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VOLATILITY AND INFORMATION OF UNDERLYING SPOT MARKET ON EXPIRATION - REFERENCE TO S&P CNX NIFTY FUTURE

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ABSTRACT

Indian capital market saw the launching of index futures on BSE on June 9, 2000 and on NSE on June 12, 2000. This launching of derivatives in Indian stock markets was perceived to increase volatility in the stock market by some researchers, at the same time some other researchers anticipated decline in volatility. In reality how was the volatility and information of stock market affected by the Nifty's index future expiration, is the objective of this study. The study has been undertaken with a comprehensive daily data set from June 2000 to May 2007. To measure the volatility GARCH (1, 1) models has been used. The result shows that, increase in volatility over expiration day and expiration week on the underlying spot market. This change in volatility is associated with increase in recent news over expiration day and expiration week. Further, as near moth contract nearing expiration, recent news surge make participants more sensitive towards price changes.

1. INTRODUCTION

In the wake of liberalization and globalization, Indian capital market, particularly the financial sector, has witnessed major transformations and structural changes. The major thrust of these reforms brought in have been, to improve market efficiency, enhancing transparency, checking unfair trade practices, and bringing up the standard of Indian Capital Market to the international level. The reforms have brought in several changes in the operations of the secondary markets, such as, automated on-line trading in exchanges, enabling trading terminals of the National Stock Exchange (NSE) and Bombay Stock Exchange (BSE) to be available across the country and making geographical location of an exchange irrelevant, reduction in the settlement period, and opening up of the stock markets to foreign portfolio investors etc. In addition to these developments, the introduction of derivative products on two of its principal existing exchanges viz., BSE and NSE in June 2000 to provide tools for risk management to investors, made India one of the forerunners among the emerging markets in South Asian region as far as stock market derivatives are concerned.

Before the introduction of derivatives, there had been a considerable debate on the question as to whether derivatives should be introduced in India or not. Finally L.C. Gupta Committee on Derivatives, which examined the whole issue in details, recommended in December 1997, the introduction of stock index futures. However the preparation of regulatory framework for the operations of the index futures contracts took another two and a half-year more, as it required not only an amendment in the Securities Contracts (Regulation) Act, 1956 but also the specified regulations for such contracts. Finally, the Indian capital market saw the launching of index futures on June 9, 2000 on BSE and on June 12, 2000 on NSE. A year later, options on index were also introduced on June 4, 2001 for trading on these exchanges.

The spot and futures markets provide investors with an opportunity to trade in the same underlying security. It is quite logical, therefore, to anticipate a trading induced dynamic relationship between the two markets. There are several ways in which opening of the futures trading can increase efficiency and smoothen price variations in a cash market and the interrelatedness of the two markets suggests that speculation in the futures market destabilizes prices in the spot market. In particular, the futures expiration's effect on the underlying spot market volatility on the day when contract expires has been investigated widely. However, the research evidence has been inconclusive. Hence, the present study aims to investigate the impact of Index Futures contract's expiration on the underlying Nifty Index spot market volatility and Information. Towards this purpose, we have used the GARCH (1, 1) models to capture the volatility clustering in financial data series.

2. REVIEW OF LITERATURE

Worldwide many theoretical and empirical studies have been carried out to evaluate the impact of listing of futures and options on the cash market. Out of which, a variety of studies have been conducted to evaluate the impact of derivatives trading on the underlying market mostly in developed countries markets. Studies in developing markets in context to introduction of derivatives are very scanty and very few studies have attempted to know the impact of introduction of derivatives trading in emerging market economies like India. Two Propositions concerning the impact of derivatives trading on the spot market are prevalent in the literature. Proposition of 'destabilizing forces' argue that derivatives trading increases stock market volatility because of the existence of high degree of leverage, expected presence of uninformed traders due to low transactions cost involved to take position in the futures market, and the availability of lower level information of derivatives traders with respect to cash market traders is likely to increase the asset volatility. Stein (1987) in his revolutionary theoretical model concluded that opening up of a futures market improves risk sharing and therefore reduces price volatility and if the speculators observe a noisy but informative signal, the hedgers react to the noise in the speculative trades, producing an increase in volatility. These uninformed traders could destabilize the cash market. Cox (1976), Figlewski (1981) and Chatrath *et al* (1995) found results supporting this proposition. On the other hand, the speculators perform the important role in providing liquidity to the market and rapid processing of information. Derivatives trading can improve the availability of information flow due to low transaction costs than those in the cash market, thereby, transmitting new information more quickly to the futures market. As a consequence, derivatives market provides an additional channel by which information can be transmitted to the cash markets. Frequent arrival and rapid processing of information might lead to increased volatility in the underlying spot market. Antoniou and Holmes (1995) however did not find link between information and volatility.

