Paper Should Investor invest in both future and spot market? : An Analysis through Optimal Hedge Ratio

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ABSTRACT

This study is to estimate optimal hedge ratio with the variables from Indian futures and spot market and also nineteen individual stock prices. Diagonal VEC-GARCH model is used for the period from June 2000 to June 2011. The Empirical results confirm that there is effective risk sharing and hedging processes in Indian futures market. It is also found that Indian futures and spot markets have strong causal relationship; which allows the trader to make perfect arbitrage process and hedge their risks.

Keywords : Hedge Ratio, Futures Market, Spot Market, Causal Relationship

JEL Classification Code: G190

1 INTRODUCTION

PRINCIPAL functions of futures market are price discovery, speculation, risk sharing and hedging (Johnson 1960, Silber 1985, Fortune 1989, Jahangir sultan et.al 2010). The cash market is playing a vital role by providing two benefits like long term capital appreciation and regular dividend income to its players. The futures market is the expectation of underlying cash market but its consistency cannot be predicted and the number of traders are different from spot market. The futures market encourages arbitragers, promotes investors and helps the hedgers to minimize the risk level of their investment by taking the opposite position in cash as well as futures market.

Hedgers use the futures market as means to avoid the risk associated with price changes in the underlying cash market. According to Hull (2003) hedge ratio is the ratio of the size of the position taken in futures contract to the size of exposure in cash market. It is very difficult to make a perfect hedge ratio in the time varying and more volatile market, in short, a perfectly correlated hedging instrument is not available in futures market.

Conventional view of hedging and hedge ratio estimated through regression is challenged by Holbrook (1953). He argues that the hedgers are basically risk lovers and the prime aim is to maximize profit and do not aim to minimize risk. The theory of maximization of profit is the prime motive of the hedgers is challenged and argued that the objective of hedging is to maximize the variance of the assets port folio held by the investor, Johnson (1960) and Edirington (1979). Further they argue that during 1980, researchers employed the traditional regression analysis assuming that the optimal hedge ratio is time variant.

The conventional approach for optimal hedge ratio is to regress historical cash prices, price changes or return on futures prices. The resulting slope coefficient is then used as the estimated optimal hedge ratio (Ederington 1979, Khal 1983, Myers 2000). There are two problems with the conventional regression approach to optimal hedge ratio estimation. The first problem is that it fails to take proper account of all of the relevant conditioning information available to the hedgers when they make their hedging decision (Myer and Thompson 1989) and the second is that it implicitly assumes that the covariance matrix of cash and futures prices and hence optimal hedge ratio are constant over time (Myers 2000).

The development of Generalized Autoregressive Conditional Heteroskedastic (GARCH) modeling techniques to deal with time varying volatility has generated interest on the empirical analysis on the effectiveness of dynamic hedging that allows the hedge ratio to be time varying (Jahangir Sultan 2010). The hedge ratio equal to the ratio of covariance between cash and futures prices to the variance of the futures price (Anderson et.al and Benninga 1984). GARCH model of Bollerslev (1986) provides a flexible and consistent framework for estimating time varying optimal hedge ratio, but requires non linear maximum likely estimator. The GARCH model represents a flexible specification for modeling time varying volatility in assets prices and maximum likely hood is an optimal approach to inferences. This model is having significant theoretical advantages over moving sample variances and covariance.

There are many studies which empirically revealed the disadvantages of different econometrics model for estimating optimal hedge ratio. Hedge ratio obtained from the regression methodology becomes biased one if there exists a cointegration relationship between the spot and futures return (Saumitra etal.2010). In this context Vector Error Correction model can be used to estimate the hedge

ratio as suggested by Kroner and Sultan (1993). These empirical methodologies are criticized due to the unconditional moment and the constant hedge ratio does not consider the fact that joint distribution of spot and futures prices varies over time (Cecchetti, 1988). A multivariate GARCH method developed by Bollerslev, Engle and Wooldridge (1988) is to be used to estimate the time varying hedge ratio by considering the conditional variance and covariance of spot and futures market return.

The risk reduction efficiency of Indian futures market is estimated through optimal hedge ratio by using Bivariate Diagonal Vector- GARCH model. Estimation of hedge ratio is a statistical process which involves regressing cash market return on futures market (Kapil Gupta et al, 2009).

The remaining part of the study is organized as follows: second part explains the review of literature, third section is depicting objectives and methodologies of the study, analysis and discussions are included in the fourth section and conclusion is in last part of the study.

2 REVIEW OF LITARATURE

Robert J. Myers (1991), Phil Holmes(1995), Manolis. G. Kavussanos and Nikos k. Nomikos (2000), Amir Alizadeh and Nikos Nomikos (2004), Paul Kofman and Patrict Mcglenchy (2005), Richard D.F.Harris and Jain Shen (2006),Olivia Ralevski (2008) estimate hedge ratio of different developing and developed markets by considering the time varying aspects of Market behavior.

