Estimating the Optimal Hedge Ratio in the Indian Equity Futures Market

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Abstract:

The present study attempts to suggest an optimal hedge ratio for Indian traders through the examination of three indices (namely; Nifty, BankNifty and CNXIT) and eighty four most liquid individual stock futures traded on National Stock Exchange of India, over the sample period Jan. 2003 to Dec. 2006. The present study compares the efficiency of hedge ratios estimated through OLS, GARCH (p,q), TARCH (p,q), EGARCH (p,q), VAR and VECM in the minimum variance hedge ratio framework as suggested by Ederington (1979). Findings of the present study confirm the theoretical properties of futures markets and suggest that unconditional hedge ratio after controlling for basis risk, outperform the conditional hedge ratio. Results favour the hedge ratios estimated through VAR or VECM because both markets are cointegrated in Engle and Granger (1987) framework and these findings are consistent with Alexander (1999).

Key Words: Basis Risk, Conditional Heteroscedasticity, Error Correction, Volatility Clustering, Cointegration and Information Transmission.

JEL Classification: C13, C22, C32, D81, D82, G12, G14, N25 and O16.

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Section I: Introduction

Existence of organized futures markets furnish legitimate traders to hedge non diversifiable risk element contained in their portfolio and help the informed market participants to speculate on the basis risk in order to secure risk free profit, which is offered as a reward to restore market equilibrium. The reward to restore market equilibrium arises due to noise trading by uninformed market agents, which induces information asymmetry and the underlying asset starts trading at disequilibrium price, resulting into jump in the basis risk (Cox (1976), Danthine (1978), Carlton (1984), Hodgson and Nicholls (1991), Castelino (1992), Mckenzie et al., (2001), Chatrath et al., (2003) and Illueca and Lafuente (2003)). Whereas, informed trading by market agents is expected to bring fairness in price change of the underlying asset and help it to stabilize, consequently the required rate of return will decline (Bessembinder and Seguin (1992) and Gulen and Mayhew (2000)). Therefore, an organized futures market would be a joint product, where portfolio risk insurance is furnished to hedgers, gambling to speculators and arbitrageurs undertake the responsibility to restore market equilibrium (Telser (1981)).

Academic literature has widely appreciated the information transmission role of futures markets, which implies that price movement in futures market can be efficiently used to price the cash market transactions (Cox (1976), Peck (1976), Telser (1981), Garbade and Sibler (1983b) and Carlton (1984)). Since both markets are linked through arbitrage process (see, Garbade and Sibler (1983b) and Mackinlay and Ramaswamy (1988)), therefore convergence of both markets on the maturity date is natural (see figure 1) however in the short-run both may move away from each other[3].

[3] Carlton (1984) while explaining the contributions of organized futures markets mentioned that futures markets perform the role of price discoverer, helps in transferring risk involved in the portfolio, improves liquidity in the underlying asset market and help in improving the price discovery efficiency of the underlying asset market. Carlton (1984) further mentioned that prediction of cash market through futures market may sometime attract uninformed traders in the market who makes noise and deteriorates the pricing efficiency. Whereas at the same time, joint action of arbitrageurs and speculators in the market will help in restoring the equilibrium.

Efficient information exchange role of the futures market and strong and stationery comovement between two markets[4] provides an important input for hedgers to transfer risk contained in their portfolio to the speculator's portfolio[5]. Hedging through futures market has different connotations due to varied portfolio objectives of traders, therefore different hedging theories persist viz; conventional hedging theory, Working's hedging theory, Portfolio hedging theory etc. (for example see Ederington (1979), Howard and D'Antonio (1984), Castelino (1992), Pennings and Leuthold (2000) and Lien and Tse (2002)).

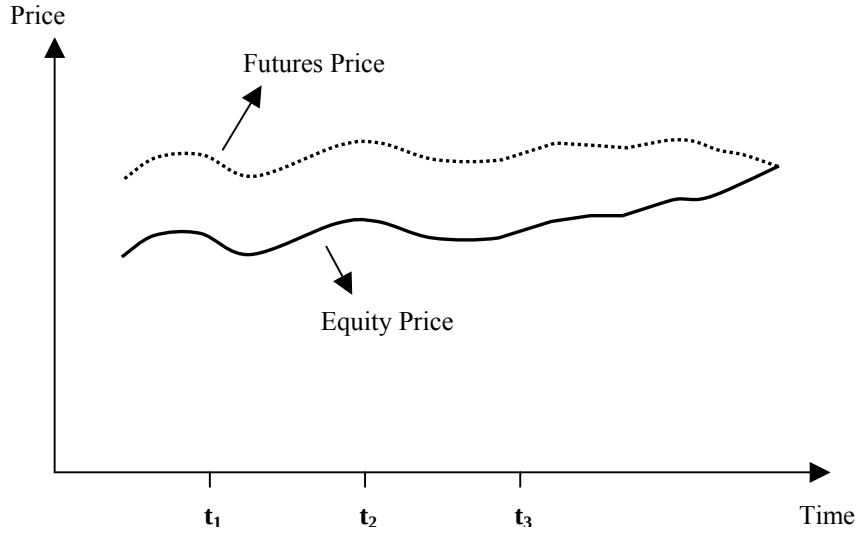

Figure 1 Illustrating Cost-of-Carry Relationship Between Two Markets Over the Contract Cycle

The conventional hedging theory (also known as Naïve hedging) presumes that both futures and cash markets are subject to common information set, therefore it suggests that hedger should take inverse position in the futures market but equal in size to that in the cash market, hence the portfolio risk will significantly decline. Conventional hedging theory presumes equal price change in both markets due to new information shock because efficiency of conventional hedging theory is conditioned upon no market preference doctrine. Therefore the conventional hedging theory can successfully provide

[4] See Fortenbery and Zapata (1997), Alexander (1999), Neuberger (1999), Sahadevan (2002), Lin et al., (2003), Kumar (2004) and Pattarin and Ferretti (2004)).

[5] For example see, Ederington (1979), Telser (1981), Figlewski (1984), Merrick Jr. (1988), Castelino (1992), Kroner and Sultan (1993), Lien and Tse (1998), Neuberger (1999), Jensen et al., (2000), Pennings and Leuthold (2000), Frechette (2001), Giaccotto et al., (2001), Chen et al., (2002), Lo et al., (2002), Chen et al., (2004), Lien and Wang (2004), Terry (2005) and In and Kim (2006) etc.

price risk hedge to the portfolio manager but fails to take care of basis risk, because both markets are in equilibrium in long-run, however in short-run due to the presence of various market frictions[6] both markets observe statistically significant and strategically exploitable lead-lag relationship (for example see, Kawaller et al., (1987), Ng (1987), Stoll and Whaley (1990), Chan (1992), Wahab and Lashgari (1993), Chan and Lien (2001), Chen et al., (2002), Lin et al., (2002), Lien et al., (2003) and Thomas (2006)), which generates risk free profit marking opportunities (for example see, Cornell and French (1983), Mackinlay and Ramaswamy (1988), Yadav and Pope (1990), Chung (1991), Neal (1996), Hsu and Wang (2004), Lee (2005) and Vipul (2005)).

Lien and Li (2003) and Lien (2003) after evaluating different hedging theories, suggested that when capital allocation in the underlying asset is limited or low, hedger may avoid the basis risk as well as the mark-to-market risk and may choose for complete hedging as suggested by conventional hedge theory but when the capital allocation increases, hedger will prefer to underhedge so that transaction cost escalations may be avoided (also see Lo et al., (2002)). Therefore, in order to hedge both price as well as basis risk, Working (1953) came out with a new hedging theory, which defines hedger as risk selector not as risk avoider and assumes that market agent's prime objective is profit maximization not risk minimization. Working's hedging theory suggests that hedger predominantly behaves like speculator who strives to exploit all profit making opportunities available in the market. In other words, hedgers speculate on the change in basis rather than on the absolute value of basis. Therefore, short hedger[7] will hedge portfolio risk if basis is expected to fall otherwise he/she will prefer unhedged portfolio (Castelino (1992) and Li and Vukina (1998)).

Working's hedging theory though improves upon the conventional hedging theory but again it was a biased theory because it presumes was that hedgers always strive to maximize their wealth at any risk level. However, Johanson (1960) and Stein (1961) observed that hedger prefers optimum risk-return portfolio instead of only minimum risk

[6] Such as, infrequent trading of the component stocks of underlying index, difference in transaction cost in terms of bid/ask spread for the component stocks, difference in trading cost in terms of brokerage and other expenses to execute one transaction, time delays in the computation and reporting of the stock index values and low initial investment to take position in futures market etc. (for detail, see Stoll and Whaley (1990)).

[7] Short hedge means when trader is long in the cash market and hedges the cash market position by going short in the futures market.

portfolio or a portfolio, which can offer maximum return (also see, Markowitz (1952)). Therefore, a new hedging approach emerged known as portfolio hedging approach, which allows a wide range of hedge ratios to be efficient along with the efficient utility maximization frontier and the hedger may choose the best one, depending upon his/her risk preference (Howard and D'Antonio (1984) and Jensen et al., (2000)). Moreover, it is well admitted fact that presence of both informed as well as uninformed traders in both markets causes mean reversion in the basis[8], consequently basis risk varies over the contract cycle. Therefore, portfolio hedging approach became more popular because it allows for estimating time-varying optimal hedge ratios, which otherwise was not possible in conventional and Working's hedging theories (for example see, Myers (1991), Aggarwal and Demaskey (1997), Theobald and Yallup (1997), Ferguson and Leistikow (1998), Koutmos and Pericli (1998), Lien and Tse (1998), Chen et al., (2004), Yang and Allen (2004) and Bhaduri and Durai (2007)).

One of the most popular portfolios hedging theories (which also suggests constant hedge ratio) was proposed by Ederington (1979), which presumes that trader is risk averter and futures market is an unbiased predictor of cash market. Therefore, Ederington (1979) (like conventional hedging theory) prefers a hedge ratio which reduces the hedged portfolio variance to minimum level but unlike the naïve hedge ratio, the Ederington's hedge ratio is slope coefficients, which will be computed as the ratio of covariance of futures and cash market returns series to the variance of futures returns. Ederington's hedging theory implies that variance of the hedged portfolio and the correlation of futures and underlying asset are negatively associated, therefore comovement of two markets and early exploitation of arbitrage opportunities are preconditions for efficient hedging.

Ederington's efficient hedge ratio[9] has been empirically found to be negatively associated with hedge horizon because decreasing time-to-expiry tends to restrict the flexibility of hedged portfolio, which implies that longer the hedging horizon, lower will

[8] Mean reversion is a property of stochastic process where the variable value tends to revert back to some normal value. Therefore, stationary basis is presumed to observe mean reverting behavior because when spread between two prices is different from cost-of-carry, arbitrageur's activity will correct the deviation and basis will start representing its cost-of-carry (Zeng (2001), Theobald and Yallup (2001), Monoyios and Sarno (2002) and Pattarin and Ferretti (2004)).

[9] Assumed to comply with the properties of Ordinary Least Square (OLS) Model. For detailed discussion see, Ederington (1979).

be the hedge ratio, however as soon as the hedging horizon narrows, hedge ratio approaches unity (Franckle (1980), Figlewski (1984), Kamara and Siegel (1987), Merrick (1988), Castelino (1992), Li and Vukina (1998) and Chen et al., (2002)). Since, basis risk has also been found to be negatively associated with time-to-expiry of futures contract, therefore, on expiration date, hedger will be left with price risk only, which implies that during short-run (especially near to expiration date) conventional hedging theory may work efficiently[10] (Lien and Tse (1999), Arias et al., (2000), Collins (2000), Lien (2000) and Chen et al., (2004)).

Ederington's efficient hedge ratio (which is not time varying hedge ratio) has yielded immense support in the academic literature[11]. Lien (2005[b]) suggested that hedge ratio based upon OLS (despite of the violation of statistical properties) will outperform time varying hedge ratio except when major structural changes have taken place in the market. Ferguson and Leistikow (1998) by applying Dickey-Fuller test, mentioned that rejection of constant hedge ratio hypothesis may be a result of inadequate data points, therefore hedge ratio computed over long-run will be stationary and their findings were consistent with Grammatikos and Saunders (1983) and McNew and Fackler (1994) (also see Lo et al., (2002)).

Pennings et al., (1997) also found that Ederington's efficient hedge ratio is expected to reduce the portfolio variance to minimum level but Pennings et al., (1997) doubted its efficiency when futures contracts will observe thin trading. Moreover, non synchronous trading anomaly in case of index futures (as found by Stoll and Whaley (1990)) may be another prominent factor responsible for spurious calculation of minimum variance hedge ratio (Theobald and Yallup (1997 and 2001)). In such case, Anderson and Danthine (1981) suggested that cross hedging will efficiently help the hedgers to achieve their portfolio objective rather than direct hedging as proposed in previous theories (also see Broll and Wong (1999)).

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[10] Castelino (1992) stated that basis risk and futures price are negatively correlated and since both are functions of time-to-expiry therefore minimum variance hedge ratio may be less than or equal to unity when basis risk is zero and it differs from unity when variance of basis is different from the variance of futures prices.

[11] For example see, Aggarwal and Demaskey (1997), Theobald and Yallup (1997), Ferguson and Leistikow (1998), Chen et al., (2004), Yang and Allen (2004) and Bhaduri and Durai (2007).

Many empirical findings have further suggested that Ederington's hedging theory performs efficiently in the ex post setting rather than in ex ante setting, which implies that Ederington's efficient hedge ratio should be calculated by considering data for futures as well as cash markets of same periods. However, Ederington's hedge ratio computed on the basis of historical data fails to minimize the portfolio variance (Figlewski (1984), Kamara and Siegel (1987), Myers (1991), Holmes (1995), Alexander (1999) Neuberger (1999), Arias et al., (2000), Lien (2000), Giaccotto et al., (2001) and Lo et al., (2002)). Kamara and Siegel (1987), Myers (1991) and Holmes (1995) suggested that since traders lack perfect foresight with respect to cash and futures price relationship and the hedge ratio varies with time-to-expiry[12] therefore hedge ratio estimated in ex ante setting may be more efficient than the hedge ratio estimated in ex post setting.

Furthermore, Franckle (1980) commented that since an efficient portfolio is expected to generate risk free return plus risk premium (as per Capital Asset Pricing Model), hence, Ederington's hedge ratio must be interpreted very cautiously because a risk free nominal rate can be obtained for a predetermined investment horizon only. Therefore, if at the time of opening positions in both markets, hedging horizon is unknown then change in the hedge ratio may result into large gains or losses. This empirical observation should not be surprising because time varying basis risk won't allow hedge ratio to be constant over hedging horizon (also see Figlewski (1984) and Myers (1991)).

In addition, the trader has been assumed to be risk averter, which seems unreal because his/her prime objective is to maximize portfolio value, therefore trader acts as loss averter rather than risk avoider (Lien and Tse (1998)). Therefore, if the portfolio objective of trader is utility maximization, the utility function will always be concave if there are gains and convex when there are losses (Myers and Hanson (1996) and Lien (2001[a])). Howard and D'Antonio (1984) developed a model, which emphasize upon the portfolio utility maximization objective and suggested that holding position in futures market does not depend only upon the correlation between futures and cash market but

[12] See Kroner and Sultan (1993), Park and Switzer (1995), Lien and Tse (1998), Harris and Shen (2003), Poomimars et al., (2003), Floros and Vougas (2004), Pattarin and Ferretti (2004), Yang and Allen (2004), Kofman and McGlenchy (2005), Floros and Vougas (2006), Hatemi-J and Roca (2006), Bhaduri and Durai (2007) and Lee and Yoder (2007).

risk-return relative also affects the portfolio utility because trader is more interested in the change of wealth locked in portfolio rather than the absolute value of wealth (Myers (1991), Lien (2001[a]) and Theobald and Yallup (2001)).

Furthermore, besides the theoretical progress on account of suggesting optimum hedging strategy through futures contracts (as discussed above), the empirical literature of futures hedging has been progressively benefited from recent developments in the literature of financial econometrics (Lien and Tse (2002)). Various hedging theories including conventional, Working's and Ederington's hedging theory assumes constant hedging ratio, however, large body of literature (see table I) has found that time varying hedge ratio is more efficient than constant hedge ratio (for example see, Myers (1991), Aggarwal and Demaskey (1997), Theobald and Yallup (1997), Ferguson and Leistikow (1998), Koutmos and Pericli (1998), Lien and Tse (1998), Chen et al., (2004), Yang and Allen (2004) and Bhaduri and Durai (2007)).

In addition, voluminous empirical literature is available, which suggests that since both markets observe long-run relationship and are integrated of same order, therefore, hedge ratio computed through error correction methodology developed by Engle and Granger (1987) may be more efficient than others (Park and Switzer (1995), Castelino (1992), Koutmos and Pericli (1998), Alexander (1999), Poomimars et al., (2003), Alizadeh and Nomikos (2004), Floros and Vougas (2004), Pattarin and Ferretti (2004), Yang and Allen (2004), Lien and Shrestha (2005), Floros and Vougas (2006), Bhaduri and Durai (2007) and Bhargava and Malhotra (2007)).

