Journal of Commerce and Accounting Research
13 (1) 2024, 35-44
http://publishingindia.com/jcar/

Submitted: 20 July, 2022
Revision: 27 January, 2023
Accepted: 18 April, 2023

TESTING THE HEDGING EFFECTIVENESS OF GOLD DERIVATIVE MARKET IN INDIA

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Abstract *The purpose of this article is to estimate the hedging effectiveness of the Indian Gold Derivative Market from both the statistics of Static hedge methodology of Vector Error Correction Method and Time-Varying hedge methodology of DVEC-GARCH, covering the time span of 1st April 2005 till 31st March 2019, to account for any difference existence in both. The study is conducted to judge the performance of gold futures as a tool of risk management. The result reveals the fact that hedging effectiveness from both the methodologies are found to be 35%. The reason behind low hedging efficiency might be due to the fact that gold itself is used as a hedge instrument and always in demand by the Indian investors for varied reasons as well as its accessibility in various forms (Gold ETFs and Gold Bonds issued by Government). The hedgers' participation may be less as compared to speculators with respect gold future hedging. The results of phase-wise analysis, that is, before crisis (2005–2007), the hedging efficiency comes out to be 26%, during the crisis (2008–2012) 38.7% and after the crisis (2013–2018) 40% from both the static and dynamic hedge ratio models. The results showed that with the outbreak of Global Financial crisis in 2007–2009 and European debt crisis in 2010–2012 and thereafter, gold futures are increasing use as a risk management tool, but still at a minimal level.*

Keywords: *Gold, Spot Prices, Future Prices, Hedging Effectiveness, Risk Management*

INTRODUCTION

Futures trading facilitate the functions of price discovery and risk management. The managing price risk through futures implies hedging. The economic rationale behind the futures market is that it helps in transferring the risk to those who are willing to undertake it (Ghosh, 1993; Prashad, 2011). Thus, two kinds of activities are involved among the market participants in the future trading, that is, hedging and speculation. Hedgers are those who interested in managing their price risk and have position in the underlying market whereas speculators are those who are benefiting from deal of undertaking risk without having underlying asset in the cash market. Johnson (1960) referred to the theory of "normal backwardation", asserted by J.M. Keynes in his thesis "A Treatise on Money". The theory emphasised that hedgers, in order to relieve themselves from the price risk, willing to pay "risk premium" and the speculators are interested in the futures market only if they are expected to collect that premium. Thus, hedgers are usually short in futures and speculators are usually long in futures. Thus, the applicability of this theory is possible only if there is an existence of discount of a future below the current spot price by the amount of the premium. In order to hedge the assets from the adverse price changes with the future contracts, there is a need to estimate hedge ratio, that is, how many future contracts are required against the given quantity of underlying asset. Thus, an investor has to determine the optimal hedge ratio.

It has been empirically tested by many authors that in Indian gold market, both futures and spot market help in price discovery process, futures being dominant in its role. Futures, being an organised efficient market, assist in transferring the risk involved in the portfolio, improvise the liquidity in the cash market as well as enhance its informational efficiency. Thus, in this part of study second most important function of risk management through futures market, is evaluated empirically.

A vast amount of literature exist appreciating the informational efficiency role of the organised futures market, emphasising price behaviour in futures market helps in pricing spot prices. Garbade and Silber (1983) and Carlton (1984) asserted that both these markets are linked through arbitrage process (Gupta & Singh, 2007) and are based on principle of convergence, that is, converges at the time of maturity, however they both may move away from each other in the short run.

Theories of Hedging

The "Hedging Effectiveness" (HE) in the derivative market refers to the theoretical framework used to analyse the efficiency of hedging in the financial market. It is a risk management strategy undertaken by the investors to reduce or eliminate the exposure to various risks associated with the underlying assets in the financial market.

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The HE involves the following elements:

The first step is to identify the underlying asset, which is the asset that the investor needs to protect against price fluctuations. Then the investor necessities to evaluate the risk exposure associated with the asset. This involves analysing the price volatility and the other factors that may influence the asset's value. After that, investor selects the hedging strategy that best fits their investment goals. The varied hedging strategies are available to choose, such as forward contracts, future contracts, options, or swaps. In the final stage, the chosen hedging strategy involves evaluating its effectiveness in reducing the risk exposure associated with the underlying asset. Thus this involves analysing the impact of the hedging strategy on the portfolio's overall risk and return profile.

Different hedging theories persist depending upon the varied objectives of traders. These are major ones namely Conventional hedging theory, Working's hedging theory and Portfolio hedging theory advocated by Johnson (1960), Stein (1961), Ederington (1979) and Kroner and Sultan (1993).