Allan Hodgson and Okunev, Robert T. Daigler and Mark Copper (1998), Donald Lien & Yiu Kuen Tse (1999), Leigh .J. Maynard, Samhan Cock and Heath Hoagland (2001),In 2003, Narayan Y. Nayik and Prdeep K. Yadhav. Wayne Guay and S.P Kotari (2003), Norvald Instefjord (2005), Kevin Aretz, Sohneke M. and Bartram Gunter Dufey (2007) Donald Lien and Keshab Shrestha (2007) Anuradha, Sivakumar and Runa Sarkar (2008) made studies on the hedging effectiveness and the optimal hedge ratio for the different futures market by using different econometrics models.

Dimitris Bertsimas Leonid Kogm and Andrew .W. Lo (2001), Aaron Low, Jayaram Muthuswamy, Sudipto Sakar and Eric Terry (2002) suggested cost of carry model is the best method for the estimation of hedge ratio. They had used VECM, GARCH and Naïve models.

Donald Lien and Y.K Tse (2002), Sheng- Syan Chen, Cheng- Few Lee and Keshab Shrestha (2004), SVD Nageswara Rao and Sajay Kumar Thakur (2004), Abdulnasser Hatemi-J and Eduardo Roca (2006), Saumitra N. Bhaduri and S. Raja Sethu Durai (2008), Kapil Gupta and Balwinder Singh (2009), Haiang-Tai Lee (2009), Kuang-Liang Chang (2010) Ming-Yuan Leon Li (2010) suggested Bivariate GARCH model is the apt model to estimate the optimal hedge ratio. Ming- Chih Lee and Jui-Cheng Hug (2007) made an analysis on the hedging for multi period down side risk in the presence of jump dynamics and conditional heteroskedastisity.

It is found through literature, that optimal hedge ratio is determined during different study periods with different econometric models. This study aims to estimate optimal hedge ratio and assess the risk reduction efficiency of Indian futures market by applying DVEC- GARCH for the Nifty index futures and other 19 individual stocks from National Stock Exchange of India.

3 DATA AND METHODOLOGY

Nineteen individual companies who satisfy the conditions of being part of Nifty- 50 in the month of December 2010, have started its futures trading on the inception day 9th November 2001 and continuously trading from the beginning to the last date of the data period of the study 30th June 2011 are included in the study and they are listed

Insert Table No. 1

Near month daily closing prices of S&P CNX Nifty futures (FUTR) and its underlying spot prices (SPOTR) and underlying closing prices of nineteen individual stocks are included in the study. Bonus issues and Share splits responses are adjusted on the price series to avoid the unusual changes in the data series. Individual nineteen stock price series are transformed in to log form, then found the first difference to make it as a return series of Index Futures and Spot, Individual Stocks Futures (FUTR) and Spot (SPOTR).

The study takes care of ARCH effect on the residuals of the error correction model for which a Vector bivariate GARCH model of Bollerslev et al (1988) is employed. This econometric model simultaneously accommodates the conditional variance and covariance of two interact series. It is suggested that the time varying hedge ratio based on the conditional variance and covariance of spot and futures prices can be retrieved. Time varying hedge ratio is h_{sft} / h_{fft} .This study estimates the Diagonal VEC GARCH model of Bollersev et al (1988). The estimated results of the DVECV model specified in equation $h_{sst} = c_{ss} + \alpha_{11}\varepsilon^2_{st-1} + \beta_{11}h_{sst-1}$, $h_{fft} = c_{ff} + \alpha_{33}\varepsilon^2_{ft-1} + \beta_{33}h_{fft-1}$ are presented in the results of DVEC GARCH coefficient tables.

4.1. Period of the Study

Basically the study pertains to the period between 12th June 2000 and 30th June 2011. The period is divided in to four sub periods, 12th June 2000 to 28th February 2006 representing initial development of derivatives market in India, 1st March 2006 to 14th January 2008 representing pre financial crisis period, from 15th January 2008 to 31st October 2008 is a financial crisis period and 1st Novem-

ber 2008-30th June 2011 as a post financial crisis period. For individual stock, data from 9th November to 30th June is considered. The sub periods are divided based on the structural break identified in the index futures data set. It is done through Bai- Perron test and actual market movement.

4.2. Econometrics Model Used in the Study

Diagonal VEC-GARCH Model (DVEC- GARCH)

Bollerslev, Engle and Kraft have introduced a Diagonal Vector GARCH (DVEC-GARCH) Model in 1988.

By assuming $\varepsilon_t / \Omega_t \sim N(O, H_t)$ and by defining ht as Vech (Ht), which denotes the vector half operator that arrange the lower triangular elements of NxN matrix in to [N (N+1)/2] vector. The simplified Diagonal VECH GARCH (1,1) (DVEC GARCH) model, introduced by Bollerslev et al.(1988).

$$H_t = \begin{bmatrix} h_{ss,t} & 0 \\ h_{fs,t} & h_{ff,t} \end{bmatrix} = \begin{bmatrix} u_{ss} & 0 \\ u_{fs} & u_{ff} \end{bmatrix} + \begin{bmatrix} a_{ss} & 0 \\ a_{ff} & a_{ff} \end{bmatrix} \begin{bmatrix} e_{s,t-1}e_{s,t-1} & 0 \\ e_{f,t-1}e_{s,t-1} & e_{f,t-1}e_{f,t-1} \end{bmatrix} + \begin{bmatrix} b_{ss} & 0 \\ b_{fs} & b_{ff} \end{bmatrix} \begin{bmatrix} h_{ss,t-1} & 0 \\ h_{fs,t-1} & h_{ff,t-1} \end{bmatrix}$$

