Analyses of the impact of country specific macro risk variables on gold futures contract and its position as an asset class: evidence from India

RUPEL NARGUNAM, WILLIAM W. S. WEN, AND N. ANURADHA

This paper discusses the dependence of gold futures prices on macro risk factors using a multiple linear regression model. Recently introduced uncertainty indexes such as geopolitical risk index and economic policy uncertainty index are included in this study. We also examine the investment nature of gold futures contract among other assets. The results provide insights on the influence of these interrelated macro economic variables on a financial derivative contract in an emerging economy and its unique position in portfolio allocation and are aimed to help practitioners and policy makers.

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KEYWORDS AND PHRASES: Gold futures contract, Macro risk factors, Multiple linear regression, Investment nature.

1. INTRODUCTION

Many types of economic and political events can change the net worth of investments held by residents and non-residents in a country, ceteris paribus. Gold price is a complex macroeconomic variable, because factors influencing demand are sensitive to macroeconomic conditions; consequently, the dynamics is difficult to anticipate, predict and explain. Also, investment in gold is considered as a hedge against other financial instruments due to portfolio diversification characteristics [9, 4]. Among commodity prices, gold is considered as a useful indicator to track changes in macroeconomic variables, but recent trends show that the introduction of gold-backed financial instruments have eroded the lure of holding the metal itself. Hence, it is interesting to examine the impact of macro risk, that is, the financial risk associated with macroeconomic and political variables, on forecasting the prices of a gold futures contract and to evaluate its unique position among other assets in a portfolio. The behavior patterns of these variables over time are important due to the qualitative nature of the variables, and assuming smooth continuity of the data and nonstationarity, we attempt to build a model which takes into consideration all available information.

The macro risk variables used in this analysis are systematic risk factors such as Consumer Price Index (CPI) which is used as a proxy for inflation, Exchange Rate (ER), Monetary Policy Variable (M3) which is used as a proxy for money supply in the economy [8]; indices measuring policy uncertainty such as Economic Policy Uncertainty (EPU) index [2] and Geopolitical Risk (GPR) index [7]. These variables are chosen to examine the level of influence of the country’s macro risk factors on the intrinsic value of a particular type of investment.

CPI is the most anticipated information among financial market participants because it propels much activity in the marketplace. In essence, it helps the investor assess the present value of his investments and make adjustments in his portfolio for future cash flows. ER has an impact on economic activity, because a weak or depreciated Indian rupee vs. USD will encourage export growth and slow down import growth, due to the shift in demand. Foreign exchange markets are further complicated by political factors that weigh in on a country’s currency valuation. Hence, we include GPR index which is designed to account for the reactions of traders to geopolitical tensions, namely events and rumors occurring in leading newspaper reports; and EPU index, which is constructed based on newspaper articles regarding political uncertainty. The decisions of policy makers related to monetary, fiscal or regulatory policy affect economic uncertainty and are instrumental in shaping financial markets [1, 2].

In India, the broad money (M3) is a measure of domestic currency with public and deposits. This monetary aggregate is observed closely by central banks and economists because it is influenced by investors’ perception of the market resulting in changes in international capital flows and velocity of circulation. There tends to be flights into gold [9, 4], which push up its price during rapid inflation, exchange rate turbulence or global political instability. Also, prices, exchange rates and economic growth are all interrelated.

We also study the investment nature of gold futures contract, when compared to stocks and bonds by constructing a portfolio with the aforementioned types of assets. This study is useful because it will throw light on the position of a gold-backed financial contract in a portfolio, with regard to its behavior toward the above stated types of assets. More
specifically, it will help us assess if the gold futures contract behaves like other financial contracts or if it has the market characteristics of its underlying asset. We examine the correlation between them and model the dependence using a multiple linear regression model. To distinguish between them we apply the definitions and theoretical argument framed by [3]. The definitions are as follows: a hedge is defined as an asset that is uncorrelated or negatively correlated with another asset or portfolio on average, a diversifier is defined as an asset that is positively but not perfectly correlated with another asset or portfolio on average, a safe haven is defined as an asset that is uncorrelated or negatively correlated with another asset or portfolio in times of market stress or turmoil.