The Conventional hedging theory also called as naive hedging, having optimal hedge ratio of 1:1. Here the hedger, to minimise risk, envisioned to make position in the futures market equal in magnitude but of opposite sign to their positions in the underlying cash market. Then, if the spot and futures prices change by the same amount; then there will be no change in hedger's net position and he would have a perfect hedge. As per this theory, it is assumed that change in the basis[1] is zero and both the spot and future prices move together.

Since, it is not necessary that spot and future prices always move in tandem. If the future prices reflect market expectations, then it should not match the changes in the cash prices. When basis changes, certainly the traditional theory would not be consider as a perfect hedge. Then Working's (1953) came out with a new hedging theory, in which hedgers not only functioned as a risk averter, rather his prime objective is profit maximisation. He will hedge his position in expectation of a change in spot-future price relations. He speculates on the change in basis rather than on absolute price changes (absolute gain or loss). A short hedger[2] will enter the market only if he will expect fall in the basis, otherwise he will remain his portfolio unhedged.

On observing the market participants' behaviour in the futures market, Johnson (1960) and Stein (1961) argued that both hedgers and speculators position the futures market for same risk-return reasons, that is, prefer to have optimum risk-return portfolio instead of just risk-minimisation objective.

On integrating the risk avoidance of traditional theory and Workings' expected profit maximisation theory, Johnson and Stein came up with a new hedging approach called as portfolio hedging theory. This reformed theory explains why hedgers prefer to hold both hedged and unhedged commodity stocks. This theory became very popular as it permits the estimation of time-varying optimal hedge ratios on the basis of varied trader's objectives.

Ederginton (1979) proposed the most popular portfolios hedging theory which yielded immense recognition in the academic literature (Yang & Allen, 2005; Choudhry, 2004; Flous & Vougas, 2006; Kumar et al., 2008). The theory assumed that the trader in the futures market is risk-averter, and the futures market is unbiased predictor of cash market. His concept of hedging helps in estimating a hedge ratio that minimises risk and also derive a measure of HE. Ederginton's theory of hedging compute hedge ratio as the ratio of covariance of futures and cash market returns series to the variance of future returns, also known as Minimum Variance Hedge Ratio. A measure of HE is defined as a percent reduction in variance between the hedged and unhedged returns. This theory says that variance of hedged portfolio and the correlation of futures and underlying assets has to be negatively associated for its implementation. Thus, its applicability involves preconditions of having comovement between two markets and early exploitation of arbitrage opportunities (Gupta & Singh, 2007). A number of studies have followed this theory in empirical testing of hedging efficiency strategies on different markets, on different assets with varying time-span, considering varied motives.

Yang and Allen (2005) investigated the HE of the Australian market considering All Ordinaries Index and the corresponding Share Price Index futures contract from Sydney Futures Exchange for a sample period 6 June 1992 to 31 December 2000. The study estimated the future hedge ratios on the different modelling framework through OLS based model, a VAR model, a Vector Error Correction Method (VECM) model and a multivariate GARCH model, with two approaches of risk-return comparison and utility maximisation method. The results revealed that the magnitude of VECM hedge ratios is greater than VAR hedge ratio as the series are found to be cointegrated in the long run. With respect to risk-return comparison approach, the results found to be almost same in all the models, thus inconclusive. With respect to second approach i.e. utility maximisation approach, OLS model performs better in variance reduction. In comparing in-sample and out-sample period analysis, the

[1] Basis - In the futures market, basis represents the difference between the cash price of the commodity and the futures price of that commodity.(www.investopedia.com)

[2] Short Hedger - A person who shorts an asset or using a derivative contract that hedges against the potential losses in an owned investment by selling at a specified price.(www.investopedia.com)

study supported the superiority of dynamic time-varying multivariate GARCH hedge ratios. Choudhary (2004) examined the hedging effectiveness of large Pacific Basin Stock futures, that is, Australia, Hong Kong, Japan during January 1990 to December 2000, taking into account two future indices on two different expiration dates. The study concluded that hedge ratios computed through GARCH model (time-varying) outperforms constant hedge ratios models (traditional methodology and minimum variance hedge ratios); even though the risk reduction is not large. Same conclusion have been given by Flous and Vougas (2006), that Bivariate cointegration GARCH (1,1) methodology provides greater variance reduction in estimating the hedging efficiency of Greek Stock Index Futures contracts, than the conventional methodologies. The study also revealed that in out-sample forecasting, error correction model is superior to OLS model. In examining hedging effectiveness of Indian Futures market with respect to financial asset (S&P CNX Nifty Index Futures) and commodities (Gold and Soybeans futures), Kumar et al. (2008) concluded that among the constant hedge ratios, VECM performs better in variance reduction as markets are cointegrated in the long run. As well as VAR-GARCH model estimation of time-varying hedge ratios provides highest HE in comparison to the constant hedge ratios methodologies. Thus, the study emphasised that changing hedge ratios requires frequent changes in hedging positions by the traders, to reduce risk. Indian Financial Futures market are broadly examined by Gupta and Singh (2007) in examining the hedging efficiency by undertaking three Indices (NIFTY, BANK NIFTY and CNX IT) and eighty four individual stock futures contracts traded on NSE of India from January 2003 to December 2006. Six statistical tools are employed namely OLS, VAR, VECM, GARCH, EGARCH and TGARCH and concluded that unconditional hedge ratios are better in performance than conditional ones. However, VAR and VECM produce better results since the existence of cointegration between the series. Ku et al. (2007) revealed that DCC-GARCH model performs best in hedging effectiveness in two currencies, that is, British Pound and Japanese Yen and CCC-GARCH performs the worst, even inferior to time-variant hedging strategies of OLS and error correction method.