5.0 Analysis and Discussion

One of the important functions of futures market is hedging (Johnson 1960, Fortune 1989, Jahangir Sulthan 2008). Hedging is the process of taking opposite position in the futures market to protect the spot market asset which may lose its value due to the volatile behavior of the market. Conventional approach to hedging has problem as it fails to take the proper account of related conditioning information and assuming that hedge ratio are constant over time (Myer& Thompson 1989). Further, it is confirmed that for estimating hedge ratio, methodology based on ordinary least square may not be reliable (Kapil Gupta et. al 2009). Stocks returns are heteroskedastic in nature. So, ARCH model may be to obtain robust statistical estimation and it may capturer the stylized behavior of conditional volatility of market return. A bivariate GARCH methodology developed by Bollerslev, Engle and Wooldrige (1988) is used to estimate the time varying hedge ratio (Bhaduri et. al.2008).

5.1. Summary Statistics

Insert Table No. 2

Table No.2 shows the summary statistics of the variable included in the study for the index spot and futures and 19 individual companies spot and futures return series. S&PCNX Nifty futures return series and spot return series are taken for the analysis and mean, median, standard deviation, Skewness, kurtosis and Jarque- Bera measures results are presented in the table. Positive mean value of the returns of indices and most of the individual stocks in both markets may be due to the importance of the sample period. The spot market variable is negatively skewed and it is leptokurtic to the normal distribution and the Jarque-Bera test statistics shows that the distribution is not normal. Futures variable also shows the same behavior pattern and the JB test statistics does not accept the null hypothesis. The spot and futures variables of ACC, BHEL, CIPLA, GRASIM, HINDALCO, HINDUNILVR, INFOSYSTCH, RANBAXY, RELIANCE, RELINFRA, SBIN, TATA MOTORS, TATA STEEL, and TATA POWER are negatively skewed and for other companies like ITC, HDFC, AMBUJA and BPCL series are positively skewed. The negatively skewed indices and individual stocks implies that futures market is backwardation and offers significant arbitrage opportunities to traders (Vipul 2005).The spot value of the M&M is positively skewed and its futures value is negatively skewed. This negatively skewed variable provides important information connecting to the exploitation of arbitrage opportunities and establishment of equilibrium between the two markets. The kurtosis value of company's spot and futures values are leptokurtic to the normality. Jarque –Bera test statistics of all company variables indicate that there is no possibility to accept the null hypothesis and the probability value of JB test is also support the result.

5.2. Results of Stationarity Test

Table No.3 shows the results of stationary test of the variables included in the study period for sample companies and Nifty spot and futures. The return series of Nifty Spot and futures, ACC STOCK, AMBJUA CEMENT, BHEL, BPCL, CIPLA, GRASIM, HDFC, HINDULCO, HINDUNILIVR, INFOSYSTCH, ITC, M&M, RANBAXY, RELIANCE, SBIN, TATA MOTORS, TATA POWER and TATA STEEL are stationary in its level form. Augmented Dickey Fuller test and Philip Perron Unit root tests are supporting the results, variables are stationary. Stationarity shows the strong lead- lag relationship between spot and futures variables of the individual stocks and index. Existence of stationarity suggests, returns on both futures and spot market is significantly predictable. Stationary futures and spot market return suggest that information dissemination efficiency in Indian spot and futures market is weak and informed traders can frame market strategies to exploit arbitrage and speculative opportunities as they become available (Kapil Gupta, 2009).

Insert Table No. 3

The properties of the GARCH model suggest that the variables are in stationary form to reveals the ARCH effect properly. This result reveals that the all variables are having ARCH effect and it is possible to apply the bivriate D-VEC

GARCH model to estimate variance of spot return, variance of futures return and covariance of spot and futures return.

5.3. Results of Optimal Hedge Ratio by Using Diagonal Vec- Garch Model

Time varying hedge ratio is presented in the table No.4 with coefficients and its probabilities at 1% level of significance for each variable that is S&PCNX Nifty and other 19 individual companies. Variance and covariance of spot and futures return are estimated through Diagonal VEC- GARCH model. Time varying hedge ratio is determined by dividing the covariance by variance of futures. Average of this time varying hedge ratio is taken as optimal hedge ratio. The significant results of coefficients support to capture the dynamic time varying behavior of the variable. The estimated optimal hedge ratios are presented in table No.5.

Theoretically when optimal hedge ratio is 1, it is understood that there is a perfect protection for investors when they take opposite position in the futures market based on the underlying assets in the futures market. Table No.5 presents the optimal hedge ratio of variables included for the various study periods. It is found, during the whole study period starting from the introduction of derivatives in India, it is revealed that INFOSYSTECH provides opportunities to investors to protect their risk by taking less than one unit of spot in futures market. This company shows the exceptional risk protection behavior from other companies. TATA MOTORS too provide almost 100% protections. The difference between these two companies is that in INFOSYSTECH provides opportunities of holding lesser than one unit and where as in the case of TATA MOTORS, investor is expected to have equal number of units in futures market to protect the loss from spot market. Other companies except TATA POWER, needs to hold more number of units in futures market to reduce their risk from spot. In other words, futures market does not provide risk reduction opportunities to these investors due to its inherent nature of asset in spot market. The TATA POWER does not provide hedging opportunities to its investors. In order to understand the robustness of this result, efforts are made to determine optimal hedge ratio for various sub periods.

