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Gold as inflation and exchange rate hedge: The case of India

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Abstract

For a long part of the recorded past, gold has served as the basis of the monetary system and therefore, it was a prominent choice as currency risk hedge. In recent years several alternatives of gold have emerged. The use of gold vis-à-vis other alternatives, in hedging against currency risk, depends on whether gold occupies a considerable position in the hedging portfolio. We use monthly observations on gold prices, inflation and exchange rate from April 1993 to June 2016 to test this hypothesis. The results show that gold is an effective hedge only against the unexpected part of the exchange rate, although it is not so completely.

Amrendra Kumar contributed to this article in his personal capacity. The views expressed are his own and do not necessarily represent the views of Statkraft Markets Private Limited.

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1. Introduction

The paper empirically explores the importance of gold in hedging risks associated with inflation and exchange rate. Gold draws advantage as it is a low-risk hedge and movements in its price reveals important information vis-à-vis other asset returns (Carruth et al., 2000). Moreover, investors take confidence from its high liquidity as it can be easily resold without loss of time. It is worthwhile to note that for a long part of the recorded past, gold served as the basis of the monetary system and therefore it was a prominent choice as hedge (Capie et al., 2005). In recent years, however, several alternatives of gold have emerged. For example, investors are noted to be extensively using commodities, stocks and real estate to hedge against inflation and portfolio rebalancing in currencies, which requires the purchase of depreciating currencies and sale of appreciating ones, to hedge against exchange rate movement (Bodie, 1983; Hartzell et al., 1987; Tarbert, 1996; Eichengreen and Hausmann, 1999; Ciner, 2015). The official sector, which appropriates a significant stock of gold in reserves, is noted to rely on tools such as money supply, repo rates, etc. which impart greater transmission control to hedge against inflation. In dealing with exchange rate changes it also mainly relies on portfolio rebalancing strategy (Gopalan, 2011). Gold also forms an integral part of household's investment portfolio. However, households, in general, are noted to switch to gold when currencies weaken but the switch from gold when currencies strengthen is very limited mainly because it commands considerable cultural and social importance. Households are also noted to invest in real estate to hedge against inflation (Bond and Seiler, 1998).

In reconciling the use of gold vis-à-vis other alternatives in hedging against currency risk a major thrust is on the fact that whether gold occupies a considerable position in the hedging portfolio. In normal circumstances (i.e., expected risk associated with currency) it might be reasonable to expect gold to have minimal weight in the portfolio hedge as other alternatives seem more lucrative in terms of opportunity cost and logistical complexities given that in recent times gold's price is as volatile as most of the other assets. However, if there is a somewhat unpredictable event such as a crisis affecting currencies, commodities, securities, real estate, etc. across many countries in the world, gold offers a safe haven to fall back to.[1] The empirical evidences are mixed on this count (see, for example, Baur and McDermott, 2010; Baur and Lucey, 2010; Reboredo, 2013). Further evidences on this line, therefore, is a much warranted exercise. An important concern remains as the choice of method of investigation. Most papers use ARCH-ARMA family models or cointegration models for their analysis which are noted to be very sensitive to the functional form. Therefore, it is important to establish complementary evidence which is not susceptible to this problem.

We consider India as the case for our empirical exercise. Gold prices in India are noted to be closely inter-linked to international gold prices and thereby, they contain important information about several other key variables such as asset prices and exchange rates (Mishra and Mohan, 2012). Additionally, movement in gold prices is closely followed by the stock prices in India (Ray and Prabhu, 2013). Finally, it commands considerable cultural and social importance. We follow Fama and Schwert (1977) to assess the importance of gold against expected and

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[1] There is significant volume of literature on contagion effect. See, for example, Gai and Kapadia (2010) and Glasserman and Young (2015).

unexpected inflationary and exchange rate movements which are approximated using ARMA-ARCH family models. We lend further credence to our analysis by investigating the synchronization between these series using concordance index as a non-parametric tool. The results show that gold has served as a hedge against fluctuation in exchange value of the dollar, but it has done so to a degree that is highly dependent on unpredictable events.

