 0.1, respectively.

with significant and positive relation against extremely high inflation period measured by 99 per cent of its quantile. McCown and Zimmerman (2006) disclose that gold is more inflation hedging ability as compared to silver for the developed market of the US. Table 22 shows that platinum can maintain its hedging power in its various bearish and bullish conditions, the same as suggested on average condition of platinum market by Baur and Lucey (2010) model. In its bearish condition platinum can acts as safe haven asset against high inflation while this property is not observed in its bullish mood excluding 90 per cent of its quantile having significant coefficient corresponding to the quantile with high inflation period i.e., at its 95 per cent quantile. These findings are one of its unique kinds as platinum usually considers for industrial purpose rather than investment metal.

Gold cannot serve as hedge or safe haven against inflation risk of the UK as results estimated by quantile regression approach displays in Table 23. In spite of Baur and Lucey (2010) model which reports that silver and platinum cannot act as hedge on average, at its 10th and 25th quantile and 75th and 90th quantile respectively found to be hedge. Table 24 reveals that in its bearish condition silver play the role of safe haven against high inflationary period measured by 99 per cent of its quantile. This safe haven property also holds for silver and platinum (Table 25) bullish mood against extreme inflation.

Gold and platinum can hedge against Chinese inflation risk pointed out by the estimation results of Baur and Lucey (2010) model. Results from quantile regression approach (Tables 26 to 28) suggest that both of them can hedge when they are in bullish attitude during high inflation. Similarly the safe haven property holds for gold when it is in bullish as well as in bearish condition. It has been observed from Table 27 on average silver cannot hedge, at its bullish condition measured by 90th quantile founds to be hedge. The safe haven property of silver remains perfect in all bearish and bullish conditions of silver market. Thus results of quantile regression are different from Baur and McDermott (2010) study who concludes that gold cannot hedge against inflation.

Tables 29, 30 and 31 shows that the evidence that gold, silver and platinum acts as hedge against exchange rate risk in the UK is quite strong as it possesses positive and significant relation not only on average but all higher and lower quantiles of gold market. Thus results concluded that the three precious metals can hedge and became safe haven against depreciating local currency for the UK, no matter metal market is either in bearish or bullish environment.

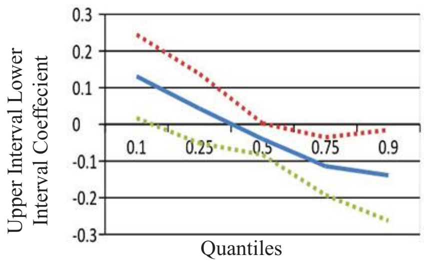
From Table 32 the hedge property of gold against markdown of Chinese Yuan is evident at various bearish and bullish conditions of gold market. When the rate of exchange rate of China drops and reaches at its 90 per cent or higher quantiles, gold mold itself as a safe haven asset. Similarly Table 33 shows that silver can hedge against exchange rate at various bearish and bullish conditions of market. It has been observed that silver represents itself as a safe haven asset in all environments of silver market while fall of local currency of China is in 99 per cent quantile. Platinum cannot hedge nor safe haven asset for China against the depreciation of Chinese currency.

The left panels from Figures 5 to 7 the quantile regression (combined) coefficients of gold, silver and platinum versus Stock markets of the US, the UK and China respectively with 95 per cent confidence intervals corresponds to the sum of coefficients of dummy variable of 5 per cent quantile of stock market returns has plotted. For the US and the UK gold became safe haven when gold market moves towards bullish environment. Investors from China cannot get benefit from precious metals by adding them in their portfolios. For silver the three countries do not enjoy its safe haven property. The safe haven characteristics for the US and the UK get strengthen when platinum market move towards bullish conditions.

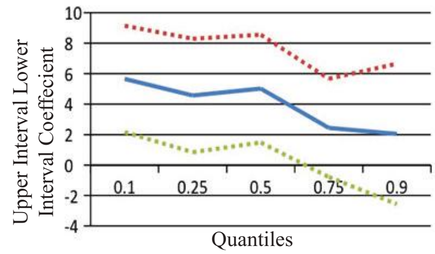
The right panels from figures 5 to 7 the quantile regression (combined) coefficients of gold, silver and platinum versus inflation of the US, the UK and China respectively with 95 per cent confidence intervals corresponds to the sum of coefficients of dummy variable of 95 per cent quantile of inflation has plotted. The safe haven characteristic of gold for the US and the UK get weak while moving from bearish to bullish conditions.

