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THE EVALUATION OF INDIAN GOLD PRICE VOLATILITY: AN EMPIRICAL ANALYSIS

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ABSTRACT

The current paper attempts to examine the volatility of gold prices in India over the period January 1, 2011 to March 31, 2024 using GARCH model. To begin with, the existence of ARCH effect has been verified applying ARCH Lagrange Multiplier (LM) test of Heteroskedasticity. After confirming the ARCH effect, the volatility measure in gold prices has been captured using GARCH (1,1) model. The results bring out that there is persistence of frequent volatility shocks in the Indian gold prices and a shock that occurs at time t will persist for future periods. Furthermore, the existence of volatility clustering has been confirmed and approximately 85 percent of the volatility of the current day's gold price is being contributed by the volatility of preceding day's gold price. Thus, it can be concluded that variations in the gold prices have an impact on long-term estimations of gold price volatility.

KEYWORDS: *Indian Gold Prices, Garch, Persistent Volatility, Volatility Clustering.*

INTRODUCTION

Gold one of the precious metals is considered as a representation of purity, beauty, strength and good fortune since ancient times. In fact, before the introduction of paper money, gold had been used as a currency.Until the collapse of Bretton Woods system, gold has been treated as a store of value and a powerful medium of exchange. It has been retained as an investment by investors and governments as part of forex reserves even after Bretton Woods. Over time, demand for gold has rose significantly since it has become an extremely valuable asset which has lured the attention of large number of investors around the globe. Eventually, gold has been recognized as most preferred investment and auspicious metal in India and consequential rising demand for the gold, India became the leading importer of gold among all nations around the globe.

Since India is the world's largest consumer of gold, movements in international gold prices might have a tremendous impact on its domestic economic activities. India generates only a marginal portion of its physical gold and the rest always need to be imported.The past few years

witnessed elevated international gold prices following the global financial crisis of 2008 which has also caused an accelerated hike in gold prices in India (Shiva & Sethi, 2015). However, COVID-19 pandemic has worsened it more than that of earlier global recession. Despite of all this, precious metals like gold carries a substantial interest as a source of investment.

Among the various variables that could impact the price of gold, the most common variables are public's opinion of its worth, global economic trends, the volume of gold purchased and sold, financial market and additional factors like important acquisitions, newest discoveries etc. Furthermore, considering the increasing demand for gold in India as well as worldwide, it has become essential to establish a model that is able to depict the pattern and trends in gold prices prevailing in India. Both academics and industry have been paying due attention to the volatility of gold prices currently. This paper is an effort in this very direction.

Review of Related Studies

There exist several studies relating to price volatility of gold spot market. This section provides brief review of previous studies relating to gold prices volatility:

Nawaz and Moomal (2012) made an effort to investigate the volatility in daily gold price returns for a period of 3 years spanning January 1, 2009 to September 31, 2011 using standard deviation and GARCH models and observed an unequal spread of residual terms also known as heteroskedasticity. Additionally, fast mean reversion indicating that the alpha and beta are very distant from unity. The findings concluded that there exist a significant volatility in international gold prices.

Jain and Ghosh (2013) examine causation and cointegration between the exchange rate of Indian Rupee vis-a-vis US dollar, global crude oil prices and price of precious metals i.e., gold, platinum, and silver using ARDL bounds test and Toda–Yamamoto Granger causality test. The ARDL bounds tests show that cointegration exists for all the variables under consideration. The overall findings highlight the significance of exchange rates in shaping local commodity prices and the impact of import demand on pricing.

Jain and Biswal (2016) analyse the dynamic relationship between global gold prices, USD/INR exchange rate, crude oil prices and the BSE Sensex using annual data from 2006 to 2015. The lead lag linkages among the variables have been examined using both symmetric and asymmetric non-linear causality tests while DCC-GARCH (standard, exponential, and threshold) models were employed to evaluate dynamic contemporaneous relationships. The results indicate that decline in prices for crude oil and gold decrease the value of the benchmark stock index i.e., the Sensex and the Indian Rupee.