The rest of the paper is structured as follows. Section 2 will describe the data and the empirical strategy. Section 3 presents the estimation results. The last section concludes.

2. Data and Empirical Strategy

We use data on gold prices as rupees per 10 gram in Mumbai from World Gold Council. To proxy inflation we find that the relative advantages/disadvantages of consumer price index (CPI) and wholesale price index (WPI) do not explicitly dictate in the favour of either of the two in the current context. The key premises behind the two measures are as follows. First, WPI, as the measure of inflation, is heavily weighted towards manufacturing articles. WPI also considers primary articles and fuel articles with a relatively moderate weightage. CPI, in contrast, offers relatively adequate weightage to four sections- industrial workers, agricultural labourers, rural labourers, and urban non-manual employees. For gold as the hedging instrument, both these ways of representing inflation deem important as gold is held in significant proportion by institutional players, market players and households. Second, a major limitation of the WPI, as noted by the National Statistical Commission (2001), is that the prices embedded in the index correspond to farm-gate, factory-gate or mine-head prices, and in many other cases they refer to prices at the level of primary markets, secondary markets or other wholesale or retail markets. So, a part of these not necessarily confirm to the 'wholesale' prices. Besides, WPI does not include services in its purview which forms the majority share of the national income. CPI, on the other hand, caters to four different sections of the working class and, hence, it also cannot be considered as the representative measures of nation-wide inflation. Of late, the literature is divided in its focus regarding the two inflation proxies. Besides, there are several works that use both the measures of inflation to strengthen their case. Following the latter approach, we use both CPI and WPI for our exercise. Data on these two series are taken from Reserve Bank of India. Finally, the data on Indian rupee-US dollar exchange rate is taken from International Financial Statistics published by the International Monetary Fund. We use month-end observations on each of the variables from April 1993 to June 2016 (279 observations).[2]

We follow the model suggested by Fama and Schwert (1977) and augment it to assess the link between inflation and exchange rate on one hand and asset return on the other, which in our context is gold return.

$$E[g_t|\varphi_{t-1}] = E[G_t|\varphi_{t-1}] + E[\pi_t|\varphi_{t-1}] + E[x_t|\varphi_{t-1}] \quad (1)$$

[2] The main motivation for using month-end gold and exchange rate observations, even though they are available at daily frequency, is to keep the order of these variables comparable to the inflation measure. However, we also check whether using the daily observations change the results or not. Using a similar method for the data generating process, as employed in the paper, we compute the monthly series by taking the mean of the daily returns over each month and dividing it by the square root of the number of observations in the respective month. The results remain consistent.

where g_t is nominal return on gold at time *t*; G_t is real return on gold at time *t*; π_t is inflation at time *t*; x_t is exchange rate at time *t*, φ_{t-1} is information available at time *t*-1 and; $E[.]$ is expectation operator.

Fama and Schwert suggest that the expected real return is determined by real factors such as productivity, discount factor and risk preference. So, it would not be affected by nominal variables. They suggest further extension in the model by incorporating both expected and unexpected inflation. Thus, we have

$$g_t = \alpha + \beta E[\pi_t|\varphi_{t-1}] + \gamma(\pi_t - E[\pi_t|\varphi_{t-1}])$$
$$+\delta E[x_t|\varphi_{t-1}] + \theta(\varepsilon_t - E[x_t|\varphi_{t-1}]) + v_t \quad (2)$$

where α, β, γ, δ and θ are the regression coefficients and v_t is error term.