The statistical criticism of Conventional, Working's and Ederington's hedging strategies can be drawn from the fact that hedge ratios in these hedging models are slope coefficients, which reflects the ratio of unconditional covariance of futures and cash price series to the unconditional variance of futures prices, however the optimal hedging rule requires conditional moments that depend upon the information available at the time when hedging decision is made (Myers (1991), Lien and Luo (1994) and Myers and Hanson (1996)). Moreover, it is an established fact that financial time series observes time varying patterns and volatility clustering is their innate feature[13], therefore time

[13] See Engle (1982), Bollerslev (1986), Lo and Mackinlay (1988) and Bollerslev et al., (1992).

varying hedge ratio may be statistically as well as economically more appropriate and reliable than others (Myers (1991), Kroner and Sultan (1993), Park and Switzer (1995), Koutmos and Pericli (1998), Harris and Shen (2003), Floros and Vougas (2004), Pattarin and Ferretti (2004), Kofman and McGlenchy (2005), Hatemi-J and Roca (2006), Bhaduri and Durai (2007) and Lee and Yoder (2007)).

Furthermore, Alexander (1999) established that in ex ante setting (where historical prices contain significant information for the prospective price movements in two markets (Holmes (1995)), and bidirectional causal relationship between these is an established fact[14]), error correction methodology proposed by Engle and Granger (1987) may provide better estimate of efficient hedge ratio than other methodologies. These findings were further tested by Kroner and Sultan (1993), Lien and Luo (1994), Park and Switzer (1995), Koutmos and Pericli (1998), Lien and Tse (1999), Poomimars et al., (2003), Alizadeh and Nomikos (2004), Floros and Vougas (2004), Pattarin and Ferretti (2004), Yang and Allen (2004), Lien and Shrestha (2005), Floros and Vougas (2006), Hatemi-J and Roca (2006) and Bhaduri and Durai (2007) and they all found that hedge ratio computed through error correction methodology provides better results than constant hedge ratio, but it could not out perform the hedge ratio estimated through different models of GARCH Methodology (except Lien and Tse (1999) and Lien and Shrestha (2005)).

Moreover, Telser (1981), Neuberger (1999), Giaccotto et al., (2001) and Lo et al., (2002) appreciated the coexistence of multiple futures contracts with varied expiry dates having same or different underlying asset because it will help traders to hedge through liquid futures contracts[15 and 16]. In order to mitigate the impact of illiquidity on hedging

[14] For example see, Kawaller et al., (1987), Stoll and Whaley (1990), Chan (1992) and Wahab and Lashgari (1993).

[15] In academic literature, it has been widely documented that futures contracts near the expiry date are more liquid as compared to the futures contracts with far maturity date (See Moschini and Myers (2002) and Thomas (2006)).

[16] Lien (2003) mentioned that liquidity constraint in either or both markets is a critical factor, which forces the hedger to partially hedge the undiversifiable risk components so that hedger can avoid additional transaction cost due to mark-to-market losses. Therefore, optimal futures position increases with the size of capital allocation in underlying asset, which implies that if the capital allocation is small, the hedger tends to completely hedge as per conventional hedging theory. However, the optimal futures position decreases with the increase in capital allocation (also see Arias et al., (2000), Frechette (2001) and Haigh and Holt (2002)).

activity, traders prefer to hedge through near to expiry futures contracts and achieve the long-term hedging objective by rolling positions to the next contract. Harris and Shen (2003) and Kofman and McGlenchy (2005) examined same hypothesis and found that rolling window methodology outperforms the constant hedge ratio but still failed to provide better forecast than hedge ratio estimated through different models of GARCH Methodology. Therefore, time varying hedge ratio estimated through appropriate version of GARCH family (such as, BGARCH, EGARCH, MGARCH etc.) has been found both statistically as well as economically a robust hedge ratio, which outperforms other hedge ratios.

On the basis of above discussion, two empirical issues can be extracted, which are equally important for policy markers, market markers, traders, practitioners and academicians. Firstly, if two markets observe stable long-run relationship, can it be economically translated to help traders in optimizing their portfolio value? Secondly, till date it is a debatable issue that which hedge ratio can help traders to achieve their portfolio objectives? Both issues have been widely examined in developed markets like U.S.A. and U.K. etc., whereas in emerging markets (which hold prominent position among different derivative markets of the world) these issues are still unexplored (see table I). In India, to the best of our knowledge Bhaduri and Durai (2007) has been the only attempt to address the second issue but that study suffers with two limitations.

Firstly, the scope of Bhaduri and Durai (2007) is limited to hedging through Nifty futures only. Although Nifty futures holds good reputation in the market (in terms of trading volume) but Bhaduri and Durai (2007) did not address the issue whether an index whose all constituent stocks are not allowed to trade in the futures and options segment can provide same hedging efficiency. Secondly, Bhaduri and Durai (2007) restricted the scope of study to hedging efficiency of index portfolio whereas it has been widely documented that index portfolio suffer from the problem of non synchronous trading of constituent stocks (see Stoll and Whaley (1990)). Therefore, it would be rather more useful if hedging efficiency of individual stock futures is examined. The present study is an attempt to plug both limitations of Bhaduri and Durai (2007).

Further discussion in the study has been organized into three sections, where section II discusses the research design including data base and research methodology employed for estimating optimum hedge ratio, section III discusses the hedged portfolio variance results for different hedge ratios estimated from various methodologies employed and section IV will conclude the study.

Section II: Data Base and Research Methodology

Since the present study aims to examine the hedging efficiency of the Indian equity futures both in terms of index as well as individual stock portfolios, therefore, (in order to secure sufficient data points[17]) the hedging efficiency of all those indices and individual stock futures, which have observed at least one continued trading year history in the Futures and Options (F&O) segment of National Stock Exchange of India as on 31st Dec. 2006. The sample period starts on 1st Jan. 2003 i.e. the period when F&O segment in India began observing immense success shown in the phenomenal growth of their trading volume. Therefore, because of insufficient liquidity, initial trading/inception period for both index as well as individual stock futures contracts have been excluded from the sample period.

Moreover, as the scope of the study has been restricted to examine whether equity futures contracts traded in India provides optimum hedging benefit? If yes, then which statistical methodology will help hedgers to compute optimal hedge ratio so that they can minimize portfolio variance to the minimum level at minimum trading as well as transaction cost to execute such strategy, resulting into increased portfolio value. Therefore, the study includes only those stocks whose prices have not been adjusted due to any corporate action (such as stock splits or issue of bonus shares) in order to avoid the potential bias of these on information dissemination efficiency of stock as well as stock futures contracts, because in the literature of Efficient Market Hypothesis[18], it is an established fact that in addition to the price adjustment on record date, these corporate actions affect the portfolio value due to information leakage and other pricing anomalies prior to the record date as well. As a result of the above mentioned sample selection

[17] For reference, see Nath (2003).
[18] See Fama (1970 and 1991) and Dimson and Mussavian (1998).

criterion, the sample size of the study restricts to three indices (i.e. Nifty, Bank Nifty and CNX IT) and eighty four individual stocks.

Hedging theory requires that trader has to take simultaneous trading positions in two markets but opposite in sign (refer to detailed discussion in section I) with the magnitude of prediction of one market (cash market) through other (futures market), which is known as hedge ratio. Since, estimation of hedge ratio is a statistical process, which involves regressing cash market returns on futures returns, therefore, prior to undertake any statistical procedures, it will be more important to examine the time series properties of data under investigation. Very first step in any econometric investigation of a time series is to examine whether the time series under examination contains unit roots, if yes, then series needs to be transformed for further examination, otherwise the statistical results will be spurious. Therefore two econometric test procedures (i.e. Augmented Dickey Fuller (ADF) and Philips Peron (PP) Tests) have been undertaken to investigate whether the prices of three indices and eighty four individual stocks in cash and futures markets are stationary.

The results in table II are consistent with findings in the literature of financial econometrics that financial time series contains unit roots, therefore, both series are transformed by taking first log difference, which has later been found stationery. The rationale of taking first log difference instead of first difference draws from the fact that stock prices are always significantly skewed because of the divergent trading interests of different traders and different perception(s) to same information. For instance, every dip in a rising market is considered as buying opportunity, which causes jumps in the trading volume of such stocks and stock prices start wandering away from their intrinsic value. Taking log of the series help researchers to avoid skewness to an extent, therefore, for further examination, first log difference of both series will be used (Karpoff (1987) and Moolman (2004))

As already mentioned that both cash and futures markets are linked through arbitrage process and the price of futures contract determined through cost-of-carry model in long-run is not expected to be different from spot price plus risk premium to hold positions in the cash market. Therefore, appreciating the stationary and stable long-

run relationship between two markets, different models have been constructed to hedge the portfolio risk. Six econometrical procedures have been undertaken, which addresses various economic as well as statistical issues involved in estimating the hedge ratio and the efficient hedge ratio will be one which will help hedgers to minimize portfolio variance to minimum level.

Ederington (1979) suggested an optimum hedge ratio, which presumes stable and strong long run relationship between two markets and hedging effectiveness will depend upon the coefficient of R^2, thus, higher the R^2, more efficient will be the hedge ratio and vice versa. Equation (1) explains the procedure suggested by Ederington (1979), which will work efficiently when futures returns are unbiased predictor of prospective cash market returns. In equation (1), $R_{s,t}$ is cash market returns, $R_{f,t}$ is futures market returns, α_o is intercept term and ε_t is error term. As already mentioned that futures contract price as per the cost-of-carry model is assumed to be unbiased predictor of prospective cash market price, therefore intercept and error term should not be significantly different from 0, consequently R^2 will improve, hence the hedging effectiveness.

$$R_{s,t} = \alpha_0 + \beta_1 R_{f,t} + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Equation (1) though may be economically justifiable but until the statistical properties of the estimation procedure are satisfied, the estimated value of β_1 won't be reliable. In addition to containing unit roots, another feature of financial time series is that these are autocorrelated, which implies that successive returns of one speculative asset are significantly predictable and it has been evidenced in the huge literature on Efficient Market Hypothesis, which suggests that successive stock and/or futures returns are not random rather are function of previous information set(s) due to mean reversion, volatility clustering, information asymmetry or inefficient microstructure system[19]. Therefore, if stock returns are autocorrelated then avoidance of it may bias the estimated hedge ratio. Hence, equation (1) repealed to equation (2) (to include autoregressive terms[20] of cash market returns), may provide better results, hence improved R^2, which

[19] For detailed discussion, see Fama (1970 and 1991) and Dimson and Mussavian (1998).
[20] Order of autoregression has been determined on the basis of Schwartz criteria. The Schwartz criterion uses a function of the residual sum of squares together with a penalty for large number of parameters.

otherwise could have been biased on account of significant serial correlation. In equation (2), $R_{s,t}$ is cash market returns, $R_{f,t}$ is futures market returns, $R_{s,t-i}$ is autoregressive term(s) whose order varies between i to p determined as per Schwartz criteria, α_o is intercept term and ε_t is error term.

$$R_{s,t} = \alpha_0 + \sum_{i=1}^{p} \alpha_i R_{s,t-i} + \beta_1 R_{f,t} + \varepsilon_t \quad \ldots\ldots (2)$$

Although inclusion of autoregressive terms of cash market returns as shown in equation (2) may improve statistical output, but still on theoretical grounds, equation (2) requires two more variables, which are lagged futures returns and joint dynamics of both markets i.e. lagged basis. Unbiased prediction of prospective cash market price is a strong theoretical property of futures contract; therefore, until the lagged futures prices are included in the model, an efficient hedge ratio can't be estimated. In addition, Fama and French (1986)[21] appreciated the function of basis as error correction term, which corrects the deviation between current cash market price from its equilibrium price (i.e. forward price assuming futures markets are efficient price discovery vehicles). Therefore, equation (4) improves upon equation (2) by including lagged futures returns and lagged basis. First lag of both futures returns and lagged basis has been included in equation (4) because, the current study employs daily data, whereas arbitrage opportunities in a highly liquid market like India[22] are not expected to persist for longer duration. Therefore, first lag of both variables will be sufficient to capture arbitrage opportunities between two

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Specifically, the Schwartz information criterion minimizes the expression: T * log (RSS) + K * (log T), where T is the number of observations, RSS is the sum of the squared residuals and K is the number of regressors. Lagged terms provide an explanation of the short-run deviations from the long-run equilibrium for the two test equations.

[21] Fama and French (1986) stated that if mispricing is governed by market factors only then actual basis (i.e. F_t - S_t) should predict the theoretical basis (i.e. $S_{t,T}$ - S_t) and if β is positive and significant in equation (3), it implies that variance of actual basis results in correcting the spot price deviation from its equilibrium.

$$S_{t,T} - S_t = \alpha + \beta (F_t - S_t) + \mu_{t,T} \quad \ldots\ldots (3)$$

Where,

$S_{t,T}$ = Theoretical futures price of the underlying asset at time t with maturity date T.

S_t = Current market price of the underlying asset.

α = Constant term.

F_t = Current futures price.

$\mu_{t,T}$ =Random error term.

[22] See Monthly Derivatives Market Updates Published by National Stock Exchange of India (www.nseindia.com).

markets. In equation (4) in addition to variables as defined in equation (2), $R_{f,t-1}$ represents lagged futures returns and $(R_{f,t-1} - R_{s,t-1})$ symbolizes lagged basis.

$$R_{s,t} = \alpha_0 + \sum_{i=1}^{p} \alpha_i R_{s,t-i} + \beta_1 R_{f,t} + \beta_2 R_{f,t-1} + \beta_3 (R_{f,t-1} - R_{s,t-1}) + \varepsilon_t \quad \ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Estimated value of β_1 will be the hedge ratio, which will guide hedgers to decide upon the optimum amount of position in futures market in order to hedge current cash market holdings. In the presence of efficient trading system, the strong and stable long-run relationship between two markets will help the hedge ratio to be equal to or less than one (providing partial hedging) assuming that hedger is loss averter not risk averter. The estimation procedure as laid down in equation (4) may be economically justifiable because Kamara and Siegel (1987), Myers (1991) and Holmes (1995) suggested that as traders lack perfect foresight with respect to cash and futures price relationship and the hedge ratio varies with time-to-expiry[23], therefore the hedge ratio estimated in ex ante setting[24] may be more efficient than the hedge ratio estimated in ex post setting.

However, the literature on financial econometrics has observed that stock returns suffer with the problem of volatility clustering, which implies that an information set continues to affect stock return volatility of few periods ahead. In other words, volatility clustering implies that large price changes will be followed by large price changes and small price changes will be followed by small price changes.

In equation (4) if the variance of error term is constant[25], the hedge ratio estimation through Ordinary Least Square (OLS) method will be valid, however, large body of literature has evidenced that stock returns are heteroscedastic in nature. Therefore, Autoregressive Conditional Heteroscedasticity model (ARCH) may be a better procedure to make robust statistical estimations. In ARCH model (first introduced by Engle (1982)), the mean equation is specified in the baseline scenario by an AR(p)

[23] See Kroner and Sultan (1993), Park and Switzer (1995), Lien and Tse (1998), Harris and Shen (2003), Poomimars et al., (2003), Floros and Vougas (2004), Pattarin and Ferretti (2004), Yang and Allen (2004), Kofman and McGlenchy (2005), Floros and Vougas (2006), Hatemi-J and Roca (2006), Bhaduri and Durai (2007) and Lee and Yoder (2007).

[24] In ex ante setting, historical returns contain significant information for the prospective price movements in the market. (see, Holmes (1995)).

[25] 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.

process and other endogenous variables such as in equation (4) and the conditional variance is regressed on constant and lagged values of squared error terms as shown in equation (5)

$$h_t = \omega + \alpha_1 \varepsilon^2_{t-1} + \alpha_2 \varepsilon^2_{t-2} + \ldots\ldots\ldots + \alpha_p \varepsilon^2_{t-p} \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots..(5)$$

This ARCH model was generalized by Bollerslev (1986) leading to generalized ARCH class of models called GARCH in which the conditional variance depends not only on the squared residuals of the mean equation but also on its own past values. The GARCH (p, q) model is given by equation (6)

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

Where, h_t is the conditional volatility, α_i is the coefficient of ARCH term with order i to p and β_j is the coefficient of GARCH term with order j to q. The conditional volatility as defined in equation (6) is determined by three effects namely the intercept term given by ω, the ARCH term expressed by $\alpha_i \varepsilon^2_{t-i}$ and the forecasted volatility from the previous period called GARCH component expressed by $\beta_j h_{t-j}$. Parameters ω and α should be higher than 0 and β should be positive in order to ensure conditional variance h_t to be non negative. Besides this, it is necessary that $\alpha_i + \beta_j \leq 1$, which secures covariance stationarity of conditional variance. A straightforward interpretation of the estimated coefficients in equation (6) is that the constant term is the long term average volatility whereas α_i and β_j represents how volatility is affected by current and past information set(s) respectively. Moreover, the magnitude of parameters α_i and β_j determines the short-run dynamics of the resulting time series volatility. Large β_j shows that shocks to the conditional variance takes long time to die out, thus volatility will persist for longer time periods. Large GARCH error coefficient indicates that volatility reacts quite intensely to market movements. Therefore, if variance of error term in equation (4) is not constant, equation (6) will be attached to equation (4), hence the estimation of hedge ratio (β_1) will be subject to the nature of stock/index return's volatility.