Soon after the introduction of derivatives in Indian market, it is found that INFOSYSTCH, ITC, and TATAMOTORS are providing high level of risk protection to investors through futures market. Investors of these companies are expected to have less than one unit of their holding in spot, in futures market to reduce their risk. RANBAXY and HINDUNILVR and its trading in futures markets helped the investors by investing equivalent number of units in futures market to reduce the risk. All other companies except TATA POWER provide adequate risk protection through futures market during the initial time of derivatives. Estimation results on optimal hedge ratio during introduction and development period shows almost same positions in all companies. In the case Nifty index, the optimal hedge ratio is almost same. While taking 1438 observations for each company and index separately. AIC, BHEL, CIPLA, HINDUNILVR, INFOSYSTCH, RANBAXY, SBIN and TATA STEEL show the increasing trend in its hedge ratio. While reducing the number of observations, the companies are showing more confidence in its risk reduction level. But AMBUJA, BPCL, HDFC, HINDALCO, M&M, RELIANCE, and TATA POWER are losing their power of risk reduction in very minimal level. INFOSYSTCH Company keeps its position in the same level that is above 1. During this period, ITC and TATAMOTORS are in the group of more than one. This group shows that in order to protect the risk of one unit spot asset, opposite sign of less than one unit position in futures market is enough. The integration between spot and futures assets of these companies very strong and the speed of adjustment to remove the equilibrium in the integrated market is very higher in the case of futures market of ITC and TATA MOTORS.

Pre- financial crisis period is another sub- study period which shows the bullish trend in the spot and futures market in India. This sub- period starts from March 2006 to January 2008. Even though there is bullish trend, it is more volatile. Compared to other two period, hedge ratio of index futures is lesser than first two periods. Hedge ratio of index futures is lesser than first two periods. Only 470 observations are taken for the estimation of optimal hedge ratio during this period. In the period before financial crisis, results find different situation. INFOSYSTCH provides greater opportunities of risk reduction through futures market, other companies except TATAPOWER to help investors through futures market. Significantly HDFC has gone up to protect the investor with equivalent units in futures market.

Insert Table No.4

In the case of ACC stock, level of variance reduction is lesser than the reduction in introduction and development period but it is higher than the whole study period. The results BHEL, BPCL, CIPLA, GRASIM, HINDUNILVR, ITC, M&M, RANBAXY, SBIN, TATA MOTORS and TATASTEEL shows decreasing trend in the hedge ratio. The risk reducing ability of futures market on these stocks is lesser while comparing the other period. According to the theory, if the market is more related through causal relationship, the possibility of hedging is also more.

Insert Table No. 5

During financial crisis period, the price moment of index futures and its spot are in stationary. There is no long term relationship between futures and spot market. The absence of cointegration between two markets in its price series may not provide any possibility to the hedgers to take long run position in the market. Vipul (2005) and Kapil Gupta (2009) find that existence of cointegration suggest even though both market may be in disequilibrium during the short run but such deviation are very quickly corrected through arbitrage process and the hedgers may take long run positions to hedge market risk to the maximum extend.

Financial crisis period shows an interesting phenomenon of TATA POWER showing higher level of risk protection un-

like the past. HDFC has improved their protection compared to previous period, with hedge rate crossing 1. INFOSYSTCH maintain its portion of higher risk protection to investors. Interestingly all companies show adequate risk protection but with minor reduction in the level of protection barriers HDFC and INFOSYSTCH. During the period the index futures hedging position is coming down than the whole period and introduction and development period, but higher than the pre- crisis period. The hedge ratio of ACC, HDFC, HINDALCO, RELINFRA and TATAPOWER is higher than the hedge ratio in other study period. Not only market trend, the external environment and many internal factors are also playing a role to maintain the standard position in the market. Hedge ratio of companies like AMBUJA, BHEL, GRASIM, HINDUNILVR, INFOSYSTCH, ITC, M&M, RANBAXY, RELIANCE, SBIN, TATAMOTORS and TATASTEEL are lesser than the pre- financial crisis period. But in the case of BPCL, and CIPLA, the hedge ratio is higher in crisis period than other periods. Making a conclusion on these results for those stocks may not be true due to the inconsistency in their risk managing capacity.

Post financial crisis period shows the long term integration between spot and futures market in India. Long term integrated markets give the opportunities to the hedgers to take long term hedging position to the maximum extent. During this period, the optimal hedge ratio of index futures is in better position than the other periods. Around 95% of the variance can be protected by hedging process of index futures. ACC, RELINFRA and TATAPOWER are showing instability in the market movement and the optimal hedge ratio of those companies are minimal than the hedge ratio during other periods. Remaining all companies except HDFC, HINDUNILVR, INFOSYSTCH and M&M are performing well in this period. M&M, HDFC, HINDUNILVR and INFOSYSTCH perform in extra ordinary manner that is these companies' optimal hedge ratio is above one. From this analysis, it is clear that time horizon is the one factor which influences the hedging efficiency of futures market. Not only time period, the movement of the market and the integrated relationship between both markets is also having their own role in the risk managing process of futures market in India.