In estimating equation (2), we need a forecasting rule for appropriating $E[\pi_t|\varphi_{t-1}]$ and $E[x_t|\varphi_{t-1}]$ which are unobservable ex ante. We rely on ARMA-ARCH family models for this purpose. A major challenge with such models is that they are very sensitive to the functional form. Therefore, to lend further credence, we also employ a simple non-parametric tool to measure how cycles in inflation ($z_{\pi,t}$) and exchange rate ($z_{x,t}$) series are synchronized with gold series ($z_{g,t}$). Essentially, we exploit the existence of rise and fall from previous values for each of the series. A rise occurs in a time series $z_{i,t}$ if at time *t*, $z_{i,t} > z_{i,t-1}$ where $i = \{\pi, x, g\}$. A fall is defined similarly. If we find many such rise and fall of two or more series clustered together and occurring at the same time, we then say that there could be synchronized movements amongst the series.[3] We do this by finding the degree of concordance (or, concordance index) between the cycles. Concordance quantifies the fraction of time two series are simultaneously in the same state. To enable this, for $i = \{\pi, x, g\}$, we define the following binary time series: $S_{i,t} = 1$ when $z_{i,t} > z_{i,t-1}$ and $S_{i,t} = 0$ otherwise. Following Harding and Pagan (2002) the concordance index, for a sample of size *T*, can be written as:

$$\hat{I}_{jg} = T^{-1}\left[\sum_{t=1}^{T} S_{j,t}S_{g,t} + \sum_{t=1}^{T}(1 - S_{j,t})(1 - S_{g,t})\right], \qquad j = \{\pi, \varepsilon\} \quad (3)$$

We can re-parameterize the above equation as:

$$\hat{I}_{jg} = 1 + \frac{2}{T}\left[\sum_{t=1}^{T} S_{j,t}S_{g,t} + \sum_{t=1}^{T}(1 - S_{j,t})(1 - S_{g,t})\right]$$
$$= 1 + 2\hat{\sigma}_{S_{j,t}\,S_{g,t}} + 2\hat{\mu}_{S_{j,t}}\,\hat{\mu}_{S_{g,t}} - \hat{\mu}_{S_{j,t}}\,\hat{\mu}_{S_{g,t}}$$
$$= 1 + 2\hat{\rho}_{S_{j,t}\,S_{g,t}}\left[\hat{\mu}_{S_{j,t}}\left(1 - \hat{\mu}_{S_{j,t}}\right)\right]^{1/2}\left[\hat{\mu}_{S_{g,t}}\left(1 - \hat{\mu}_{S_{g,t}}\right)\right]^{1/2}$$
$$+2\hat{\mu}_{S_{j,t}}\,\hat{\mu}_{S_{g,t}} - \hat{\mu}_{S_{j,t}} - \hat{\mu}_{S_{g,t}} \quad (4)$$

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[3] The strategy offers some adjustment over Bry and Boschan (1971).

where $\hat{\sigma}_{S_{j,t}\,S_{g,t}}$ is the estimated co-variance between $S_{j,t}$ and $S_{g,t}$, $\hat{\mu}_{S_{i,t}}$ is the mean of the series $S_{i,t}$ for $i = \{j, g\}$ and $\hat{\rho}_{S_{j,t}\,S_{g,t}}$ is the estimated correlation between $S_{j,t}$ and $S_{g,t}$. Since we have binary series, the estimated standard deviations take the form $\sqrt{\hat{\mu}_{S_{j,t}} - \left(\hat{\mu}_{S_{j,t}}\right)^2}$ and, therefore, the second equality evolves as the third equality, which is convenient to interpret. For example, it is easy to see that the concordance index has a maximum value of one when $S_{j,t} = S_{g,t}$ and zero when $S_{j,t} = 1 - S_{g,t}$.[4] A value of 0.5 indicates the lack of any systematic relationship in the dynamics of the two series.

A major difficulty with equation (3), as noted by McDermott and Scott (2000), is that it is not possible to compute the statistical properties of $\hat{I}_{jg}$ if its distribution properties are unknown. Moreover, concordance values may be biased because in a large sample, it is quite likely that the individual series are in a state of rise or fall for a longer period. So, a better statistic is to use a mean-corrected concordance index. Harding and Pagan (2002) suggest the following equivalent regression to estimate the correlation between the two binary time series.

$$\hat{\sigma}_{S_{j,t}}^{-1}\hat{\sigma}_{S_{g,t}}^{-1}S_{g,t} = \varphi + \hat{\rho}_{S_{j,t}\,S_{g,t}}\hat{\sigma}_{S_{g,t}}^{-1}S_{j,t} + u_t \quad (5)$$

where φ is the regression coefficient with the constant and u_t is an error term.