Dentine (1978), on the other hand argued that the futures market improves market depth and reduces volatility. Proposition of 'market completion' argue that derivatives trading helps in price discovery, improves the overall market depth, enhances market efficiency, supplements market liquidity, reduces asymmetric information and thereby reduces volatility of the cash market (Kumar *et al*, 1995; Antoniou *et al*, 1998). In addition to this, speculative activity may be transferred from the cash market to a more regulated futures market, dampening spot market volatility by reducing amount of noise trading. This also suggests that the introduction of derivatives trading would be accompanied by a decline in trading volume of the underlying market.

In Indian context, studies by Thenmozhi (2002), Nath (2003), Bandivadekar *et al.* (2003), Thenmozhi *et al*. (2004) and Y.P.Singh and Shalini Bhatia (2006) reported decline in volatility while Shenbagaraman (2003), , Pretimaya *et al*.(2007), and Sibani Prasad Sarangi *et al*. (2007) did not find significant impact on market volatility in India.

Another important factor that is affecting the volatility in post derivatives period is their expiration effects proposed by Samuelson (1965), known as the *Samuelson hypothesis* (SH) or the time-to-maturity effect (TTM). Based on the hypothesis the model proposes the rise in the volatility of futures prices as maturity nears. The intuition behind Samuelson's theory is that, as time passes and we approach the maturity date, and our future becomes our present, we become more and more sensitive to information that influence the final level of the futures price. When the maturity date arrives, arbitrage, forces the futures price to equal the actual spot price. The main source of concern regarding expiration-day effects of index derivatives arises from cash settlement. Several authors have tested for unusual volatility in the underlying market on days when derivatives expire. Expiration day effects in the United States have been examined by Stoll an Whaley (1986, 1987, 1991), Edwards (1988), Feinstein and Goetsmann (1988), Herbst and Maberly(1990), and Chen and Williams(1994) found unusual volatility, volume and price effects. From other international index futures markets, Karoyli (1996) for Japan, Stoll and Whaley (1997) for Australia, and Bollen and whaley (1998) for Hong Kong found evidence in support of expiration day effects.

In India, Thenmozhi and M. Sony Thomas (2004), Suchismita Bose and Sumon Kumar Bhaumik (2007), found the results in support of expiration day effect as increased volatility in spot market. Saravanan G and Malabika Deo (2009) identified insignificant expiration day effect on increased volatility in spot market. Whereas Y.P.Singh and Shalini Bhatia (2006) found decline in volatility which is contrary to the experience elsewhere.

The futures expiration's effect on the underlying spot market volatility on the day when contract expires has been investigated widely. However, the research evidence has been inconclusive. Hence, the present study aims to investigate the impact of Index Futures contract's expiration on the underlying Nifty Index spot market volatility and information.

3. METHODOLOGY

Data and Sample

The data for the study consist of daily closing price of the S&P CNX Nifty Index, Nifty Junior Index, and S & P 500. The data span from a period of 12th June 2000 to May 31, 2007. The reason for studying the data upto 2007 is that, derivatives contract on Nifty Junior were introduced on June 2007. Nifty Junior has been used as a control variable for market wide factors. Hence, after introducing derivatives in Nifty Junior, it cannot be used as proxy for market wide factors. Hence, data have been collected upto 31st may 2007. Nifty Junior and S & P 500 have been used as control variables to remove market-wide and international market-wide influence respectively on S&P CNX Nifty. This study is based on National Stock Exchange Data because 95 percent of the total trading in derivatives is done at NSE.

Analysis of Data

The present research is based on the stock index price returns. The daily return based on closing price is computed using the following formula.

$$R_t = \text{Log}\,(P_t / P_{t-1}) \quad (1)$$

Where, P_t - Log of price at time t, and P_{t-1}- Log of price at time $t-_1$.

