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TESTING THE HEDGING EFFECTIVENESS OF INDIAN EQUITY AND CURRENCY FUTURES CONTRACTS

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Abstract *Hedging is widely used as a risk-minimizing mechanism where hedgers invest simultaneously in cash and futures market, but in opposite direction, so that the price change in one market offsets price change in another market. Present study attempts to examine the hedging effectiveness of equity and currency futures contracts traded at National Stock Exchange of India, over the period January 2011 to December 2018. The sample size consists of three benchmark indices of equity futures market (i.e. NIFTY50, NIFTYIT and BANKNIFTY) and four currency futures contracts (i.e. USD, EURO, YEN and GBP). Optimal hedge ratios have been estimated by using five different methods. The findings suggest that equity futures market is more efficient as compared to currency futures market as variance reduction is found to be more than 95% in case of equity futures contracts; whereas in case of currency futures contracts, it is found to be less than 40%. Secondly, it is also found that for six (out of seven futures contracts understudy), hedging effectiveness is found to be highest using Ordinary Least Square (OLS) method, whereas for only NIFTYIT, it is found to be highest using Vector Autoregression (VAR) and Vector Error Correction model (VECM) methods of estimating optimal hedge ratio. Hence, the study also suggests that constant hedge ratios perform superior to time-varying hedge ratios.*

Keywords: *Optimal Hedge Ratio, Hedging Effectiveness, Currency Futures, Equity Futures*

INTRODUCTION

The underlying strategy of hedging is to invest simultaneously in cash and futures market, but in opposite direction, so that the price change in one market offset the price change in another market. In other words, losses in one market are offset by the gains from the other. The essence of hedging is the presence of cost-of-carry relationship between cash and futures market, which allows co-movement of prices in both the markets. In the cost-of-carry regime, both cash and futures prices are tied together and the arrival of information in the financial market causes contemporaneous change in both spot and futures prices. Thus, existence of stable long-run relationship between spot and futures market is a pre-requisite for efficient hedging (Ederington, 1979).

There are three different views on hedging based upon investor's objective to hedge. The traditional theory assumes investor as a pure risk avoider; whereas, Working (1953) views hedger as a pure risk-taker speculating on the spread between futures and cash prices. The third theory adopts a hybrid approach and claims that a hedger neither purely avoids risk nor does he increase his risk to the highest levels. Instead, hedger prefers a portfolio that optimizes his level of risk and return. This theory, known as Portfolio Hedging Theory, became the most widely accepted framework for designing hedge strategy and the present study applies the same in realising its objectives.

The literature on estimation of optimal hedge ratio initiated with the proposal of Minimum-Variance Hedge Ratio (MVHR) framework suggested by Johnson (1960), Stein (1961) and Ederington (1979). Johnson (1960) and Stein (1961) proposed a theoretical background for estimating MVHR, known as Portfolio hedging theory, based upon which, Ederington (1979) suggested that MVHR can be estimated as the ratio of covariance of spot-futures returns and variance of futures returns. In this view, Ederington (1979) suggested single regression equation (Ordinary Least Square (OLS)) that regresses cash returns upon futures return for estimating optimal hedge ratio. Ederington's OLS is the most simplest of all models; therefore, is highly appreciated by a large body of literature (Malliaris & Urrutia, 1991; Deaves, 1994; Lien et al., 2002; Lien, 2005; Bhargava and Malhotra, 2007; Moon et al., 2009; Mandal, 2011; Bonga and Umoetok, 2016).

Apart from this, literature suggests a wide range of methodologies for estimating optimal hedge ratio to best fit

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the varied characteristics observed in the financial time-series from time to time. For instance, a number of studies observe that spot-future prices exhibit co-integrating relationship in the long-run (Ghosh, 1992; Chou et al., 1996) and lead-lag relationship in the short-run, therefore, suggests that optimal hedge ratio can be determined using VECM and VAR models, respectively. Nonetheless, numerous studies (Choudhary, 2004; Lee & Chien, 2010) claim superior performance of the time varying hedge ratio over its counterparts.