In both multiple linear regression models, to control for the effect of gold spot market on the gold derivative market, we introduce two control variables, namely the simple returns of gold price \((r_{GS})\) in the Indian spot market, and the simple returns of London Bullion Market Association (LBMA) gold price \((r_{LBMA})\) set at 10.30 London GMT, used as a proxy for global gold spot returns. It is imperative in our study to include the market control variables because the gold futures market is influenced by the domestic gold spot market and the global gold spot market.

In this paper, we analyze the dependence of gold futures contract on macro risk factors like CPI, ER, EPU index, GPR index and M3 in the Indian context, taking into account the market control variables. We attempt to find an interactive cause and effect relationship between gold futures prices and macro risk variables. We also examine the investment nature of gold futures in a portfolio with regard to other types of investment like stock and bond, while taking into account the market control variables. We are not aware that a similar analysis of the gold futures market in an emerging economy with sentimental attachment towards physical gold exists.

The rest of paper is organized as follows: section 2 describes the data and methodology used in the analysis, section 3 discusses the results, and section 4 concludes the study.

2. DATA AND MODELING METHODOLOGY

2.1 Data

The primary focus of this study is to understand the response of gold futures price changes to the changes in country specific macro risk factors, allowing for market control variables; and also the investment nature of the gold futures contract and its position as an asset class.

In our first analysis examining the dependence of gold futures on macro risk factors, we let \(Y_t\) be the dependent variable denote the price of the gold futures contract which is the closing price of the commodity derivative contract titled Multi Commodity Exchange of India Gold Commodity Future Continuation 1 (RIC: MAU(1)), obtained from Thomson Reuters Eikon platform for 12 years from January 2005 to May 2017. It is a continuation series of closing price considering the rollover of the contracts on the fifth day of the contract expiry month. The independent variables and their sources are listed as follows: let \(X_{CPI,t}\) denote the CPI which is used as a proxy for inflation (Source: Organization for Economic Co-operation and Development, Consumer Price Index: All Items for India [INDCPIALLMINMEI], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/INDCPIALLMINMEI, May 28, 2020); let \(X_{ER,t}\) denote the real broad effective exchange rate for India which is calculated as weighted averages of bilateral exchange rates adjusted by relative consumer prices (Source: Bank for International Settlements, Real Broad Effective Exchange Rate for India [RBINBIS], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/RBINBIS, May 27, 2020); let \(X_{EPU,t}\) denote the EPU index used to measure the influence of policy-related economic uncertainty in India, newspaper articles regarding policy uncertainty (Source: https://www.policyuncertainty.com/gpr.html); and let \(X_{M3,t}\) denote M3, also known as broad money, which is used as a measure of supply of money in the economy (Source: Organization for Economic Co-operation and Development, M3 for India [MABMM301INM189N], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/MABMM301INM189N, May 28, 2020). The model data set is for the period from January 2005 \((t = 1)\) to May 2016 \((t = 137)\) and follows a monthly time unit.

In our analysis examining the position of gold futures as an asset class, we let \(Y_t\) be the dependent variable denoting the price of the gold futures contract which has the same specification given in the previous paragraph. The independent variables and their sources are listed as follows: let \(r_{X_{bond},t}\) denote the returns on bond, which are the short term interest rates, and are the yields from government securities and government bonds in India (Source: International Monetary Fund, Interest Rates, Government Securities, Government Bonds for India [INTGSBINM193N], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/INTGSBINM193N, May 1, 2020) and let \(X_{stock,t}\) denote the closing price of the Morgan Stanley Corporate International (MSCI) India Index which tracks the performance of the large and mid-cap segments of the Indian market (Source: https://in.investing.com/indices/msci-india-historical-data). The model data set is for the period from January 2005 \((t = 1)\) to May 2016 \((t = 137)\) and follows a monthly time unit.