Many studies, Saumitra et.al (2008), kapil Gupta et.al (209), Sheng-syan Chen et. al (2004), Robert Myers (2000), Jahangir Sultan et.al (2008), Guy-Hyenmoon (2007), Lagesh et.al (2009) make an attempt to estimate different econometrics model and found Diagonal Vector GARCH model gives high optimal hedge ratio than the other econometrics model. This study uses the D-VEC-GARCH model to estimate the optimal hedge ratio for different study period and find that the level of risk protection efficiency of futures market is varying due to the time horizon and market movement. The market movement is having effect on the hedging efficiency of futures market.

6 CONCLUSION

Optimal hedge ratio estimated through DVEC-GARCH for the whole study period shows that Index futures and individual stocks of all companies included in the study do reduce the risk of the assets in the spot market. Similar results are seen through the analysis of risk protection various sub periods. Therefore it is confirmed through empirical analysis that Indian Futures Markets is efficient to protect the investors when they hold asset in spot market.

REFERENCES

[1] 1.Alizadesh, A., & Nomikos, N. (2004). A Markov Regime switching Approach for Hedging stock indices. The Journal of Futures markets 24 , 649-674.

[2] 2. Aretz, K., Bartram, S. M., & Dufey, G. (2007). Why hedge rationales for corporate hedging and Value implications. The Journal of Risk Finance 8 , 434-449.

[3] 3. Bertsimas, D., Kogan, L., & Lo, A. W. (2001). Hedging Derivatives securities and imcompletes markets- An E- arbitrage approach. Operation Research 49,3 , 372-397.

[4] 4.Bhaduri, S. N., & Durai, R. S. (2008). Optimal Hedge Ratio and Hedging effectiveness of stock index futures evidence from India . Macroeconomics and Finance in Emerging market economics 1 , 121-134.

[5] 5.Chan, K. L. (2010). The Optimal value at risk hedging strategy under byvariate regime switching ARCH frame work. Applied Economics , 1-14.

[6] 6.Charness, J. M., & Koch, P. (2003). Measuring Hedging Effectiveness for FAST- 133Complience . Journal of Applied Corporate Finance 15,4 , 95-104.

[7] 7.Chen, S. -S., Lee, C. -F., & Shretha, K. (2004). An empirical analysis of the relationship between the hedge ratio and hedging hirizon- A simultaneous estimation of the short and long run hedge ratios. The Journal of Futures Markets 24 , 359-386.

[8] 8.Daigler, R. T. (1998). A futures duration convexity hedging method. The Financial Review 33 , 61-80.

[9] 9.Guay, W., & P, K. S. (2003). How much Do firms Hedge with derivatives. Journal of Financial Economics 70 , 423-461.

[10] 10.Gupta, K., & Singh, B. (2006). An examination of price discovery and hedging efficiency of equity futures markets. Working papers SSRN , 1-24.

[11] 11.Gupta, K., & Singh, B. (2009). Estimating the optimal hedge ratio in the Indian Equity Futures market. The IUP Journal of Financial Risk Management 6 , 39-98.

[12] 12.Harris, R. D. (2006). Hedging and Value at Risk . The Journal of Futures Market 26 , 369- 390.

[13] 13.Holmes, P. (1995). Ex ante Hedge Ratio and the hedging effectiveness of the FTSE-100 stock index futures contracts . Applied Economics Letters 2 , 56-59.

[14] 14.Instefjord, N. (2005). Risk and Hedging, Do credit derivatives increases bank risk ? Journal of Banking and Finance 29 , 333-345.

[15] 15.J, A. N., & Roca, E. (2006). Calculating the Optiamal Hedge Ratio Constant, Time Varying and the Kalman Filter Approach. Applied Economics Letter 13 , 293-299.

[16] 16.Jones, R. A., & Perignon, C. (2009). Derivatives clearing and systematic risk. Working papers SSRN , 1-40.

[17] 17. Kaussanos, M. G., & Nomikos, N. K. (2000). Futures hedging when the structure of the underlying assets changes- The case of the BISFEX contacts. The Journal of Futures Markets 20,8 , 775-801.

[18] 18.Kavussanos, M. G., & Visvikis, I. D. (2008). Hedging effectiveness of the Athens Stock Index Futures contracts. The Eropean Journal of Finance 14 , 243-270.

[19] 19.Kenourgios, D., Samitas, A., & Drosos, P. (2008). Hedge ratio estimation and hedging effectiveness- The case of S&P 500stock index futures contracts. International Journal of Risk assessment and management 9 , 121-134.

[20] 20.Lee, M. C., & Hung, J. -C. (2007). Hedging for Multiperiod down side risk in the presence of jump dynamics and conditional heteroskedasticity. Applied Economics 39 , 2403- 2412.

[21] 21.Li, M. Y. (2010). Dynamic hedge ratio for stock index futures - Application of thresh hold VECM. Applied Economics 42 , 1403-1417.

[22] 22.Lien, D., & Shrestha, K. (2007). An empirical analysis of relationship between Hege Ratio and Hedging Horizon Using Walvet Analysis . The Journal of Futures Markets 27 , 127-150.

