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How does indian gold price react to the changes in real exchange rates?

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ABSTRACT: This study investigates the relationship between the Indian gold price and the real exchange rates of major international currency and how does Indian gold price reacts to the exchange rates of these currencies. The data set consists of monthly gold prices from Indian market and the real exchange rates of major currencies like USD, Euro, Yen and INR for the period from 1994:01 to 2011:12. The relationship and reaction is tested through the Johansen cointegration test, Granger causality test and VAR models like Impulse response function and Variance Decomposition. It is found that the Indian gold prices have long run relationship with the real exchange rates of major currencies and it is also found that the Indian gold prices are caused by the real exchange rate of Yen but the vice versa does not exist. The Indian gold prices react positively to the shocks from Yen and negatively to the INR.

Keywords: *Gold price, Exchange rates, Cointegration, Causality*

INTRODUCTION

A change in exchange rate of domestic currency against the international currency will have an effect on the prices of commodities traded in an organized exchange basically because trading is in domestic currency and therefore any changes in domestic currency against International currency expected to have impact; gold is one such commodity. Gold is traded in all the major commodity exchanges in the world NYMEX division of COMEX in USA, Tokyo Commodity exchange (TOCOM) in Japan, London metal exchange (LME) in London and Multi Commodity exchange (MCX) in India but the quantity and the size of trade differs from one exchange to another.

Gold is also traded in the retail market in order to meet the jewelery and other demands. The gold market in a country may either be a supply driver due to sufficient domestic production or demand driven due to larger import demand. Countries like India depending entirely on gold import are price takers, depending upon London fixes of gold price implying for an exogenous impact of gold price on physical gold demand. Hence the domestic gold price is determined by global gold price and exchange rate ((R.Kannan and Sarat Dhal (2008)). India is the largest consumer of gold in the world and the major proportion of gold goes into jewelery. Any appreciation or depreciation in the Indian rupees and the major currencies in the world (USD, EURO and Japaneese Yen) may have a strong impact on the Indian gold market price. The value preserving ability of gold will not always be same. This is due to the correlation between the exchange rate and gold prices, exchange rate shocks are likely to have more impact on domestic price level and domestic denominated wealth (Le, Thai-Ha and Cheung 2011).

India is the largest consumer of gold in the international markets but the research in precious metals with respect to gold is very scarce. The researches Sjaastad and Scacciavillani (1996), Beckers and Soenen (1984) and Baker and Van Tassel (1985) analysed the relationship between the currency and the gold price movements. Researches in India Arti Gaur and Monica Bansal (2010), Ganesh Mani and Srivyal Vuyyuri (2003) accounted the correlation between the Indian rupees exchange rate and the gold price. Gold is quoted in US dollar in the international markets and hence any appreciation or depreciation of domestic and major currency against the US dollar will have its impact on the domestic market price. This study is an attempt to test the causal relationship between the major currency USD, Euro, JPY and INR and Indian gold market price.

With the above background, the study is thus organised. Section 2 provides a brief review on the relationship between the Exchange rate and the gold price. Section 3 explains the Data used in the study and the Methodologies adopted for the empirical analysis. Section 4 deals with the empirical results. Section 5 provides the findings and conclusions.

2. REVIEW OF THE LITERATURE

The relationship between gold price and the exchange rate has been investigated empirically by several studies. The notable studies which are contributed to the literature are:

Capie, Mills .C and wood (2005) found the relationship between gold and exchange rates but the strength of this relationship had shifted over time. Gold acted as a hedge against fluctuation in the foreign exchange value of the Dollar. ***Larry A. Sjaastad (2008)*** made an attempt to examine the theoretical and empirical relationship between the major exchange rates and the price of gold with the help of the forecast error data by considering the gold price and the three major currencies USD, the Euro and the Yen and found that the US dollars, the Yen and the Euro blocs dominated the international market while a 10 percent appreciation of the DM Euro against all other currencies increases the dollar price of gold.