Furthermore, Nelson (1991) by taking into account the asymmetric relationship between conditional volatility and conditional mean, proposed an Exponential GARCH (EGARCH) model, which is based upon the logarithmic expression of conditional volatility in cash and futures market returns. Therefore, if the stock returns are asymmetric and the interaction between old and new information observes leverage affect, EGARCH model (i.e. equation (7)) may improve the hedge ratio estimation as compared to that estimated through GARCH process in equation (6).

$$h_t = \gamma_1 + \gamma_2 \left| \frac{\varepsilon_{t-1}}{h_{t-1}} \right| + \gamma_3 \frac{\varepsilon_{t-1}}{h_{t-1}} + \gamma_4 h_{t-1} \quad \text{.....(7)}$$

Equation (7) reports the leverage relationship between old and new information but in the speculative markets besides the leverage effect, it has been observed that traders react heterogeneously to positive and negative news. For instance, Karpoff (1987) in a survey on relationship between information arrival (trading volume as proxy for information arrival) and behavior of stock market volatility has reported that volatility in the declining market was always higher than in the rising market. Therefore, it would be more appropriate (if conditional volatility behaves differently to positive and negative news) to segregate the impact of both positive and negative news, which can be done by specifying the variance equation in TARCH (Threshold Autoregressive Conditional Heteroscedasticity) framework and then estimate the optimal hedge ratio in the mean equation.

Equation (8) lays down the variance equation of TARCH model where, equation (6) is modified to include $\varepsilon^2_{t-i}\xi_{t-i}$, which is a dummy for negative news having value 1 if there is negative news and 0 otherwise. Therefore, appropriate GARCH methodology would be able to capture the stylized behaviour of conditional volatility of cash market returns hence the estimated hedge ratio will be statistically robust.

$$h_t = \omega + \sum_{i=1}^{p} \alpha_i \varepsilon^2_{t-i} + \sum_{i=1}^{p} \alpha_k \varepsilon^2_{t-i} \xi_{t-i} + \sum_{j=1}^{q} \beta_j h_{t-j} + \upsilon_t \quad \text{……..(8)}$$

where,

(a) $\xi_{t-i} = 1$, if $\varepsilon_{t-i} < 0$

(b) $\xi_{t-i} = 0$, if $\varepsilon_{t-i} > 0$

The equation (4) estimated through OLS, GARCH or EGARCH process may provide better estimate of the hedge ratio but optimality of hedge ratio will still be doubtful because both markets observes significant lead-lag relationship in terms of volatility spillover and information dissemination. Therefore, estimating an optimal hedge ratio by regressing only the cash market returns on lagged returns of both futures and cash market may be biased because other way round is also true as volatility spillover is bidirectional and continuous.

Therefore, in the present case, either Vector Autoregression Model (VAR) (when the returns of both markets under consideration are significantly autocorrelated) or Vector Error Correction Methodology (VECM) (when both markets are cointegrated) may provide efficient speculative forecasts hence robust hedge ratio may be estimated. VAR model simultaneously regress the lagged returns of both variables, whereas, VECM in addition to lagged returns also considers the error correction term (if both series are cointegrated). Hence both methodologies estimate the optimal hedge ratio by considering theoretical relationship between two markets (i.e. lead-lag in short-run and cointegration in long-run), which confirms the volatility spillover between two markets through arbitrage process. Equations (9) and (10) specify the estimation process of VAR methodology and equations (11) and (12) stimulate the estimation procedure of VECM. The hedge ratio on the basis of VAR and VECM will be computed as $\sigma_{s,f}/\sigma^2_f$ where $\sigma_{s,f} = \text{cov}(\varepsilon_{ft},\varepsilon_{st})$ and $\sigma^2_f = \text{var}(\varepsilon_{ft})$.

$$R_{s,t} = \sum_{i=1}^{M}\alpha_i R_{s,t-i} + \sum_{j=1}^{N}\beta_j R_{f,t-j} + \varepsilon_{st} \quad \text{.....(9)}$$

$$R_{f,t} = \sum_{k=1}^{O}\alpha_k R_{s,t-k} + \sum_{l=1}^{P}\beta_l R_{f,t-l} + \varepsilon_{ft} \quad \text{.....(10)}$$

$$R_{f,t} = \alpha_{0f} + \sum_{i=1}^{p}\alpha_{if}(F_{t-i} - S_{t-i}) + \sum_{j=1}^{q}\beta_f R_{f,t-j} + \sum_{k=1}^{m}\beta_f R_{s,t-k} + \varepsilon_{ft} \quad \text{.....(11)}$$

$$R_{s,t} = \alpha_{0s} + \sum_{i=1}^{p}\alpha_{is}(F_{t-i} - S_{t-i}) + \sum_{l=1}^{n}\beta_s R_{s,t-l} + \sum_{h=1}^{o}\beta_s R_{f,t-h} + \varepsilon_{st} \quad \text{.....(12)}$$

In nutshell, the present study estimates optimal hedge ratio in different statistical and economic theory framework, hence aims to propose efficient hedge ratio estimation methodology, which is both statistically as well as theoretically robust. After estimating

the optimal hedge ratio through above mentioned six statistical procedures (i.e. OLS, GARCH, EGARCH, TARCH, VAR and VECM), the hedging effectiveness of all hedge ratios will be compared and the optimal hedge ratio, which reduces the portfolio variance to minimum level will be proposed as efficient hedge ratio. The efficiency of optimal hedge ratio will be measured through equation (13). Where Var (U) and Var (H) represents variance of un-hedged and hedged portfolios respectively. σ_s and σ_f are standard deviation of the cash and futures returns respectively, $\sigma_{s,f}$ represents the covariability of the cash and futures returns and h^* is the optimal hedge ratio.

$$\frac{Var(U) - Var(H)}{Var(U)} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(13)$$

$$Var(U) = \sigma_s^2 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(14)$$

$$Var(H) = \sigma_s^2 + h^{*2}\sigma_f^2 - 2h^*\sigma_{s,f} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(15)$$

Section III: Analysis and Discussion

Prior to discussing the optimal hedge ratio estimation results through various econometric procedures proposed in section II and comparing their efficiency in reducing the portfolio risk, it is more important first to discuss the time series properties of series under examination. Table III provides important information relating to the summary statistics of futures and cash markets and for joint movement in two markets (i.e. Basis). Table III provides that returns of both futures and cash markets are significantly skewed (negatively skewed in most of cases) and their coefficient of kurtosis is significantly different from three, which implies that futures and cash market returns does not conform to normal distribution. The null hypothesis that futures and cash market returns follow normal distribution is further tested through Jarque-Bera test, but Jarque-Bera coefficient significantly rejects the null hypothesis for all indices as well as individual stock futures and cash market returns. Finding asymmetric returns in futures and cash market is not a new observation and summary statistics in the current study are consistent with the findings of Kendall (1953), Fama (1965), Stevenson and Bear (1970), Chen (1996), Reddy (1997) and Kamath (1998).

Rejecting the null hypothesis that returns of speculative assets does not follow normal distribution, suggests that information dissemination process may not be efficient

and the return are not symmetrically distributed among buyers and sellers. Significantly skewed returns implies that extremely divergent risk perceptions for same information set persists in the market, which may not allow futures and cash market returns to represent their intrinsic value and indicates that markets do not adequately discount the risk premium included in the new information set traveled to the market. Asymmetry in the cash and futures market returns is not an unexpected phenomenon because traders with varied trading interests, interact in the market and react heterogeneously to different news. For instance, the risk averse nature of traders in the market may be a prominent cause for the asymmetric returns (Moolman (2004)) because due to high degree of volatility in speculative markets, both optimistic and pessimistic views of traders to new information causes unexpected variations in prices (Diagler and Wiley (1999)). Furthermore, in speculative markets like stock, derivatives and commodity markets, it has been observed that volume on uptick (positive news) is always higher than the volume on downtick (pessimistic news), because in bull market traders consider every dip in the stock/index as an opportunity to buy, which in turn causes speculative asset's returns to behave asymmetrically (for detail see, Karpoff (1987)).

In addition, basis (which is a proxy for joint dynamics between futures and cash markets) also observes asymmetric behavior, where basis is significantly skewed and coefficient of kurtosis significantly differs from three. An important observation in the summary statistics of basis is that it is negatively skewed for all indices and individual stocks (except for DIVISLAB, JINDALSTEL and NDTV), which implies that more or less futures are in backwardation state, which may offer significant arbitrage opportunities to traders as found by Vipul (2005) but as the mean value of basis is meager (approximately close to zero), therefore available arbitrage opportunities seems not to persist for longer time duration. This observation supports the sample selection criterion because sample understudy covers the period when Indian equity futures market began observing phenomenal growth in trading volume thus sample selection criterion conforms to market completion hypothesis, which suggests that in a liquid market arbitrage opportunities does not last long.

In addition, the negatively skewed basis provides important information relating to the exploitation of arbitrage opportunities and reestablishment of equilibrium between

two markets. Kawaller et al., (1987), Ng (1987), Stoll and Whaley (1990), Chan (1992), Wahab and Lashgari (1993), Martikainen et al., (1995), Arshanapalli and Doukas (1997), Jong and Donders (1998), Pizzi et al., (1998), Booth et al., (1999), Min and Najand (1999), Tse (1999), Frino et al., (2000), Chan and lien (2001), Chen et al., (2002), Lin et al., (2002), Thenmozhi (2002), Lin et al., (2003), Lien et al., (2003), Covrig et al., (2004), Kenourgios (2004), Pattarin and Ferretti (2004), So and Tse (2004), Zong et al., (2004), Mukherjee and Mishra (2006) and Thomas (2006) were few prominent works, which have found that during long-run both markets are in equilibrium however exploitable arbitrage opportunities were available during short-run, reflected in the form of lead-lag relationship between two markets as a result of the presence various market frictions as observed by Stoll and Whaley (1990).

Types of traders in the market may be a potential factor affecting the theoretical distribution of speculative asset's returns. It is an admitted fact that Indian cash market is predominantly run by foreign as well as domestic institutional investors and retail investors plays little role in the market movements. On the other hand, in futures market retail investors participation is very significant and institutional investors have little role to play[26]. Therefore asymmetric profile of investors in both markets may be a strong determinant for significant asymmetry in basis because institutional investors base their trading decision on sophisticated analysis undertaken by a team of professional whereas retail traders base their decision on firm-specific or insider information (Thomas (2006)), which will be little stale or late resultantly timing of trading by two group of investors will be different, hence new information will take time to die out and will cause asymmetric jumps in the conditional volatility of both markets.

Moreover, exploitation of available arbitrage opportunities to secure reward out of market disequilibrium causes mean reversion in basis, which implies that increase in spread on account of reaction by different market agents reverts back to its intrinsic value because basis like any financial time series possesses asymptotic property. Therefore, stationary basis is presumed to observe mean reverting behavior because when spread between two prices is different from cost-of-carry, arbitrageur's activity will correct the

[26] For reference, see Monthly Derivatives Market Update published by National Stock Exchange of India (www.nseindia.com).

deviation and basis will start representing cost-of-carry of the underlying asset (Zeng (2001), Theobald and Yallup (2001), Monoyios and Sarno (2002) and Pattarin and Ferretti (2004)). Thus, mean reverting behavior and negative correlation between basis and time-to-expiry of a contract may be another potential reason for basis to be negatively skewed.

In addition, positive mean value of returns for all indices and individual stocks in both markets may be due to the sample selection bias because the sample period understudy observed steady bull-run in the Indian equity market and this was the period when major sources of FDI and FII (viz, USA, UK and Japan) were aggressively attracted towards the mushroom growth in the Indian economy, consequently there was huge buying pressure in the market, which reflected into the phenomenal growth of Indian stock market indices like SENSEX and NIFTY, which grew from 3400 to 13800 and 1100 to 4000 respectively during the sample period[27].

In addition to the theoretical distributional properties of futures and cash markets, another important observation can be drawn from unit root test results, which suggests that returns in both futures and cash markets are significantly predictable, thus refuting the null hypothesis of Efficient Market Theory that returns in speculative markets follow random walk model[28]. Random walk model requires that price changes in speculative markets should be a function of new information set and asset prices immediately discounts all relevant information as it becomes available, which implies weak form efficiency of the speculative asset (for detail, see Fama (1970)). However, stationery futures and cash market returns suggests that information dissemination efficiency in Indian equity futures and cash markets is weak and informed traders can frame market strategies to exploit arbitrage and/or speculative opportunities as these become available. These findings are consistent with early works on similar hypothesis in Indian capital market by Barua (1981), Sharma (1983), Gupta (1985), Rao (1988), Chaudhuri (1991), Reddy (1997), Mishra (1999), Anshuman and Goswami (2000), Ranjan and Padhye

[27] Source, www.bseindia.com for SENSEX and www.nseindia.com for NIFTY.
[28] For reference on testing the Random Walk Hypothesis by applying Stationarity Tests, see Crowder and Phengpis (2005) and Evans (2006).

(2000), Pant and Bishnoi (2001), Nath (2002), Marisetty (2003), Mangala and Mittal (2005) and Gupta and Singh (2006b).

Furthermore, stationary behavior of one additional variable that is "Basis" provides important information relating to the joint dynamics of Indian futures and cash markets. As the cost-of-carry model (which is followed to determine the price of futures contracts) suggests that price of a futures contract at any time should be sum of the spot price of underlying asset traded in cash market and risk premium to hold such asset. Therefore on maturity date when risk premium ceases, both markets will converge. Stationery behavior and low mean of basis in table II and III respectively confirms that both markets observe stable and strong comovement over the contract cycle, which implies that both markets are in long-run equilibrium however exploitable arbitrage opportunities may be available during very short-run. These findings are consistent with Fortenbery and Zapata (1997), Alexander (1999), Neuberger (1999), Sahadevan (2002), Lin et al., (2003), Pattarin and Ferretti (2004) and Kumar (2004). Fortenbery and Zapata (1997) and Kumar (2004) further mentioned that absence of stationary and predictable basis may be a result of either immaturity of the market(s) and/or inappropriate regulatory framework.

Stationery basis and strong comovement between futures and cash markets during long-run[29] motivates the authors to modify the minimum variance hedge ratio estimation model, which was proposed by Ederington (1979) (as given in equation (1)) to include first lag of futures returns and basis, thus the original model was repealed to equation (4), which will help traders to predict future spot price movements on the basis of current futures price and lags of spot price itself. Hedge ratio estimation through equation (4) (with appropriate estimation procedure like OLS, GARCH, EGARCH and TARCH) though theoretically seems better than that proposed in Ederington (1979) but the results of variance reduction through different optimal hedge ratios estimated by applying six econometric methodologies in the present study favors the estimation of optimal hedge ratio through either VAR or VECM.

[29] In order to determine the long-run relationship between futures and cash markets, the cointegration procedure proposed by Johansen and Juselius (1990) has been undertaken and the results of λ_{Max} and λ_{Trace} tests suggests that both markets are in equilibrium during long-run. In order to save the space, results of cointegration tests are not attached with this paper but are available on demand.

Hedge ratios estimated through VAR methodology was lowest for three indices (namely Bank Nifty, CNXIT and Nifty) as compared to that estimated through other methodologies and the time varying hedge ratios estimated through GARCH, EGARCH or TARCH methodologies was highest, which implies that ignoring the theoretical relationship between series under examination escalates the hedging cost, which is later reflected in the lower portfolio value. These findings support the theoretical relationship between two markets, because CNXIT and Nifty observes significant bidirectional causality where as, cash market returns significantly caused futures returns for BankNifty. Moreover, the causal relationship between two markets with the aid of Impulse Response Analysis could be further interpreted in terms of lead-lag relationship between two markets.

It was observed that in case of Bank Nifty and Nifty, cash market leads futures market and in case of CNXIT futures market leads cash market. Furthermore, in case of Bank Nifty, it depends upon futures market to correct the disequilibrium whereas in case of Nifty, the error correction term is significant for both markets but the magnitude of the coefficient of error correction term suggests that in order to reestablish market equilibrium, futures market has to make double adjustment as compared to that by cash market. The findings that cash market leads futures market in India are not new observations and are consistent with the early findings of Gupta and Singh (2006c), Mukherjee and Mishra (2006) and Thomas (2006).

