Volatility Behaviour of Gold Mini Futures Price in India

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ABSTRACT

Measuring and forecasting commodity price volatility has important implication for investors, portfolio managers because volatility has information content. Traditionally precious metals command a much higher price due to a number of factors such as economic crises, demand in emerging economies and inflation expectations. They also have relation with other assets and hence convey certain information which can be used by investors to forecast financial asset prices. So far as commodity prices are concerned, they have become more volatile in recent years. One obvious reason for commodity market volatility is supply constraint or any form of disruptions due to hoarding, cartel, political uncertainty, war, weather conditions. Apart from this, in case of trading in F&O, ETFs precious metals are used as collaterals and hence can affect volatility. Commodities along with financial assets tend to move in tandem due to effect of common macroeconomic fundamentals such as interest rate, inflation and exchange rate. This paper models gold mini futures price volatility in India using the threshold generalised autoregressive conditional heteroscedasticity (TGARCH) model for the period from January 17, 2015 till October 17, 2022. The study founds presence of asymmetric volatility in gold futures indicating gold price increases more during good economic phase compared to decrease in gold price of same magnitude during bad phase of economy. This means gold behaves opposite to other financial asset classes and therefore should be included in portfolio.

Keywords: TGARCH; volatility; financial assets; gold price.

1. Introduction

Precious metals like gold, platinum, silvers are rare and hence have a higher economic value than common metals. These metals have attracted much of attention for numerous reasons. First, they are used as a vehicle of savings, investment, fashion, art and industrial purposes. Second, they especially gold act as reserve assets by all Central banking authorities across World. Third, they are believed to have a very close relation with financial assets like stocks. Traditionally precious metals command a much higher prices due to a number of factors such as economic crises, demand in emerging economies and inflation expectations (Lee & Lin, 2011). For instance, gold mini futures price in India has almost doubled within a span of only seven and half years (from INR 27,000 per 10 gm in January 2015 to around INR 51,000 per 10 gm in October 2022). Precious metals have spill over relation with other assets and hence convey certain information which can be used by investors to forecast financial asset prices (Adrangi et al., 2003; Shiva & Sethi, 2015). Volatility is the measure of risk associated with an investment during a given time period. Investment value fluctuates due to change in securities prices and hence leading to risk. More the abrupt change in security prices, more will be the volatility and vice versa. According to Ross (1989) volatility is a measure of information flow.

Therefore, forecasting volatility of financial asset returns has become a very important area of research among practitioners. So far as commodity prices are concerned, they have become more volatile in recent years. One obvious reason for commodity market volatility is supply constraint or any form of disruptions due to hoarding, cartel, political uncertainty, war, weather conditions etc. Apart from this, in case of trading in F&O, ETFs precious metals are used as collaterals and hence can affect volatility. Any change in expectations by end consumers can also have rippling effect on commodity prices. According to Hammoudeh et al., (2010) commodities along with financial assets tend to move in tandem due to effect of common macroeconomic fundamentals such as interest rate, inflation and exchange rate. With this background, one of the important commodities i.e., gold is considered as a reference to examine the magnitude and extent of volatility in gold market. This study will contribute particularly for investors who have exposure to both commodity and financial assets. The study has policy implications for Government as well.

2. Literature review

Numerous literatures are available on study of different aspects of precious metals like gold. The studies can broadly be divided into two types; In first category, linkage of gold price and its volatility with other asset classes are studied while in second category, analysis of impact of macro-economic variables on gold prices.

Mishra et al.,2010 examined linkage between gold and stock returns using Granger causality test and found bidirectional impact of both the asset classes on each other. The same result was obtained by Narang & Singh, 2012; Bhunia & Das, 2012. In a similar study Tripathi et al.,2014 examined causal impact using much broader assets from exchange rate (INR/USD) and crude price and found gold price has significant effect on USD exchange rate and crude. On the contrary, Tiwari & Gupta, 2015 found no evidence of significant relationship between gold and Sensex return from 2005 to 2014. Jain & Biswal,2016 explored relation among multi assets such as INR/USD rate, crude oil, stocks and gold prices under DCC-GARCH framework and found evidence gold and crude price systematically affect other two assets. Dadhich, 2017 examined gold price volatility due to macro-economic variables especially dollar return and stock return and found no long run relationship between gold and dollar or stock. Natchimuthu et al., 2017 investigated presence of leverage effect in gold price taking a sample of six cities in India using APARCH model and its relation with US gold

price over a period of five years from 2011 to 2017 and found volatility clustering and leverage effect. Kumar & Robiyanto, 2021 recently investigated the relation between dollar index, stock volatility of both India and China and the gold price returns using Covid period data from 2019 to 2020 using GARCH (1,1) model. They found gold price does not have significant impact on any of the stock markets.