Swain and Samal (2017) analysed the time varying effects of gold prices volatility in India spanning January 1, 2011 to June 30, 2016 using different ARCH family models namely, GARCH, EGARCH and TARCH. The findings of GARCH (1, 1) model depict that the previous day's forecast provides about 85 percent of the information concerning the volatility of the current period's gold price while E- GARCH reveals that downward trend in daily return of goldleads to subsequent rise in volatility. Further, as per TARCH model, both positive and negative shocks have same impact on the volatility of gold prices in the future.

Mahajan and Mahajan (2021) aims to investigate the combined dynamics of gold and stock market returns during the periods of health crisis and economic shock subsequent to COVID-19, i.e., January 2020 and May 2020 applying Granger causality test, ARMA model and GARCH

model. The results demonstrate that gold had a substantial negative effect on nifty returns during the period of COVID-19. The findings also show the investors' perceptions towards gold as a safe-haven investment during the periods of severe uncertainty.

Ejap et al. (2022) used the GARCH (1,1), EGARCH (1,1), and TGARCH (1,1) models to capture the forecasting and volatility of gold prices for the period from January 4, 2016 to October 29, 2021. The model with the lowest information criteria values is considered the best one for modelling volatility. As a result, TGARCH (1,1) has been selected as it performs better than other models and captures the effects of both the good and bad news. The results of the study highlight that investors have not gained a significant amount of return from the investment in gold price over the sample period.

To put it briefly, the a fore mentioned studies indicate that minimum efforts have been made to assess the volatility of gold prices in India. Thus, the current study aims to bridge this gap and provides an insight into the time varying volatility of Indian gold prices.

Research Methodology

ARCH Lagrange multiplier (LM) test

The Autoregressive Conditional Heteroskedasticity or ARCH effect, also referred to as volatility clustering or the heteroscedastic stochastic process, is generally exhibit in the financial time series data. Before applying the GARCH model, the existence of ARCH effect is prerequisite which can be tested through ARCH-LM test given by Engle (1982). If the p-value of chi-square (χ^2) found to be significant then in such condition, the null hypothesis indicating no ARCH effect in considered series is rejected and the alternative hypothesis signifying existence of arch effect is accepted.

GARCH (1, 1) Model:

Bollerslev (1986) proposed Generalised Autoregressive Conditional heteroscedasticity (GARCH) model which has been applied to measure time varying volatility of the Indian gold prices. This is a symmetric model that captures both the persistence of volatility shocks and the impact of volatility clustering in a given time series. The GARCH (1,1) can be estimated as per equations mentioned below:

$$Y_t = c + \mu_t \ldots\ldots\ldots\ldots\ldots (1)$$

$$\hbar_t^2 = \sigma_0 + + \sum_{i=1}^{p} \alpha_1 \varepsilon_{t-1}^2 + \sum_{i=1}^{q} \beta_1 \sigma_{t-j}^2 \ \ldots\ldots\ldots\ldots\ldots (2)$$

Equation (1) represents the mean specification where c stands for the intercept term and μ_t denotes the disturbance term whereas equation (2) signifies the conditional variance specification which consists of three parameters i.e., mean (σ_0), mean lag of the squared error term from the mean equation (ε^2_{t-1}) also known as ARCH term and previous period's forecast variance (σ^2_{t-1}) also known as GARCH term.

Objective of the study

The present study focused on accomplishing following objectives:

1. To examine the existence of volatility clustering in the Indian gold prices.

2. To evaluate the time varying volatility in the Indian gold prices.

Data Description

The present study considers the secondary data on monthly average gold pricesper 10 grams for the period spanning January 1, 2011 to March 31, 2024 which hasbeen collected from official website of Reserve Bank of India under the head 'Database of Indian economy'. The analysis is based on time series data which includes 159 observations in total and analysis of time varying volatility has been performed using ARCH and GARCH models.

Results and Discussion

ARCH Lagrange multiplier (LM) test

The very first step in applying a GARCH model and before evaluating the volatility is to figure out whether the considered variable contains ARCH effect or not. This prerequisite has been identified using the ARCH Lagrange multiplier (LM) test based on Engle (1982) and the computations with respect to ARCH LM test is presented in Table 1.

The findings of ARCH LM test depicts that the value of observed R-square is 12.702 and corresponding p-value of chi-square (χ^2) is 0.000. This signifies that the null hypothesis indicating no ARCH effect can be rejected at one percent probability level meaning thereby, the alternate hypothesis which point towards the existence of ARCH effect can be accepted. Furthermore, the coefficient of squared error term i.e., 0.285 is also statistically significant at one percent level of significance which again indicates about the existence of ARCH effect.