The estimation procedure of equation (2) and (5) must be robust to possible serial correlation in the residuals, as they inherit the serial correlation properties of the dependent variables. Ordinary least squares estimator, thus, would not suffice as the standard error with the estimator would be unreliable, though the estimators themselves are consistent. We get around this issue by using Prais-Winsten and Newey-West estimation methods. In Prais-Winsten method the estimated errors are assumed to follow first-order autoregressive process. Newey-West method, on the other hand, is flexible in the order of serial correlation and it also adjusts for heteroscedasticity.

3. Results

In estimating equation (2), we fit a forecasting rule for $E[\pi_t|\varphi_{t-1}]$ and $E[x_t|\varphi_{t-1}]$ in the following way: first, we construct the return series as the change in the log of π_t and ε_t series from the previous month. Second, we check for stationarity and structural break in the return data. We find it to be stationary and without any structural break. Third, we choose lag length based on Akaike, Bayesian and Schwarz criteria and correlograms and; check for ARCH effect series using Lagrange multiplier test. Fourth, we choose the best fit among the various models in the ARMA-ARCH family based on step three. We find x_t series o be ARMA(1, 6) and GARCH(1, 1) and; π_t series to be ARMA(1, (3, 12)) and GARCH(1, 1). x_t series is represented as equations (6A-6B) whereas π_t series is represented as equations (7A-7B).[5]

$$x_t = 0.001 + 0.260x_{t-1} + 0.179\omega_{x,t-6} + \omega_{x,t} \quad (6A)$$

[4] Note that $\hat{\rho}_{S_{j,t}\,S_{g,t}} = 1$ corresponds to a concordance index value of one and that $\hat{\rho}_{S_{j,t}\,S_{g,t}} = -1$ corresponds to a concordance index value of zero.

[5] The intermediary results are omitted to save space. They can be furnished on request.

$$\sigma_{x,t}^2 = 0.820\omega_{t-1}^2 + 0.521\sigma_{x,t-1}^2 \quad (6B)$$

$$\pi_t = 0.001 + 0.405\pi_{t-1} - 0.184\omega_{\pi,t-3} + 0.175\omega_{\pi,t-12} + \omega_{\pi,t} \quad (7A)$$

$$\sigma_{\pi,t}^2 = 0.249\omega_{\pi,t-1}^2 + 0.734\sigma_{\pi,t-1}^2 \quad (7B)$$

where $\omega_{j,t}$ is innovation and $\sigma_{j,t}^2$ is variance for $j = \{x, \pi\}$.

Using the estimates of equations (6A-6B) and (7A-7B), we forecast x_t and π_t for estimating equation (2). We perform checks on forecasts using five different measures: mean squared error, median squared error, mean absolute error, adjusted mean absolute percentage error and Theil's inequality coefficient.

Table I: Regressions of gold returns on exchange rate and inflation (CPI)

Dependent var: Gold return	OLS/ Newey-West estimate	OLS t-statistic	Newey-West t-statistic	Prais-Winsten estimate	Prais-Winsten t-statistic
Expected Exchange rate	-0.028	0.96	1.14	-0.029	1.15
Unexpected Exchange rate	0.430*	2.26	2.39	0.410*	2.18
Expected inflation (CPI)	0.044	1.22	1.44	0.045	1.44
Unexpected inflation (CPI)	0.207	1.27	1.34	0.186	1.33
R^2	0.085		0.085	0.087	
Prob. > F	0.027		0.045	0.046	