The market control variables used in the regression models and their sources are listed as follows: \(X_{GS,t}\) de-
2.2 Econometric model

This section provides the econometric approach we use to build a good statistical model that tests interaction between theory and empirical observation.

A preliminary multiple linear regression model excluding control variables is fit using the original time series to examine the linear dependence of gold futures prices on macro risk factors and the linear relationship of the gold futures contract on other investments in a portfolio.

In our first analysis, a multiple linear regression model is fitted with the macro risk factors as independent variables, namely, short term government bonds and large and mid-cap segments stock index, and the gold futures prices as the dependent variable. We examine the interaction terms under the assumption that a portfolio comprises of these three investments. The sign of the coefficients in the estimated model is used to make inferences about the dependence between the assets in the portfolio that is expected to be present based on definitions given in the previous section.

Also, a sub-sample analysis is carried out to examine whether the results based on the full sample period are also valid in sub-sample. This period is from January 2007 (t = 26) to December 2009 (t = 61). This sub-sample analysis which includes the time period of the Global Financial Crisis (GFC) examines the linear dependence of gold futures prices on macro risk factors and different asset classes, during a period of economic uncertainty. However, this study does not model the period around the GFC as a structural break.

The general form of a multiple regression equation is given below: We consider the standard regression model following ([15], Chapter 15):

$$Y_t = X_t' \beta + \varepsilon_t,$$

for, $t = 1, 2, \ldots, n$, where, $Y_t$ is a dependent variable, $X_t$ is a vector of independent variables, $\beta$ is a vector of parameters and $\varepsilon_t$ is an error term often assumed to be white noise, i.i.d. $N(0, \sigma^2)$. However, when time series data are used, as pointed out by ([12], Chapter 15), the error term is normally not white noise and follows a time series model given in Equation (3).

$$\varepsilon_t = \phi_1 \varepsilon_{t-1} + \cdots + \phi_p \varepsilon_{t-p} + n_t,$$
Figure 2. Plot of the CPI, $X_{\text{CPI},t}$.

Figure 3. Plot of Exchange Rate, $X_{\text{ER},t}$.

Figure 4. Plot of broad money, $X_{M3,t}$.

Figure 5. Plot of Economic Policy Uncertainty Index, $X_{\text{EPU},t}$.

Figure 6. Plot of Geopolitical Risk Index, $X_{\text{GPR},t}$.

Figure 7. Plot of the return from short term government securities, $rX_{\text{bond},t}$.
2.3.2 Preliminary model fitting

A preliminary multiple linear regression model is fitted using the original time series to examine the influence of macro risk factors on gold futures prices. The fitted model is as follows

\[
\hat{Y}_{GF,t} = 613.8 X_{CPI,t} - 148.3 X_{ER,t} + 41.07 X_{EPU,t} - 44.23 X_{GPR,t} - 1.669 \times 10^{-10} X_{M3,t} + \varepsilon_t,
\]

with all parameters being significant.

### Table 1. VIF of independent variables and control variables for the model in Equation (5)

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>(X_{CPI,t})</td>
<td>1113.534</td>
</tr>
<tr>
<td>(X_{ER,t})</td>
<td>152.1158</td>
</tr>
<tr>
<td>(X_{EPU,t})</td>
<td>5.0317</td>
</tr>
<tr>
<td>(X_{GPR,t})</td>
<td>24.4622</td>
</tr>
<tr>
<td>(X_{M3,t})</td>
<td>474.6896</td>
</tr>
</tbody>
</table>

The calculated values for VIF as given in the above table suggest that the variance among \(\beta_j\)'s is inflated and that \(\beta_j\)'s are not independent in the fitted model. Therefore this model is not used in further analysis. Hence, the time series of the independent variables is made stationary before re-fitting a suitable multiple linear regression model.

A preliminary multiple linear regression model is fitted using the original time series to examine the influence of other assets in a portfolio on gold futures prices. The fitted model is as follows

\[
Y_{GF,t} = -19098.996 + 2587.721 rX_{bond,t} + 26.401 X_{stock,t} + \varepsilon_t,
\]

with all parameters being significant.