In order to determine whether the arrival of futures trading has any effect on volatility of the underlying spot market, it is necessary to separate the volatility arising from market wide factors, international wide factors and day of the week effects; those are responsible for other than futures trading. Earlier authors, such as, Antoniuo and Holmes (1995), Kamara, *et al* (1992), and Greoge, *et al.* have not removed the factors which are responsible for market wide and international wide volatility by regressing the spot market returns against a proxy variable for which there was no related futures contract available. For Indian stock market, Nifty Junior Index comprises stocks for which no futures and options contracts were traded until June 1, 2007. Hence, it serves as a control variable for us to isolate market wide factors and S & P 500 have been used as a control variable to remove international market-wide influence and days dummies to remove day of the week effects on S&P CNX Nifty, thereby we can concentrates on the residuals volatility in the Nifty as a direct result of introduction of index futures contracts.

The Ordinary Least Squares Regression (OLS) assumes constant error variance, but heteroskedasticity causes the OLS estimation to be inefficient. In case of financial data large and small errors tend to occur in clusters, i.e. large returns are followed by more large returns, and small returns by more small returns. As volatility clustering is a characteristic of financial data where large changes tend to follow large changes and small changes tend to follow small changes. OLS estimation becomes inefficient to analyze the volatility in the face of such heteroskedasticity. Findings of heteroskedasticity in stock returns are well documented (Mandelbrot 1963, Fama 1965, Bollerslev 1986). The presence of heteroskedasticity in the data calls for the use of ARCH family model to study volatility. Hence, this study makes use of non-linear models like ARCH.

Autoregressive Conditional Hetroscedastic (ARCH) model was first introduced by Engel (1982). And then the ARCH model was generalized by Bollerslev (1986), and it is called GARCH (Generalised Autoregressive Conditional Hetroscadasticity). GARCH models explain variance by two distributed lags: firstly, on past squared residuals to capture high frequency effects or news about volatility from previous period measured as lag of the squared residuals from mean equation, and secondly, on lagged values of variance itself to capture long-term influences. A GARCH (p, q) model is given by the following equation.

$$Y_t = \beta_0 + \beta_1 X_i + \varepsilon_t \quad \varepsilon t / \Psi t\text{-}_1 \sim (0, h_t) \qquad (2)$$

$$h_t = \alpha_0 + \sum_{t=1}^{p} \alpha_1 \varepsilon^2 t\text{-}_1 + \sum_{j=1}^{q} \alpha_2 h_{t-1} + v_t \qquad (3)$$

Equation (2) represents the conditional mean equation (Y_t), is written as a function of constant (β_0), exogenous variable (X_i) and error term (ε_t). Equation 3, represents the conditional variance equation (h_t), is the one period ahead forecast variance. The conditional variance equation is a function of constant (α_0), lagged squared residual from the mean equation- ARCH ($\varepsilon^2 t\text{-}_1$), lagged values of variance itself (h_{t-1}) - GARCH, and v_t is white noise error term. In variance equation P is the degree of ARCH, and q is the degree of GARCH. The size of the parameters α_1 and α_2 determine the short-term dynamics of the resulting volatility time-series. Large co-efficient of α_2 shows that shocks to conditional variance take a long time to cancel out, so volatility is persistence. To measure the volatility implication of spot market on introduction of futures contract, in our study GARCH (1, 1) is used as mentioned in the following mean and variance equation:

$$R_t = \beta_0 + \beta_1 R_{NiftyJunior,\,t} + \beta_2 R_{S\&P\ 500,\,t-1} + \varepsilon t \qquad (4)$$
$$h_t = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \alpha_2 h_{t-1} + v_t \qquad (5)$$

Where in equation (4), R_t is daily return on the S&P CNX Nifty, $R_{NiftyJunior,\,t}$ is daily return of Nifty Junior is used to eliminate the effect of market wide factors in India, $R_{S\&P\ 500,\,t-1}$ is lagged daily return of S&P 500 to eliminate the effect of international wide factors and thereby variance equation can able to focus only on volatility related derivatives introduction. To study how the futures contract expiration influences cash market, the maturity effect is examined in terms of volatility and information flows on expiration day and expiration week of futures. To check the volatility changes over expiration day and expiration week, the variance equation is augmented with expiration day dummy with the following specification:

$$h_t = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \alpha_2 h_{t-1} + \alpha_3 D_{FED} \qquad (6)$$
$$h_t = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \alpha_2 h_{t-1} + \alpha_3 D_{FEW} \qquad (7)$$

To study how the futures contract expiration influences the cash market volatility, an expiration day dummy and expiration week dummy are introduced in the conditional variance equation (6) and (7) respectively. The expiration day dummy takes the value '0' for all trading days on which no futures contracts are expiring and it takes the value '1' for the last Thursday of each month when Index futures expire, in post derivatives period. If the last Thursday happens to be a public holiday then the contracts will expire on the previous day, i.e. a Wednesday when the dummy will take the value 1, as this will be the expiration day for that month. Likewise, The expiration week dummy takes the value '0' for all the trading days of non-expiration week on which no futures contracts are expiring and it takes the value '1' for all the trading days of expiration week of each month in post derivatives period. If the coefficients of the expiration day or week dummies are significant then it would imply that the expiration of futures contracts causes abnormal stock price movements on expiration days or week.