Kauffmann and Winters .A (1989) studied the price of gold for the year 1974 – 1988. The results showed that the volatility in the dollar tend to move the predicted gold price for the future. ***Sjaastad L.A and Scacciavillani .F (1996)*** tested the effect of changes in major currency exchange rates on the daily price of gold. The major currency such as USD and Deutsche market, UK Pound Sterling were employed. It is found that the world gold market is dominated by the Euro zone currency and hence any fluctuations in the Euro had a greater effect on the price of gold in other currencies. ***Sari .R, Hammoudeh .S and Soytas .U (2010)*** examined the co-movements and the information transmission among the spot prices of four precious metals, Oil price and USD/Euro exchange rate. They have concluded that there are no long run equilibrium relationships between the spot price returns of the precious metals and the exchange rates. However these two are closely linked in the short run after a shock is occurred in the markets.

Gaur and Bansal (2010) examined the relationship between the Indian and the International gold price and the exchange rate impact. The results showed that any depreciation in the exchange rates tend to reduce the gold prices thereby increasing its demand. In Indian market, the gold prices were highly depending on the prices in international gold market and the variation in the exchange rates. ***Wang K. & Lee .Y (2011)*** tested the existence of the asymmetric effect on the relationship between the gold price and exchange rate fluctuation. The empirical results suggested that the behavior of gold return and the Yen/Dollar exchange rate fluctuations were non-linear and the exchange rate fluctuations had a positive impact on the gold return implying that the gold return and fluctuations in exchange rate were positively correlated and the high depreciation in Yen could be hedged with gold.

Beckers and Soenen (1984) documented the impact of the relationship between the gold price and the US dollar on the performance of the gold investment. The empirical results evidenced that any investor with the non-US dollar base currency will assume the exchange risk exposure, as the gold transaction takes place in US dollar. Further the gold price and the strength of the US dollar had inverse relationship in the history. ***Pukthuanthong and Roll (2011)*** tested the relationship between gold price and exchange rates by taking the four major currencies in the world US dollar, Euro, Yen and Pound. He found out that a higher gold price was correlated with a weaker currency throughout the period in the analysis and concluded that the price of gold is strongly associated with the currency depreciation. ***Wang M.L, Wang C.P and Huang T.Y (2010)*** examined the impact of fluctuation rates of the US Dollar Vs various currencies on the gold price and the stock price indices of the United States, Germany, Japan, Taiwan and China respectively as well as the long and short term correlation among these variables. It was concluded that there existed long term stable equilibrium relationship among the nation‟s stock index and crude oil prices, Gold price and exchange rates and, there existed a two way feedback relationship between the crude oil prices and the Taiwan stock prices/Gold prices of Taiwan group. Gold price was leading the exchange rates.

The review of Indian studies on gold price have accounted the trend and determinants: Vaidyanathan(1999), examined the relationship between the gold price volatility and stock market returns in India: Mishra .P.K, Das.J.R and Mishra .S.K (2010), analysed the gold pricing in India: R.Kannan and Sarat Dhal(2008), documented the gold demand in India from Macro Economic policy perspective, Ganesh Mani and Srivyal Vuyyuri (2003), explained gold as better investment during financial crisis Suryavanshi Anil.G (2010).

It is evident from the review listed above that there are no studies which have linked the gold price with real exchange rates; they all have tried either to find the trend or determinants; examined the relationship between gold and equity. Therefore this study aims to investigate the relationship between the gold price in India and the exchange rates of international major currencies and also it attempts to find the reaction of gold price to the changes in exchange rates of major international currencies.