[23] 23.Lien, D., & Tse, Y. K. (1999). Fractional Cointegration and Futures hedging . The Journal of Futures Markets 19,4 , 457-474.

[24] 24.Lien, D., & Tse, Y. K. (2002). Some recent development in Futures Hedging. Journal of Economic Survey 16,3 , 357-396.

[25] 25.Low, A., Muthuswamy, J., Sarkar, S., & Terry, E. (20023). Multiperiod Hedging with Futures Contracts . The Journal of Futures Markets 22,12 , 1179-1203.

[26] 26.Maynard, L. J., Hancock, S., & Hoagland, H. (2001). Performance of Shrimp Futures markets as price discovery and hedging mechanism . Aquaculture Economics and Management 5 , 115-128.

[27] 27.Moon, G. H., Yu, W. C., & Hong, C. H. (2008). Dynamic hedging perfomance with the evaluation of Multivariate Garch models- Evidence from KOSTAR index futures . Working papers series SSRN , 1-19.

[28] 28.Myers, R. J. (1991). Esimating Time varying Optimal Hedge Ratios on Futures Markets. The Journal of Futures markets 20,1 , 73-87.

[29] 29.Naik, N. Y., & Yadav, P. K. (2003). Risk Management withDerivatives by dealers and market quality in Govt. bond markets. The Journal of Finance 58 , 1873-1904.

[30] 30.Ralevski, O. (2008). Hedging in the art market, creating art derivatives. Working Papers Series SSRN , 1-58.

[31] 31.Rao, N., & Thakur, S. K. (2004). Optimal hedge ratio and Hedging Efficiency- An empirical efficiency of hedging in Indian derivatives markets. Working Papers Series , 1-23.

[32] 32.Speight, A. E., Millan, D. G., & Gwilym, O. A. (2000) Intraday Volatility Components on FTSE-100 Stock Index futures . The Journal of Futures Markets 20,5 , 425-444.

[33] 33.Sultan, J., & Hasan, M. S. (2008). The effectiveness of dynamic hedging- Evidence from selected European stock index futures. The European Journal of Finance 14 , 469- 488.

[34] 34.Yang, W., & Allen, D. E. (2004), Multivariate GARCH Hedge Ratio and Hedging Effectivenes in Australian Futures Markets . Accouting and Finance 45 , 301-321.

TABLE NO. 1

LIST OF INDIVIDUAL STOCKS INCLUDED IN THE SAMPLE OF THE STUDY

ACC	BHEL.	CIPLA	GRASIM	HINDALCO	RELINFRA	RELIANCE
SBIN	TATA POWER	TATA MOTORS	TATA STEEL	BPCL	INFOSYSTCH	ITC
	M&M	HDFC	AMBUJA	HINDUNILVR	RANBAXY	

TABLE NO. 2

SUMMARY STATISTICS OF NIFTY AND NINETEEN SAMPLE COMPANIES INCLUDED IN THE STUDY

Name of stock	Variables	Mean	Median	SD	Skewness	Kurtosis	Jarque-Bera	Obser:
Nifty	Spot	0.000495	0.001329	0.016607	-0.301831	11.09207	7577.775*	2762
	Future	0.000491	0.000994	0.017515	-0.47349	12.01075	9447.236*	2762
ACC	Spot	0.000776	0.000685	0.023057	-0.320418	6.774148	1468.540*	2405
	Future	0.000784	0.000758	0.023555	-0.335877	7.000946	1649.311*	2405
AMBU-JA	Spot	0.000733	0.000449	0.023395	0.020050	6.133366	984.0048*	2405
	Future	0.000729	0.000305	0.023866	0.016770	6.430821	1179.618*	2405
BHEL	Spot	0.001377	0.000536	0.024812	-0.052966	9.561382	4315.267*	2405
	Future	0.001376	0.000844	0.025130	-0.161757	14.06017	12268.70*	2405
BPCL	Spot	0.000553	-0.00017	0.026681	0.092210	7.717315	2233.350*	2405
	Future	0.000553	0.000000	0.026946	0.240545	9.764555	4608.647*	2405
CIPLA	Spot	0.000564	0.000219	0.020239	-0.259639	7.991588	2523.807*	2405
	Future	0.000562	0.000202	0.020290	-0.277101	8.683949	3268.236*	2405
GRASIM	Spot	0.000828	0.000265	0.022462	-0.277591	11.84225	7865.711*	2405
	Future	0.000826	0.000000	0.022948	-0.235351	11.28255	6896.566*	2405
HIN-DALCO	Spot	0.000434	0.000772	0.028023	-0.304236	7.565782	2126.081*	2405
	Future	0.000442	0.000268	0.028152	-0.277332	7.409839	1979.549*	2405
HINDU-NILVR	Spot	0.000192	-0.00019	0.019861	-0.130442	6.351571	1132.463*	2405
	Future	0.000194	-0.00021	0.019584	-0.220085	6.732820	1415.713*	2405
INFO-SYSTCH	Spot	0.000854	0.000384	0.023241	-0.946080	18.66360	24944.73*	2405
	Future	0.000854	0.000542	0.022546	-0.929727	18.78411	25312.21*	2405
ITC	Spot	0.000871	0.000202	0.019475	0.152169	5.612825	693.3890*	2405
	Future	0.000869	0.000322	0.019204	0.050204	5.790889	781.5392*	2405
M&M	Spot	0.001449	0.001120	0.026787	0.229725	8.577260	3138.216*	2405
	Future	0.001451	0.001356	0.026662	-0.007129	6.994552	1598.989*	2405
RAN-BAXY	Spot	0.000470	0.000635	0.024983	-0.103443	12.44633	8946.196*	2405
	Future	0.000467	0.000831	0.025507	-0.524192	15.79685	16520.20*	2405
RE-LIANCE	Spot	0.000797	0.001012	0.023386	-0.324432	10.71934	6013.423*	2405
	Future	0.000795	0.001282	0.023501	-0.362376	10.93291	6358.856*	2405
RELIN-FRA	Spot	0.000430	-0.00023	0.031741	-0.281082	10.49668	5663.406*	2405
	Future	0.000435	0.000000	0.032287	-0.371236	9.935087	4874.805*	2405
SBIN	Spot	0.001034	0.001074	0.024394	-0.072449	7.143257	1722.338*	2405
	Future	0.001033	0.000994	0.025055	-0.117632	7.741830	2258.726*	2405
TATA-MOTO	Spot	0.000993	0.001087	0.028382	-0.165894	6.870223	1512.015*	2405
	Future	0.000997	0.000978	0.028367	-0.254729	7.211746	1803.584*	2405
TATAS-TEEL	Spot	0.001121	0.001597	0.030066	-0.289095	6.388758	1184.260*	2405
	Future	0.001118	0.001270	0.030518	-0.293943	6.272272	1107.640*	2405
HDFC	Spot	0.000968	0.000000	0.024959	0.414236	7.828089	2404.680*	2405
	Future	0.000961	0.000000	0.024512	0.483965	9.482824	4305.340*	2405
TATA-POWER	Spot	0.000984	0.001050	0.030336	-0.649138	91.53869	785711.9*	2405
	Future	0.000981	0.000810	0.030828	-0.548841	87.91496	722678.1*	2405