Bhaduri and Durai (2008) estimated the optimal hedge ratio for stock index futures in India and compare its HE with four competing time series econometric models with the daily data for the time period from 4th September 2000 to 4th August 2005. The study also analysed the effectiveness of the optimal hedge ratios through mean returns and the average variance reduction with respect to unhedged position for 1-, 5-, 10- and 20-day horizons out-of-sample validation. The results revealed that time-varying hedge ratios estimated from DVEC-GARCH model gives higher mean returns compared to other models and gives better variance reduction but only in the long run horizon whereas simple OLS methodology performs better in the short term horizons. In case of out-of-sample validation, DVEC-GARCH model has an edge over OLS and other models. Anjali Prashad (2011) revealed that all the models namely OLS, VAR, VECM and multivariate GARCH model are effective in variance reduction of the hedged portfolios with respect to unhedged portfolio but GARCH offers the highest variance reduction, that is, 95 per cent as compared to others (92–93 per cent). Thus, in nutshell, Nifty futures Index is an effective tool of risk management in the spot market in India. Chang et al. (2011) examined the performance of several multivariate volatility models for crude oil spot and futures returns of two international oil markets, that is, Brent & WTI for a time span from 4th November 1997 till 4th November 2009. The models applied for estimating optimal portfolio weights and optimal hedge ratios for evaluating crude oil hedging strategies are CCC, DCC, VARMA-GARCH, BEKK and diagonal BEKK. The results indicated that in case of all volatility models, it has been appropriate to hold larger proportion of futures than spot except for BEKK in WTI market. It has been recommended to short hedger is to short crude oil futures, with a high proportion of one dollar long in crude oil spot. The result of HE revealed that diagonal BEKK was the best (worst) volatility model with respect to variance reduction. Yagauti and Kamaiah (2012) investigated the hedging effectiveness of commodity futures contract for spices and base metals by employing cointegration and error correction methodology. The study analysed different maturity time horizon varying from one month to three months. The study concluded that there is no significant difference in hedging performance between far month and nearby month maturity periods for species but in case of metals, slight difference exists.

The results concluded that only 40 per cent of the contracts are suitable for effective hedging. Satya Ranjan Sahoo, Dissertion (2014) examined the hedge ratios and HE of futures contract of crude oil, iron ore, soyabean, corns and wheat with the application of constant and time-varying hedging models. The study employed OLS, VAR, VECM as constant hedge models and OLS-GARCH and Bivariate GARCH as dynamic hedging models. The findings of the study stated the hedging effectiveness for crude oil is around 90 per cent, soybeans is around 70 per cent and for corn derivatives is around 70 per cent Thus, market participants can use futures/derivatives as a tool of risk management against volatility in these commodities. In addition to it, in comparing the different models involved, the study emphasised that it is not necessary that time-varying models always performs better than the constant models or vice-verse. Tripathy (2011) also examined the hedge ratios and HE of S&P CNX NIFTY Index futures, gold futures and crude oil futures contract for a time span September 2008 to

September 2010 by employing OLS, VAR, VECM and VAR-GARCH methodologies. The study revealed the fact that time varying hedge ratio estimated through VAR-GARCH model provides highest variance reduction as compared to other models.

The hedging theories namely Conventional, Working's and Ederington are criticised on the ground that hedge ratios computed through these models are slope coefficients, which reflects the ratio of unconditional covariance of spot and futures prices to the unconditional variance of futures prices, however the optimal hedging requires the conditional moments, that is, based on the available information at the time of making hedging decision (Myers, 1991). Moreover, the fact is that the financial time series possesses salient features of time-varying patterns and volatility clustering (Engle, 1982; Bollerslev, 1986). Therefore, dynamic hedge ratios may be seem to be more appropriate and reliable than the conventional models (Myers, 1991; Kroner & Sultan, 1993; Floros & Vougas, 2004; Bhaduri & Durai, 2007; Gupta & Singh, 2007; Prashad, 2011**;** Tripathy, 2011). Some studies empirically tested hedge ratios and found that error correction methodology propounded by Engle and Granger (1987) may provide better hedge ratios and helps in variance reduction than the other models that are estimated through GARCH methodology.