The theoretical relationship between two markets seems to be a significant factor contributing to the efficiency of the optimal hedge ratio. Thus finding VAR or VECM hedge ratios better than time varying hedge ratios estimated through GARCH, TARCH and EGARCH is justifiable and these results are consistent with the findings of Castelino (1992), Park and Switzer (1995), Koutmos and Pericli (1998), Alexander (1999), Poomimars et al., (2003), Alizadeh and Nomikos (2004), Floros and Vougas (2004), Pattarin and Ferretti (2004), Yang and Allen (2004), Lien and Shrestha (2005), Floros and Vougas (2006), Bhaduri and Durai (2007) and Bhargava and Malhotra (2007).

Furthermore, out of eighty four individual stocks under examination, fifty four (64.28%) and nine (10.71%) stocks favour the optimal hedge ratio estimated through

VAR and VECM respectively, fifteen (17.86%) and four (4.76%) stocks supports OLS and GARCH hedge ratio respectively, whereas five (5.95%) stocks each favours the hedge ratio estimated through EGARCH and TARCH methodology respectively[30]. Out of total number of stocks under examination, approximately 93% stocks favors constant hedge ratio and out of total stocks favoring constant hedge ratio, 81% stocks favor the optimal hedge ratio estimated through VAR or VECM, which is consistent with the results of optimal hedge ratio for indices as discussed above.

Therefore, overall results in the current study favors constant hedge ratio, which are consistent with Lien (2005[b]) who suggested that hedge ratio based upon OLS (despite of violation of statistical properties) will outperform time varying hedge ratio except when major structural changes have taken place in the market. Moreover, Ferguson and Leistikow (1998) by applying Dickey-Fuller test, mentioned that rejection of constant hedge ratio hypothesis may be result of inadequate data points, therefore hedge ratio computed over long-run will be stationary. Since the sample period did not observe any structural change in the Indian cash or futures market and the sample period contains sufficient data points (see Nath (2003)) drawn out of liquid market, thus our results (as discussed above) are consistent with the findings of Grammatikos and Saunders (1983), McNew and Fackler (1994), Ferguson and Leistikow (1998), Lo et al., (2002) and Lien (2005[b]).

Furthermore, many empirical findings have suggested that Ederington's optimal hedge ratio performs better in the ex post setting rather than in ex ante setting, which implies that Ederington's efficient hedge ratio should be calculated by considering data for futures as well as cash markets of same periods. However, as already mentioned that in equation (4), optimal number of lags of cash market returns (on the basis of Schwarz Information Criteria), one lag of both futures returns and basis was included to efficiently forecast the cash market changes. Therefore, the optimal OLS hedge ratio (in table IV) does not suffer from the criticism of Ederington's hedge ratio by Figlewski (1984),

[30] The total number of optimal hedge ratios (92) exceeds the total number of stocks (84) because seven stocks (namely, HEROHONDA, IDBI, IPCL, KTKBANK, ORIENTBANK, RELCAPITAL and SCI) have optimal hedge ratio for more than one methodology.

Kamara and Siegel (1987), Myers (1991), Holmes (1995), Alexander (1999) Neuberger (1999), Arias et al., (2000), Lien (2000), Giaccotto et al., (2001) and Lo et al., (2002).

Findings in the study are equally important for traders, regulatory bodies, practitioners and academicians because it comments upon the theoretical relationship between two markets and interpret such relationship in economic terms to reduce the portfolio risk. The authors have found that hedging through index futures reduces portfolio variance by approximately 96% where as in case of individual stocks, the reduction in portfolio variance ranges between 79% for SUNPHARMA and 98.50% in case of TITAN. Therefore, it is evident from above discussion that strong and stable comovement between Indian equity futures and cash markets will be helpful for traders to significantly reduce portfolio variance subject to the coefficient of determinant between two markets as suggested by Ederington (1979).

Since the efficiency of optimal hedge ratio is subject to strong and stable comovement between futures and cash markets, therefore, these results can help The Securities and Exchange Board of India (SEBI) in policy framing[31]. Therefore, prior to announce any policy changes, SEBI should give due consideration to their potential impact upon the cost-of-carry relationship between two markets because any reform in the Indian capital market will affect the hedging efficiency of derivatives market. Thus SEBI should make efforts to strengthen the relationship between two markets by removing various imperfections in the Indian derivatives markets like restriction on institutional traders to participate in futures market, large lot sizes in case of individual stock futures, underdevelopment of equity options market etc.

Section IV: Conclusion

Last one and half decade has brought sea change in the Indian capital market such as, screen based trading replaced open out cry trading system, demat accounts replaced

[31] Reduction in tick size of TSE 35 Index Participation Units from 0.60% to 0.25% of the prevailing price improved its price discovery efficiency in Canada, which implies that improvements in contract specifications improve price discovery efficiency of the asset. Furthermore, Jiang et al., (2001) found that contemporaneous relationship between futures and cash market strengthened with removal of short selling restrictions in the Hong Kong cash market particularly when the market was undergoing bear phase and the underlying asset was relatively overpriced. Therefore, irrational trading specifications of the futures contracts will be responsible for violation of the common notion that an asset which involves zero investment will always be better price discovery vehicle (Beaulieu et al., (2003)).

share certificates, floor trading replaced by internet trading, badla trading has been banned, compulsory rolling settlement was introduced, fixed price issues were replaced by partial or complete book building issues in primary issue market, establishment of interconnected stock exchange etc. One of the most important reforms in the Indian capital market had been to introduce equity derivatives (futures and options) as efficient price discovery and hedging instrument.

The success of derivatives trading in Indian capital market can be adjudged from the fact that index and individual stock futures contracts have been continuously rated amongst top five exchanges (in terms of trading volume) in the world[32]. Volume explosion in the futures market has been a subject of interest for practitioners, traders, regulatory bodies and academicians because huge volume in the market especially through retail traders (because retail traders contributes to approximately 60% of total trading volume in Indian derivatives market) raises many questions relating to the information dissemination efficiency of futures markets as well as the change in price discovery efficiency of cash market after the introduction of futures trading, hedging, arbitrage efficiency of futures market and another important question whether futures trading has stabilized or destabilized the cash market.

All these issues have been adequately answered in the developed markets as well as emerging markets but hedging efficiency of the Indian equity futures market has not yet been given due attention. To the best of researcher's knowledge, Bhaduri and Durai (2007) has been the only work (see section I), which examined the hedging efficiency of Indian equity futures market but the scope of that study as well (like studies conducted in developed markets) is restricted to the investigation of hedging efficiency of Index (i.e. Nifty) futures only. Therefore, present study has been an attempt to fill the literature gap by examination of the hedging efficiency of both index as well as individual stock futures contracts traded on National Stock Exchange of India over the sample period Jan. 2003 to Dec. 2006.

[32] For reference see Monthly Derivatives Market Updates Published by National Stock Exchange of India (www.nseindia.com).

The study finds asymmetric and significantly kurtic futures and cash market returns, which refutes the null hypothesis that in an efficient speculative market returns are symmetrically distributed among buyers and sellers. Furthermore, both futures and cash market returns have been found stationery, which rejects the hypothesis that in a liquid stock market successive price movements follows random walk model, which implies that information dissemination process in both futures and cash markets is not efficient. In addition, joint dynamics of both markets (i.e. Basis) has been found stationery, which implies that stable long-run relationship between two markets persist, which was later confirmed through Johansen and Juselius (1990) cointegration test results (Cointegration results are not reported but are available on demand).

After examining the nature of series under consideration and the relationship between two markets, the hedging efficiency of both index as well as individual stock futures contracts has been investigated in the minimum variance hedge ratio framework as suggested by Ederington (1979). The original model was repealed to accommodate the theoretical relationship between two markets (for detail see section II) and the final model was estimated through six econometric procedures (subject to the fitness of model) namely, OLS, GARCH, TARCH, EGARCH, VAR and VECM. The study finds that hedge ratio estimated through VAR or VECM reduced the portfolio variance by maximum extent, whereas other methodologies by considering the stylized features of futures and cash markets, estimated higher hedge ratios, requiring higher initial investment, which was later shown in the reduced portfolio value.

Results in the present study are consistent with the findings of Castelino (1992), Park and Switzer (1995), Koutmos and Pericli (1998), Alexander (1999), Poomimars et al., (2003), Alizadeh and Nomikos (2004), Floros and Vougas (2004), Pattarin and Ferretti (2004), Yang and Allen (2004), Lien and Shrestha (2005), Floros and Vougas (2006), Bhaduri and Durai (2007) and Bhargava and Malhotra (2007), who found that ignoring the theoretical relationship between futures and cash markets will escalate the hedge ratio. In addition, the hedge ratio estimated through OLS (despite of the violation of statistical properties) provides better hedging than the hedge ratios estimated through either of conditional heteroscedasticity model applied in the study.

The study also finds that hedging through index futures in India reduces portfolio variance by 96% however hedging through individual stock futures reduces portfolio variance in the range of 79% for SUNPHARMA and 98.50% in case of TITAN subject to the strength of liaison and stable comovement between two markets, which is consistent with the findings of Ederington (1979). Findings of the study are important for traders because it suggests that hedgers should hedge (either straight or cross hedge) through liquid futures contracts so that they can avoid hedging cost escalations and they should estimate the long-run hedge ratio on the basis of cost-of-carry relationship between two markets.

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Table I Empirical Evidence on Hedging Efficiency of Futures Markets					
Author (Year of Study)	**Market Understudy**	**Symbols**	**Sample Period**	**Methodology Applied**	**Hedging Effectiveness**
Ederington (1979)	U.S.A.	GNMA and T-Bill Futures Markets	Jan. 1976 to Dec. 1977 and Mar. 1976 to Dec. 1977	**OLS**	Futures hedging is better for longer period than short period
Figlewski (1984)	U.S.A.	S&P500, NYSE, AMEX, NASDAQ, DOW	June 1982 to Sept 1983	**OLS**	Basis risk disturbs the hedging effectiveness therefore one week hedging is better than overnight hedging.
Kamara and Siegel (1987)	U.S.A.	Soft Wheat and Hard Wheat	Jan. 1970 to March 1981	**OLS**	Far period hedging is better than near to expiration period
Myers (1991)	U.S.A.	Wheat Futures	June 1977 to May 1983	OLS and **BGARCH**	Time varying hedge ratio is better that constant hedge ratio
Kroner and Sultan (1993)	U.S.A.	BP, CD, GM, JY and SF	Feb. 1985 to Feb. 1990	Naïve, OLS, ECM and **ECM-GARCH**	Time varying error correction methodology takes care of transaction cost thus outperforms other methodologies.
Lien and Luo (1994)	U.S.A.	BP, CD, GM, JY and SF	March 1980 to Dec. 1988	OLS, **BGARCH**, ECM	If trader is extremely risk averter, both constant and time varying hedge ratios are equally efficient whereas to achieve utility maximization objective GARCH hedge ratio is most efficient
Holmes (1995)	U.K.	FTSE100 Futures and FTSE100 Index	July 1984 to June 1992	Ex Post MVHR, Ex Ante MVHR and Beta	MVHR based upon historical data is better
Park and Switzer (1995)	U.S.A. and Canada	S&P500, MMI and TSE35	June 1988 to Dec. 1991	Naïve, OLS, OLS with Cointegration and **BGARCH**	Time varying hedge ratio is superior to constant hedge ratios

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Aggarwal and Demaskey (1997)	Hong Kong, South Korea, Singapore, Taiwan, Indonesia, Philippines and Thailand	BP, CD, GM, JY and SF	Jan. 1983 to Dec. 1992	Naïve and **OLS**	Cross hedging is beneficial
Theobald and Yallup (1997)	U.K.	FTSE100 Futures and FTSE100 Index	Jan. 1985 to Dec. 1995	OLS	Futures contracts can provide hedging benefit only when both markets do not suffer with the problem of non synchronous trading.
Li and Vukina (1998)	U.S.A.	Corn Yield Futures	Jan. 1951 to Dec. 1994	OLS	Dual hedging through price as well as yield futures contracts can be more effective than through price futures only
Lien and Shaffer (1999)	Japan, U.S.A., South Korea, Hong Kong and Spain	Nikkei, S&P500, TOPIX, KOSPI, Hang Seng and IBEX Futures	Sept. 1986 to Sept. 1989, April 1982 to April 1985, April 1990 to Dec. 1993, May 1996 to Dec. 1996, Jan. 1987 to Dec. 1989 and April 1993 to March 1995	Minimum-Extended Gini Hedge Ratio	The extended Gini coefficient as an alternative measure of dispersion has strong theoretical promise for use in futures hedging because it does not require the restrictive requirement of quadratic utility functions
Lien and Tse (1999)	Singapore	Nikkei Futures	Jan. 1989 to Aug. 1997	ARFIMA-GARCH, OLS, VAR, **EC**, FIEC	Consideration of cointegration framework improves the hedging performance
Neuberger (1999)	U.S.A.	Crude oil futures	July 1986 to Dec. 1994	Ex ante OLS	Rollover of futures contracts adds to hedging effectiveness.
Kavussanos and Nomikos (2000)	U.K.	BIFFEX	Aug. 1988 to Oct. 1997	OLS, VECM-GARCH	Structural changes helps in improving hedging efficiency of futures market

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Chen et al., (2001)	U.S.A.	S&P500 Futures	April 1982 to Dec. 1991	**M-GSV**, MEG, Sharpe, OLS and Standard Mean Variance	M-GSV minimizes the portfolio variance by maximum.
Haigh and Holt (2002)	U.K.	Corn, Soybean, Wheat and BIFFEX	May 1985 to Jan. 1998	OLS, SUR and **BEKK**	Though time varying hedge ratio is more expensive but reward in terms of reduced volatility considerable outweigh the extra transaction costs.
Moschini and Myers (2002)	U.S.A.	Corn Futures	Jan. 1976 to June 1997	BEKK, GARCH and OLS	Supports time varying hedge ratio
Chen et al., (2002)	Taiwan	TAIFEXTAIEX-TAIEX and SGXMSCI[b]-MSCI[b]	July 1998 to July 2000	OLS, **Bayesian Approach**	Hedging effectiveness observes positive relationship with hedging horizon
Harris and Shen (2003)	U.K.	FTSE100 Futures and FTSE100 Index	May 1984 to May 2002	EWMA, Rolling Window **ROHR**	Time varying hedge ratio is better but ROHR which accounts for non normality of data proves better hedge ratio.
Veld-Merkoulova and Roon (2003)	U.S.A.	Crude oil, orange juice and lumber	Feb. 1984 to June 1998 Jan. 1973 to May 1998 Jan. 1974 to March 1998	Naïve and **One Factor Model**	Presence of multiple maturity contracts helps to efficiently achieve the objective of mean-variance portfolio
Alizadeh and Nomikos (2004)	U.S.A., U.K.	S&P 500 Futures and S&P500 Index and FTSE100 Futures and FTSE100 Index	May 1984 to March 2001	OLS, ECM, GARCH and **Markov Regime Switching Models**	By allowing the hedge ratio to be dependent upon the state of market, one may obtain more efficient hedge ratio.
Chen et al., (2004)	U.S.A., U.K. Canada, Japan, Australia	7 Stock Market Index futures, 11 Commodity futures, 2 metals and 5 currencies	June 1982 to Dec. 1997	OLS	Short-run hedge ratio is significantly < 1 but as the hedge horizon increases it approaches to 1 and the hedging effectiveness also improves.

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Pattarin and Ferretti, (2004)	Italy	Fib30 and Mib30 Index	Nov. 1994 to Sept. 2002	NAÏVE, OLS, ECM, GARCH, **EWMA**	Time varying hedge ratio based upon EWMA is better
Yang and Allen (2004)	Australia	AOI and SPI	June 1992 to Dec. 2000	**OLS**, VAR, VECM and **MGARCH**	Risk minimization theory prefers time varying hedge ratio however when return effects are also considered, the utility based measure prefers OLS. During out-of-sample hedging dynamic hedge ratio proves better than OLS.
Kofman and McGlenchy (2005)	Hong Kong	HSIF and HIS	Jan. 1994 to July 2003	Naïve, Expanding window, Rolling Window, EWLS and **ROC**	Dynamic hedging is better than constant hedging
Lien and Shrestha (2005)	U.S.A., U.K. Canada, Japan, Australia	Seven Stock Index Futures, Two precious metals, five currencies and Ten commodities	1982 to 1997	**ECM(AIC)** and **ECM(FIC)**	Both are equally fruitful but ECM(AIC) is little bit better than other.
Floros and Vougas (2006)	Greece	FTSE/ASE20 Index Futures and FTSE/ASE Mid 40 Index Futures	Aug. 1999 to Aug. 2001 and Jan. 200 to Aug. 2001	OLS, ECM, VECM and **BGARCH**	Time varying hedge ratio is superior to constant hedge ratios
In and Kim (2006)	U.S.A.	S&P500 Futures and S&P500 Index	April 1982 to Dec. 2001	**Wavelet Analysis**	Hedging effectiveness does not only depends upon hedging horizon but risk aversion of hedger also affects the hedging effectiveness. Investor with low risk aversion have short run HE and vice versa.
Bhaduri and Durai (2007)	India	Nifty Futures and Nifty	Sept. 2000 to Aug. 2005	**OLS**, ECM, BVAR and **MGARCH**	GARCH model performs better in the long run whereas OLS is a better measure during short-run.