**denotes significance of Jarque –Bera test value*

TABLE NO.3

RESULTS OF STATIONARITY TESTS OF THE VARIABLES INCLUDED IN THE STUDY.

Stock	**Variables**	**ADF**	**PP**
Nifty	Spot	-12.45741**	-48.67637**
	Future	-12.52330**	-51.13509**
ACC	Spot	-35.02677**	-47.12683**
	Future	-35.15612**	-47.56897**
AMBUJA	Spot	-36.32088**	-50.42023**
	Future	-36.35220**	-51.10561**
BHEL	Spot	-22.19032**	-45.94265**
	Future	-22.12670**	-46.41972**
BPCL	Spot	-47.73851**	-47.73831**
	Future	-47.22247**	-47.20565**
CIPLA	Spot	-22.11433**	-48.09884**
	Future	-22.09582**	-47.70283**
GRASIM	Spot	-8.723311**	-47.37496**
	Future	-8.692334**	-47.63018**
HDFC	Spot	-23.54333**	-47.64170**
	Future	-23.31610**	-47.38351**
HINDALCO	Spot	-17.98697**	-44.82432**
	Future	-45.59273**	-45.56088**
HINDUNILIVR	Spot	-48.69948**	-48.87262**
	Future	-48.82641**	-48.91272**
INFOSYSTCH	Spot	-22.42255**	-48.01793**
	Future	-21.99945**	-47.42749**
ITC	Spot	-30.41886**	-50.47789**
	Future	-30.19178**	-50.29118**
M&M	Spot	-7.843338**	-43.42763**
	Future	-43.45085**	-43.24694**
RANBAXY	Spot	-13.68568**	-47.00020**
	Future	-13.70522**	-47.37672**
RELIANCE	Spot	-11.74149**	-46.31071**
	Future	-11.74448**	-46.83024**
RELINFRA	Spot	-35.59358**	-46.90684**
	Future	-35.51483**	-47.35364**
SBIN	Spot	-17.33125**	-45.36178**
	Future	-17.41861**	-46.48320**
TATAMOTORS	Spot	-9.651064**	-44.67444**
	Future	-9.590744**	-44.97826**
TATAPOWER	Spot	-29.79310**	-46.23649**
	Future	-35.98367**	-46.58405**
TATASTEEL	Spot	-14.19696**	-45.60048**
	Future	-14.14920**	-46.78940**

AIC CRITERION IS USED TO SELECT LAG LENGTH, ** DENOTES THE 5 % LEVEL OF SIGNIFICANCE.