Furthermore, with the advancement of econometrics, highly improved procedures and models have been suggested by the literature for estimating optimal hedge ratios that capture the time-varying nature of relationship between spot and futures prices. Some of the widely used methods include GARCH, B-GARCH, M-GARCH, etc. Though, voluminous literature (see, Park & Switzer, 1995; Lypny & Powalla, 1998; Moschini & Myers, 2002; Choudhary, 2003; Floros & Vougas, 2004; Yang & Allen, 2004; Choudary, 2004; Floros & Vougas, 2006; Lee & Yoder, 2007; Srinivasan, 2011; Bekkerman, 2011; Kim et al., 2014; Basher & Sadorsky, 2016), observes superiority of time-varying hedge ratios over constant hedge ratios, a strand of literature (see, Lien, 2005; Bhargava and Malhotra, 2007; Maharaj et al., 2008; Rao and Thakur, 2008; Lee and Chien, 2010; Awang et al., 2014; Gupta and Kaur, 2015b; Kaur and Gupta, 2018c) observes superiority of constant hedge ratios over time-varying hedge ratios and suggests that econometric sophistication does not help to improve hedging effectiveness.

Further, Ederington (1979) suggested a measure of hedging effectiveness, based upon portfolio theory approach proposed by Johnson (1960) and Stein (1961), according to which hedging effectiveness is measured as proportionate reduction in standard deviation of returns from hedged portfolio. Ederington's measure to estimate hedging effectiveness is simple to compute and understand and, therefore, has been highly appreciated by various empirical studies (see, Park & Switzer, 1995; Holmes, 1995; Lypny & Powalla, 1998; Yang & Allen, 2004; Floros & Vougas, 2004, 2006; Bhargava & Malhotra, 2007; Bhaduri & Durai, 2008; Men & Men, 2008; Gupta & Singh, 2009; Pradhan, 2011; Hou & Li, 2013).

Apart from the above discussed issues, National Stock Exchange (NSE) of India holds a significant position in world's top derivatives exchanges as it is consistently being ranked among top-ten derivatives exchanges of the world in terms of trading of futures contracts since year 2011, and, presently, offers futures contracts on more than 190 securities and 9 indices, all of which observes voluminous trading. Further, in terms of trading of currency futures and options contracts, NSE became world's leading exchange in the year 2017. However, despite voluminous increase in the trading of currency futures contracts in India, there is dearth of literature examining the hedging effectiveness of futures contracts, especially currency futures contracts. To the best of researcher's knowledge, only one study (Lingareddy, 2013) attempts to examine the hedging effectiveness of currency futures contracts in India; whereas, most of the studies have restricted their scope to investigate the hedge effectiveness of either equity futures contracts or commodity futures contracts. Furthermore, debate on superiority of constant and time-varying hedge ratio models is not yet settled as, on the one hand, voluminous studies[1] support time-varying hedge ratio models; whereas, on the other hand, numerous studies[2] support constant hedge ratio models. Therefore, in the light of the above discussion following research questions arise:

Is currency futures market equally efficient as equity futures market in India?

Which optimal hedge ratio model generates most effective hedge ratio for both equity and currency futures contracts, whether constant or time-varying hedge ratio model?

Hence, in order to address the above-mentioned research issues, the present study attempts to contribute to the existing literature by examining hedging effectiveness of both currency as well as equity futures contracts in India.

DATABASE AND RESEARCH METHODOLOGY

The focus of the study is to investigate hedging effectiveness of futures contracts of equity and currency futures market in India. The sample of the study comprises of futures contracts on three benchmark equity indices namely NIFTY50, NIFTYIT and BANKNIFTY, being traded at NSE as well as futures contracts on four currencies namely, USD, GBP, YEN and EURO being traded at NSE. The data has been collected for near month futures contracts for a period of eight years from January 1, 2011 to December 31, 2018 from the website of NSE (www.nseindia.com). The sample stocks have been selected keeping in consideration their consistent trading and high liquidity.

[1] Park and Switzer (1995), Lypny and Powalla (1998), Moschini and Myers (2002), Choudhary (2003), Floros and Vougas (2004), Yang and Allen (2004), Choudary (2004), Floros and Vougas (2006), Lee and Yoder (2007), Srinivasan (2011), Bekkerman (2011), Kim et al. (2014) and Basher and Sadorsky (2016).

[2] Park and Switzer (1995), Holmes (1995), Lypny and Powalla (1998), Yang and Allen (2004), Floros and Vougas (2004, 2006), Bhargava and Malhotra (2007), Bhaduri and Durai (2008), Men and Men (2008), Gupta and Singh (2009), Pradhan (2011), Hou and Li (2013).