TABLE 1. LAGRANGE MULTIPLIER TEST OF HETEROSKEDASTICITY

Heteroskedasticity Test: ARCH				
F-statistic	13.644*	Prob. F(1,155)		0.000
Observed R^2	12.702*	Prob. Chi-Square(1)		0.000
Test Equation:				
Dependent Variable: RESID^2				
Test: Least Squares				
Sample (adjusted): 2011M03 2024M03				
Included observations: 157 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	P-value
C	11360*	27931	4.0673	0.000
RESID^2(-1)	0.285*	0.077	3.6938	0.000
R^2	0.080	AIC		32.78
Adjusted R^2	0.074	SBC		32.82
F-statistic	13.64	HQC		32.80
P-value (F-stats)	0.000	DW-stat		1.892

* denotes 1 percent level of significance.

Having checked the preliminary condition of existence of ARCH effect in the gold prices data, the GARCH model has been employed for estimating its volatility. This model is useful for predicting volatility in the context of time varying volatility.

GARCH (1,1) Model

TABLE 2. GARCH (1,1) MODEL

GARCH (1, 1) Model			
Dependent Variable: GOLD_PRICE			
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)			
Mean Equation			
Variable	Coefficient	Std. Error	P-value
C	-155.46	254.76	0.541
GOLD PRICE (-1)	1.010*	0.006	0.000
C	57042	5286	0.280
Variance Equation			
α_1 (ARCH)	0.129*	0.062	0.037
β_1 (GARCH)	0.854*	0.075882	0.000
R^2	0.991	AIC	16.99
Adjusted R^2	0.991	SBC	17.08

* denotes 1 percent level of significance.

Table 2 shows the findings of parameter estimates from the GARCH (1,1) model for gold prices prevailing in India. The findings reveal that both the ARCH (α_1) and GARCH term (β_1) i.e., 0.129 and 0.854 are significant at one percent level of significance. The significant value of ARCH coefficient implies the existence of volatility clustering in the considered time series which infers that small changes tend to followed by small changes and large changes tend to followed by large changes, irrespective of sign. Further, the combined value of ARCH and GARCH parameters equate to 0.983 which is less than one or close to unity. It signifies that a shock that occurs at time t will persist for some future periods or it can be said that there is persistence of frequent volatility shocks in the upcoming time period.A large ARCH coefficient indicates a less persistent and more spiky form of volatility whereas a large GARCH coefficient signifies persistent volatility. Here, in our model, there is persistence of volatility shocksin the Indian gold price series since the GARCH coefficient value is higher than the ARCH coefficient. The model further demonstrates that almost 85 percent of the information concerning to the volatility of current day'sgold price is being contributed by the goldprice of the preceding day. Therefore, it may be concluded that variations in the gold price have an impact on long-term forecasting of gold price volatility.

CONCLUSION

The current study is an attempt to analyse the time varying volatility of Indian gold prices using secondary data on monthly average gold prices per 10 grams for the period spanning January 1, 2011 to March 31, 2024. At the outset, the existence of ARCH effect has been verified by using ARCH Lagrange Multiplier (LM) test of Heteroskedasticity. Having confirmed the existence of ARCH effect, the volatility has been measured using GARCH (1,1) model. The findings of GARCH model demonstrate that both the ARCH (α_1) and GARCH term (β_1) are statistically significant at 1 percent level of significance and the sum of both the parameters is 0.983 which is less than one or close to unity (1). It signifies that there is persistence of frequent volatility shocks in the gold prices and a shock that occurs at time t will persist for several upcoming

periods. The significant value of ARCH coefficient implies the existence of volatility clustering in the considered time series which signifies that small changes tend to followed by small changes and large changes tend to followed by large changes, irrespective of sign. Moreover, there is persistence of volatility shocks in the Indian gold price series since the GARCH coefficient value is greater than that of ARCH. The results further reveal that 85 percent of the information concerning to the volatility of the current day's gold price is being contributed by the preceding day's gold price. In nut shell, it can be concluded that gold prices variation has a substantial impact upon forecasting gold price volatility.

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