* represents level of significance at 5%

Table I and II present the estimates for equation (2) using alternate measures of inflation as CPI and WPI. They show that gold is effective hedge only for the unexpected part of the exchange rate but its coefficient is not statistically equal to one. This implies that even though gold effectively hedges against unexpected exchange rate, it does not do so completely. It is unsurprising given that in times of exchange rate uncertainty the risk contagion is a real threat. Thus, alternative hedging instruments such as other currencies, commodities, securities, real estate, etc. are likely to seem less lucrative than gold since physical gold is one of the few investments that is not simultaneously an asset and someone else's liability. Essentially, gold seems to be a good exchange rate crisis hedge, even though it isn't a perfect one. The coefficient of unexpected part of inflation, however, does not share the same analogy mainly because contagion is less likely to be a threat in this case. Thus, use of alternative hedges is still relevant. For example, real estate is considered to be an effective hedge against inflation (Bond and Seiler (1998)). On a similar note, the insignificant coefficient associated with both the expected variables suggest that in such circumstances (i.e., when risk is expected) investors attach minimal weight to gold in the portfolio hedge as other alternatives seem more lucrative in terms of opportunity cost and logistical complexities.

Table II: Regressions of gold returns on exchange rate and inflation (WPI)

Dependent var: Gold return	OLS/ Newey-West estimate	OLS t-statistic	Newey-West t-statistic	Prais-Winsten estimate	Prais-Winsten t-statistic
Expected exchange rate	-0.051	1.26	1.14	-0.053	1.53
Unexpected exchange rate	0.369*	2.05	2.01	0.365*	2.04
Expected inflation (CPI)	0.008	0.46	0.55	0.008	0.58
Unexpected inflation (WPI)	0.379	0.57	0.67	0.456	0.78
R^2	0.096		0.103	0.099	
Prob. > F	0.031		0.041	0.047	

* represents level of significance at 5%

Table III: Concordance and estimated correlation of gold returns with exchange rate and inflation

Variables	Concordance index	Estimated Correlation				
		OLS/ Newey-West Estimate	OLS *t*-statistic	Newey-West *t*-statistic	Prais-Winsten estimate	Prais-Winsten t-statistic
Exchange rate	0.564	0.143*	2.42	2.45	0.150*	2.76
Inflation (CPI)	0.522	0 .046	0.78	0.82	0.063	0.78
Inflation (WPI)	0.501	0.028	0.24	0.33	0.041	0.25

* represents level of significance at 5%

Table III assesses the synchronization between $Z_{g,t}$ (gold series) and $Z_{j,t}$ (exchange rate and inflation) outlined in equation (3) and (5). Concordance index values closer to 0.5 seem to suggest that exchange rate and inflation series lack any systematic relationship with gold series. But, as noted before, such concordance values may arise if the individual series are in a state of rise or fall for a longer period. Mean-corrected concordance index, represented by the estimated correlation, gives a more reliable measure of synchronization. It is evident in the table that the gold series is significantly synchronized with only the exchange rate series, i.e. gold is effective hedge only for the exchange rate. This is a consistent with tables I and II given the exchange rate series in table III consists of both, the expected part as well as the unexpected part where the latter is driving the result.[6]

4. Conclusion

The paper empirically explores the importance of gold in hedging risks associated with inflation and exchange rate following the model suggested by Fama and Schwert (1977) and a non-parametric concordance index. It uses monthly observations on each of the variables from April 1993 to June 2016. The results, using the Prais-Winsten and the Newey-West estimation methods, show that gold has served as a hedge against the fluctuation in rupee-dollar exchange rate, but only to a degree that is highly dependent on unpredictable events. Future research may consider employing the current framework to assess the viability of a portfolio of assets as hedge against inflation and exchange rate risk.

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[6] It is important to note that the information on inflation is available with a lag (typically two to three weeks). A rational investor would endogeneise this lag and strategize on inflation expectations. In our exercise, we decompose the inflation series into expected and unexpected parts making it relevant to the context. We also explore the possibility that investors lack sufficient expertise in forecasting the series ahead in time. This possibility implies the main model should focus on lagged inflation rather than the current one. To this discourse, we reiterate the exercise and obtain results. The only change we obtain from our main results is that the coefficients associated with unexpected inflation change sign (from positive to negative). However, they remain insignificant. So, essentially the results remain the same.

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