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Bhargava and Malhotra (2007)	U.S.A.	Cotton and Soybeans Futures	Jan. 1994 to Dec. 1999 and Jan. 1995 to Dec. 2000	Traditional regression method, Modified regression method and ECM	Traditional regression method performs better than others
Lee and Yoder (2007)	U.K.	Corn and Nickel Futures and Spot Markets	Jan. 1991 to Dec. 2004	**RS-BEKK**, BEKK and OLS	Time varying hedge ratio performs better.

Source: Compiled from various empirical studies.

Where, AIC= Akaike Information Criteria, AOI= All Ordinary Share Price Index, BP= British Pound, CD= Canadian Dollar, ECM= Error Correction Methodology, EWMA= Exponential Weighted Moving Average, GARCH= Generalized Autoregressive Conditional Heteroscedasticity, GM= German Mark, , HIS= Hang Seng Index, HSIF= Hang Seng Index Futures, MVHR= Minimum Variance Hedge Ratio, SF=Swiss Franc, SPI= Share Price Index Futures, OLS= Ordinary Least Square, U.S.A.= United States of America, U.K.= United Kingdom, VAR=Vector Autoregression.

Table II Unit Root Test Results

Symbols	Variables	Augmented Dickey Fuller Test		Philips Perron Test	
		Without Drift	With Drift and Trend	Without Drift	With Drift and Trend
BANKNIFTY	FUTURES	-16.73*	-16.76*	-16.74*	-16.65*
	CASH	-14.19*	-14.26*	-16.24*	-16.20*
	BASIS	-6.32*	-6.34*	-10.21*	-10.22*
CNXIT	FUTURES	-30.17*	-30.34*	-30.48*	-31.03*
	CASH	-29.04*	-29.21*	-29.30*	-29.75*
	BASIS	-6.49*	-6.58*	-16.15*	-16.36*
NIFTY	FUTURES	-31.16*	-24.31*	-31.16*	-31.33*
	CASH	-23.77*	-24.01*	-28.52*	-28.72*
	BASIS	-7.76*	-8.61*	-12.25*	-13.80*
ABB	FUTURES	-18.74*	-18.94*	-18.97*	-19.05*
	CASH	-17.77*	-17.97*	-17.93*	-18.06*
	BASIS	-8.24*	-8.35*	-8.09*	-8.19*
ACC	FUTURES	-31.38*	-31.61*	-31.39*	-31.62*
	CASH	-30.82*	-31.06*	-30.82*	-31.07*
	BASIS	-10.24*	-10.78*	-10.29*	-10.82*
ALBK	FUTURES	-18.95*	-18.92*	-18.95*	-18.92*
	CASH	-18.53*	-18.49*	-18.54*	-18.50*
	BASIS	-3.34*	-3.38**	-4.02*	-4.10*
ALOKTEXT	FUTURES	-15.98*	-15.94*	-18.98*	-18.93*
	CASH	-16.16*	-16.12*	-18.30*	-18.25*
	BASIS	-5.70*	-5.80*	-7.55*	-7.72*
ANDHRABANK	FUTURES	-21.84*	-21.84*	-25.35*	-25.34*
	CASH	-21.53*	-21.53*	-24.86*	-24.85*
	BASIS	-7.31*	-9.09*	-12.46*	-13.35*
ARVINDMILLS	FUTURES	-20.34*	-20.45*	-24.89*	-24.94*
	CASH	-20.27*	-20.40*	-24.65*	-24.71*
	BASIS	-31.06*	-31.02*	-77.93*	-77.95*
ASHOKLEY	FUTURES	-15.58*	-15.66*	-18.57*	-18.62*
	CASH	-18.24*	-18.29*	-18.15*	-18.19*
	BASIS	-6.37*	-7.03*	-7.59*	-8.23*
AUROPHARMA	FUTURES	-19.65*	-19.73*	-19.66*	-19.73*
	CASH	-19.70*	-19.79*	-19.70*	-19.79*
	BASIS	-5.07*	-6.87*	-12.73*	-15.13*
BAJAJAUTO	FUTURES	-31.07*	-31.26*	-31.07*	-31.26*
	CASH	-31.29*	-31.48*	-31.29*	-31.48*
	BASIS	-6.84*	-6.92*	-13.16*	-13.26*
BANKBARODA	FUTURES	-22.19*	-22.18*	-26.05*	-26.06*
	CASH	-21.67*	-21.66*	-24.90*	-24.91*
	BASIS	-7.33*	-7.60*	-12.83*	-13.29*
BANKINDIA	FUTURES	-25.86*	-25.89*	-25.72*	-25.74*
	CASH	-25.83*	-25.86*	-25.69*	-25.71*
	BASIS	-7.82*	-9.71*	-13.78*	-14.77*
BEL	FUTURES	-28.87*	-29.01*	-28.78*	-28.93*
	CASH	-28.54*	-28.69*	-28.44*	-28.59*
	BASIS	-6.96*	-8.62*	-14.67*	-17.68*
BHEL	FUTURES	-24.97*	-25.41*	-29.68*	-30.03*
	CASH	-24.72*	-25.16*	-29.28*	-29.65*
	BASIS	-8.31*	-8.42*	-20.03*	-20.03*
BILT	FUTURES	-20.82*	-20.78*	-20.82*	-20.78*
	CASH	-16.37*	-16.35*	-20.66*	-20.63*
	BASIS	-6.47*	-7.85*	-9.78*	-11.40*

BONGAIREFN	**FUTURES**	-18.26*	-18.29*	-18.26*	-18.28*
	CASH	-17.71*	-17.74*	-17.71*	-17.75*
	BASIS	-5.05*	-5.08*	-5.27*	-5.31*
BPCL	**FUTURES**	-29.69*	-29.70*	-29.74*	-29.75*
	CASH	-30.61*	-30.63*	-30.62*	-30.66*
	BASIS	-7.12*	-7.37*	-16.25*	-16.45*
CANBANK	**FUTURES**	-22.24*	-22.24*	-26.75*	-26.80*
	CASH	-22.15*	-22.15*	-27.34*	-27.40*
	BASIS	-7.11*	-7.21*	-13.32*	-13.55*
CENTURYTEXT	**FUTURES**	-21.73*	-21.82*	-21.69*	-21.79*
	CASH	-21.47*	-21.57*	-21.44*	-21.54*
	BASIS	-3.06*	-6.08*	-6.84*	-12.04*
CESC	**FUTURES**	-19.21*	-19.21*	-19.21*	-19.20*
	CASH	-19.34*	-19.35*	-19.34*	-19.35*
	BASIS	-4.74*	-5.96*	-10.32*	-12.62*
CHAMBLFERT	**FUTURES**	-19.59*	-19.56*	-19.59*	-19.56*
	CASH	-18.96*	-18.94*	-18.97*	-18.94*
	BASIS	-4.13*	-4.13*	-4.98*	-4.99*
COLGATE	**FUTURES**	-20.46*	-20.52*	-20.46*	-20.53*
	CASH	-20.59*	-20.67*	-20.59*	-20.68*
	BASIS	-6.59*	-11.23*	-11.20*	-11.78*
CORPBANK	**FUTURES**	-17.64*	-17.59*	-17.61*	-17.56*
	CASH	-17.14*	-17.10*	-17.08*	-17.04*
	BASIS	-6.27*	-6.85*	-8.98*	-9.80*
CUMMINSIND	**FUTURES**	-19.76*	-19.80*	-19.76*	-19.81*
	CASH	-19.58*	-19.62*	-19.58*	-19.62*
	BASIS	-5.45*	-7.05*	-8.96*	-11.50*
DIVISLAB	**FUTURES**	-18.68*	-18.83*	-18.71*	-18.83*
	CASH	-18.21*	-18.36*	-18.25*	-18.37*
	BASIS	-5.56*	-8.29*	-11.27*	-15.07*
ESCORTS	**FUTURES**	-19.70*	-19.66*	-19.71*	-19.67*
	CASH	-19.36*	-19.32*	-19.35*	-19.31*
	BASIS	-18.69*	-19.10*	-18.69*	-19.09*
ESSAROIL	**FUTURES**	-20.53*	-20.49*	-20.62*	-20.59*
	CASH	-20.36*	-20.32*	-20.48*	-20.44*
	BASIS	-2.82*	-9.00*	-7.63*	-13.69*
FEDERALBANK	**FUTURES**	-16.78*	-16.76*	-20.21*	-20.18*
	CASH	-17.37*	-17.35*	-20.51*	-20.54*
	BASIS	-6.17*	-6.94*	-9.13*	-10.26*
GAIL	**FUTURES**	-22.78*	-22.79*	-28.56*	-28.57*
	CASH	-22.62*	-22.63*	-27.92*	-27.93*
	BASIS	-6.74*	-7.51*	-9.21*	-10.33*
GLAXO	**FUTURES**	-20.47*	-20.54*	-20.48*	-20.57*
	CASH	-16.45*	-16.56*	-20.06*	-20.16*
	BASIS	-5.98*	-5.99*	-9.80*	-9.83*
GNFC	**FUTURES**	-19.62*	-19.61*	-19.67*	-19.66*
	CASH	-19.63*	-19.62*	-19.67*	-19.70*
	BASIS	-4.39*	-4.97*	-5.47*	-6.43*
GRASIM	**FUTURES**	-30.81*	-31.09*	-30.85*	-31.09*
	CASH	-30.67*	-30.96*	-30.73*	-30.96*
	BASIS	-9.36*	-9.74*	-13.78*	-14.39*
HCLTCH	**FUTURES**	-32.26*	-32.31*	-32.66*	-32.99*
	CASH	-31.61*	-31.66*	-32.02*	-32.28*
	BASIS	-5.45*	-6.10*	-23.73*	-23.89*
HDFC	**FUTURES**	-24.58*	-24.75*	-31.90*	-32.26*
	CASH	-24.69*	-24.86*	-32.06*	-32.43*
	BASIS	-9.23*	-9.38*	-17.95*	-18.14*

HDFCBANK	**FUTURES**	-30.64*	-22.96*	-30.71*	-31.00*
	CASH	-23.07*	-23.26*	-31.06*	-31.44*
	BASIS	-7.88*	-8.19*	-18.06*	-18.51*
HEROHONDA	**FUTURES**	-30.33*	-30.39*	-30.40*	-30.55*
	CASH	-30.63*	-30.69*	-30.81*	-31.00*
	BASIS	-7.86*	-8.08*	-9.55*	-9.85*
HINDLEVER	**FUTURES**	-30.68*	-30.67*	-30.68*	-30.67*
	CASH	-29.54*	-29.53*	-29.52*	-29.50*
	BASIS	-7.85*	-7.88*	-10.08*	-10.11*
HINDPETRO	**FUTURES**	-29.48*	-29.46*	-29.46*	-29.44*
	CASH	-28.60*	-28.58*	-28.57*	-28.54*
	BASIS	-9.32*	-9.42*	-12.42*	-12.58*
ICICIBANK	**FUTURES**	-22.92*	-23.11*	-28.09*	-28.40*
	CASH	-22.72*	-22.90*	-27.75*	-28.06*
	BASIS	-5.65*	-7.05*	-14.67*	-15.69*
IDBI	**FUTURES**	-18.90*	-18.86*	-18.88*	-18.84*
	CASH	-18.70*	-18.66*	-18.68*	-18.64*
	BASIS	-3.75*	-6.32*	-7.41*	-9.55*
IDFC	**FUTURES**	-14.65*	-14.64*	-18.48*	-18.45*
	CASH	-14.61*	-14.60*	-18.75*	-18.71*
	BASIS	-4.85*	-4.98*	-6.10*	-6.30*
IFCI	**FUTURES**	-18.27*	-18.23*	-18.24*	-18.19*
	CASH	-17.93*	-17.89*	-17.85*	-17.80*
	BASIS	-2.57*	-9.34*	-6.45*	-13.97*
INDUSINDBANK	**FUTURES**	-18.90*	-18.86*	-18.91*	-18.86*
	CASH	-18.92*	-18.88*	-18.93*	-18.88*
	BASIS	-4.58*	-7.05*	-8.16*	-10.85*
IOB	**FUTURES**	-17.73*	-17.71*	-17.78*	-17.78*
	CASH	-15.53*	-15.52*	-17.93*	-17.93*
	BASIS	-6.29*	-6.65*	-7.74*	-7.83*
IOC	**FUTURES**	-24.42*	-20.07*	-24.38*	-24.35*
	CASH	-23.53*	-23.50*	-23.52*	-23.49*
	BASIS	-7.13*	-7.16*	-15.13*	-15.18*
IPCL	**FUTURES**	-25.19*	-25.25*	-33.22*	-33.32*
	CASH	-25.29*	-25.35*	-32.82*	-32.93*
	BASIS	-7.10*	-8.62*	-8.08*	-8.80*
JETAIRWAYS	**FUTURES**	-20.06*	-20.10*	-20.05*	-20.10*
	CASH	-19.19*	-19.23*	-19.13*	-19.21*
	BASIS	-5.87*	-6.16*	-13.36*	-13.69*
JINDALSTEL	**FUTURES**	-9.09*	-9.21*	-18.32*	-18.35*
	CASH	-9.03*	-9.16*	-18.12*	-18.16*
	BASIS	-4.59*	-7.51*	-10.25*	-13.50*
JPHYDRO	**FUTURES**	-19.25*	-19.20*	-19.22*	-19.17*
	CASH	-18.78*	-18.74*	-18.74*	-18.69*
	BASIS	-4.60*	-8.05*	-7.11*	-12.28*
JSTAINLESS	**FUTURES**	-21.01*	-20.97*	-21.01*	-20.97*
	CASH	-21.54*	-21.49*	-21.55*	-21.50*
	BASIS	-6.01*	-8.68*	-8.38*	-11.82*
KTKBANK	**FUTURES**	-20.04*	-20.04*	-20.04*	-20.04*
	CASH	-19.74*	-19.74*	-19.74*	-19.74*
	BASIS	-3.94*	-4.09*	-4.87*	-5.15*
LICHSGFIN	**FUTURES**	-18.65*	-18.65*	-18.61*	-18.61*
	CASH	-18.46*	-18.46*	-18.46*	-18.46*
	BASIS	-4.68*	-4.93*	-5.89*	-6.41*
MARUTI	**FUTURES**	-29.41*	-29.59*	-29.41*	-29.60*
	CASH	-29.31*	-29.49*	-29.31*	-29.51*
	BASIS	-8.11*	-8.58*	-16.10*	-17.05*