The reason behind the same is that these models take into consideration the existence of long-run cointegration between the series (Kroner & Sultan, 1993; Floros & Vougas, 2004; Yang & Allen, 2004; Bhaduri & Durai, 2007; Yagauti & Kamaiah, 2012).

Thus, on the basis of above discussion, it can be stated that dynamic (time-varying) hedge ratio methodologies may be better in variance reduction than the constant hedge ratio models of estimating hedging efficiency. However, some studies viewed that constant hedge ratio methodologies are better in performance. Thus, The present study attempt to estimate the hedging efficiency of Indian gold futures market by using constant hedge ratio model of VECM and dynamic hedge ratio model of DVEC (GARCH), to analyse the existence of any difference between them.

OBJECTIVE OF THE STUDY

The primary objective of this study is to evaluate the hedging efficiency of Indian gold derivative market. Specifically, the study aims to estimate and compare the HE of the Constant Hedge Ratio Methodology and the Dynamic (time-varying) Hedge Ratio Methodology. The research will investigate whether any differences exist in the HE between these two approaches.

DATA

The study is based on secondary data, employs daily gold spot prices and gold futures prices (Derivatives) from the period 1st April 2005 till 31st March 2019 of Indian Market. The data has been extracted from the highest traded commodity exchange website, that is, Multi-Commodity Exchange of India.

METHODOLOGY

Johansen and Juselius (1990) test have been employed to examine the long run relationship between two series (gold spot and gold future prices). Since, both the series are found to be cointegrated in the long run (the result is available on the request), thus it implies that there exist valid error correction representations of the price series that include short term dynamics and long run information (Srinivasan, 2012). Now, the most appropriate strategy to examine the lead-lag relationship among the series is VECM. For this purpose, the causality between the series (Futures and spot prices) are estimated by using following VECM equations:

$$R_{St} = a_S + \sum_{i=1}^{p-1} \beta_{Si} r_{St-i} + \sum_{i=1}^{p-1} \lambda_{St} r_{Ft-i} + \alpha_S Z_{t-1} + \varepsilon_{St} \quad (1)$$

$$R_{Ft} = a_F + \sum_{i=1}^{p-1} \beta_{Fi} r_{St-i} + \sum_{i=1}^{p-1} \lambda_{Ft} r_{Ft-i} + \alpha_F Z_{t-1} + \varepsilon_{Ft} \quad (2)$$

Where a_F , a_s are intercept terms, β_{Fi}, β_{Si}, λ_{Ft}, λ_{St} are the short-run coefficients and $Z_{t-1}=S_{t-1}-\delta F_{t-1}$ is the error correction term with (1-δ) are cointegrating vectors.

Most of the financial time series, when taken on returns generally possesses heteroscedastic volatility that partly invalidates the estimation of hedge ratios and HE. Thus, a VEC multivariate GARCH model is employed to account for the autoregressive conditional heteroskedasticity, that is, (ARCH) effects in the residual series obtained from the VECM.

The ARCH model, as proposed by Engle (1982) further extended by Bollerslev (1986), not only examined the second moment of financial time-series but also generalised the model to best fit the situation under analysis. VEC-GARCH model captures the ARCH effects and assist in estimating a time-varying optimal hedge ratio. Thus, for estimating the hedge ratios, the univariate GARCH is generalised to multivariate M-GARCH, as specified in the following form:-

$$\begin{bmatrix} h_{ss} \\ h_{sf} \\ h_{ff} \end{bmatrix} = \begin{bmatrix} \alpha_{ss} \\ \alpha_{sf} \\ \alpha_{ff} \end{bmatrix} + \begin{bmatrix} \lambda_{11}\lambda_{12}\lambda_{13} \\ \lambda_{21}\lambda_{22}\lambda_{23} \\ \lambda_{31}\lambda_{32}\lambda_{33} \end{bmatrix} \begin{bmatrix} \varepsilon_s^2 \\ \varepsilon_s\varepsilon_f \\ \varepsilon_f^2 \end{bmatrix}_{t-1} + \begin{bmatrix} \gamma_{11}\gamma_{12}\gamma_{13} \\ \gamma_{21}\gamma_{22}\gamma_{23} \\ \gamma_{31}\gamma_{32}\gamma_{33} \end{bmatrix} \begin{bmatrix} h_{ss} \\ h_{sf} \\ h_{ff} \end{bmatrix}_{t-1}$$