3. DATA AND METHODOLOGY

3.1 Data

The data set consists of monthly observations of Indian Spot gold price data obtained from Hand book of statistics of Reserve bank of India and the exchange rate of the major currencies are proxied by the broad real effective exchange rate index data of US dollar, Euro, Japaneese Yen and Indian Rupees. The broad real effective exchange rate index is taken from the website of Bank for International Settlements. This broad real effective exchange rate index is the basket of the 61 economies. The sample period covers from January 1994 to December 2011 and it comprised of 216 monthly data points for each of the variables included in the study. Data are converted into continuously compounded rate of return, as it provides the advantage of symmetric while the other form of return will not.

3.2 Methodology

Unit root test

A time series is said to be stationary, when its statistic characteristics do not change over time. The early and pioneering work on testing for a unit root in time series was done by Dickey and Fuller (Fuller 1976; Dickey and Fuller, 1979) and Phillip and Perron (1988) (Conventional test). The basic objective of the test is to examine the null hypothesis that $\beta=0$ (Y_t is non stationary) against the alternative hypothesis alternative hypothesis $\beta \neq 0$ (Y_t is stationary).

Johansen Cointegration test

The cointegration can be used to test whether two non-stationary time series "move together" in the long run. Johansen (1991) developed two likelihood ratios to test for the number of co integrating vectors in an unrestricted vector auto regression (VAR) model: the maximum Eigen value test and the trace test. The former test the null hypothesis of r cointegrating vectors against the alternative hypothesis of r+1 co integrating vectors and the later test the null hypothesis of r cointegrating vectors at most against the alternative hypothesis of more than r vectors. This is formulated as follows

$$\lambda_{trace}(r) = \quad T \sum_{i=r+1}^{g} \quad \ln(1 \quad \hat{\lambda}_i)$$

and

$$\lambda_{max}(r, r+1) = \; -T \; \ln(1 - \hat{\lambda}_{i+1})$$

Where r is the number of cointegrating vectors under the null hypothesis and $_i$ is the estimated value for the ith ordered eigenvalue from matrix. Intuitively, the larger is $_i$, the more large and negative will be ln(1-$_i$) and hence the larger will be the test statistic. Each eigenvalue will have associated with it a different cointegrating vector, which will be eigenvectors. A significantly non-zero eigenvalue indicates a significant cointegrating vector.

$_{trace}$ is a joint test where the null is that the number of cointegrating vectors is less than or equal to r against an unspecified or general alternative that there are more than r. It starts with p eign values, and then successively the largest is removed. $_{trace}$ = 0when all the $_i$ = 0, for i=1,….δ

$_{max}$ conducts separate test on each eigenvale, and has as its null hypothesis that the number of cointegrating vectors is r against an alternative of r+1.

Granger causality test

Causality test seeks to answer the simple question of the type, Do changes in X cause changes in Y. If X causes Y, lags of X should be significant in the equation for Y. If this is the case and not vice versa, it would be said that X Granger-causes Y or there exist a unidirectional causality from X to Y. On the other hand, if Y causes X lags of Y should be significant in the equation of X. If both sets of lags were significant, it would be said that there exist a Bi-directional causality. A time series X is $Y_t = \sum^{p} A_{11.i} Y_{t-i} + \sum^{p} A_{12.i} X_{t-i} + \varepsilon_{1t}$ said to Granger-cause Y if it can be shown usually through a series of F test on lagged values of X, that those X values provide statistically significant information about future values of Y. Consider series Y_t and X_t:

$$X_t = \sum_{j=1}^{p} A_{21,j} Y_{t-j} + \sum_{j=1}^{p} A_{22,j} X_{t-j} + \varepsilon_{2t}$$

Where p is the maximum number of lagged observations included in the model, the matrix A contains the co efficient of the model and ε_1 and ε_2 are residuals for each time series. If the variance of ε_1 is reduced by the inclusion of the X terms in the first equation then it is said that X Granger-causes Y. In other world, X Granger-causes Y if the co efficient in A_{12} are jointly significantly different from zero. This can be tested by performing an F-test of the null hypothesis that $A_{12} = 0$ given assumptions of covariance stationarity on Y and X. The magnitude of a Granger causality interaction can be estimated by the logarithm of the corresponding F-statistic