### Table 2. VIF of independent variables and control variables for the model in Equation (6)

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>(rX_{bond,t})</td>
<td>1.2896</td>
</tr>
<tr>
<td>(X_{stock,t})</td>
<td>2.7012</td>
</tr>
</tbody>
</table>

The calculated values for VIF as given in the above table suggest that the variance among \(\beta_j\)'s is inflated and that \(\beta_j\)'s are not independent in the fitted model. Therefore this model is not used in further analysis. Hence, the time series of the independent variable \(X_{stock,t}\) is made stationary before re-fitting a suitable multiple linear regression model.

2.3.3 Interaction between variables

2.3.3.1. Intercorrelation matrix

The correlation matrix of independent and control variables in our first analysis using original time series is given below:
The correlation matrix of independent and control variables in our second analysis using original time series is given below:

\[
\begin{bmatrix}
EPU & ER & CPI & GPR & GS & M3 & LBMAGS \\
1.0000 & -0.1249 & 0.3714 & -0.0656 & 0.6174 & 0.3744 & 0.6098 \\
ER & 0.3714 & -0.2235 & 1.0000 & -0.1316 & 0.9066 & 0.7810 \\
CPI & -0.0656 & -0.2569 & -0.1316 & 1.0000 & -0.1851 & -0.1160 & -0.2944 \\
GPR & 0.6174 & 0.9066 & 1.0000 & 0.9024 & 1.0000 & 0.7776 & 1.0000 \\
M3 & 0.3744 & -0.1851 & -0.1160 & -0.1160 & 1.0000 & 0.7776 & 1.0000 \\
LBMAGS & 0.6098 & 0.9024 & 1.0000 & 0.9024 & 1.0000 & 0.7776 & 1.0000 \\
\end{bmatrix}
\]

2.3.3.2. Unit root test

The stationarity of the time series of independent variables is evaluated using the ADF test and the results are tabulated as follows.

Table 3. Unit root test P-values of independent variables in multiple linear regression model in Equation (5).

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Original</th>
<th>First Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>(X_{EPU,t})</td>
<td>0.7534</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>(X_{ER,t})</td>
<td>0.5492</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>(X_{CPI,t})</td>
<td>0.0627</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>(X_{GPR,t})</td>
<td>0.4078</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>(X_{M3,t})</td>
<td>0.6087</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

The results given in the above table with p-value less than 0.5 suggest that regular differencing is needed for independent variables.

The stationarity of the time series of independent variables in the second analysis is evaluated using the ADF test and the results are tabulated as follows.

Table 4. Unit root test P-values of independent variables in multiple linear regression model in Equation (6).

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Original</th>
<th>First Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>(rX_{Bond,t})</td>
<td>&lt;0.01</td>
<td>Not applicable</td>
</tr>
<tr>
<td>(rX_{stock,t})</td>
<td>0.9288</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

The results given in the above table with p-value less than 0.5 suggest that suitable transformation is needed for independent variables.

The stationarity of the simple returns series of control variables is evaluated using the ADF test and the results are tabulated as follows.

Table 5. Unit root test P-values of control variables.

<table>
<thead>
<tr>
<th>Control variables</th>
<th>Returns series</th>
</tr>
</thead>
<tbody>
<tr>
<td>(rX_{GS,t})</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>(rX_{LBMAGS,t})</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

To ensure equal level of integration and stationarity of the independent and control variables, the simple returns are computed for the following time series: \(X_{GS,t}\); \(X_{LBMAGS,t}\); \(\gamma_{GF,t}\) and \(X_{stock,t}\), are calculated using the simple returns formula, and are denoted as \(rX_{GS,t}\) denoting the returns from the Indian gold spot market, \(rX_{LBMAGS,t}\) denoting the returns from the global gold spot market, \(rX_{stock,t}\), denoting the returns from the MSCI India Index and \(r\gamma_{GF,t}\) denoting the returns from the Indian gold futures market, respectively. Similarly, regular differencing is carried out for the following time series: \(X_{CPI,t}\), \(X_{ER,t}\), \(X_{M3,t}\), \(X_{EPU,t}\) and \(X_{GPR,t}\), and are denoted as \(dX_{CPI,t}\) denoting the change in CPI, \(dX_{ER,t}\) denoting the change in ER, \(dX_{M3,t}\) denoting the change in M3, \(dX_{EPU,t}\) denoting the change in EPU and \(dX_{GPR,t}\) denoting the change in GPR.