Where h_{ss} and h_{ff} are the conditional variance of the errors ($\varepsilon_{s,t}\varepsilon_{f,t}$) from the mean equations and h_f is the conditional covariance of both the series i.e. spot and futures. In order to simplify the model from large number of parameters involved, Bollerslev et al., 1988, proposed a restricted model with only diagonal elements of matrix λ and γ are taken into account. The assumption of constant correlations between conditional variances has been taken. Conditional variances and covariances rely on their own lagged squared residuals and lagged values. The diagonal representations of the conditional variances elements h_{ss} and h_{ff} and covariance element h_{sf} is specified by Bollerslev et al. (1988) in the following way:

$$h_{sst} = \alpha_{ss} + \lambda_{ss}\varepsilon_{st-1}^2 + \gamma_{ss}h_{sst-1}$$

$$h_{sft} = \alpha_{sf} + \lambda_{sf}\varepsilon_{st-1}\varepsilon_{ft-1} + \gamma_{sf}h_{sft-1}$$

$$h_{fft} = \alpha_{ff} + \lambda_{ff}\varepsilon_{ft-1}^2 + \gamma_{ff}h_{fft-1}$$

Hence, the method involves a two-step procedure whereby firstly VECM is estimated and then the residuals obtained are used to account for the ARCH (γ) and GARCH (λ) effects present in the system.

The time-varying hedge ratio is computed by applying the following formula:-

$$h_t = \frac{h_{sft}}{h_{fft}}$$

Measuring the Hedging Effectiveness

The examination of the performance of any hedging strategy can be carried out with the help of determining its HE. For this purpose, unhedged position is constructed on the spot/cash market and hedged position is formulated with the combination of spot as well as future contracts. The hedge ratios helps in determining the number of future contracts needed for minimisation of risk, given a certain quantity of underlying asset. And the hedging effectiveness is estimated by the variance reduction in the hedged position compared to unhedged position. According to Baillie and Myers (1991), the returns on un-hedged and hedged positions are calculated as follows:

$$R_{unhedged} = S_{t+1} - S_t \quad R_{unhedged} = S_{t+1} - S_t$$

$$R_{hedged} = (S_{t+1} - S_t) - h^*(F_{t+1} - F_t)$$

Where $R_{unhedged}$ and R_{hedged} are the returns on un-hedged and hedged positions. S_t and F_t are logged spot and futures prices at time t and h* is optimal hedge ratio. In the similar manner, the variances of the un-hedged and hedged positions are estimated as follows:-

$$Var(u) = \sigma_s^2$$

$$Var(h) = \sigma_s^2 + h^2\sigma_f^2 - 2h^*\sigma_{s,f}$$

Where Var (u) and Var (h) are the variances of un-hedged and hedged positions. Here σ_s, σ_f and σ_{sf} are standard deviations of spot, future prices and covariance between spot and futures returns respectively. Ederington (1979) defined a measure of HE as the percentage reduction in variance of the hedged and un-hedged positions. The hedging effectiveness is calculated as

$$\frac{Var(u) - Var(h)}{Var(u)}$$

Empirical Analysis

Since the estimation of HE of the Gold spot and Gold future prices involves the estimation of the residuals from both the statistics of VECM Model and DVEC (GARCH) Model. Subsequently, hedge ratios as well as HE are calculated from both statistics from its estimated coefficients with the application of above stated formulas.

Table 1: VECM Estimates

Spot Prices Equation	Coefficients	Future Prices Equation	Coefficients
a_s	0.00025 (0.00012)	a_f	0.00037 (0.00016)
β_{s1}	0.67075 (0.0190)	β_{f1}	-0.00286 (0.02644)
β_{s2}	0.3474 (0.0231)	β_{f2}	-0.00611 (0.0320)
β_{s3}	0.1923 (0.0235)	β_{f3}	0.03162 (0.0326)
β_{s4}	0.1157 (0.0225)	β_{f4}	0.06453 (0.0312)
β_{s5}	0.04859 (0.0189)	β_{f5}	0.002015 (0.0262)
λ_{s1}	-0.4818 (0.0227)	λ_{f1}	0.02867 (0.0316)

Spot Prices Equation	Coefficients	Future Prices Equation	Coefficients
λ_{s2}	-0.2639 (0.02446)	λ_{f2}	-0.00528 (0.0339)
λ_{s3}	-0.1707 (0.02419)	λ_{f3}	-0.0329 (0.0335)
λ_{s4}	-0.0754 (0.0223)	λ_{f4}	-0.0248 (0.0309)
λ_{s5}	0.02334 (0.0150)	λ_{f5}	0.06433 (0.0208)
R^2	**0.421**	R^2	**0.0141**

Table 2: Optimal Hedge Ratio and Hedging Effectiveness from VECM Model

Variance(ε_s)	0.0000518
Variance(ε_f)	0.0000995
Covariance ($\varepsilon_s\varepsilon_f$)	0.0000426
h^*(Hedge Ratio)	0.428
Variance(H)	0.00003356
Variance(U)	0.0000518
Hedging Effectiveness	0.35210027