Vector Auto Regression (VAR)

Vector auto regression (VAR) is an econometric model used to capture the inter dependencies between multiple time series, generalizing the univariate AR models. Consider two economic time series Y_t and X_t. Here we are considering the relationship between the price of gold and exchange rate, then Y_t and X_t respectively. The VAR model with p lag with k endogenous variable would be

$$Y_t = A_1 Y_{t-1} + A_{2j} Y_{t-2} + \ldots\ldots + A_p Y_{t-p} + \varepsilon_t$$

Where Y_t and lagged values, and vectors and A_1 …..A_p are K*K matrices of constant to be estimated. The VAR analysis will be divided into two parts namely Impulse response function and Variance de composition. The Impulse responses function trace out the responsiveness of the dependent variables in the VAR to shocks to each of the variables. In IRF for each variable from each equation separately, a unit shock is applied to the error and the effects upon the VAR system over time are noted. The variance decomposition provides a proportion of the movements in the dependent variables that are due to their own shocks versus shocks to other variables. In VDC a shock to the i^{th} variable will directly affect that variable of course, but it will also be transmitted to all of the other variables in the system through a dynamic structure of the VAR. Variance decompositions determine how much of the s-step-ahead forecast error variance of a given variable is explained by innovations to each explanatory variable for s = 1, 2 ...

IV. Empirical Analysis

Table 1
Descriptive Statistics

	DIGP	DEURO	DINR	DJPY	DUSD
Mean	0.835282	-0.02291	-0.0081	-0.09615	-0.03562
Median	0.474137	-0.04784	0.022391	-0.36469	-0.04273
Std. Dev.	3.456532	1.510068	1.563929	2.528205	1.262924
Skewness	0.44566	0.418561	-0.0926	0.824654	0.134903
Kurtosis	4.851972	3.257854	4.21556	5.07401	4.573146
Jarque-Bera	37.84227	6.873387	13.54395	62.90304	22.8221
Probability	0.00000	0.032171	0.001145	0.00000	0.000011
Observations	215	215	215	215	215

The table 1 shows the summary statistics of the variables included in the study. It is observed that the mean return 0.8352 of the Indian gold is positive with high standard deviation. The other variables real exchange rates of USD, EURO, JPY and INR produced negative return with low standard deviation. The DINR alone negatively skewed -0.926 and the other variables like DIGP, DUSD, DJPY, DEURO are skewed positively. This implies that the negative return occurred in the major currency could be hedged with the positive return from the gold. The return series of the variables are represented in the below Figure 1. It is observed that all the variables almost show a similar trend in the long run with little deviation in the short run.

Figure 1
Monthly return series gold price and the major currencies

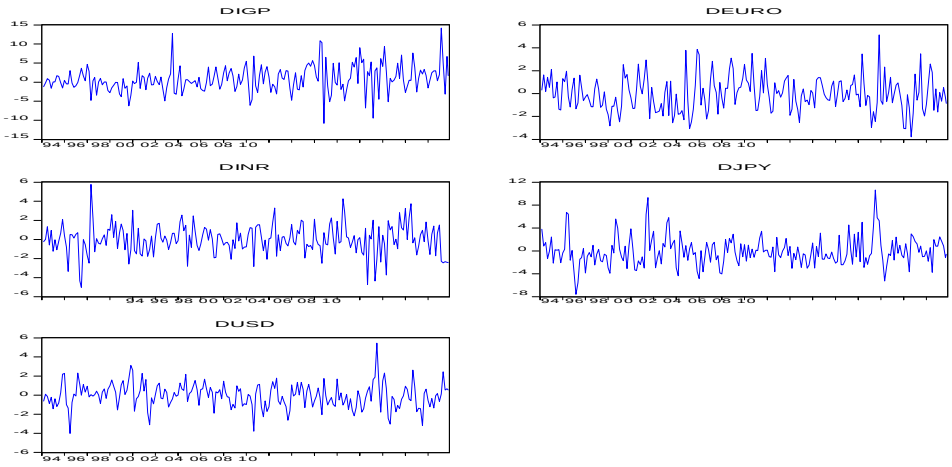


Table 2
Augmented Dickey-Fuller and Phillips-Perron unit root test statistic - Level