Further to check the information flow or recent news changes over expiration day and expiration week of futures contracts, the variance equation (8) and (9) augmented with following specification:

$$h_t = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \alpha_2 h_{t-1} + \alpha_3 \varepsilon^2_{t-1} * D_{FED} \qquad (8)$$
$$h_t = \alpha_0 + \alpha_1 \varepsilon^2_{t-1} + \alpha_2 h_{t-1} + \alpha_3 \varepsilon^2_{t-1} * D_{FEW} \qquad (9)$$

To check the recent news changes in spot market over expiration day and expiration week of futures contracts, recent news term ε^2_{t-1} or Arch term in conditional variance equation is interacted with expiration day dummy and week dummy of futures respectively. Arch term is squared residual from mean equation, which explains impact of yesterday or recent news on today's volatility determination. To determine any change or shift in the recent news on expiration day, α_3 co-efficient is considered. If the coefficient of the interactive dummy is significant then it would imply that the expiration of futures contracts causes abnormal recent news movements on expiration days and expiration week respectively. In other word, it can be understood as volatility changes on expiration day in response to change in recent news.

4. EMPIRICAL RESULTS

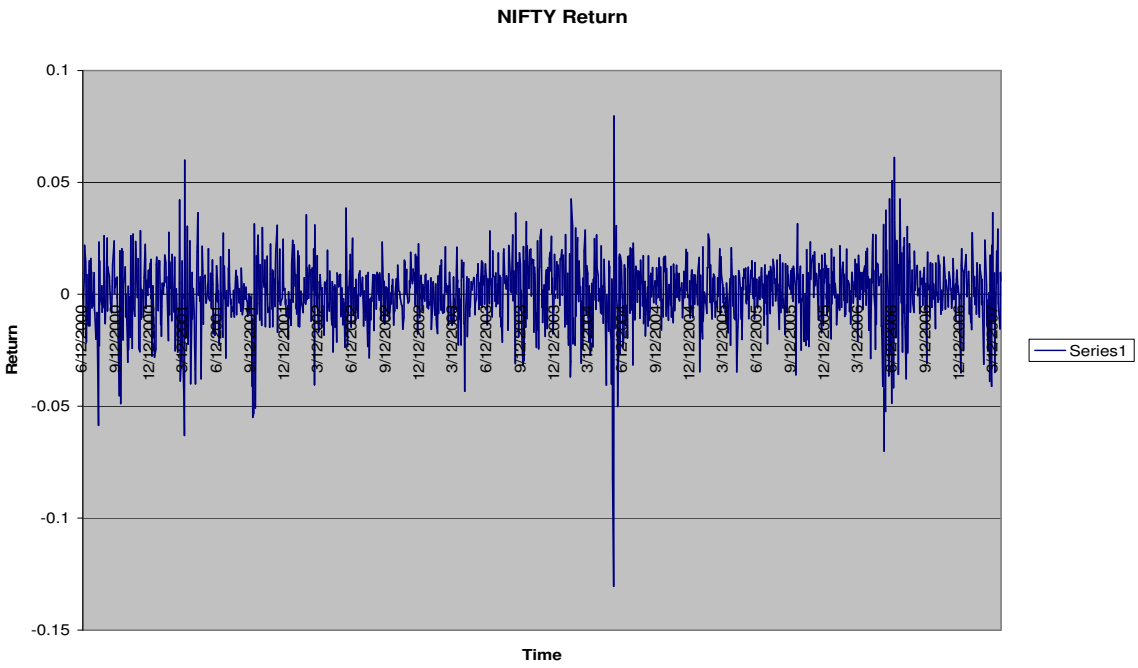
The descriptive statistics in table-1 indicate that the daily mean return on nifty is 0.000681 and the standard deviation is 0.014451. Standard deviation is more than the mean return and indicates that the fluctuation in the market is very high. Skewness of Nifty return is -0.90919 which indicates that the most of the returns are in positive side and there is upward trend of NSE Nifty index.