VI. Conclusions

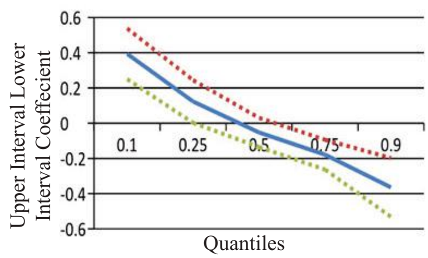
This paper aims to investigate the relationship of precious metal prices with economic and financial variables i.e. stock market index, exchange rate and inflation. The countries under observation are the US, the UK and China. The study also want to identify that whether and to what extent three precious metals serve as hedge against the extreme movements of stock market indices, exchange rate and Consumer Price Index (CPI) during several bearish and bullish conditions of metal markets. Previous studies focused mainly on gold market, this study also considers silver and platinum along with the gold to establish the relationship between metal market and stock market, exchange rate and inflation. Earlier studies like Baur and Lucey (2010) and Baur and McDermott (2010) only incorporate the average behavior of metal markets while this study inspectsthe hedging ability and safe haven property by undertaking various bearish and bullish conditions of metal market by employing the quantile regression approach. Study found that the three metals gold, silver and platinum can hedge stock market risk of the US. For the UK gold and silver can hedge while platinum holds negative but insignificant hedge coefficient against stock market. The three metals do not hold the unusual property of hedge and safe haven for emerging economy like China. Gold, silver and platinum cannot acts as hedge for the UK and China while gold and platinum can hedge for the US against inflation. Platinum is playing the role of



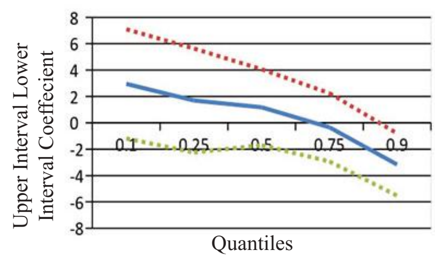
Quantile Regression coefficients and 95% confidence Interval: gold versus stock in the US



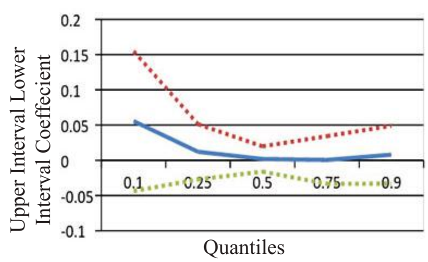
Quantile Regression coefficients and 95% confidence Interval: gold versus inflation in the US



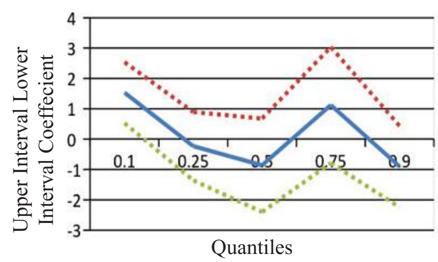
Quantile Regression coefficients and 95% confidence Interval: gold versus stock in the UK



Quantile Regression coefficients and 95% confidence Interval: gold versus inflation in the UK



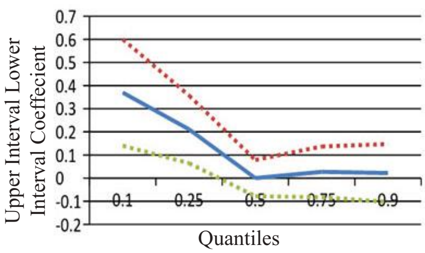
Quantile Regression coefficients and 95% confidence Interval: gold versus stock in the China



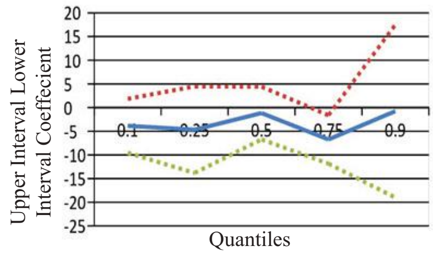
Quantile Regression coefficients and 95% confidence Interval: gold versus inflation in the China

FIGURE 5

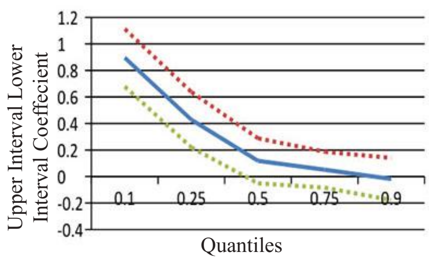
Quantile Regression Coefficients and 95 per cent Confidence Interval of Gold at Extremes 5 per cent Quantile of Stock and 95 per cent Quantile of Inflation



