International Journal for Multidisciplinary Research (IJFMR)
E-ISSN: 2582-2160 ● Website: www.ijfmr.com ● Email: editor@ijfmr.com

Expiration Day Effect of Index Futures on Spot Market Volatility: An Exploration

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Abstract

The present paper examines theexpiration day effect of index futures contracts on spot market volatility in Indian stock market by using daily return of CNX Nifty Index from April 2017 to March 2019 excluding holidays when there were no transactions. The GARCH (1, 1) model that captures the heteroscedasticity in returns has been applied to study market volatility by using Nifty midcap index return as independent variables in order to remove the influence of market-wide factors price movement on CNX Nifty returns. The results indicate that the expiration day has had a significant impact on market volatility. The results of GARCH coefficients suffice the fact that there is a marginal decrease in volatility on the expiration day of index futures contract. This implies that index arbitrageurs hold simultaneous positions in cash market as well as in futures market and unwind their positions at the termination of trading in derivatives contract in order to realize arbitrage profits. When such trades happen to be on one side of the market at the close of the contract, a substantial order imbalance in cash market arises and the temporary mismatch between these orders, can significantly affect prices and volatility in the underlying cash market.

Introduction

Financial markets have been witnessing calendar anomalies for the last three decades and the ‘expiration day effect’ in the context of derivatives trading is significant one that attracted attention of regulators, market participants and policy makers. Owing to the typical characteristics of derivatives trading, it is well documented in the financial literature that the volatility of futures prices should increase as the contract approaches expiration and signifies that near expiration, there is more volatility than in the beginning. Virtually, the futures prices exhibit seasonal volatility and they are more volatile at some specific periods rather than at others. This behaviour is attributed to the convergence characteristics of futures price with that of spot price at the day of expiration of the contract. The prices of derivatives would normally converge with the prices of underlying at the expiration of derivative contract and facilitate price determination of future and current price.The aforementioned issue suffices a zero ‘basis’ that is the difference between spot price and future price of the underlying asset is zero at the day of expiration of derivatives contract.

Moreover, during the ‘witching’ hour-the last hour of trading on days on which derivative contracts expire, there is abnormal price movement in the underlying asset and sometimes it is significantly higher on expiration days comparable to non-expiration days. The cause of expiration day volatility is well documented. Such volatility occurs when market participants such as index arbitrageurs who hold cash positions related to futures positions unwind their positions at the termination of trading in derivatives contract in order to realize arbitrage profits. Further, the cash settlement feature of index

futures and options contracts makes unwinding positions at the termination of derivatives trading particularly attractive and by doing so, traders can eliminate any basis risk associated with closing out their positions. When such trades happen to be on one side of the market at the close of the contract, a substantial order imbalance in cash market arises. The consequent increase in the number of large buy and sell orders, and the temporary mismatch between these orders, can significantly affect prices and volatility in the underlying cash market. Taking a serious note of it, regulators around the world have responded with a number of measures aimed at reducing price volatility on account of the so-called expiration effect of index derivatives.

The present paper examines the expiration day effect of index futures contracts on the volatility of spot market in India. In particular, whetherexpiration of index futures contractsincrease spot market volatility. The study is aimed at testing the null hypothesis that there is no expiration day effect of index derivatives on the underling spot market volatility. The rest of the paper proceeds as follows: the next section provides a review of previous studies and documents theempirical conclusions concerning the impact of expiration day; section-III contains the data used and the detailed methodology adopted to unfold the impact; section-IV discusses the empirical result of the study and conclusions are purported in the last section.

Section-II

Review of Literature

The importance of expiration day effects on the cash market to regulators has, in turn, generated interest on such effects within the research community to undertake empirical investigation into the issue of what impact, Index derivatives would have, on the volatility of the underlying market at the close of the contract.

Chamberlin, Cheung and Kwan (1989) examined index futures and options expiration day effects on the US market. The result of the study signifies that there is significant impact of derivatives contract expiration on both mean returns and volatility.Chen and Williams (1994) studied the impact of expiration of futures and options contracts on the underlying cash market in the US market. They found no effect of expiration on mean returns and volatility of the underlying asset prices in the cash market.

Schlag (1996) studied the expiration day effect of stock index derivatives in Germany. The result of the study suggests that there is a significant increase in trading volume on quarterly futures expiration days in Germany. Delays in the opening for the majority of index stocks indicate that a large part of this extraordinary volume is indeed traded right at the opening of the market. An increase in trading activity is also observed over the ten minute settlement period for index options. Volatility remains unchanged around the expiration of a future contract. An increase is found for the ten minute settlement period of DAX options. Return reversals as the measure for the economic costs of contract expirations are significantly higher when a futures contract expires at the open. When an option expires at the close, no clear pattern for reversals can be found.

Kan (2001) studied the impact of expiration of futures and options contracts on the underlying cash market in Hong Kong. He does not observe significant price volatility and price reversal in Hong Kong as a consequence to the impact of expiration days of futures and option contracts.Chow, Yung and Zhang (2003) analyzed the impact of expiration of futures and options contracts on the

underlying cash market in Hong Kong. They observe a negative price effect and some return volatility of cash prices on account of expiration day effects.

Hagelin and Alkeback (2004) examined index futures and options expiration day effects on the Swedish market. While the results for the period 1988-1998 indicate that trading volumes on the cash market were significantly higher on expiration days than on other days, no evidence suggesting that price distortions occurred is found. This could be due to the longer settlement period on the Swedish market, compared with that of the Canadian, German and the US markets, where price distortions have been documented. However, some price distortion may have been experienced for the first half of the sample period.