In order to obtain optimal number of futures contracts to hedge a given spot position, a wide range of models are available as discussed in section 2. However, as far as the present study is concerned, out of the models suggested by the literature, a total of five econometric procedures have been used for estimating optimal hedge ratio. These models are one-to-one naive model, standard OLS, Vector Autoregression (VAR), Vector Error Correction model (VECM) and Generalized Autoregressive Conditional Heterskedasticity (GARCH) as discussed below:

Research Methods for Estimating Optimal Hedge Ratio

- *Naïve Hedge Ratio*: The first is the naive or traditional one-to-one hedging model, which assumes that futures and cash market observes perfect correlation; therefore, optimal hedge ratio suggested by this model is one which implies equal investment in both futures and spot market.
- *Ordinary Least Squares (OLS) Method:* The second is OSL method, also known as single equation method in which cash market returns are regressed upon futures, returns to estimate optimal hedge ratio as given in equation (1). Suggested by Ederington (1979), this method is the most widely used for estimating OHR as discussed in section 2 and is specified as follows:

$$R_{s,t} = \alpha_0 + \beta_1 R_{f,t} + \mu_t \qquad (1)$$

  In the given regression equation (1), $R_{s,t}$ is the cash returns, $R_{f,t}$ is the futures return, α_0 is the intercept term, β_1 is the optimal hedge ratio and μ_t is the error term.
- *Vector Autoregression (VAR)*: Vector Autoregression overcomes the limitation of OLS regression equation (Equation 1) by modelling the serial correlation of residual series, which OLS fails to capture. VAR model can be specified as under:

$$R_{s,t} = \sum_{i=1}^{M} \alpha_i R_{s,t-i} + \sum_{j=1}^{N} \beta_j R_{f,t-j} + \mu_{st} \qquad (2)$$

$$R_{f,t} = \sum_{k=1}^{O} \alpha_k R_{s,t-k} + \sum_{l=1}^{P} \beta_1 R_{s,t-1} + \mu_{ft} \qquad (3)$$

  After running the given regression equations, optimal hedge ratio can be estimated as ratio of covariance of $\mu_{s,t}$ and variance of μ_{ft}. However, this model fails to capture the long-run cointegration between spot and futures prices.
- *Vector Error Correction Model (VECM):* Ghosh (1993) and Lien (2004) argue that when spot-future prices are cointegrated in the long-run, the OLS equation gives an underestimated value of the optimal hedge ratio. Therefore, VAR model with an error correction term (known as VECM) is used to account for long-run co-integrating relationship in addition to capturing short-run lead-lag relationship. The VECM model can be specified as below:

$$R_{f,t} = \alpha_{0f} + \sum_{i=1}^{p} \alpha_{if}(F_{t-i} - S_{t-i}) + \sum_{j=1}^{q} \beta_f R_{f,t-j} + \sum_{k=1}^{m} \beta_f R_{s,t-k} + \mu_{ft}. \qquad (4)$$

$$R_{s,t} = \alpha_{0s} + \sum_{i=1}^{p} \alpha_{is}(F_{t-i} - S_{t-i}) + \sum_{l=1}^{n} \beta_s R_{s,t-l} + \sum_{h=1}^{o} \beta_s R_{f,t-h} + \mu_{st} \qquad (5)$$

  The optimal hedge ratio using VECM can be estimated as ratio of covariance of ($\mu_{s,t}$) and variance of (μ_{ft}), as computed in case of VAR model above.
- *Generalized Autoregressive Conditional Heterskedasticity (GARCH):* In equation (1), if the variance of error term is constant,[3] the hedge ratio estimated through OLS method will be valid; however, vast amount of academic literature (Engle, 1982; Bollerslev, 1987; Myers, 1991; Park and Switzer, 1995; Floros and Vougas, 2004; Pattarin and Ferretti, 2004) has evidenced that stock returns are heteroscedastic in nature. Therefore, Autoregressive Conditional Heteroscedasticity (ARCH) model (Engle, 1982) generalized by Bollerslev (1986) called GARCH (p,q) in which conditional variance depends not only upon the squared residuals of the mean equation but also on its own past values. The GARCH (p, q) model is given by equation (6)

$$h_t = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_j h_{t-j} + \upsilon_t. \qquad (6)$$

Where, h_t is the conditional volatility, α_i is the coefficient of ARCH term with order i to p and βj is the coefficient of GARCH term with order j to q. The conditional volatility as defined in equation (4.3) is determined by three effects: namely, the intercept term (ω), the ARCH term ($\alpha_i \varepsilon^2_{t-i}$) and the forecasted volatility from the previous period called GARCH component ($\beta_j h_{t-j}$). Parameters ω and α should be higher than 0 and β_j should be positive in order to ensure

[3] Langrage Multiplier Test whose null hypothesis states that variance of error term is homoscedastic. Therefore rejection of null hypothesis will ask researcher to apply appropriate model out of GARCH family.

conditional variance (h_t) to be non-negative. Besides this, it is necessary that $\alpha_i+\beta_j\leq 1$, which secures the covariance stationarity of conditional variance.