2.3.4 Fitting multiple linear regression models on stationary time series

2.3.4.1. Impact of country specific macro risk factors on the gold futures contract

The estimates of the multiple linear regression model examining the dependence of returns of gold futures contract on changes in macro risk factors when controlled for Indian gold spot returns and global gold spot returns is as follows:

\[
\hat{r}_{\gamma_{GF,t}} = 0.8015 \ dX_{CPI,t} - 0.7381 \ dX_{ER,t} + 0.0183 \ dX_{EPU,t} + 0.1408 \ rX_{GS,t} + 0.6007 \ rX_{LBMAGS,t} + a_t,
\]

with all parameters being significant. The independent variable \(dX_{M3,t}\) denoting the change in broad money, that is, money in circulation is omitted in the model fitting due to multicollinearity with CPI.

The error analysis for the fitted model in Equation (7) is tabulated as follows:

Table 6. Error analysis for the model in Equation (7)

<table>
<thead>
<tr>
<th>Residual standard error</th>
<th>1.748</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple (R^2)</td>
<td>0.8197</td>
</tr>
<tr>
<td>Adjusted (R^2)</td>
<td>0.8128</td>
</tr>
<tr>
<td>(F_{5,131}) statistic</td>
<td>119.1</td>
</tr>
</tbody>
</table>

The Variance Inflation Factor (VIF) for the independent variables and control variables in the fitted multiple regression model is tabulated as follows.

Table 7. VIF of independent variables and control variables for the model in Equation (7)

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>(dX_{CPI,t})</td>
<td>1.0243</td>
</tr>
<tr>
<td>(dX_{ER,t})</td>
<td>1.1244</td>
</tr>
<tr>
<td>(dX_{EPU,t})</td>
<td>1.1053</td>
</tr>
<tr>
<td>(rX_{LBMAGS,t})</td>
<td>1.3011</td>
</tr>
<tr>
<td>(rX_{GS,t})</td>
<td>1.3186</td>
</tr>
</tbody>
</table>

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The calculated values for VIF as given in Table 7 are approximately equal to 1. This suggests that the variance among $\beta_j$'s is not inflated and that $\beta_j$'s are independent in the fitted model in Equation (7).

The residual autocorrelation and partial autocorrelation plots given below indicate the adequacy of the model.

The error analysis for the fitted model in Equation (8) is tabulated as follows:

<table>
<thead>
<tr>
<th>Residual standard error</th>
<th>2.207</th>
</tr>
</thead>
<tbody>
<tr>
<td>Multiple $R^2$</td>
<td>0.7104</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>0.7106</td>
</tr>
<tr>
<td>$F_{4,132}$ statistic</td>
<td>80.93</td>
</tr>
</tbody>
</table>

The calculated values for VIF as given in Table 9 are approximately equal to 1. This suggests that the variance among $\beta_j$'s is not inflated and that $\beta_j$'s are independent in the fitted model in Equation (8).

The VIF for the independent variables and control variables in the fitted multiple regression model is tabulated as follows.

<table>
<thead>
<tr>
<th>Independent variable</th>
<th>VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>$r_{X_{bond,t}}$</td>
<td>1.0934</td>
</tr>
<tr>
<td>$r_{X_{stock,t}}$</td>
<td>1.0399</td>
</tr>
<tr>
<td>$r_{X_{LBMAGS,t}}$</td>
<td>1.2955</td>
</tr>
<tr>
<td>$r_{X_{GS,t}}$</td>
<td>1.3210</td>
</tr>
</tbody>
</table>

The residual autocorrelation and partial autocorrelation plots given below indicate the adequacy of the model.