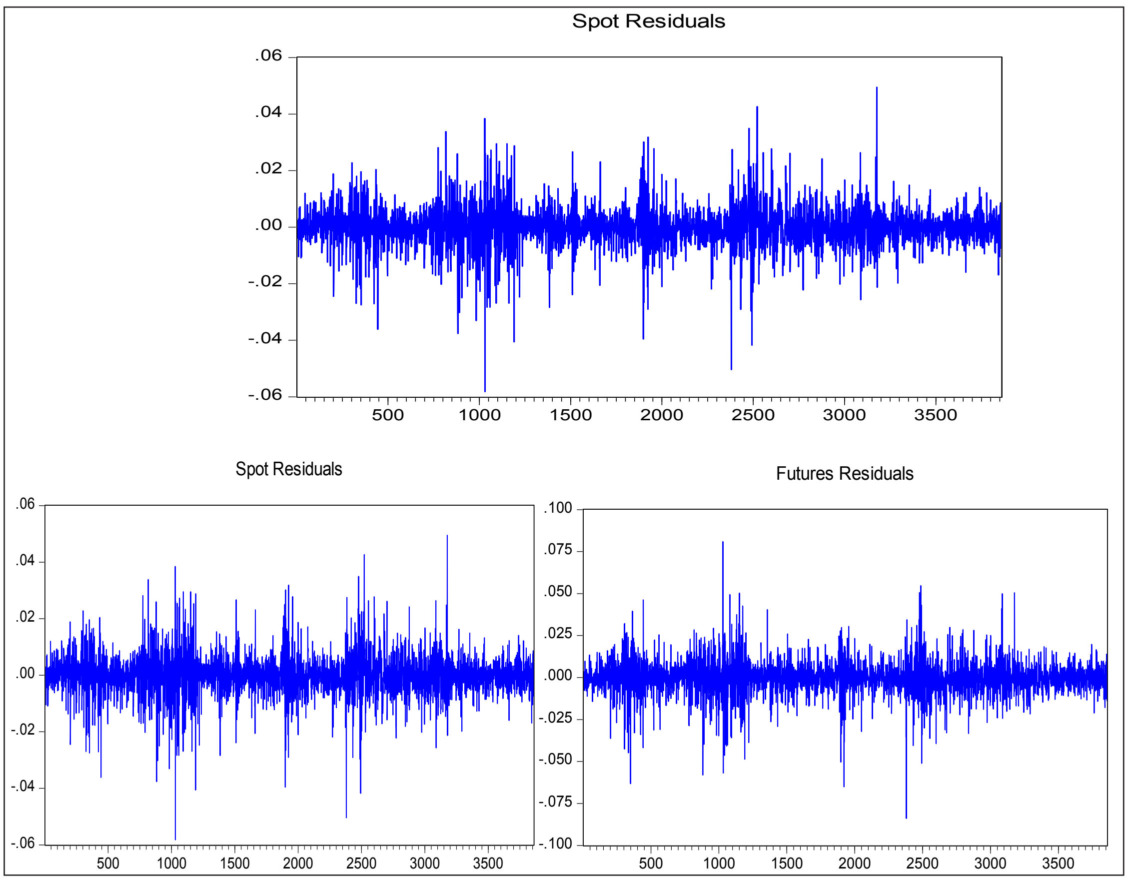

Fig. 1: Residual Series from Spot and Future Equation in VECM Model

Table 3: DVEC-GARCH Model Estimates

	Coefficients
α_{ss}	0.00000116 (0.000000122)**
α_{sf}	0.000000602 (0.00000007)**
α_{ff}	0.000000867(0.000000098)**
λ_{11}	0.046045(0.002475)**
λ_{22}	0.037479(0.002440)**
λ_{33}	0.081919(0.004547)**
γ_{11}	0.941530(0.002919)**
γ_{22}	0.942470(0.003380)**
γ_{33}	0.901821(0.004516)**

In the parentheses are the standard errors, ** denotes significance at 1 per cent level.

Table 4: Optimal Hedge Ratio and Hedging Effectiveness from DVEC-GARCH Model

Variance(ε_s)	0.000052
Variance(ε_f)	0.0000999
Covariance ($\varepsilon_s \varepsilon_f$)	0.0000429
h^* (Hedge Ratio)	0.429429429
Variance(H)	0.000033577
Variance(U)	0.000052
Hedging Effectiveness	0.354279279