MATRIXLABS	**FUTURES**	-16.79*	-16.83*	-21.10*	-21.10*
	CASH	-16.88*	-16.94*	-21.10*	-21.15*
	BASIS	-6.12*	-6.56*	-4.77*	-5.04*
MRPL	**FUTURES**	-19.82*	-19.78*	-19.81*	-19.76*
	CASH	-19.74*	-19.69*	-19.74*	-19.69*
	BASIS	-3.95*	-6.22*	-5.98*	-8.63*
MTNL	**FUTURES**	-23.84*	-23.84*	-29.73*	-29.72*
	CASH	-23.81*	-23.80*	-30.09*	-30.08*
	BASIS	-8.84*	-9.57*	-11.33*	-12.33*
NAGARFERT	**FUTURES**	-17.96*	-17.92*	-17.87*	-17.82*
	CASH	-17.73*	-17.69*	-17.62*	-17.57*
	BASIS	-3.57*	-7.23*	-7.09*	-14.01*
NATIONALUM	**FUTURES**	-29.07*	-29.07*	-29.02*	-29.02*
	CASH	-28.17*	-28.18*	-28.09*	-28.09*
	BASIS	-5.73*	-6.77*	-11.98*	-13.95*
NDTV	**FUTURES**	-18.38*	-18.34*	-18.39*	-18.35*
	CASH	-18.28*	-18.24*	-18.25*	-18.21*
	BASIS	-2.88*	-9.66*	-9.54*	-15.24*
NEYVELILIG	**FUTURES**	-18.68*	-18.66*	-18.64*	-18.62*
	CASH	-17.80*	-17.78*	-17.71*	-17.69*
	BASIS	-5.58*	-7.44*	-10.43*	-13.43*
NICOLAPIR	**FUTURES**	-19.58*	-19.53*	-19.56*	-19.52*
	CASH	-19.01*	-18.97*	-18.98*	-18.93*
	BASIS	-5.21*	-5.57*	-11.29*	-11.93*
NTPC	**FUTURES**	-22.51*	-22.55*	-22.53*	-22.60*
	CASH	-18.19*	-18.27*	-22.25*	-22.31*
	BASIS	-4.99*	-5.90*	-9.62*	-11.05*
ORIENTBANK	**FUTURES**	-21.91*	-21.91*	-24.89*	-24.88*
	CASH	-22.46*	-22.46*	-24.61*	-24.60*
	BASIS	-8.81*	-9.06*	-10.77*	-11.12*
PATNI	**FUTURES**	-15.70*	-15.69*	-18.89*	-18.86*
	CASH	-19.63*	-19.60*	-19.60*	-19.58*
	BASIS	-8.37*	-9.84*	-13.86*	-14.48*
PNB	**FUTURES**	-26.68*	-26.71*	-26.61*	-26.64*
	CASH	-25.98*	-26.01*	-25.91*	-25.92*
	BASIS	-4.83*	-4.98*	-9.02*	-9.19*
POLARIS	**FUTURES**	-29.54*	-29.52*	-29.50*	-29.49*
	CASH	-29.04*	-29.03*	-28.99*	-28.97*
	BASIS	-5.21*	-7.92*	-8.95*	-14.77*
REL	**FUTURES**	-22.08*	-22.07*	-28.34*	-28.33*
	CASH	-21.52*	-21.51*	-27.60*	-27.57*
	BASIS	-4.45*	-4.48*	-10.55*	-10.60*
RELCAPITAL	**FUTURES**	-19.62*	-19.74*	-19.70*	-19.77*
	CASH	-19.29*	-19.41*	-19.37*	-19.43*
	BASIS	-3.18*	-7.54*	-6.62*	-11.88*
RELIANCE	**FUTURES**	-31.77*	-31.90*	-31.78*	-31.90*
	CASH	-32.65*	-32.78*	-32.64*	-32.80*
	BASIS	-6.55*	-8.79*	-14.54*	-17.05*
SBIN	**FUTURES**	-30.31*	-30.40*	-30.28*	-30.39*
	CASH	-23.64*	-23.78*	-29.70*	-29.81*
	BASIS	-6.58*	-7.88*	-9.22*	-11.73*
SCI	**FUTURES**	-28.86*	-28.87*	-28.79*	-28.80*
	CASH	-29.40*	-29.41*	-29.36*	-29.37*
	BASIS	-8.63*	-9.20*	-12.44*	-13.13*
SRF	**FUTURES**	-18.56*	-18.67*	-18.64*	-18.71*
	CASH	-18.37*	-18.49*	-18.45*	-18.52*
	BASIS	-4.81*	-6.51*	-6.58*	-9.41*

STAR	**FUTURES**	-20.08*	-20.04*	-20.10*	-20.07*
	CASH	-18.68*	-18.65*	-18.63*	-18.60*
	BASIS	-4.57*	-5.10*	-12.44*	-13.06*
SUNPHARMA	**FUTURES**	-20.97*	-21.11*	-20.97*	-21.16*
	CASH	-20.57*	-20.70*	-20.58*	-20.78*
	BASIS	-3.11*	-10.56*	-7.54*	-10.57*
SYNDIBANK	**FUTURES**	-20.70*	-20.72*	-24.29*	-24.29*
	CASH	-20.71*	-20.73*	-24.55*	-24.56*
	BASIS	-6.07*	-6.20*	-9.50*	-9.77*
TATACHEM	**FUTURES**	-21.80*	-21.85*	-21.80*	-21.88*
	CASH	-21.16*	-21.24*	-21.15*	-21.24*
	BASIS	-2.58*	-2.58	-5.45*	-5.49*
TATAMOTORS	**FUTURES**	-31.41*	-31.55*	-31.44*	-31.65*
	CASH	-24.07*	-24.27*	-30.73*	-30.90*
	BASIS	-6.18*	-6.33*	-14.80*	-15.44*
TATAPOWER	**FUTURES**	-24.69*	-24.87*	-30.26*	-30.39*
	CASH	-24.57*	-24.76*	-29.52*	-29.65*
	BASIS	-7.25*	-7.75*	-11.54*	-12.38*
TATATEA	**FUTURES**	-28.31*	-28.43*	-28.19*	-28.27*
	CASH	-28.08*	-28.22*	-27.96*	-28.04*
	BASIS	-7.01*	-7.58*	-10.77*	-11.95*
TITAN	**FUTURES**	-18.14*	-18.27*	-18.15*	-18.24*
	CASH	-18.00*	-18.13*	-18.01*	-18.09*
	BASIS	-4.24*	-7.62*	-6.50*	-10.19*
TVSMOTORS	**FUTURES**	-18.92*	-18.96*	-18.90*	-18.92*
	CASH	-18.44*	-18.48*	-18.39*	-18.42*
	BASIS	-4.99*	-5.67*	-9.06*	-10.49*
UNIONBANK	**FUTURES**	-25.56*	-20.94*	-25.38*	-25.39*
	CASH	-21.29*	-21.32*	-25.69*	-25.71*
	BASIS	-7.87*	-8.22*	-12.00*	-12.50*
UTIBANK	**FUTURES**	-19.68*	-19.74*	-19.69*	-19.72*
	CASH	-20.04*	-20.08*	-20.04*	-20.11*
	BASIS	-8.45*	-8.79*	-13.21*	-13.68*
VIJAYABANK	**FUTURES**	-19.21*	-19.17*	-19.21*	-19.17*
	CASH	-19.35*	-19.31*	-19.38*	-19.34*
	BASIS	-5.13*	-8.30*	-9.62*	-12.64*
WOCKPHARMA	**FUTURES**	-18.52*	-18.56*	-18.48*	-18.50*
	CASH	-17.76*	-17.80*	-17.66*	-17.68*
	BASIS	-4.81*	-6.06*	-9.30*	-12.21*
* and ** Significant at 1% and 5% significance level respectively.					

Table III Descriptive Statistics

Symbols	Variables	Count	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
BANKNIFTY	**FUTURES**	385	0.001335	0.018441	-0.402322	4.926330	69.73120*
	CASH	385	0.001303	0.017815	-0.342960	4.806104	59.71997*
	BASIS	385	0.000145	0.004792	-1.331375	7.626209	455.8728*
CNXIT	**FUTURES**	833	0.001543	0.018978	-0.453098	16.48191	6337.159*
	CASH	833	0.001540	0.018263	-0.150685	10.59900	2007.378*
	BASIS	833	9.52E-05	0.004863	-0.971186	10.69806	2187.767*
NIFTY	**FUTURES**	998	0.001283	0.016032	-1.335249	16.58976	7976.229*
	CASH	998	0.001285	0.014715	-1.118830	12.02216	3593.070*
	BASIS	998	-0.001852	0.004742	-1.336837	7.776468	1245.969*
ABB	**FUTURES**	417	0.002772	0.022791	-0.339925	7.085139	297.9909*
	CASH	417	0.002768	0.021458	-0.280058	5.979046	159.6492*
	BASIS	417	0.003975	0.038626	-0.995076	10.68534	1095.062*
ACC	**FUTURES**	998	0.002074	0.022250	-0.250975	6.084294	397.9166*
	CASH	998	0.001858	0.021621	-0.183568	5.662628	294.3933*
	BASIS	998	0.012291	0.046800	-0.793499	9.895391	2040.148*
ALBK	**FUTURES**	423	0.000294	0.021564	-0.223252	4.700786	54.36834*
	CASH	423	0.000232	0.021425	-0.405819	5.169430	94.33782*
	BASIS	423	0.001232	0.014579	-3.247397	13.33929	2621.382*
ALOKTEXT	**FUTURES**	395	0.000134	0.026311	0.065873	5.190530	79.25971*
	CASH	395	0.000137	0.026282	0.017793	5.279955	85.57444*
	BASIS	395	0.001771	0.010369	-2.754389	15.91163	3243.228*
ANDHRABANK	**FUTURES**	833	0.000810	0.029950	-0.338393	8.411993	1032.493*
	CASH	833	0.000827	0.029366	-0.283542	8.193922	947.4825*
	BASIS	833	0.002679	0.007080	-1.767211	8.270047	1397.549*
ARVINDMILLS	**FUTURES**	813	0.000146	0.030516	-0.279557	5.144003	166.3044*
	CASH	813	0.000154	0.029736	-0.298970	5.452913	215.9300*
	BASIS	813	0.004382	0.004635	-0.294555	5.244214	182.3676*
ASHOKLEY	**FUTURES**	422	0.001817	0.025420	-0.181066	5.608429	121.9411*
	CASH	422	0.001824	0.025064	-0.127605	5.270487	91.78925*
	BASIS	422	0.003194	0.008299	-3.217242	15.92440	3665.116*
AUROPHARMA	**FUTURES**	406	0.002081	0.025001	0.479721	4.715901	65.38025*
	CASH	406	0.002089	0.024749	0.678356	6.310551	216.5403*
	BASIS	406	0.004288	0.006542	-2.809096	27.34115	10556.94*
BAJAJAUTO	**FUTURES**	998	0.001639	0.019676	-0.104925	6.148982	414.1751*
	CASH	998	0.001642	0.019678	-0.040934	5.004078	167.2910*
	BASIS	998	-0.001049	0.008782	-1.911327	8.652267	1936.154*
BANKBARODA	**FUTURES**	833	0.000597	0.033301	-0.823895	17.86207	7760.657*
	CASH	833	0.000612	0.031868	-0.490668	11.58042	2588.779*
	BASIS	833	0.001931	0.008273	-2.815133	18.32002	9246.403*
BANKINDIA	**FUTURES**	833	0.001596	0.034389	-0.166660	6.004010	317.0668*
	CASH	833	0.001621	0.034037	-0.074083	5.676542	249.4081*
	BASIS	833	0.002404	0.006736	-1.585889	8.524413	1408.440*
BEL	**FUTURES**	976	0.001947	0.025039	0.060880	7.305953	754.6129*
	CASH	976	0.001950	0.024119	0.138879	7.309824	758.5037*
	BASIS	976	0.003505	0.005707	-0.755653	5.499208	346.8902*
BHEL	**FUTURES**	998	0.002589	0.024581	-1.186682	23.85182	18314.60*
	CASH	998	0.002591	0.024130	-0.620137	14.83131	5884.793*
	BASIS	998	-0.000248	0.006504	-1.562464	11.29107	3264.584*
BILT	**FUTURES**	406	-2.81E-05	0.025048	-0.579796	8.185470	477.6210*
	CASH	406	-3.29E-50	0.024139	-0.678891	8.284907	503.6737*
	BASIS	406	0.003183	0.005823	-1.154101	6.462803	292.9764*
BONGAIREFN	**FUTURES**	406	-0.001709	0.025518	-0.442867	8.706698	564.1865*
	CASH	406	-0.001716	0.024594	-0.564479	9.040376	638.7851*
	BASIS	406	0.001834	0.014850	-3.319707	13.76468	2705.992*
BPCL	**FUTURES**	998	0.000383	0.024143	-0.185078	6.791118	603.3571*
	CASH	998	0.000410	0.023929	0.084930	5.798982	326.9726*
	BASIS	998	-0.001918	0.010126	-3.209833	26.26418	24219.55*

CANBANK	**FUTURES**	833	0.000936	0.030764	-0.250610	6.433211	417.8244*
	CASH	833	0.000957	0.030920	-0.065459	6.402834	402.4923*
	BASIS	833	0.001075	0.008502	-2.692085	15.37631	6322.552*
CENTURYTEXT	**FUTURES**	422	0.002684	0.035582	-0.369469	6.724674	253.5381*
	CASH	422	0.002677	0.034392	-0.396010	6.884538	276.3560*
	BASIS	422	0.004385	0.004284	-0.641326	5.113970	107.5056*
CESC	**FUTURES**	406	0.001330	0.027587	-0.869823	9.273369	716.9542*
	CASH	406	0.001326	0.027025	-1.006838	10.94087	1135.317*
	BASIS	406	0.003612	0.005945	-1.289694	6.360096	303.5440*
CHAMBLFERT	**FUTURES**	406	0.000521	0.024639	-0.390165	6.468803	213.8522*
	CASH	406	0.000525	0.023743	-0.586453	6.953154	287.6363*
	BASIS	406	0.000951	0.014609	-2.478882	8.652594	956.3200*
COLGATE	**FUTURES**	422	0.001556	0.024736	0.873068	11.77748	1408.303*
	CASH	422	0.001528	0.023366	1.124075	12.49708	1674.791*
	BASIS	422	0.002442	0.006500	-2.458244	14.08489	2585.568*
CORPBANK	**FUTURES**	385	-9.56E-05	0.029089	-0.310687	8.409757	475.6606*
	CASH	385	-9.44E-05	0.028359	-0.231358	7.591893	341.6809*
	BASIS	385	0.002224	0.007254	-0.899296	4.416888	85.01406*
CUMMINSIND	**FUTURES**	380	0.001888	0.029101	0.340740	5.301170	91.19684*
	CASH	380	0.001888	0.027654	0.349189	5.177467	82.79397*
	BASIS	380	0.003775	0.005524	-0.891310	6.370101	230.1425*
DIVISLAB	**FUTURES**	406	0.002855	0.027671	-0.156406	6.595236	220.3154*
	CASH	406	0.002849	0.026382	-0.243415	7.151616	295.5836*
	BASIS	406	0.005037	0.006216	1.429376	26.81189	9730.106*
ESCORTS	**FUTURES**	395	0.000763	0.038772	-0.039455	4.863097	57.23151*
	CASH	395	0.000773	0.037868	0.051479	5.058868	69.94029*
	BASIS	395	0.006151	0.038586	-0.134932	5.234083	83.34425*
ESSAROIL	**FUTURES**	406	0.001044	0.041188	0.138441	7.144109	291.8176*
	CASH	406	0.001034	0.040439	0.167222	7.628565	364.3084*
	BASIS	406	0.005228	0.004320	-0.135010	3.921563	15.60036*
FEDERALBANK	**FUTURES**	406	0.000814	0.027951	-0.343400	7.535135	355.9122*
	CASH	406	0.000790	0.027611	-0.271982	8.000690	428.0390*
	BASIS	406	0.002999	0.007755	-2.182783	11.18824	1456.617*
GAIL	**FUTURES**	813	0.000730	0.029285	-0.076069	29.40212	23614.10*
	CASH	813	0.000787	0.028511	-0.096079	24.97598	16360.97*
	BASIS	813	-0.001980	0.010168	-1.724453	7.245408	1013.487*
GLAXO	**FUTURES**	422	0.001218	0.023397	-0.068218	6.968143	277.1973*
	CASH	422	0.001169	0.021536	-0.144371	5.917356	151.1171*
	BASIS	422	0.000309	0.008384	-1.374097	5.874785	278.1149*
GNFC	**FUTURES**	406	0.000642	0.029120	-0.021057	7.329326	317.1002*
	CASH	406	0.000638	0.028522	0.015836	7.404770	328.2341*
	BASIS	406	0.003714	0.008721	-3.572083	18.46984	4911.842*
GRASIM	**FUTURES**	998	0.002180	0.022067	0.279324	7.077563	704.3638*
	CASH	998	0.002198	0.021803	0.359303	7.023161	694.5339*
	BASIS	998	0.001351	0.005973	-0.736194	4.074133	138.1268*
HCLTCH	**FUTURES**	976	0.001387	0.027283	-0.396541	9.931323	1979.337*
	CASH	976	0.001409	0.026749	-0.516477	8.857187	1438.528*
	BASIS	976	-0.000405	0.007440	-4.659567	62.55508	147768.57*
HDFC	**FUTURES**	998	0.001524	0.021535	0.457972	10.87127	2611.263*
	CASH	998	0.001522	0.021993	0.325851	6.623006	563.4911*
	BASIS	998	-0.001091	0.006983	-1.932181	9.850296	2572.338*
HDFCBANK	**FUTURES**	833	0.001627	0.021293	-0.900584	33.22990	31830.71*
	CASH	833	0.001626	0.021872	0.163143	31.95491	29102.70*
	BASIS	833	-0.001394	0.007019	-1.926467	16.23957	6599.142*
HEROHONDA	**FUTURES**	976	0.001120	0.021874	-0.037283	4.855592	140.2505*
	CASH	976	0.001124	0.022953	-0.059975	4.401217	80.43041*
	BASIS	976	-0.002607	0.011626	-2.880215	14.44140	6672.918*