2.3.4.2. Investment nature of the gold futures contract as an asset class

The estimates of the multiple linear regression model examining the dependence of returns of gold futures on returns from other assets in the portfolio when controlled for Indian gold spot returns and global gold spot returns is as follows:

$\hat{r}_{GF,t} = 0.0535 \times r_{X_{bond,t}} - 0.0948 \times r_{X_{stock,t}}$

$+ 0.1684 \times r_{X_{GS,t}} + 0.6170 \times r_{X_{LBMAGS,t}} + a_t$, with all parameters being significant.

2.3.5 Sub-sample analysis

This section examines whether the results based on the full sample period are also valid in the sub-sample. We consider in the sample the period from January 2007 ($t = 26$) to December 2009 ($t = 61$) which includes the GFC in 2007–08. This investigates the question whether the role of the gold futures contract is different during the market crash.

Analyses of the impact of country specific macro risk variables on gold futures contract and its position as an asset class
2.3.5.1. Impact of country specific macro risk factors on the gold futures contract

The estimates of the multiple linear regression model examining the dependence of returns of gold futures on changes in macro risk factors when controlled for Indian gold spot returns and global gold spot returns using the sub-sample data, did not give statistically significant results. Therefore, the results from model fitting are not included here.

2.3.5.2. Investment nature of the gold futures contract as an asset class

The estimates of the multiple linear regression model examining the dependence of returns of gold futures on returns from other assets in the portfolio when controlled for the global gold spot returns using the sub-sample data, is as follows:

\[
\hat{Y}_{GF,t} = 0.0647 r_{X_{bond},t} - 0.0987 r_{X_{stock},t} + 0.8088 r_{X_{LB.MAGS},t} + \zeta_t, \\
\]

with all parameters being significant, except the coefficient for \( r_{X_{bond},t} \).

The error analysis for the fitted model in Equation (9) is tabulated as follows:

<table>
<thead>
<tr>
<th>Table 10. Error analysis for the model in Equation (9)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residual standard error</td>
</tr>
<tr>
<td>Multiple ( R^2 )</td>
</tr>
<tr>
<td>Adjusted ( R^2 )</td>
</tr>
<tr>
<td>( F_{3,33} ) statistic</td>
</tr>
</tbody>
</table>

The VIF for the independent variables and control variables in the fitted multiple regression model is tabulated as follows.

The calculated values for VIF as given in Table 11 are approximately equal to 1. This suggests that the variance among \( \beta_j \)'s is not inflated and that \( \beta_j \)'s are independent in the fitted model in Equation (9).

The residual autocorrelation and partial autocorrelation plots given below indicate the adequacy of the model.

3. DISCUSSION

3.1 The inclusion of control variables

To control for the effect confounding variables in the multiple regression models in our study, we include returns from...
the Indian gold spot market and the returns from the global gold spot market. Theoretically, the derivative market is influenced by the domestic spot market and the global spot market. Therefore, the inclusion of these control variables in the multiple linear regression models enables us to analyse the influence of country specific macro risk factors on the gold futures contract and the investment nature of the gold futures contract, excluding the effect the domestic and global gold spot market.

3.2 Influence of country specific macro risk factors on the gold futures contract

3.2.1 Effect of CPI

The plots in Figures 1, 2 show that CPI and the price of gold follow a similar increasing trend. This is because, fixed income, equity and foreign exchange markets react adversely to sharp increases in inflation. CPI measures the effects inflation and also drives consumer spending towards investment in precious metals, which are traditionally assumed to be hedge for inflationary pressures [6]. Similarly, it can be inferred from the estimated positive coefficient of $dX_{CPI,t}$ in the regression model given in Equation (7), that CPI also drives the price of the gold futures contract.