	ADF test statistic Level			**PP test statistic Level**		
Variables	None	Intercept	Trend and Intercept	None	Intercept	Trend and Intercept
IGP	3.718885 (1.0000)	2.926675 (1.0000)	-0.252293 (0.9915)	3.479041 (0.9999)	3.067431 (1.0000)	-0.189696 (0.9929)
INR	-0.101117 (0.6478)	-2.457275 (0.1275)	-2.981449 (0.1399)	-0.098730 (0.6486)	-2.712508 (0.0735)	-3.312177 (0.0670)
EURO	-0.320188 (0.5692)	-1.948521 (0.3097)	-1.936645 (0.6318)	-0.245629 (0.5968)	-1.655488 (0.4525)	-1.642941 (0.7727)
JPY	-0.584394 (0.4632)	-2.281981 (0.1788)	-2.564440 (0.2972)	-0.514994 (0.4926)	-1.939393 (0.3138)	-2.018865 (0.5873)
USD	-0.268722 (0.5883)	-1.323545 (0.6187)	-1.649311 (0.7700)	-0.358063 (0.5549)	-1.017386 (0.7472)	-1.338568 (0.8755)

Table 3
Augmented Dickey-Fuller and Phillips-Perron unit root test statistic – First difference

	ADF test statistic – First Difference			**PP test statistic – First Difference**		
Variables	None	Intercept	Trend and Intercept	None	Intercept	Trend and Intercept
IGP	-12.80**	-13.46**	-14.144**	-13.053**	-13.476**	-14.137**
INR	-13.08**	-13.05**	-13.020**	-13.083**	-13.053**	-13.020**
EURO	-11.03**	-11.00**	-10.173**	-10.817**	-10.790**	-10.765**
JPY	-10.83**	-10.82**	-10.841**	-10.580**	-10.566**	-10.566**
USD	-10.22**	-10.20**	-10.273**	-10.029**	-10.006**	-9.9769**

, * indicates the significance at 1% and 5% level respectively

Unit root test is applied to test whether a time series variable is non stationary when using an autoregressive model. A stationary time series is one whose statistical properties such as mean, variance and autocorrelation are constant over a time. Table 2 & 3 indicate the test results of ADF and PP both level and their first difference of the continuously compounded return series of data. It is clear from the results that the null hypothesis of unit root at their first difference is rejected. Thus the variables are stationary and integrated of same order I(1). This condition permits to proceed to test the Johansen Co integration test to examine the long relationship between the gold price and the exchange rates of the major currencies.

Table 4

Results of Johansen Cointegration test

Variables	Hypothesis	Eigen value	Trace Statistics	Critical value at 5%	P value	Max-Eigen Statistic	Critical value at 5%	P value
IGP & INR	r = 0*	0.121209	37.50967	15.49471	0.0000**	27.39204	14.26460	0.0003**
	r ≤ 1*	0.046604	10.11763	3.841466	0.0015**	10.11763	3.841466	0.0015**
IGP & EURO	r = 0*	0.100603	25.74826	15.49471	0.0010**	22.47855	14.26460	0.0020**
	r ≤ 1	0.015305	3.269713	3.841466	0.0706	3.269713	3.841466	0.0706
IGP & USD	r = 0*	0.097373	25.23012	15.49471	0.0013**	21.71841	14.26460	0.0028**
	r ≤ 1	0.016428	3.511715	3.841466	0.0609	3.511715	3.841466	0.0609
IGP & JPY	r = 0*	0.120640	29.95303	15.49471	0.0002**	26.86921	14.26460	0.0003**
	r ≤ 1	0.014647	3.083828	3.841466	0.0791	3.083828	3.841466	0.0791