In second category of study, Bapna et al., 2012 investigated information content of gold price and macroeconomic variables and their spill over on each other using granger causality test. They found fiscal deficit, inflation and forex reserves in India significantly impact gold return with low causation between gold and stock returns and GDP. Bin et al., 2015 examined effect of macro-economic factors on Malaysian gold price and found positive relation between crude and gold, but ringgit is negatively related to gold price with no effect of inflation on gold price. Hashim et al.,2017 examined impact of macro-economic variables on gold prices in multiple countries including India and concluded that gold price is positively related to crude, however negatively related to inflation, GDP and real interest rate. Kusumawati & Asandimitra, 2017 studied effect on global indices along with macro factors on gold price in Indonesia and found mixed evidence of gold price with few indices. Chen et al., 2022 using VAR-BEKK GARCH model showed there is a volatility transmission from other asset classes; exchange rate and oil to gold in Brazil and India from 2005 to 2020.

Two things can be concluded from the literature. First almost all studies in the first category shows relationship of different asset classes with gold. This gave mixed evidence with a majority of studies concluding that gold has significant relation with chosen assets. Second category shows the impact of one or more macro-economic factors on gold. The fundamental assumption that gold as a commodity provides hedge against inflation risk and gives a substantial positive return if held for a longer period of time itself negates results of earlier studies (see for instance Bin et al.,2015). Further, many earlier studies found mixed evidence of gold and other asset classes suggesting a reinvestigation to gold price behaviour. The fundamental question arising at this point is whether gold provides safer alternative or behaving more or less in similar way with other asset classes. This has motivated to investigate gold price behaviour particularly the asymmetry component. Asymmetry can well be understood as extent of impact of positive and negative news on the same asset is different. If this is so, then gold behaves just like other assets implying that gold

may not protect portfolio in long run. Except the study by Natchimuthu et al., 2017 on asymmetry behaviour of gold price, none of the above examined this behaviour. They applied APARCH which fundamentally capture different degrees of persistence in conditional volatility for negative and positive shocks only without capturing structural breaks in given series. Presence of structural breaks can significantly affect the model's performance. Therefore, in this study threshold GARCH (TGARCH) is proposed which takes on both asymmetry and non-linearities in series.

3. Objective of the study

To study the asymmetric effect on time varying volatility of return of gold mini futures.

4. Data and methodology

For this study, all data being secondary in nature were collected from in.investing.com. Data are related to price of gold mini futures. The reason for choosing gold mini futures is that it is considered as an asset class unlike gold in spot market which is mostly used for consumption purpose. Further studies found a lead-lag correlation between gold spot and futures (see Srinivasan & Deo, 2009; Pavabutr & Chaihetphon, 2010; Pandey, 2014). The data represents daily price of gold mini futures in India ranging from January 17, 2015 till October 14, 2022 consisting of a total of 1997 datapoints. This is a correlational study that basically correlates current with lag values across a time series. Correlation with lagged values quantifies both magnitude and memory in time series data. Volatility modelling requires methodologies to capture jumps, clustering, fat tails present in a time series. ARCH family models best capture volatility in time series. Since the objective is to measure leverage effect in volatility, TGARCH is proposed. First, all price data were converted to daily log return. Thereafter, the series was tested for presence of unit root and ARCH effect. Finally, TGARCH was applied on the residuals. All calculation was conducted using R.

Zakoian (1991) proposed the following threshold generalised autoregressive conditional heteroscedasticity model. In TGARCH (1,1),

$$\sigma_t^2 = \omega + \alpha r_{t-1}^2 + \gamma D_t r_{t-1}^2 + \beta \sigma_{t-1}^2$$

$$\text{Where } D_t = \begin{cases} 1 & rt-1 < 0 \\ 0 & rt-1 \geq 0 \end{cases}$$

ω is a constant term, α captures sudden shocks to time series, β refers to GARCH term and γ captures asymmetry in the time series. Dt is the threshold term which is one in case of negative return or zero otherwise.