3.2.2 Effect of ER

The plots in Figures 1, 3 show that while there is a irregular fluctuation in the real effective exchange of the domestic currency vs. the dollar, there is a steady increase in the price for gold futures. However, the depreciation in the exchange rate does not help with every industry. Globally, India is the second largest consumer and ranks ninth in terms of private holdings of gold (Source: World Economic Forum https://www.weforum.org/videos/these-10-countries-have-the-world-s-largest-gold-reserves). Gold is one of the highest imports leading to trade deficits in the current account in the balance of payments. Our results suggest that due to the intrinsic value of the derivative, in order to preserve the value of their investments investors may have switched to gold futures contracts which are relatively a reflection of their intrinsic value, when compared to other foreign exchange derivative contracts involving a price in dollars. This theory is supported by the negative value of the coefficient of $dX_{ER,t}$ in the multiple linear regression model given in Equation (7). Therefore, it shows that gold futures has a negative linear dependence on exchange rate.

3.2.3 Effect of EPU

There is not much that we can infer from the plots in Figures 1, 5 about the degree of dependence between gold futures prices and economic uncertainty. However, it is evident that the price of gold futures is increasing during periods of economic uncertainty. A country which imports is likely to be vulnerable to economic shocks and political disturbances from its trading partners. The increasing Indian appetite towards gold futures is observed during periods of uncertainty as observed from the plots, for example, during the Global Financial Crisis ($t = 38$ to $t = 57$), and the stock market fall signalled by a fear of contagion of the European sovereign debt crisis ($t = 81$ to $t = 93$), there is a steep increase in the price of gold futures, suggesting that it was considered as a secure investment during times of economic uncertainty. This relationship is evidenced by the positive coefficient of $dX_{EPU,t}$ in the multiple linear regression model given in Equation (7).

3.2.4 Effect of GPR

The plot of GPR index in Figure 6 shows that it has a huge spike during the Global Financial Crisis ($t = 38$ to $t = 57$) and is varies consistently throughout the period of analysis. The presence of geopolitical risk tends to trigger investors to hedge their portfolio against financial risk and move toward safe haven assets. A study on the physical commodity has shown that there is no increase volatility of gold returns due to geopolitical risk [5]. We contribute to the existing study by examining the impact of geopolitical tension on the gold futures market. We observe that the effect of change in GPR on the returns from the Indian gold futures contract is not statistically significant. The coefficient of $dX_{GPR,t}$ is not included in the multiple linear regression model given in Equation (7) as it is not statistically significant. While a preliminary model fitting given in Equation (5) suggests a negative relationship between geopolitical tension and gold futures prices, it may be attributed to the multicollinearity and confounding effect in the original time series. Therefore, we are unable to statistically confirm the influence of geopolitical risk on the returns from Indian gold futures market.

3.3 Relationship of gold futures with bond and stock

When constructing an optimal portfolio, fund managers choose assets that allow for returns and exposure in accordance with investors’ risk appetite. Our study on a portfolio consisting of the gold futures contract, bond and stock, shows that the returns from gold futures depends on returns from government securities and returns from an index fund tracking the performance of large and mid cap segments of the Indian market. The plot in Figure 7 shows that the bond returns has a steep yield curve except during the the Global Financial Crisis ($t = 47$ to $t = 57$), and fell during ($t = 121$ to $t = 137$) due to a ripple effect over the fears of a slow down in some big neighboring countries like China and a below average monsoon in 2015. The linear dependence modeled by Equation in (8) also shows a positive relationship. Therefore, the definition of diversifier and results of our analysis suggest that in a portfolio, the gold futures contract acts as a portfolio diversifier when compared to returns on bonds. However, from plots in Figures 1, 7 we see that the
price of gold futures does not fall when the bond returns fall and a recent study examining efficacy of tax policy on market prices shows that Government intervention in the gold futures market is not statistically significant [13].

The plots in Figures 1, 8 show that the price of the stock follows an upward trend similar to the price of gold futures except during the the Global Financial Crisis (t = 47 to t = 53) and during t = 81 to t = 93, when MSCI announced changes in the MSCI India index. The inclusion and exclusion of stocks in the index caused a short-term price volatility. The linear dependence modeled by Equation in (8) also shows a negative relationship. Therefore, the definition of hedge and results of our analysis suggest that in a portfolio, the gold futures contract acts as a hedge when compared to stocks.