HINDLEVER	**FUTURES**	998	0.000174	0.020556	-0.411778	8.205080	1154.815*
	CASH	998	0.000175	0.020382	-0.300527	7.919760	1021.507*
	BASIS	998	-0.000350	0.009383	-3.797757	22.52323	18248.77*
HINDPETRO	**FUTURES**	998	-9.67E-05	0.024773	-0.247158	7.106269	711.3159*
	CASH	998	-9.14E-05	0.023750	-0.291095	6.565608	542.7666*
	BASIS	998	0.001062	0.009080	-3.424464	19.64624	13473.21*
ICICIBANK	**FUTURES**	976	0.001825	0.022797	-0.003587	6.651226	542.1477*
	CASH	976	0.001827	0.022909	0.125677	5.805752	322.7072*
	BASIS	976	-0.002242	0.010131	-1.508705	5.872128	705.7246*
IDBI	**FUTURES**	422	-0.000251	0.030504	-0.000706	6.125992	171.8213*
	CASH	422	-0.000242	0.029766	0.018229	6.363526	198.9491*
	BASIS	422	0.003765	0.005785	-2.061354	11.10935	1455.165*
IDFC	**FUTURES**	341	0.000337	0.025504	0.519285	6.892131	230.5630*
	CASH	341	0.000335	0.025223	0.578860	6.718258	215.4802*
	BASIS	341	0.001789	0.008195	-2.317441	10.57766	1121.082*
IFCI	**FUTURES**	395	-0.000170	0.040209	0.206555	6.082381	159.1806*
	CASH	395	-0.000182	0.038698	0.139327	6.106062	160.0617*
	BASIS	395	0.008117	0.005607	-0.311999	3.920426	20.35169*
INDUSINDBANK	**FUTURES**	406	-0.000437	0.037144	-0.301624	7.088246	288.8971*
	CASH	406	-0.000453	0.036060	-0.237605	7.189613	300.7560*
	BASIS	406	0.004320	0.005991	-1.431988	6.732466	374.4277*
IOB	**FUTURES**	422	0.001046	0.029337	-0.206758	5.348146	99.95746*
	CASH	422	0.001059	0.028689	0.039968	5.312882	94.17304*
	BASIS	422	0.002506	0.009047	-2.329941	11.05953	1523.955*
IOC	**FUTURES**	813	0.000257	0.026377	-0.741857	14.01838	4187.158*
	CASH	813	0.000267	0.025008	-0.300557	9.565449	1472.426*
	BASIS	813	0.000806	0.008691	-3.783534	30.40557	27382.03*
IPCL	**FUTURES**	976	0.001188	0.028615	-0.348666	21.74013	14301.60*
	CASH	976	0.001196	0.027993	-0.264025	20.89999	13041.33*
	BASIS	976	0.003118	0.008364	-4.065384	29.14024	30476.48*
JETAIRWAYS	**FUTURES**	447	-0.001671	0.024585	-0.966197	11.33246	1362.680*
	CASH	447	-0.001673	0.023963	-0.292208	8.809893	635.0454*
	BASIS	447	-0.000706	0.007656	-1.420026	6.720142	407.9871*
JINDALSTEL	**FUTURES**	422	0.001886	0.027820	-1.290973	13.93283	2218.899*
	CASH	422	0.001911	0.027083	-1.226843	12.89687	1828.113*
	BASIS	422	0.004215	0.005885	0.293948	6.778386	257.1004*
JPHYDRO	**FUTURES**	424	-0.000108	0.025078	-0.222276	7.423126	349.1229*
	CASH	424	-0.000116	0.024048	-0.414247	7.518913	372.8900*
	BASIS	424	0.005721	0.005045	-0.267651	5.494220	114.9690*
JSTAINLESS	**FUTURES**	406	0.000387	0.035912	0.308638	8.646619	545.8220*
	CASH	406	0.000410	0.035034	0.373328	9.414194	705.4145*
	BASIS	406	0.004630	0.005711	-1.290295	7.801603	502.6760*
KTKBANK	**FUTURES**	395	0.001534	0.032399	0.742804	8.116029	467.1004*
	CASH	395	0.001539	0.031147	0.760213	7.596209	385.7311*
	BASIS	395	0.002609	0.010235	-2.662576	10.47427	1386.153*
LICHSGFIN	**FUTURES**	422	-0.000959	0.022164	-0.353068	6.924634	279.5993*
	CASH	422	-0.001005	0.021463	-0.366455	6.390991	211.6326*
	BASIS	422	0.002956	0.009162	-2.581933	11.74453	1813.410*
MARUTI	**FUTURES**	869	0.001992	0.025530	0.143740	5.475066	224.8030*
	CASH	869	0.001994	0.025618	0.219604	5.094221	165.7859*
	BASIS	869	0.000990	0.005719	-0.766788	5.023050	233.3479*
MATRIXLABS	**FUTURES**	422	0.000493	0.028562	0.516713	9.585583	781.3660*
	CASH	422	0.000486	0.027217	0.954753	10.80431	1135.065*
	BASIS	422	0.000521	0.020014	-5.562085	36.57705	21999.66*
MRPL	**FUTURES**	422	-0.000298	0.028653	-0.124371	7.606824	374.2559*
	CASH	422	-0.000271	0.027545	-0.047958	7.832747	410.8282*
	BASIS	422	0.004505	0.005729	-1.228438	5.230728	193.6344*

MTNL	**FUTURES**	998	0.000395	0.026942	-0.004390	6.994797	663.6067*
	CASH	998	0.000395	0.026911	0.103027	6.617215	545.8520*
	BASIS	998	0.002487	0.006506	-2.130174	11.43759	3715.198*
NAGARFERT	**FUTURES**	395	-0.000324	0.032234	-0.466661	8.717735	552.4005*
	CASH	395	-0.000328	0.030799	-0.380586	8.194810	453.6811*
	BASIS	395	0.007119	0.005592	-1.255557	9.429140	784.0674*
NATIONALUM	**FUTURES**	976	0.000882	0.028790	-0.637795	9.188547	1623.626*
	CASH	976	0.000915	0.027043	-0.614264	7.778732	990.0529*
	BASIS	976	-0.000919	0.011090	-1.996910	9.643297	2443.416*
NDTV	**FUTURES**	406	0.000423	0.035213	-0.698990	5.914259	176.7327*
	CASH	406	0.000426	0.034415	-0.702015	5.918178	177.4061*
	BASIS	406	0.005304	0.004734	0.387026	8.847174	588.5072*
NEYVELILIG	**FUTURES**	422	-0.000477	0.029089	-0.372302	11.01527	1139.382*
	CASH	422	-0.000473	0.027605	-0.255497	11.87559	1389.737*
	BASIS	422	0.004036	0.005690	-1.337218	8.289599	617.7460*
NICOLASPIR	**FUTURES**	422	0.000505	0.026606	0.358507	8.103587	467.0259*
	CASH	422	0.000490	0.024957	0.259100	7.086441	298.3457*
	BASIS	422	0.002254	0.007874	-1.570145	7.258059	492.2012*
NTPC	**FUTURES**	534	0.001108	0.018365	0.060440	4.909661	81.46655*
	CASH	534	0.001108	0.018242	0.100341	4.681064	63.77407*
	BASIS	534	0.002581	0.004999	-0.770315	4.737951	120.0169*
ORIENTBANK	**FUTURES**	833	0.000296	0.030977	-0.995533	18.05781	8007.277*
	CASH	833	0.000326	0.030432	-0.808975	16.58796	6499.153*
	BASIS	833	0.001829	0.007996	-3.585844	24.46533	17777.38*
PATNI	**FUTURES**	422	0.000557	0.024456	0.774594	10.17715	947.9438*
	CASH	422	0.000557	0.023896	1.170232	11.78044	1451.923*
	BASIS	422	0.003218	0.007121	-5.897579	78.73916	103311.70*
PNB	**FUTURES**	833	0.001268	0.029463	-0.389100	8.349188	1014.157*
	CASH	833	0.001289	0.028943	-0.294956	7.392712	681.8077*
	BASIS	833	-0.000638	0.011536	-3.226099	16.89808	8149.084*
POLARIS	**FUTURES**	976	0.000140	0.034277	-0.519652	7.174737	752.6825*
	CASH	976	0.000134	0.033443	-0.472296	7.494669	857.8348*
	BASIS	976	0.004670	0.004816	-0.505143	4.977865	200.5936*
REL	**FUTURES**	699	-0.000499	0.027611	-2.495871	48.08156	59917.84*
	CASH	699	-0.000505	0.025437	-1.848650	37.69288	35452.87*
	BASIS	699	0.000686	0.009461	-3.820795	23.25176	13645.87*
RELCAPITAL	**FUTURES**	422	0.002794	0.034957	0.148279	9.839599	824.0967*
	CASH	422	0.002788	0.034579	0.266310	10.28676	938.6079*
	BASIS	422	0.004377	0.004117	-1.300050	8.519489	654.5444*
RELIANCE	**FUTURES**	998	0.001450	0.021022	-1.941301	23.32110	17798.58*
	CASH	998	0.001453	0.021628	-2.891479	40.21221	58973.11*
	BASIS	998	0.002935	0.005287	-2.573320	25.21641	21625.69*
SBIN	**FUTURES**	998	0.001474	0.022421	-0.845029	9.828168	2057.551*
	CASH	998	0.001479	0.021559	-0.760732	8.368103	1294.547*
	BASIS	998	0.003286	0.005472	-1.691051	9.358685	2156.990*
SCI	**FUTURES**	976	0.000979	0.029597	-0.681709	12.87896	4044.408*
	CASH	976	0.000984	0.029558	-0.277285	14.13659	5056.132*
	BASIS	976	0.002817	0.008808	-3.570780	23.68975	19482.08*
SRF	**FUTURES**	395	0.000799	0.041022	0.135958	7.368090	315.2454*
	CASH	395	0.000791	0.040056	0.274910	7.632840	358.2240*
	BASIS	395	0.004205	0.005249	-1.509533	7.621817	501.5835*
STAR	**FUTURES**	395	0.001083	0.032332	0.729723	9.359736	700.7337*
	CASH	395	0.001098	0.030201	0.793652	7.658975	398.7127*
	BASIS	395	0.003025	0.011056	-3.623565	24.97127	8809.446*
SUNPHARMA	**FUTURES**	422	0.001783	0.018775	-0.167620	4.558419	44.68023*
	CASH	422	0.001744	0.018986	-0.146669	5.084428	77.90977*
	BASIS	422	-0.006860	0.009731	-1.773672	8.085354	675.9819*

SYNDIBANK	**FUTURES**	813	0.001240	0.032792	-0.214321	12.09846	2810.463*
	CASH	813	0.001248	0.032233	-0.162561	10.61696	1968.946*
	BASIS	813	0.001916	0.009703	-2.613639	13.82178	4892.747*
TATACHEM	**FUTURES**	422	0.000909	0.022666	0.114437	8.905212	614.0788*
	CASH	422	0.000891	0.020121	0.051186	6.830779	258.2174*
	BASIS	422	-0.002017	0.016568	-2.698518	10.48717	1497.848*
TATAMOTORS	**FUTURES**	998	0.001705	0.024067	-0.391477	5.661021	319.9444*
	CASH	998	0.001716	0.023699	-0.219446	4.416916	91.49484*
	BASIS	998	0.000807	0.007141	-2.113637	9.452582	2474.443*
TATAPOWER	**FUTURES**	998	0.001611	0.025291	-0.940810	13.84204	5035.337*
	CASH	998	0.001618	0.024284	-0.975664	12.14387	3635.132*
	BASIS	998	0.000236	0.009586	-3.064836	17.89188	10784.26*
TATATEA	**FUTURES**	998	0.001422	0.021926	-0.293821	7.626037	904.2521*
	CASH	998	0.001423	0.021389	-0.245959	7.387312	810.4795*
	BASIS	998	0.002475	0.006628	-1.322060	6.407631	773.5881*
TITAN	**FUTURES**	406	0.002818	0.034111	0.611560	8.413550	521.0765*
	CASH	406	0.002810	0.033619	0.766275	9.415784	736.0610*
	BASIS	406	0.004238	0.004833	-1.334417	7.068273	400.4771*
TVSMOTORS	**FUTURES**	406	0.000505	0.030824	0.032698	5.198335	81.82514*
	CASH	406	0.000499	0.029622	0.033343	5.344065	93.02620*
	BASIS	406	0.003239	0.007113	-2.239002	11.24138	1488.208*
UNIONBANK	**FUTURES**	833	0.001126	0.030345	-0.293890	6.256172	379.9918*
	CASH	833	0.001157	0.030585	-0.209484	6.577444	450.2933*
	BASIS	833	0.002051	0.007399	-1.948479	9.848563	2155.009*
UTIBANK	**FUTURES**	422	0.001748	0.024848	-0.134632	4.770174	56.37252*
	CASH	422	0.001702	0.025921	-0.163013	4.990935	71.56621*
	BASIS	422	-0.000649	0.008231	-2.207599	14.17195	2537.387*
VIJAYABANK	**FUTURES**	422	-0.000525	0.025694	0.487474	7.548503	380.4929*
	CASH	422	-0.000541	0.025697	0.822026	9.802587	861.1981*
	BASIS	422	0.004378	0.005747	-0.701811	4.744345	88.14346*
WOCKPHARMA	**FUTURES**	422	9.87E-05	0.023289	-0.353951	4.947124	75.47499*
	CASH	422	5.37E-05	0.022064	-0.194878	4.511717	42.85407*
	BASIS	422	0.004169	0.006388	-2.119171	11.27596	1520.168*
* Significant at 1% significance level.							

Table IV Optimal Hedge Ratios

S. No.	SYMBOL	OLS	GARCH	TARCH	EGARCH	VAR	VECM
1	**BANKNIFTY**	0.954325	0.976778	0.979427[H]	0.976822	0.945011[L]	0.954110
2	**CNXIT**	0.958219	0.982394	0.983521	0.991445[H]	0.956613[L]	0.958691
3	**NIFTY**	0.907241	0.920750	0.921465[H]	0.921447	0.904111[L]	0.913727
4	**ABB**	0.912704	0.935855	0.952362	0.953889[H]	0.904726[L]	0.910182
5	**ACC**	0.954642	0.957348	0.975383	0.976054[H]	0.950969[L]	0.953824
6	**ALBK**	0.946337	N.A.	N.A.	N.A.	0.948235[H]	0.933401[L]
7	**ALOKTEXT**	0.958443[L]	0.973128	0.981862[H]	0.980272	0.962647	0.972321
8	**ANDHRABANK**	0.974391	0.980668	0.982491	0.982571[H]	0.970474[L]	0.978616
9	**ARVINDMILLS**	0.969002	0.970021	0.973318[H]	0.972296	0.963478	0.963178[L]
10	**ASHOKLEY**	0.965287	0.986265[H]	0.982336	0.976827	0.960472[L]	0.962431
11	**AUROPHARMA**	0.943356	N.A.	N.A.	N.A.	0.943692[H]	0.938530[L]
12	**BAJAJAUTO**	0.960501	0.997923	1.001164[H]	0.994442	0.955667[L]	0.962976
13	**BANKBARODA**	0.945734	0.962970	0.977531[H]	0.976293	0.945709[L]	0.951251
14	**BANKINDIA**	0.982385	0.990092	0.994005[H]	0.993629	0.976964[L]	0.985451
15	**BEL**	0.953256[H]	N.A.	N.A.	N.A.	0.948546[L]	0.953236
16	**BHEL**	0.958345[H]	N.A.	N.A.	N.A.	0.957845	0.953114[L]
17	**BILT**	0.941232	0.952642	0.962219[H]	0.961004	0.936157[L]	0.937734
18	**BONGAIREFN**	0.925423	0.933928	0.908194[L]	0.934694	0.919504	0.943417[H]
19	**BPCL**	0.945423	0.963960	0.987400	0.998869[H]	0.942187[L]	0.958599
20	**CANBANK**	0.984180	0.991028	0.993827	1.002752[H]	0.980598[L]	0.981850
21	**CENTURYTEXT**	0.963095[H]	N.A.	N.A.	N.A.	0.960754[L]	0.962317
22	**CESC**	0.947205	0.949122	0.958047[H]	0.954839	0.941882	0.938909[L]
23	**CHAMBLFERT**	0.922341	N.A.	N.A.	N.A.	0.916986[L]	0.933672[H]
24	**COLGATE**	0.927758	0.956610	0.966530[H]	0.966530[H]	0.916193[L]	0.929679
25	**CORPBANK**	0.962303	0.968125	0.969059[H]	0.966842	0.951816[L]	0.957046
26	**CUMMINSIND**	0.938138[H]	N.A.	N.A.	N.A.	0.932345[L]	0.936126
27	**DIVISLAB**	0.956411	0.965586	0.973834	0.976852[H]	0.931019[L]	0.953682
28	**ESCORTS**	0.968391[H]	N.A.	N.A.	N.A.	0.964717[L]	0.966340
29	**ESSAROIL**	0.969641[H]	N.A.	N.A.	N.A.	0.968545	0.966547[L]
30	**FEDERALBANK**	0.956336	0.959471[H]	0.954741	0.958261	0.951219	0.938818[L]
31	**GAIL**	0.957567	0.967431[H]	0.965953	0.960674	0.954746[L]	0.958083
32	**GLAXO**	0.897584	0.910195	0.939107	0.942953[H]	0.887324[L]	0.888758
33	**GNFC**	0.965649	N.A.	N.A.	N.A.	0.960971[L]	0.968097[H]
34	**GRASIM**	0.970778	N.A.	N.A.	N.A.	0.968321[L]	0.973551[H]
35	**HCLTCH**	0.966956	0.991114	0.992009	0.997673[H]	0.963477[L]	0.971265
36	**HDFC**	1.001205	1.020666	1.020784	1.028577[H]	0.994144[L]	0.995631
37	**HDFCBANK**	1.009090	1.015543	1.017352	1.019549[H]	1.004205[L]	1.009169
38	**HEROHONDA**	0.999769	N.A.	N.A.	N.A.	0.999800[H]	0.978935[L]
39	**HINDLEVER**	0.965539	0.987412	0.992936[H]	0.988889	0.960892[L]	0.968040
40	**HINDPETRO**	0.932271	0.939642	0.938635	1.000936[H]	0.926845[L]	0.939635
41	**ICICIBANK**	0.953019[L]	0.975379[H]	0.975163	0.971114	0.954736	0.960489
42	**IDBI**	0.964884	0.975507	0.977574[H]	0.975595	0.959912[L]	0.964816
43	**IDFC**	0.963684	0.975763	0.978087[H]	0.975652	0.954968	0.939510[L]
44	**IFCI**	0.957699	0.960395	0.960784	0.961568[H]	0.951049[L]	0.960012
45	**INDUSINDBANK**	0.958858	0.960619	0.970285[H]	0.970269	0.954756	0.953694[L]
46	**IOB**	0.963501	0.982740[H]	0.976422	0.969685	0.954705[L]	0.963392
47	**IOC**	0.926873	0.940523	0.942203[H]	0.928559	0.923865[L]	0.929784
48	**IPCL**	0.968143[H]	0.963934	0.965591	0.966184	0.965701	0.960829[L]
49	**JETAIRWAYS**	0.949671	0.939650[L]	0.964825	0.975767[H]	0.941893	0.954784
50	**JINDALSTEL**	0.960258[H]	N.A.	N.A.	N.A.	0.952262[L]	0.952657