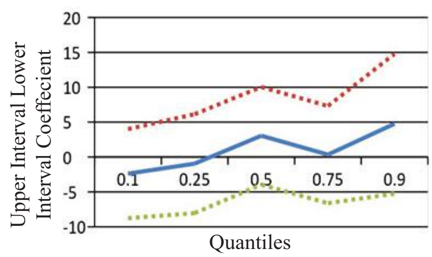
Quantile Regression coefficients and 95% confidence Interval: silver versus stock in the US



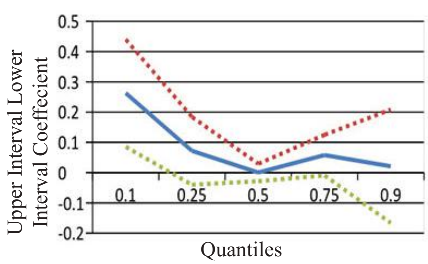
Quantile Regression coefficients and 95% confidence Interval: silver versus inflation in the US



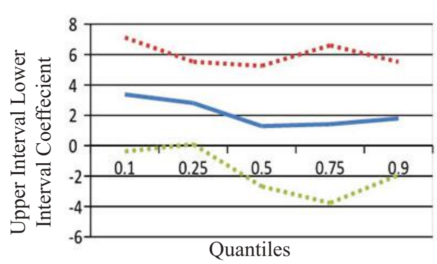
Quantile Regression coefficients and 95% confidence Interval: silver versus stock in the UK



Quantile Regression coefficients and 95% confidence Interval: silver versus inflation in the UK



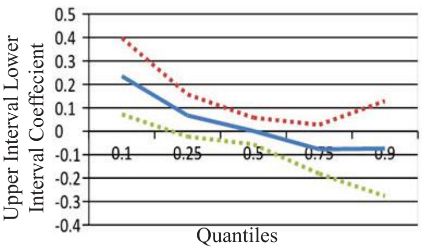
Quantile Regression coefficients and 95% confidence Interval: silver versus stock in the China



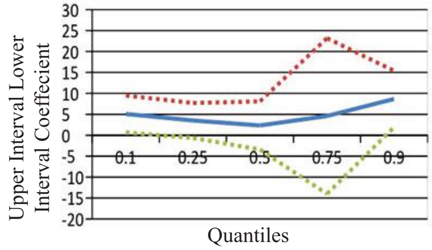
Quantile Regression coefficients and 95% confidence Interval: silver versus inflation in the China

FIGURE 6

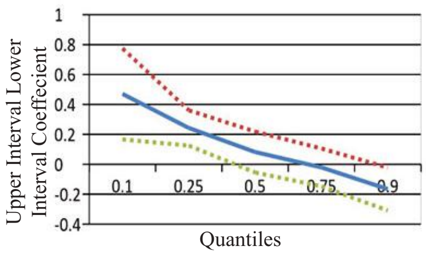
Quantile Regression Coefficients and 95 per cent Confidence Interval of Silver at Extremes 5 per cent Quantile of Stock and 95 per cent Quantile of Inflation



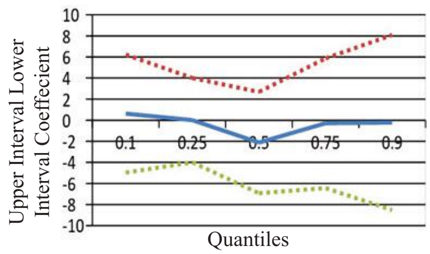
Quantile Regression coefficients and 95% confidence Interval: platinum versus stock in the US



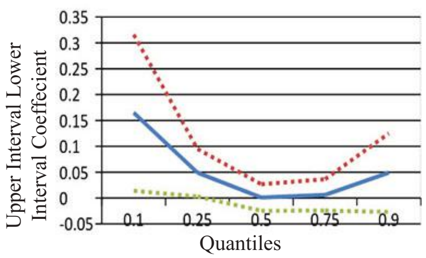
Quantile Regression coefficients and 95% confidence Interval: platinum versus inflation in the US



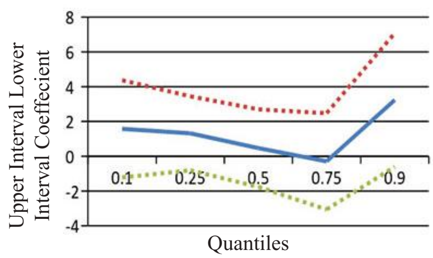
Quantile Regression coefficients and 95% confidence Interval: platinum versus stock in the UK



Quantile Regression coefficients and 95% confidence Interval: platinum versus inflation in the UK