Research Method for Estimating Hedging Effectiveness

After estimating the optimal hedge ratio(s) using the above-discussed econometric procedures, their effectiveness has been tested by using the measure suggested by Ederington (1979), where hedging effectiveness is measured as a proportionate reduction in the variance of hedged portfolio as compared to unhedged portfolio, as given below:

$$\text{Hedge effectiveness} = \frac{\text{Var (U) - Var (H)}}{\text{Var (U)}} \quad (7)$$

In the above equation,

Variance of Unhedged Portfolio [VAR (U)] = σ_s^2 and;

Variance of Hedged Portfolio [VAR (H)] = $\sigma_s^2 + h^{*2}\sigma_f^2 - 2h^*\sigma_{s,f}$

ANALYSIS AND INTERPRETATION

Preliminary Analysis

As the present study involves the analysis of financial time-series to achieve its objectives, the first step is to test the presence of unit-roots in the series. ADF unit-root test has been applied in three different forms (stationarity with only trend, with trend and intercept and without both) to check the stationarity of series. As expected, the price series was found to be non-stationary. Hence, price series is transformed by taking log of first difference of prices, and the resultant return series is found to be stationary[4] paving the way for further analysis.

Further, Table 1 reports the statistics of lower and higher moments of returns of spot and futures contract for all the seven futures contracts under study. All futures contracts show excess kurtosis and their coefficient of skewness is negative implying that the return series are leptokurtic in nature. These statistics indicate that the returns are not normal, which is further supported by Jarque-Bera test that rejects the null hypothesis that cash and futures market returns are normal.

[4] The results of ADF unit root test have not been reported in the paper, but are available on demand.

Table 1: Descriptive Statistics of Cash and Futures Returns

Market	Symbol	Variables	Count	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
Equity	NIFTY50	Futures	1980	0.000287	0.009970	-0.198879	4.939804	323.4868*
		Cash	1980	0.000287	0.009727	-0.197010	4.861382	298.6495*
	NIFTYIT	Futures	1980	0.000332	0.012448	-0.636017	12.02611	6854.814*
		Cash	1980	0.000331	0.012609	-0.700567	12.27489	7258.906*
	BANKNIFTY	Futures	1980	0.000422	0.014164	0.047986	5.424267	485.8635*
		Cash	1980	0.000421	0.013937	0.090758	5.432967	491.3110*
Currency	USD	Futures	1933	0.000229	0.004702	0.360850	7.786474	1887.187*
		Cash	1933	0.000231	0.005808	0.808434	104.9759	837769.7*
	GBP	Futures	1933	0.000129	0.006115	-0.774306	14.53845	10916.14*
		Cash	1933	0.000126	0.011456	0.506934	436.9271	15165496*
	YEN	Futures	1933	7.43E-05	0.007504	0.295561	6.466128	995.7742*
		Cash	1933	7.23E-05	0.008782	0.697715	67.21654	332291.7*
	EURO	Futures	1933	0.000207	0.009480	16.45255	533.9318	22790982*
		Cash	1933	0.000153	0.008311	0.551575	153.7850	1831303*

* Significant at 1% level of significance.

Optimal Hedge Ratio and Hedging Effectiveness

The estimation of optimal hedge ratio has been done using five hedging models proposed in the literature. These results are reported in Table 2. It is found that in case of all seven futures contracts, the optimal hedge ratio of one suggested by traditional naive hedging approach is the highest estimate; whereas optimal hedge ratio estimated by either OLS, VAR, VECM or GARCH model is lowest for all seven futures contracts. It implies that the cost of hedging using naïve hedge ratio is highest as compared to other optimal hedge ratio models. Another observable fact is that all the estimates of the OHR are very close to each other making it insignificant for investors to decide upon the model to be used for hedging, which confirms the findings of Yaganti and Kamiah (2012).