Asymmetry assumes information to have either positive or negative impact. Therefore, both positive and negative shocks are believed to have different effect on return. This means volatility varies with time and hence different under rising and falling market situations. The following hypothesis was assumed to test asymmetry in data.

Null Hypothesis: No asymmetric ARCH effect presents.

Alternate Hypothesis: Asymmetric ARCH effect presents in data.

The following table (Table 1) shows results of descriptive statistics and stationarity.

Table 1. Result of descriptive statistics and stationarity.
Panel A: Descriptive statistics

Parameters	Gold futures Ret.
Mean	-0.000299
St. Deviation	0.008267
Skewness	0.218622
Kurtosis	4.333541
JB	1583.1 [0.000]
ARCH	76.989 [0.000]

JB is Jarque-Bera test of normality, p values are in brackets.

Panel B: Unit root tests

Parameters	Gold futures Ret.
ADF	-12.036 [0.000]
PP	-2021.9 [0.001]

Panel A shows that the mean of the series is negative with a daily standard deviation of 0.008. Skewness of 0.218 indicates a relatively small asymmetry in the distribution. The series appears to be leptokurtic indicating a fat tail, a common characteristic for financial time series. The data series are not normal as evident from JB statistic which is significant a 1%. ARCH test is significant suggesting that variance is heteroscedastic. This confirms application of GARCH type models. Panel B shows results of unit roots to test stationarity of series. The statistic of ADF and PP tests is significant at 1% significance level, hence we can reject null hypothesis of presence of unit root, indicating data are suitable for further analysis.

5. Empirical result

Panel A: Estimation Results

Coefficients	TGARCH
μ	-0.000[0.342
ω	0.000[0.506]
α	0.020[0.000]
β	0.980[0.000]
γ	-0.031[0.000

Figures in parenthesis are *p* values.

Panel B: Diagnostic Tests

Parameters	TGARCH
Log-likelihood	6823.733
AIC	-6.83
BIC	-6.81
SIC	-6.83
HQIC	-6.82

Panel C: Nyblom Stability Test

Coefficients	Statistic
μ	0.05404
ω	161.8843
α	0.14145
β	0.10821
γ	0.13492

To start the analysis from μ which represents conditional mean of the series which changes slowly over time in the presence of long memory. ω is constant term (unconditional variance) in conditional mean equation. It is not significant indicating a zero conditional mean with a negative conditional variance for the gold returns over the sample period. The parameters α, β and γ are all significant. This implies that the conditional volatility of return on futures is significantly influenced by its past conditional volatility and shocks (residuals). The coefficient of alpha and beta is less than/equal to one indicating that volatility of return series is stationary. Finally, a high value of β (0.98) shows persistence in volatility. Asymmetry coefficient (γ) is -0.031 which is significant at 5%. This means gamma (γ) is significantly different from zero indicating presence of asymmetric or leverage effect. This means positive shocks increase the volatility more than negative shocks since γ is negative. The result of Nyblom stability test indicates all the parameters are stable individually (asymptotic critical value at 5%

is 0.47 for individual) and don't show time varying features. Result of positive sign bias test (t-value 1.809, prob Sig. 0.07067) is significant implying that positive returns are more likely than negative returns of gold mini futures.