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level, * denotes rejection of the hypothesis at the 0.05 level **MacKinnon-Haug-Michelis (1999) p-values, IGP means the Indian Gold price,

The table 4 provides the results of Johansen"s Trace and Maximum Eigen value test. If the exchange rate and the gold price are cointegrated then the movements of these two asset prices are tied together in the long run. The trace test indicates the existence of more than one co integrating equations at 5% level significance between IGP and INR and one cointegrating equation between IGP and EURO, JPY and USD. The results indicate a long run equilibrium relationship between the real exchange rates of major currencies and the Indian gold price. Hence they are dependent on one another and their prices could be used to forecast by each other in the long run. The maximum Eigen value test confirms the long run dynamic relationship among them.

Table 5

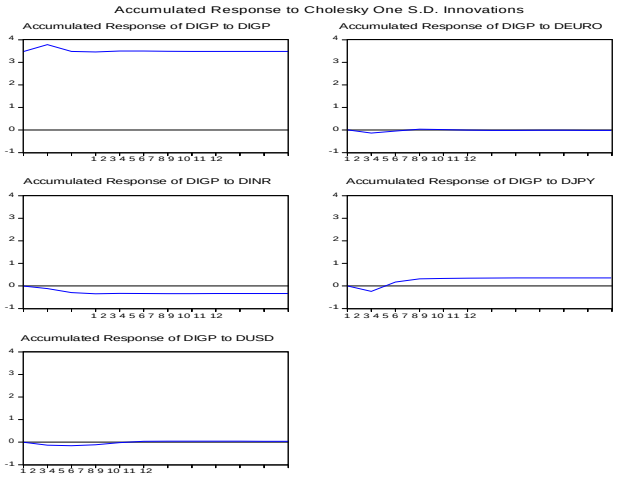
Pairwise Granger Causality Tests

Null Hypothesis:	F-Statistic	Prob.
DEURO does not Granger Cause DIGP	0.95178	0.4165
DIGP does not Granger Cause DEURO	0.06262	0.9795
DINR does not Granger Cause DIGP	0.43415	0.7288
DIGP does not Granger Cause DINR	0.35852	0.783
DJPY does not Granger Cause DIGP	2.30739	0.0458*
DIGP does not Granger Cause DJPY	0.16179	0.9762
DUSD does not Granger Cause DIGP	0.20617	0.8921
DIGP does not Granger Cause DUSD	0.36969	0.775

* significance at 0.05 level

Granger-causality means only a correlation between the current value of one variable and the past values of other variables. The Table 5 shows the results of the Granger causality test. It indicates that the real exchange rate of Japanese Yen granger-cause the Indian gold price and the vice versa is not true. Hence there existed a uni-directional causality running from the real exchange rate of Japanese Yen to Indian gold price. The past values of real exchange rate of Japanese Yen contain information about the Indian gold price and the same could be used to forecast. The real exchange rates of USD, Euro and INR do not granger-cause the Indian gold price and vice versa are also not true. The insignificant P values in these results indicate that these real exchange rates are independent of the Indian gold price and their past values do not contain predictive power about our gold price.

Figure 2 Impulse Response Function



The Figure 2 explains the results of the Impulse response function. The Impulse response function helps to identify the level of responsiveness of the dependent variable in the VAR to shocks to each of the variables. One standard deviation positive innovation is applied to each variable (DGIP, DEURO, DUSD, DINR & DJPY) and its effect on the dependent variable (DIGP) is observed over the 12 months period in the VAR system. It is observed from the figures that DIGP responses immediately and positively to the one standard deviation positive innovation to DGIP itself and it affects only in the short run period and not in the long run. The response of Indian gold price to the one standard deviation positive shocks of real exchange rate of Indian rupees was immediate and negative in the long run. The real exchange rate of US dollar and Euro showed almost the same effect on the Indian gold price. The Japanese Yen real exchange rate had a negative impact and this negative impact continued only for two months. After that the Indian gold market showed a positive response to Japanese Yen in the long run.