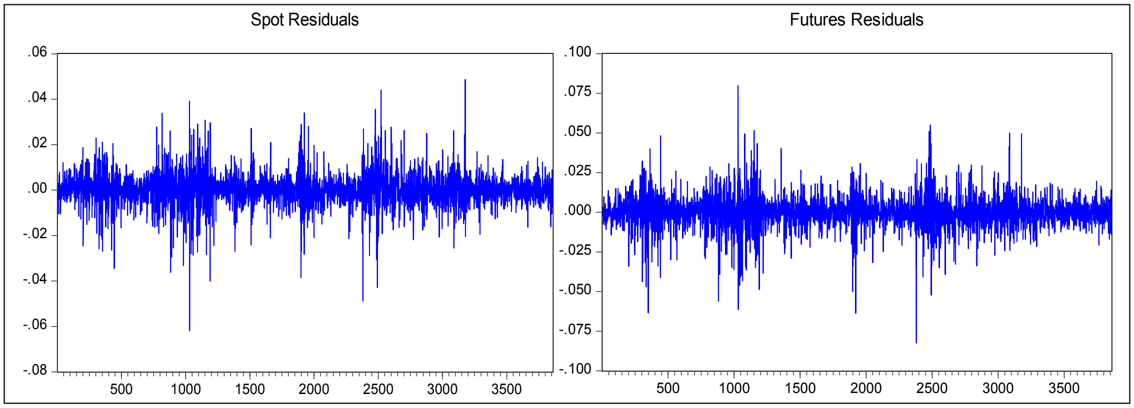

Fig. 2: Residual Series from Spot and Future Equation in DVEC-GARCH Model

Thus, the HE of the Indian gold market is estimated from the residuals series obtained from two models, that is, VECM as the Gold spot and Future prices are found to be coinegrated in the long run), a constant hedge ratio method and another one is DVEC (GARCH) where GARCH (1,1) is employed to account for volatility, being a time-varying (dynamic) hedge ratio methodology. On an analysis, the result reveals that the hedging efficiency of gold futures market is found out to be around 35 per cent from both the methodologies. Thus, it implies that no significant difference exit in HE from constant as well as dynamic hedge ratios. The study confirm to the findings of Yang and Allen, 2004; Choudhary, 2004; Kumar et al., 2008; Gupta and Singh, 2008. The reason behind low hedging efficiency might be due to the fact that gold itself is used as a hedge instrument and always in demand by the Indian investors for varied reasons (associated with weddings and ceremonies) as well as its availability in various forms (Gold ETFs and Gold Bonds issued by Government). The hedger's participation may be less as compared to speculators with respect gold future hedging. Despite the low hedging effectiveness, gold futures can be used as a tool of risk management by the traders.

Since, the analysis involve such huge time span of 14 years (2005 till 2019) in estimating the hedging role of gold derivatives, the phase-wise analysis is also conducted for the period, before the crisis (Phase I- 1st April 2005 to 30th Nov 2007), during the crisis accounting for Financial Crisis 2007–2009 and European Debt Crisis 2010–2012 (Phase II- 1st December 2007 to 30th December 2012) and after the crisis (Phase III- 1st January 2013 to 31st March 2019), to analyse the role of gold futures market as a tool of risk management in these different phases of its performance.

Phase-Wise Analysis

Table 5: VECM Estimates

	Coefficients of Spot Prices				Coefficients of Future Prices		
	Phase-I	**Phase-II**	**Phase-III**		**Phase-I**	**Phase-II**	**Phase-III**
a_s	0.00029 (0.0002)	0.0004 (0.0002)	0.00001 (0.0001)	a_f	0.00053 (0.0003)	0.0006 (0.0002)	0.00001 (0.0002)
β_{s1}	0.66905 (0.0432)	0.5552 (0.0492)	0.5246 (0.0264)	β_{f1}	0.00992 (0.0634)	0.07199 (0.0705)	-0.0469 (0.0366)
β_{s2}	0.26957 (0.0495)	0.33095 (0.0494)	0.2278 (0.0319)	β_{f2}	-0.0180 (0.0726)	0.0520 (0.0708)	-0.0339 (0.0442)
β_{s3}	0.2049 (0.0474)	0.20976 (0.0468)	0.0805 (0.0328)	β_{f3}	0.05617 (0.0695)	0.0555 (0.0671)	0.05575 (0.0454)

	Coefficients of Spot Prices				Coefficients of Future Prices		
	Phase-I	Phase-II	Phase-III		Phase-I	Phase-II	Phase-III
β_{s5}	-	0.13855 (0.0327)	-0.0530 (0.0275)	β_{f5}	-	0.1082 (0.0469)	-0.0812 (0.0381)
λ_{s1}	-0.3394 (0.0493)	-0.4136 (0.0500)	-0.3998 (0.0345)	λ_{f1}	0.0624 (0.0723)	-0.0549 (0.0716)	0.0782 (0.0478)
λ_{s2}	-0.2079 (0.0489)	-0.2751 (0.0485)	-0.1344 (0.0373)	λ_{f2}	0.00352 (0.0718)	-0.1028 (0.0695)	0.0862 (0.0516)
λ_{s3}	-0.1191 (0.0457)	-0.1839 (0.0449)	-0.1005 (0.0375)	λ_{f3}	0.0292 (0.0671)	-0.0650 (0.0644)	-0.0906 (0.0519)
λ_{s4}	-0.0257 (0.0284)	-0.1646 (0.0384)	0.0542 (0.0358)	λ_{f4}	-0.0677 (0.0417)	-0.1213 (0.0550)	0.07845 (0.0495)
λ_{s5}	-	0.01096 (0.0231)	0.0642 (0.0272)	λ_{f5}	-	0.0292 (0.0331)	0.09114 (0.0377)
R^2	0.5373	0.5172	0.2693	R^2	0.0254	0.0154	0.0375