Graphical analysis

Following figures refers to the results of TGARCH output. Figure:1 shows two conditional SD superimposed. Figure: 2 indicates high volatility during sample period. Figure:3 shows empirical density of standardised residuals and figure:4 showing auto correlation plot. ACF function plot implies conditional volatility is significant up to 3 lags. Figure:5 shows News impact curve indicating an exponential rise of volatility. The news impact curve shows that larger positive shocks have greater impact on volatility.
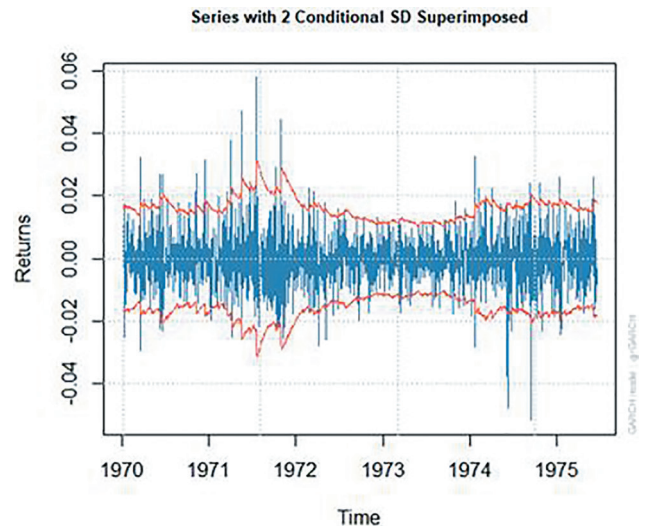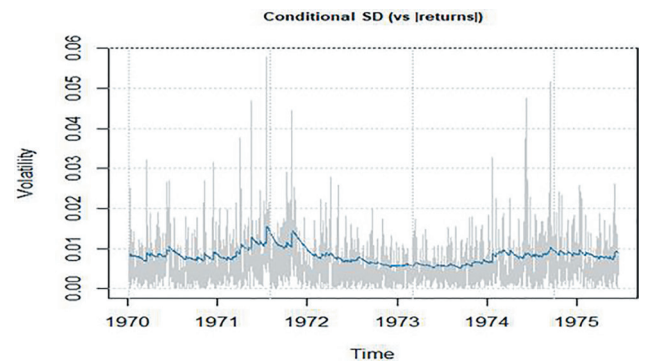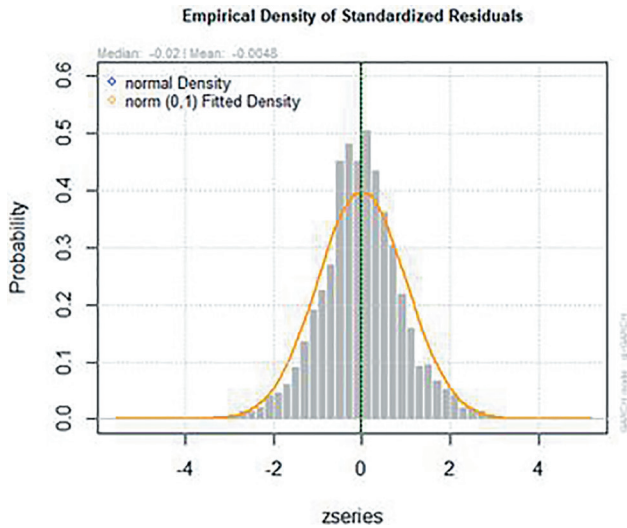

Figure 1.

Figure 2.

Empirical Density of Standardized Residuals

Median: -0.02 | Mean: -0.0048

Figure 3.

ACF of Squared Standardized Residuals
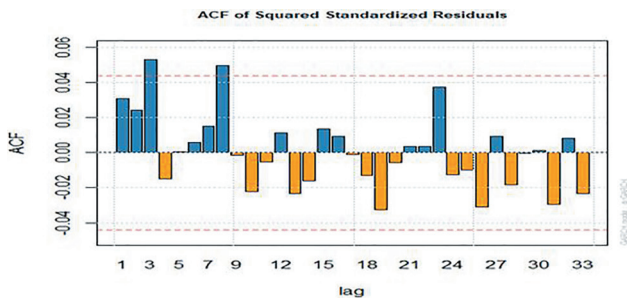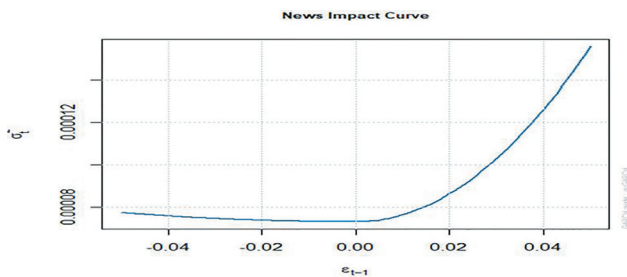

Figure 4.

News Impact Curve

Figure 5.

6. Conclusion

Empirical results establish negative correlation between return and conditional variance of next period's return. This means positive (negative) returns are associated with upward (downward) revision of conditional volatility. The presence of asymmetric volatility in gold futures indicates gold price increases more during booming economic phase compared to decrease in gold price of same magnitude during bad phase of economy. This means gold behaves opposite to most of other financial asset classes thereby supporting the notion that it can be act as good hedge and should be included in portfolio.

Declaration of Conflicting Interests

The authors declare that they have no competing interests.

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