Table 2: Optimal Hedge Ratio of Equity and Currency Futures Contracts

Market	Symbol	Optimal Hedge Ratio				
		Naive	OLS	VAR	VECM	GARCH
Equity	NIFTY50	1^H	0.960812^L	0.9648321	0.9669077	0.978575
	NIFTYIT	1^H	0.999513	0.9994151	0.999079^L	0.999758
	BANKNIFTY	1^H	0.973164^L	0.9771773	0.9771728	0.987283
Currency	USD	1^H	0.651657	0.6255544^L	0.6283243	0.797373
	GBP	1^H	0.689781	0.6744763^L	0.6752571	0.858581
	YEN	1^H	0.736365^L	0.7477514	0.74758491	0.860067
	EURO	1^H	0.250565	0.2426034	0.2711070	0.228568^L

L = Lowest Optimal Hedge Ratio, H = Highest optimal hedge ratio

Further, using Variance Reduction Framework, the effectiveness of optimal hedge ratios obtained using five models applied in the study has been estimated and the results are shown in Table 3. A significant observation from these results is that OLS hedge ratio gives highest hedging effectiveness for six out of seven futures contracts (NIFTY50, BANKNIFTY, USD, GBP, YEN and EURO) under study. The exception to these results is NIFTYIT for which VAR and VECM model provide maximum variance reduction in hedged portfolio. These results imply that investors can use simple OLS model for estimating optimal hedge ratio instead of using time-varying models like GARCH, which are complex to understand.

Table 3: Variance Reduction in Equity and Currency Futures Contracts

	Symbol	Hedging Effectiveness				
		Naive	OLS	VAR	VECM	GARCH
Equity	NIFTY50	0.967358^L	0.969011^H	0.968990	0.968966	0.968662
	NIFTYIT	0.972648^L	0.972648^L	0.972649^H	0.972649^H	0.972648^L
	BANKNIFTY	0.976416^L	0.97718^H	0.977177	0.977172	0.976966
Currency	USD	0.198359^L	0.278045^H	0.277610	0.277698	0.264064
	GBP	0.107939^L	0.135422^H	0.135358	0.135364	0.127269
	YEN	0.344625^L	0.395523^H	0.395422	0.395424	0.384280
	EURO	-0.649344^L	0.081592^H	0.081513	0.081036	0.080970

L = Lowest Optimal Hedging Effectiveness, H = Highest Hedging Effectiveness

CONCLUSION

The sample of the study comprises of futures contracts on three benchmark equity indices namely NIFTY50, NIFTYIT and BANKNIFTY being traded at NSE as well as futures contracts on four currencies namely, USD, GBP, YEN and EURO being traded at NSE, chosen on the basis of high liquidity and consistent trading history. The data has been collected for near month futures contracts for a period of eight years from January 1, 2011 to December 31, 2018.

For estimating the optimal hedge ratio, five econometric procedures have been used including naive, ordinary least square, vector autoregression, vector error correction and generalized autoregressive conditional heterskedasticity model. The results of optimal hedge ratio suggest that the estimates of the OHR are very close to each other for all the seven futures contracts under study. It is an important finding for investors as it makes it insignificant for them to decide upon the model to be used for hedging. These findings are consistent with the findings of Yaganti and Kamaiah (2012).

Further, hedging effectiveness of the optimal hedge ratios have been estimated using variance-reduction framework of Ederington (1979) and the results suggest that simple OLS model performs best in providing highest hedging effectiveness as six out of seven futures contracts (namely, NIFTY50, BANKNIFTY, USD, EURO, GBP and YEN) favour OLS. In other words, the results indicate that the investors can reduce the variance of their hedged portfolio to the maximum extent by using OLS model for investing in cash and futures market. These results are consistent with the findings of Malliaris and Urrutia (1991), Deaves (1994), Lien et al. (2002), Lien (2005), Bhargava and Malhotra (2007), Moon et al. (2009), Mandal (2011) and Bonga and Umoetok (2016).

Overall, the findings of the study suggest that futures contracts in equity and currency market provide efficient platform for hedging; however, equity futures market is found to be comparatively more efficient as compared to currency futures market. Moreover, study also suggests that investors can use simple OLS model to achieve highest hedging effectiveness rather than using complicated time-varying models like GARCH.

The present study can be further extended to examine if other time-varying hedge ratio models like MGARCH, etc., can provide better hedging effectiveness as compared to constant hedge ratio models. Moreover, in future, research can be done to examine the hedging effectiveness of currency and equity futures markets of other countries as different countries have different market microstructure settings. Furthermore, hedging effectiveness of individual stock futures contracts may help to generalize the results of the present study.

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