Table1: Descriptive statistics of S&P CNX NIFTY Returns

Mean	0.000681
Median	0.001639
Maximum	0.079691
Minimum	-0.130539
Std. Dev.	0.014451
Skewness	-0.909199
Kurtosis	10.06939
Jarque-Bera	3387.899
Probability	0

Chart-1 depicts the time series of nifty return. Where it indicates that the some periods are more risky than other i.e. the expected magnitude of error at some times is greater than the others, which indicate that Stock Return is of hetroscedastic nature. These risky returns are not distributed randomly across the data. Instead, there is a degree of auto correlation in the riskiness of financial returns. This characteristic of a time series is known as "Volatility Clustering". The Jarque Bera test for Nifty Return is significant and the series has excess kurtosis as 10.066939. All these results indicate that the Stock Return is of hetroscedastic nature which justifies the use of ARCH model in the present study.

Chart 1: Time series of Daily S&P CNX NIFTY Returns



To study the expiration effect on Spot market volatility, the maturity effect is examined in terms of volatility and information flows on expiration day and expiration week of futures.

Table 2: Future expiration and Spot Market Volatility

Variance Equation				
	Expiration Day		Expiration week	
	Co-efficient	z-Statistic	Co-efficient	z-Statistic
Constant	1.89E-06*	1.977146	4.27E-06**	2.922480
ARCH 1	0.061970**	4.643741	0.090811**	4.611889
GARCH 1	0.889101**	36.25755	0.822774**	23.01202
D_{FED} / D_{FEW}	2.47E-05**	3.762642	4.78E-06**	2.855861
R-squared Log likelihood	0.699239 6024.351		0.699201 6017.800	

**and * statistically significant at 1% and 5% level respectively.

The expiration day dummy in GARCH model has a co-efficient of 2.47E-05, which is positive and statistically significant, implying that the futures contract expiration increases the Volatility in underlying spot index. Further, the expiration week dummy in GARCH model has a co-efficient of 4.78E-06, which is positive and statistically significant. This also implying that the futures contract expiration increases the Volatility in underlying spot index in expiration week, however, when comparing to volatility of expiration day, volatility of expiration week is less, this implies that volatility is increasing as futures contract nearing to expiration, as news coming makes the trader more sensitivity and presence of arbitrage trading activity.

Table 3: Future expiration and Spot Market Information

Variance Equation				
	Expiration Day		Expiration week	
	Co-efficient	z-Statistic	Co-efficient	z-Statistic
Constant	3.40E-06**	3.466704	3.02E-06**	3.342389
ARCH 1	0.063328**	4.350822	0.055308**	4.157282
GARCH 1	0.878409**	33.83608	0.887044**	36.65189
ARCH 1*D_{FED} / ARCH 1*D_{FEW}	0.098546	1.407586	0.044440*	1.995704
R-squared Log likelihood	0.698985 6014.351		0.698988 2.013902	

**and * statistically significant at 1% and 5% level respectively.

To check the recent news changes in spot market over expiration day and expiration week of futures contracts, recent news term ε^2_{t-1} or Arch term in conditional variance equation is interacted with expiration day dummy and week dummy of futures respectively in GARCH model. Table 3, shows the results of information flow over expiration day and week. The interactive dummy (ARCH 1*D_{FED}) has a co-efficient of 0.098546, which is positive and statistically insignificant. This suggest insignificant recent news surge on expiration day.

The interactive dummy (ARCH 1*D_{FEW}) has a co-efficient of 0.044440, which is positive and statistically significant. This suggests presence of significant recent news surge over expiration week than non-expiration weeks. Though, the interactive dummy (ARCH 1*D_{FED}) has insignificant value, but, it has greater value than the interactive dummy of ARCH 1*D_{FEW}. This shows the greater influence of recent news on expiration day over expiration week. These results reveal that the volatility of underlying is increasing as a result of recent news surge in underlying. In other word, recent news makes near month contract holder more sensitive, as a result, volatility of the underlying is increases on maturity.

Overall the results of the study reveal that the volatility of the underlying is increased as a result of increase in recent news on expiration day and expiration week. Further, recent news surge make participants more sensitive towards price changes.

CONCLUSION

In this paper an attempt was made to study the impact of expiration of Index Futures on the underlying stock market volatility. The results estimated using GARCH model revealed significant increase in volatility over expiration day and expiration week on the underlying spot market. This change in volatility is associated with increase in recent news over expiration day and expiration week. Further, as near moth contract nearing expiration, recent news surge make participants more sensitive towards price changes.

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