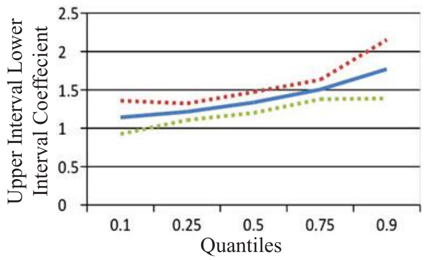
Quantile Regression coefficients and 95% confidence Interval: platinum versus stock in the China



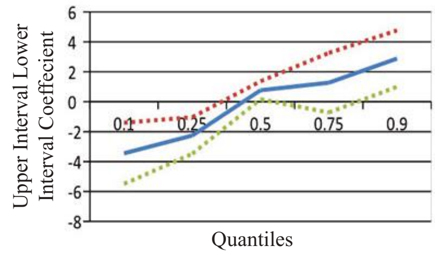
Quantile Regression coefficients and 95% confidence Interval: platinum versus inflation in the China

FIGURE 7

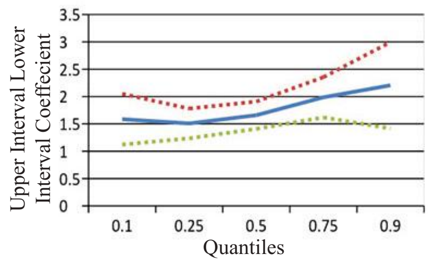
Quantile Regression Coefficients and 95 per cent Confidence Interval of platinum at Extremes 5 per cent Quantile of Stock and 95 per cent Quantile of Inflation



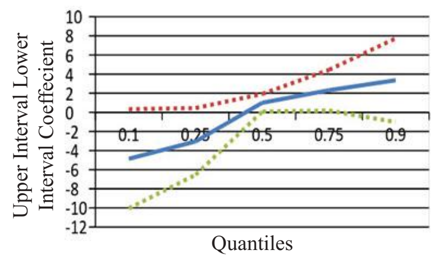
Quantile Regression coefficients and 95% confidence Interval: gold versus exchange rate in the UK



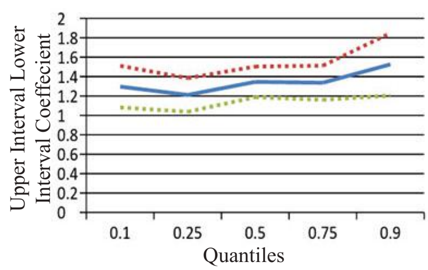
Quantile Regression coefficients and 95% confidence Interval: gold versus exchange rate in China



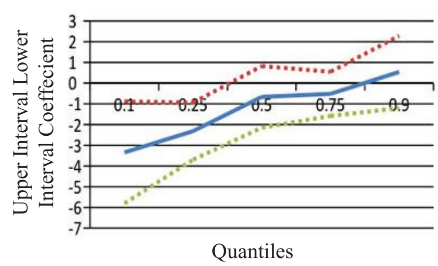
Quantile Regression coefficients and 95% confidence Interval: silver versus exchange rate in the UK



Quantile Regression coefficients and 95% confidence Interval: silver versus exchange rate in China



Quantile Regression coefficients and 95% confidence Interval: platinum versus exchange rate in the UK



Quantile Regression coefficients and 95% confidence Interval: platinum versus exchange rate in China

FIGURE 8

Quantile Regression Coefficients and 95 per cent Confidence Interval of Gold, Silver and Platinum at Extremes 95 per cent Quantile of Exchange Rate in UK and China safe haven for the UK and the US in high inflation situation. Similarly the three metals can acts as hedge and also as safe haven asset for the UK and China against depreciating local currency.

By employing the quantile regression approach proposed by Iqbal (2017) this study provides an insight for investors and financials to diversify their portfolios by adding precious metals in it. The results estimated by quantile regression shows that gold, silver and platinum can hedge in all bearish and bullish conditions of metal market for the UK against high inflation. It's safe haven property is evident by presence of significant coefficients in all the bearish and bullish conditions of metal market under studied against extremely high inflation measured by 90% quantile or higher. The results reveal that China can neither hedge nor safe haven against stock market risk. Moreover only platinum can hedge against high inflation in the US. Thus this study elaborates the clearer and complete picture of the relationship between metal markets and financial and economic variables. This study has essentially investigated the hedging potential of precious metals against economic risks from the point of view of active investor. Many investors however invest in risky markets taking a long term view. The study can be extended in this direction by considering possible long run hedge potential of precious metals using cointegration approaches. This approach will also enable us to reconsider our treatment of precious metal prices as endogenous and stock prices, exchange rate and inflation as exogenous by investigating the causality between precious metal prices and the financial assets and commodity prices.

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