The results from our analysis show that the investment nature of gold futures contract is unique. It correlates with other types of investment like stock and bond and the price driven by consumer demand, this shows that investors expect the gold futures contract to have similar investment characteristics of the underlying asset. Therefore, we say that gold futures contract is an investment class which possesses the similar properties of other financial contracts but is perceived to have the investment attributes of gold.

3.4 Inferences from the sub-sample analysis

The estimation results for the multiple linear regression model examining the dependence of returns of the gold futures contract on changes in country specific macro risk factors during the time period from January 2007 (t = 26) to December 2009 (t = 61) does not give statistically significant results. The intuition for this model was based on the inferences from the plots of the country specific macro risk factors and gold futures prices during the aforementioned period. However, due the statistically insignificant results, we are unable to comment on the linear dependence of returns of the gold futures contract on changes in country specific macro risk factors in the sub-sample period.

The estimation results for the multiple linear regression model during the time period from January 2007 (t = 26) to December 2009 (t = 61) given in Equation (9) suggests a positive relationship between the returns from gold futures contract and returns from bond, and a negative relationship between the returns from gold futures contract and the returns from stocks in MSCI India Index. The results show that the gold futures contract is a safe haven for stocks implies that investors that hold gold futures in normal times and in times of financial stress to receive compensation for losses caused by negative stock returns through positive returns in gold futures. Whereas, the gold futures contract acts as a diversifier for bonds in normal times and in times of financial stress. This shows that in a portfolio with gold futures contract, bonds and stocks, the gold futures contract is both a hedge and a safe haven for stocks, while it is a diversifier, it is neither a hedge nor a safe haven for bonds.

4. CONCLUSION

The gold futures contract is an emerging investment option in India which is affected by macroeconomic factors and other investments. For convenience of analysis, we control for the effect of domestic and global gold spot market on the derivative and we introduce variables to represent country specific macro risk factors and conventional investments. In our analysis, we see that the returns from the gold futures contract is related to changes in macroeconomic variables such as consumer price index, exchange rate, economic policy uncertainty index and investments returns from bond and stock. However, for our period of study, we are unable to determine statistically significant results of interactive cause and effect relationship between the variables and the returns from the gold futures contract.

In this paper, the collected data is used to build proper time series regression models to describe the relations of the above introduced variables after the time series are made stationary. Specifically, using the returns from the gold futures contract as dependent variable, we construct two time series regression models. For the first one, we relate the returns from gold futures to changes in country specific macro risk factors such as consumer price index, exchange rate and economic policy uncertainty index which serve as independent variables. For the second one, we examine the investment nature of gold futures by positioning it in a portfolio consisting of returns from bond and stock which serve as independent variables. The coefficient of determination, $R^2$ for the first model is .8197, and for the second one is .7194. To control for the effect of confounding variables in both regression models we introduce two variables, namely returns from Indian gold spot market and returns from the global gold spot market. The model adequacy for both fitted models are validated through the VIF given in Tables 7 and 9, and plots of ACF and PACF of residuals.

Through our analysis, we are able to show the dependence of the gold futures contract on macroeconomic factors and other investments which is validated by statistically significant results. Subsequently, it follows that in terms of assessing the degree of influence of various factors on the dependent variable, the price of gold futures contract is a complex variable with similar market characteristics as its underlying asset. While the gold futures market closely follows the gold spot market, when assessed in a portfolio, it has similar investment features to a bond. Our analysis on the investment nature of the gold futures contract shows that, in a portfolio with the gold futures contract, stocks and bond, it acts as a diversifier to short-term government securities but acts as a hedge and safe haven to stocks. From the results from examining the influence of country specific macro risk factors, we see that investor perception towards this type of investment is like that towards physical gold, but it is not influenced by geopolitical tension. It is hoped that this study will be useful for researchers, investment analysts and fund managers in isolating risk factors which influence gold futures prices and in portfolio allocation.
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