51	**JPHYDRO**	0.948162 [H]	N.A.	N.A.	N.A.	0.937365	0.936154 [L]
52	**JSTAINLESS**	0.960963	0.960704	0.967406 [H]	0.966743	0.953477 [L]	0.955825
53	**KTKBANK**	0.950089 [H]	N.A.	N.A.	N.A.	0.947965	0.947531 [L]
54	**LICHSGFIN**	0.935007 [H]	N.A.	N.A.	N.A.	0.929800	0.920178 [L]
55	**MARUTI**	0.990548	0.992219	1.000960 [H]	0.999270	0.989256 [L]	0.992867
56	**MATRIXLABS**	0.899863	0.922476	0.940174 [H]	0.906115	0.903317	0.899701 [L]
57	**MRPL**	0.949350	0.953326	0.952727	0.962575 [H]	0.943742 [L]	0.950182
58	**MTNL**	0.984175	0.992940 [H]	0.985609	0.987772	0.981108 [L]	0.984754
59	**NAGARFERT**	0.948359	N.A.	N.A.	N.A.	0.940287 [L]	0.954510 [H]
60	**NATIONALUM**	0.920248 [H]	0.916345	0.916534	0.916414	0.912135 [L]	0.918957
61	**NDTV**	0.972484	0.971805	0.985647 [H]	0.981297	0.964819 [L]	0.970361
62	**NEYVELILIG**	0.940307 [H]	N.A.	N.A.	N.A.	0.932623 [L]	0.936333
63	**NICOLASPIR**	0.911381	0.920017	0.934407	0.948092 [H]	0.905843 [L]	0.908916
64	**NTPC**	0.968335 [H]	N.A.	N.A.	N.A.	0.963719 [L]	0.965639
65	**ORIENTBANK**	0.969299	0.953482 [L]	0.968998	0.968893	0.961077	0.970264 [H]
66	**PATNI**	0.935187 [H]	N.A.	N.A.	N.A.	0.920845 [L]	0.929961
67	**PNB**	0.963860	0.961331	0.960765	0.959728	0.958686 [L]	0.977065 [H]
68	**POLARIS**	0.972154	0.970692	0.974387	0.974904 [H]	0.969881	0.967509 [L]
69	**REL**	0.907802	0.960732	0.972070 [H]	0.970936	0.901684 [L]	0.913750
70	**RELCAPITAL**	0.978211	0.973013 [L]	0.976443	0.979334 [H]	0.979300	0.976862
71	**RELIANCE**	0.994086	0.980958	0.978266 [L]	0.980839	0.995285 [H]	0.988868
72	**SBIN**	0.953816	0.955742	0.955413	0.956528	0.950890 [L]	0.958962 [H]
73	**SCI**	0.975516	0.967939 [L]	0.970005	0.970645	0.972781	0.978573 [H]
74	**SRF**	0.970648	0.979503	0.978219	0.981196 [H]	0.967064	0.963270 [L]
75	**STAR**	0.888055	N.A.	N.A.	N.A.	0.893274 [H]	0.881545 [L]
76	**SUNPHARMA**	0.911938	0.932685	0.933352 [H]	0.929106	0.907949 [L]	0.926307
77	**SYNDIBANK**	0.969323	0.987456	0.990526 [H]	0.989387	0.965842 [L]	0.969212
78	**TATACHEM**	0.837807	0.918946	0.902495	0.923732 [H]	0.818968 [L]	0.849541
79	**TATAMOTORS**	0.967558	0.988508	0.981823	0.992923 [H]	0.961909	0.955582 [L]
80	**TATAPOWER**	0.932961 [L]	0.955435	0.961104 [H]	0.958351	0.934184	0.941624
81	**TATATEA**	0.958970	0.962644	0.964136	0.965601 [H]	0.954237 [L]	0.960587
82	**TITAN**	0.977876 [H]	N.A.	N.A.	N.A.	0.975998	0.972918 [L]
83	**TVSMOTORS**	0.935610	0.946936	0.951129	0.953403 [H]	0.935741	0.934675 [L]
84	**UNIONBANK**	0.993981	0.997009	0.998034 [H]	0.992475	0.990109 [L]	0.995370
85	**UTIBANK**	0.999688	1.023904 [H]	1.017679	1.019552	0.994333 [L]	1.013133
86	**VIJAYABANK**	0.985474	0.974782 [L]	0.983783	0.987734 [H]	0.975170	0.976661
87	**WOCKPHARMA**	0.932771	0.945409	0.948700	0.952743 [H]	0.923674 [L]	0.926119

N.A.= Methodology not applicable, H= Highest hedge ratio and L= Lowest hedge ratio.

Table V Variance Reduction

S. No.	SYMBOL	OLS	GARCH	TARCH	EGARCH	VAR	VECM
1	**BANKNIFTY**	0.950805	0.949675	0.949471[L]	0.949672	0.950957[H]	0.950811
2	**CNXIT**	0.955930	0.954402	0.954300	0.953505[L]	0.955987[H]	0.955912
3	**NIFTY**	0.961293	0.960842	0.960806[L]	0.960807	0.961336[H]	0.961131
4	**ABB**	0.900701	0.899106	0.897230	0.897026[L]	0.900970[H]	0.900802
5	**ACC**	0.960924	0.960904	0.960377	0.960344[L]	0.960926	0.960927[H]
6	**ALBK**	0.914810	N.A.	N.A.	N.A.	0.914822[H]	0.914537[L]
7	**ALOKTEXT**	0.916689[H]	0.916412	0.916042[L]	0.916121	0.916654	0.916438
8	**ANDHRABANK**	0.964682	0.964494	0.964424	0.964421[L]	0.964759[H]	0.964565
9	**ARVINDMILLS**	0.980852	0.980843	0.980797[L]	0.980813	0.980866[H]	0.980865
10	**ASHOKLEY**	0.940281	0.939434[L]	0.939661	0.939927	0.940347[H]	0.940326
11	**AUROPHARMA**	0.921277	N.A.	N.A.	N.A.	0.921282[H]	0.921186[L]
12	**BAJAJAUTO**	0.906473	0.904454	0.904147[L]	0.904760	0.906530[H]	0.906426
13	**BANKBARODA**	0.963128	0.962557	0.961570[L]	0.961672	0.963129[H]	0.963016
14	**BANKINDIA**	0.967079	0.966877	0.966728[L]	0.966744	0.967149[H]	0.967013
15	**BEL**	0.960165[L]	N.A.	N.A.	N.A.	0.960236[H]	0.960165[L]
16	**BHEL**	0.945072[L]	N.A.	N.A.	N.A.	0.945076	0.945088[H]
17	**BILT**	0.953608[H]	0.953465	0.953128[L]	0.953181	0.953582	0.953596
18	**BONGAIREFN**	0.892829	0.892484	0.893052[H]	0.892445	0.892978	0.891914[L]
19	**BPCL**	0.888247	0.887473	0.885493	0.884116[L]	0.888311[H]	0.887769
20	**CANBANK**	0.957005[H]	0.956946	0.956895	0.956629[L]	0.956999	0.957004
21	**CENTURYTEXT**	0.957477[L]	N.A.	N.A.	N.A.	0.957557[H]	0.957505
22	**CESC**	0.958038[L]	0.958081	0.958180[H]	0.958164	0.957878	0.957764
23	**CHAMBLFERT**	0.905836	N.A.	N.A.	N.A.	0.905865[H]	0.905572[L]
24	**COLGATE**	0.934594	0.932727	0.931654[L]	0.931654[L]	0.934818[H]	0.934527
25	**CORPBANK**	0.947591	0.947394	0.947355[L]	0.947443	0.947767[H]	0.947708
26	**CUMMINSIND**	0.968903	N.A.	N.A.	N.A.	0.968901[L]	0.968910[H]
27	**DIVISLAB**	0.941778	0.941067	0.940269	0.939940	0.942781[H]	0.941954
28	**ESCORTS**	0.942228[L]	N.A.	N.A.	N.A.	0.942369[H]	0.942310
29	**ESSAROIL**	0.981288[H]	N.A.	N.A.	N.A.	0.981280	0.981259[L]
30	**FEDERALBANK**	0.941067	0.941070	0.941058	0.941071[H]	0.941020	0.940683[L]
31	**GAIL**	0.950459	0.950182[L]	0.950236	0.950394	0.950500[H]	0.950449
32	**GLAXO**	0.922377	0.921788	0.919022	0.918505[L]	0.922579[H]	0.922566
33	**GNFC**	0.966496	N.A.	N.A.	N.A.	0.966500[H]	0.966476[L]
34	**GRASIM**	0.959930	N.A.	N.A.	N.A.	0.959938[H]	0.959907[L]
35	**HCLTCH**	0.915811	0.913782	0.913684	0.913022[L]	0.916003[H]	0.915538
36	**HDFC**	0.925591	0.924538	0.924529	0.923902[L]	0.925793[H]	0.925759
37	**HDFCBANK**	0.917565	0.917222	0.917112	0.916970[L]	0.917773[H]	0.917562
38	**HEROHONDA**	0.910895[H]	N.A.	N.A.	N.A.	0.910895[H]	0.910436[L]
39	**HINDLEVER**	0.927895	0.926948	0.926554[L]	0.926849	0.927971[H]	0.927836
40	**HINDPETRO**	0.933186	0.933029	0.933057	0.927141[L]	0.933227[H]	0.933029
41	**ICICIBANK**	0.889314[H]	0.888583[L]	0.888594	0.888799	0.889293	0.889180
42	**IDBI**	0.978009[H]	0.977893	0.977843[L]	0.977892	0.977982	0.978009[H]
43	**IDFC**	0.916576	0.916014	0.915872[L]	0.916021	0.916796	0.916804[H]
44	**IFCI**	0.977300	0.977256	0.977248	0.977231[L]	0.977342[H]	0.977263
45	**INDUSINDBANK**	0.980403	0.980408[H]	0.980322[L]	0.980323	0.980364	0.980348
46	**IOB**	0.948590	0.947760[L]	0.948118	0.948408	0.948711[H]	0.948592
47	**IOC**	0.918249	0.917490	0.917368[L]	0.918178	0.918360[H]	0.918122
48	**IPCL**	0.975016	0.975016	0.975021[H]	0.975021[H]	0.975021[H]	0.974993[L]
49	**JETAIRWAYS**	0.917958	0.918183[H]	0.917216	0.916380[L]	0.918151	0.917762
50	**JINDALSTEL**	0.952676[L]	N.A.	N.A.	N.A.	0.952778[H]	0.952776
51	**JPHYDRO**	0.947974[L]	N.A.	N.A.	N.A.	0.948185	0.948193[H]
52	**JSTAINLESS**	0.974178[H]	0.974177	0.974161	0.974167	0.974089[L]	0.974130
53	**KTKBANK**	0.971422[L]	N.A.	N.A.	N.A.	0.971429[H]	0.971429[H]

54	**LICHSGFIN**	0.928263 [H]	N.A.	N.A.	N.A.	0.928256	0.928092 [L]
55	**MARUTI**	0.967303	0.967288	0.967120 [L]	0.967164	0.967311 [H]	0.967281
56	**MATRIXLABS**	0.894986 [H]	0.894504	0.893340 [L]	0.894965	0.894985	0.894985
57	**MRPL**	0.977623	0.977616	0.977619	0.977467 [L]	0.977575	0.977625 [H]
58	**MTNL**	0.969045 [H]	0.968952	0.969040	0.969025 [L]	0.969041	0.969043
59	**NAGARFERT**	0.966231	N.A.	N.A.	N.A.	0.966320 [H]	0.966067 [L]
60	**NATIONALUM**	0.934873 [L]	0.934961	0.934958	0.934960	0.935018 [H]	0.934906
61	**NDTV**	0.977256	0.977264	0.976901 [L]	0.977058	0.977296 [H]	0.977279
62	**NEYVELILIG**	0.960659 [L]	N.A.	N.A.	N.A.	0.960766 [H]	0.960731
63	**NICOLASPIR**	0.922389	0.922100	0.921241	0.919987 [L]	0.922486 [H]	0.922441
64	**NTPC**	0.951203 [H]	N.A.	N.A.	N.A.	0.951177 [L]	0.951193
65	**ORIENTBANK**	0.965351	0.965225	0.965354 [H]	0.965354 [H]	0.965350	0.965342 [L]
66	**PATNI**	0.895364	N.A.	N.A.	N.A.	0.895466 [H]	0.895451 [L]
67	**PNB**	0.948692	0.948722	0.948727	0.948735	0.948740 [H]	0.948319 [L]
68	**POLARIS**	0.985904	0.985912	0.985883	0.985876 [L]	0.985915 [H]	0.985914
69	**REL**	0.944228	0.939366	0.937466 [L]	0.937670	0.944364 [H]	0.944011
70	**RELCAPITAL**	0.983954	0.983895 [L]	0.983940	0.983960 [H]	0.983960 [H]	0.983944
71	**RELIANCE**	0.959559	0.959054	0.958910	0.959048 [L]	0.959589	0.959398
72	**SBIN**	0.976294	0.976275	0.976278	0.976264	0.976308	0.976224 [L]
73	**SCI**	0.943282	0.943308	0.943312 [H]	0.943312 [H]	0.943304	0.943238 [L]
74	**SRF**	0.989289 [H]	0.989217	0.989237	0.989184 [L]	0.989271	0.989223
75	**STAR**	0.889724	N.A.	N.A.	N.A.	0.889609 [L]	0.889779 [H]
76	**SUNPHARMA**	0.786826	0.785804	0.785757 [L]	0.786040	0.786926 [H]	0.786207
77	**SYNDIBANK**	0.962099	0.961565	0.961407 [L]	0.961468	0.962124 [H]	0.962100
78	**TATACHEM**	0.841057	0.827893	0.831913	0.826595 [L]	0.841723 [H]	0.840187
79	**TATAMOTORS**	0.955779	0.955117 [L]	0.955426	0.954862	0.955803 [H]	0.955751
80	**TATAPOWER**	0.937454 [H]	0.936746	0.936394 [L]	0.936574	0.937443	0.937311
81	**TATATEA**	0.959963	0.959924	0.959900	0.959872 [L]	0.959971 [H]	0.959949
82	**TITAN**	0.984268 [H]	N.A.	N.A.	N.A.	0.984265	0.984244 [L]
83	**TVSMOTORS**	0.961840	0.961870 [H]	0.961811	0.961763 [L]	0.961842	0.961825
84	**UNIONBANK**	0.966330	0.966302	0.966288 [L]	0.966337	0.966339 [H]	0.966319
85	**UTIBANK**	0.892742	0.891582 [L]	0.891983	0.891870	0.892852 [H]	0.892231
86	**VIJAYABANK**	0.948245	0.948377 [H]	0.948281	0.948188 [L]	0.948376	0.948371
87	**WOCKPHARMA**	0.940480	0.939911	0.939704	0.939417 [L]	0.940670 [H]	0.940637

N.A.= Methodology not applicable, H= Highest variance reduction and L= Lowest variance reduction.