Table 6: Phase-Wise Estimation of Hedging Efficiency (VECM Model)

	Phase-I	Phase-II	Phase-III
Variance(ε_s)	0.0000438	0.0000568	0.0000433
Variance(ε_f)	0.0000941	0.000117	0.0000829
Covariance (ε_s ε_f)	0.0000329	0.0000508	0.0000379
h^* (Hedge Ratio)	0.3496	0.4341	0.4571
Variance(H)	0.0000322	0.0000347	0.0000259
Variance(U)	0.0000438	0.0000568	0.0000433
Hedging Effectiveness	0.26262	0.38832	0.40016

Table 7: DVEC-GARCH Model

Coefficients	Phase-I	Phase-II	Phase-III
α_{ss}	0.00000134(0.0001)*	0.00000144(0.0000)*	0.00000171(0.0000)*
α_{sf}	0.00000101(0.0117)*	0.000000679(0.000)*	0.00000143(0.0000)*
α_{ff}	0.00000293(0.0000)*	0.00000109(0.0000)*	0.00000151(0.0000)*
λ_{11}	0.066033(0.0000)*	0.041987(0.0000)*	0.049703(0.0000)*
λ_{22}	0.046938(0.0041)*	0.037322(0.0000)*	0.055513(0.0000)*
λ_{33}	0.150033(0.0000)*	0.103553(0.0000)*	0.088774(0.0000)*
γ_{11}	0.920832(0.0000)*	0.942868(0.0000)*	0.929947(0.0000)*
γ_{22}	0.910237(0.0000)*	0.941578(0.0000)*	0.901621(0.0000)*
γ_{33}	0.781014(0.0000)*	0.880706(0.0000)*	0.876396(0.0000)*

* Significance at 1 per cent level.

Table 8: Phase-Wise Estimation of Hedging Efficiency (DVEC-GARCH Model)

	Phase-I	Phase-II	Phase-III
Variance(ε_s)	0.0000441	0.0000574	0.0000440
Variance(ε_f)	0.0000944	0.000118	0.0000834
Covariance ($\varepsilon_s\varepsilon_f$)	0.0000330	0.0000512	0.0000384
h^* (Hedge Ratio)	0.349576	0.433898	0.46043
Variance(H)	0.00003256	0.00003518	0.00002631
Variance(U)	0.0000441	0.0000574	0.0000440
Hedging Effectiveness	0.261587	0.38703	0.401831

Hedging with futures implies the reduction in risk of an investment by undertaking an offsetting position in futures market. The gold hedging effectiveness is carried out covering three different phases of market scenario to see how effective gold futures are as a risk managing vehicle. Before crisis (2005–2007), the hedging efficiency comes out to be 26 per cent, during the crisis (2008–2012) 38.7 per cent and after the crisis (2013–2018) 40 per cent estimated from both the static and dynamic hedge ratio models. The results showed that with the outbreak of Global Financial crisis in 2007–2009 and European debt crisis in 2010–2012 and thereafter, gold futures are increasing use as a risk management tool, but still at a low level. This may be due to the fact that Indian investors prefer to hold gold in other forms like Gold ETFs and Gold Sovereign Bonds or in physical form, to minimise the risk inherent in their portfolios. Thus gold itself is used as a protection instrument against the uncertainties.

CONCLUSION

This article has estimated the HE of the Indian Gold Derivative Market from both the statistics of Static hedge methodology of VECM and Time-Varying hedge methodoly of DVEC-GARCH, covering the time span of 1st April 2005 till 31st March 2019, to account for any difference existence in both. The result reveals the fact that HE from both the methodologies are found to be 35 per cent. The reason behind low hedging efficiency might be due to the fact that gold itself is used as a hedge instrument and always in demand by the Indian investors for varied reasons (associated with weddings and ceremonies) as well as its availability in various forms (Gold ETFs and Gold Bonds issued by Government). The hedger's participation may be less as compared to speculators with respect gold future hedging. Despite the low hedging effectiveness, gold futures can be used as a tool of risk management by the traders. As well as, the gold HE is also carried out covering three different phases of market scenario to see how effective gold futures are, as a risk managing vehicle. Before crisis (2005–2007), the hedging efficiency comes out to be 26 per cent, during the crisis (2008–2012) 38.7 per cent and after the crisis (2013–2018) 40 per cent estimated from both the static and dynamic hedge ratio models. The results showed that with the outbreak of Global Financial crisis in 2007–2009 and European debt crisis in 2010–2012 and thereafter, gold futures are increasing use as a risk management tool, but still at a low level.

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