Table No.4

ESTIMATION OF COEFFICIENTS OF DIAGONAL VECTOR GARCH MODEL FOR THE VARIABLES INCLUDED IN THE STUDY

	S&P CNX Nifty	ACC-stock	AMBUJA	BHEL	BPCL	CIPLA	GRASIM
Css	8.00000106***	1.00000355***	2.00000755***	2.00000635***	3.000006405***	6.00000615***	3.00000095***
Csf	8.00000256***	1.00000315***	2.00000665***	2.00000565***	3.00000535***	6.00000695***	3.00000025***
Cff	8.00000746***	1.00000345***	2.00000795***	2.0000605***	3.00000485***	6.00000915***	3.00000115***
α_{11}	0.102274***	0.079368***	0.093681***	0.102468***	0.105195***	0.120617***	0.10831***
α_{22}	0.100559***	0.080067***	0.094306***	0.104844***	0.108521***	0.121463***	0.106942***
α_{33}	0.101947***	0.081801***	0.095132***	0.110179***	0.113238***	0.125748***	0.10679***
β_{11}	0.861531***	0.899326***	0.855724***	0.846667***	0.862894***	0.727855***	0.825311***
β_{22}	0.863295***	0.899822***	0.855905***	0.845779***	0.861598***	0.721287***	0.827493***
β_{33}	0.862612***	0.899184***	0.856086***	0.842644***	0.860304***	0.714778***	0.82823***
	HDFC	**HINDALCO**	**HINDUNILIV**	**INFOSYSTCH**	**ITC**	**M&M**	**RANBAXY**
Css	9.00000326***	1.00000875***	3.00000865***	3.00000175***	2.00000215***	2.00000055***	7.00000186***
Csf	8.00000786***	1.00000785***	3.00000225***	2.00000915***	2.00000245***	2.00000115***	6.00000436***
Cff	8.00000756***	1.00000785***	2.00000745***	2.00000775***	2.00000355***	2.00000175***	5.00000086***
α_{11}	0.068947***	0.096837***	0.074797***	0.094198***	0.08358***	0.072215***	0.043574***
α_{22}	0.067457***	0.096625***	7.00000152***	0.094745***	0.085134***	0.068743	0.037705***
α_{33}	0.066646***	0.097277***	7.00000162***	0.096709***	0.091797***	0.067417	0.032378***
β_{11}	0.918055***	0.878109***	8.00000241***	0.846234***	0.858839***	0.896857	0.944459***
β_{22}	0.91943***	0.8791***	0.839887***	0.847892***	0.853526***	0.897052	0.950155***
β_{33}	0.920095***	0.879074***	0.854683***	0.847858***	0.844685***	0.897217	0.958019***
	RELIANCE	**RELINFRA**	**SBIN**	**TATAMOTOR**	**TATAPOWER**	**TATASTEEL**	
Css	1.00000595***	1.00000885***	2.00000195***	2.00000585***	5.00000045***	5.00000105***	
Csf	1.00000595***	1.00000865***	2.00000135***	2.00000535***	9.00000595***	5.00000055***	
Cff	1.00000635***	1.00000895***	2.00000155***	2.00000575***	1.00000874***	5.00000125***	
α_{11}	5.00000642***	0.093787***	0.072415***	0.086867***	6.00000661***	0.108435***	
α_{22}	0.057561***	0.09159***	0.072207***	0.087398***	0.765891***	0.105733***	
α_{33}	0.058846***	0.089529***	0.073286***	0.089339***	0.881349***	1.00000061***	
β_{11}	0.906506***	0.886396***	0.883743***	0.879492***	0.587844***	8.00000171***	
β_{22}	0.905094***	0.888528***	0.88541***	0.878516***	0.462797***	8.00000201***	
β_{33}	0.903531***	0.890665***	0.885381***	0.876592***	0.364223***	8.00000211***	

*Tranformed Variance Coefficients are in the table . *** denotes the level of significance at 1%.*

TABLE NO.5

OPTIMAL HEDGE RATIO BY USING DIAGONAL VECH-GARCH MODEL FOR THE STUDY PERIOD

Name of the Stock index	Whole period	Development period	Pre crisis period	Crisis period	Post Crisis period
Nifty	0.937894	0.944198051	0.911600846	0.929115267	0.945537136
ACC	0.950186	0.967175347	0.961006824	0.973717717	0.907437193
AMBUJA	0.944978	0.938015245	0.954357137	0.947992571	0.948820623
BHEL	0.978125	0.979267594	0.976894076	0.971930578	0.978983074
BPCL	0.974500	0.96767739	0.966338893	0.974118484	0.991677448
CIPLA	0.985105	0.986143998	0.982182697	0.98244529	0.986282027
GRASIM	0.959405	0.969632014	0.946783925	0.941140596	0.95708331
HDFC	0.988863	0.964494881	0.994655942	1.014605369	1.017095595
HINDALCO	0.972761	0.958702891	0.981257318	0.985008088	0.986140712
HINDUNILIR	0.987830	0.994026517	0.968663192	0.951460927	1.002251497
INFOSYSTECH	1.027416	1.028242092	1.032204585	1.002535492	1.030093172
ITC	0.994635	1.002723	0.989326	0.963676	0.994409
M&M	0.986656	0.982533359	0.983327547	0.96830985	1.001321282
RANBAXY	0.977113	0.997362569	0.978466448	0.901458957	0.965510129
RELIANCE	0.985415	0.985014988	0.986432931	0.976294226	0.988079686
RELINFRA	0.949013	0.926384746	0.951965174	0.985145163	0.973297972
SBIN	0.969646	0.971969209	0.958834601	0.936367562	0.98353555
TATAMOTORS	0.992922	1.005493088	0.980496364	0.949655646	0.994099798
TATAPOWER	0.848979	0.841087557	0.851714346	0.987864321	0.8183617
TATASTEEL	0.971686	0.972285994	0.971544682	0.964016258	0.973097966