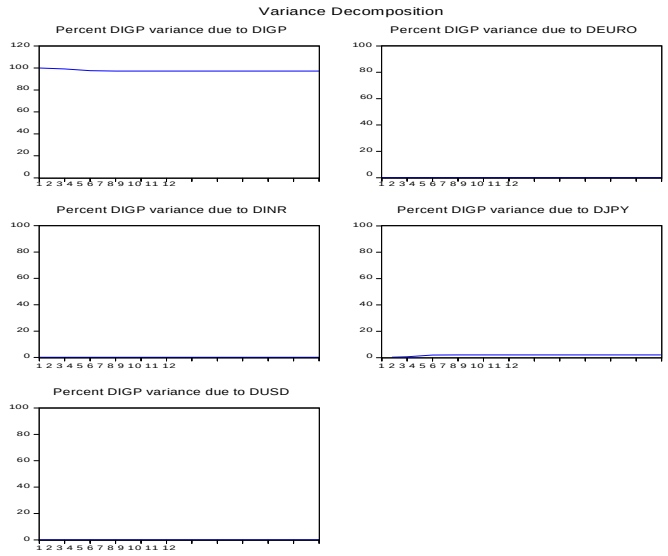
Table 6: Variance Decomposition

Period	DIGP	DEURO	DINR	DJPY	DUSD
1	100	0	0	0	0
2	99.13665	0.148953	0.104144	0.471624	0.138634
3	97.51147	0.200959	0.342863	1.806096	0.138614
4	97.25653	0.256425	0.368768	1.969365	0.148911
5	97.18011	0.257835	0.372362	1.969452	0.220243
6	97.1459	0.263963	0.372602	1.969331	0.248209
7	97.14333	0.264929	0.37327	1.969755	0.248715
8	97.14268	0.264944	0.373442	1.970189	0.248744
9	97.14242	0.265023	0.373533	1.97028	0.248743
10	97.14242	0.265023	0.373536	1.97028	0.248746
11	97.1424	0.265031	0.373537	1.97028	0.248748
12	97.1424	0.265032	0.373537	1.97028	0.248748

Cholesky Ordering: DIGP DEURO DINR DJPY DUSD

Figure 3

Variance Decomposition



The table 6 and figure 3 report the results of the variance decompositions for the price of gold and the real exchange rate of USD, EURO, JPY and INR. It is interesting to note that the percentage of the errors that is attributable to own shocks is 100% in the case of Indian gold price. Hence the forecast error variance of the Indian gold price can be largely explained by itself. However in the long run real exchange rate of Japanese Yen show little explanatory power of the forecast error variance of the Indian gold price. It means that the price of Indian gold market is slightly affected by the real exchange rate of Japanese Yen.

V Conclusions

The purpose of this paper was to test the causal relationship between the Indian market gold price and the real exchange rate of the major currencies USD, Euro, Yen and INR. The empirical results concluded that there existed a long run equilibrium relationship between the gold price and the real exchange rates of the major currencies. The Granger causality results revealed that the Indian gold price is caused by the Yan and not by

any of the real exchange rates included in the study. The Indian gold price caused none of the real exchange rates. Hence the real exchange rate of Yen contains information about the Indian gold market price and this information will help the investors to forecast. The real exchange rates of USD, Euro and INR are independent of the Indian gold price and their past values do not contain any information about our gold market price.
Further the VAR models such as Impulse response function and variance decompositions concluded that gold price responses immediately and negatively to the real exchange rate of Indian rupees and positively to the real exchange rate Yen. The other real exchange rates are independent of gold price. The forecast error variance of the Indian gold market price can be largely explained by itself.

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