Fung and Yung (2007) conducted an examination of the intra-day trading activities of index stocks on the common expiration day of index derivatives. In Hong Kong, index futures and index options use an Asian-style settlement procedure. All contracts are settled against the estimated average settlement (EAS) price, which is the arithmetic average of the underlying cash index taken every five minutes on the expiration day. Trading volume and total trade count on the expiration day are found to both be higher than normal. Most important, trading intensifies in terms of both volume and frequency at times close to five-minute time marks. Significant order imbalance and price reversal patterns are not found and there is no systematic order imbalance pattern that explains the absence of a price reversal pattern.

Lien and Yang (2008) executed a study on availability and settlement of individual stock futures and options expiration effects using high frequency data in Australian Stock exchange from 1993 to 1997. They found that options expiration has significant effects on return and volatility of the underlying stocks in absence of individual stock futures. After introduction of cash settled stock futures contract, the effects decrease notably. However, the switch of a futures contract from cash settlement to physical delivery promotes the expiration effects on return and volatility and boosts temporary price changes on expiration days. Further, they also found that options expiration has little effect on trading volume.

Kiran and Bodla (2007) attempted to analyze the effect of expiration of stock derivatives on the volatility, return and trading volume of underlying individual stocks listed on NSE in India. The results from the sample period show the presence of an abnormally high volume on expiration day, thereby suggesting that arbitrage and manipulating activities take place in the market and that positions are unwound at the expiration. Hence, there is a greater volatility in the market on the expiration day. However, the unwinding of arbitrage positions failed to cause any significant price distortion at expiration, as there is no significant change in the return on stocks on the expiration day.

Bose and Bhaumik (2007) studied the impact of expiration of derivatives contracts on the underlying cash market on trading volume, returns and volatility of returns by using AR-GARCH model in India. The results indicate that trading volumes were significantly higher on expiration days leading up to expiration days compared with non-expiration days. They also found significant expiration day effects on daily returns to the market index, and on the volatility of these returns. Further, the study indicates that it might be prudent to undertake analysis of expiration day effects using methodologies that model the underlying data generating process, rather than depend on comparison of mean and median alone.

A comprehensive review of literature in section-IIillustrates that even when one group of researchers find a significant impact of the expiration of derivatives on the return and volatility of the underlying

market, the other group assert a contradictory conclusion of insignificant impact of the expiration of derivatives on the return and volatility of the underlying market.

Owing to the aforementioned deliberations, it can be concluded that the impact of expiration day effect on the underlying volume and volatility has been different in different markets with respect to different span of time. And, it is difficult to arrive at a consensus with respect to the impact of expiration day on volatility of the spot market. This in turn, necessitates further empirical investigation on the impact of expiration day on spot market volatility.

Section-III

Data and Model Specification

The data employed in this paper comprises of daily close prices of CNX Nifty, the benchmark index of National Stock Exchange (NSE). The data spans from April 01, 2017 to March 31, 2019 excluding holidays when there were no transactions. In addition, daily close prices of Nifty midcap Index have also been used. The CNX Nifty index is an index of 50 most actively traded stocks on the National Stock Exchange and Nifty midcap is an index of 50 midcap stocks traded on NSE.

The computation of descriptive statistics such as skewness, Kurtosis and Jarque-Bera provides basic albeit, elementary evidence about changes in the time series behavior and explains the fact that returns distribution of indexes are not normally distributed which is a well documented fact in financial literature. Further, given the fact that the presence of a stochastic trend or deterministic trend in a financial time series or its stationary or non-stationary in levels is a prerequisite for conducting any analysis, the study begins with testing of return series for a unit root using Augmented Dickey Fuller (ADF) tests. A stationary time series is one for which the mean and variance are constant over time; they depend only on the distance or lag between the two time periods and not on the actual time at which they are computed. The presence of a unit root indicates that the given series has become unstable or non-stationary; showing an uneven movement.

The coefficient of ADF test of Nifty return series having zero probability indicate that the series is stationary at first difference. Further, property of heteroscedasticity in index returns is well documented (Fama 1965, Bollerslev 1986). The presence of heteroscedasticity in the time series calls for the use of ARCH family of models to study volatility.

The standard GARCH (p, q) model introduced by Bollerslev (1986) suggests that conditional variance of returns is a linear function of lagged conditional variance and past squared error terms. A model with errors that follow the standard GARCH (1, 1) model can be expressed as follows:

$R_t = c + \varepsilon_t \ \ where, \varepsilon_t / \psi_{t-1} \sim N\ (0, h_t)$ ***Equation 1***

$and\ h_t = \ \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1}$ ***Equation 2***

The underlying asset being the CNX Nifty Index, the term R_t is replaced by $R_{nifty\ ,t}$ in the mean equation. Further, the impact of expiration day effect on stock market volatility can be isolated by removing from the time series, any predictability associated with other factors contributing to the volatility. Nifty midcap has been used as the independent variable in mean return equation to isolate market wide factors other than those which are associated with the expiration day. The mean equation to be estimated is as follows:

$R_{nifty\ ,t} = \gamma_0 + \gamma_1 R_{niftymidcap\ \ ,t} + + \varepsilon_t$ ***Equation 3***

To study the relationship between expiration day and volatility, a dummy variable has been introduced in the conditional variance equation where the dummy takes on a value of zero for non-

expiration day and a value of one for the expiration day. The conditional variance equation to be estimated is as follows:

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \alpha_2 h_{t-1} + \alpha_3 D_{Expiration\ \ day} \qquad \textit{Equation 4}$$

where, D_t is a dummy variable and α_3 is the coefficient of the dummy variable. If α_3 is statistically significant, it can be said that the expiration day has had an impact on spot market volatility. Further, a significant positive value for α_3 would indicate that expiration day effect increases the volatility of the spot market.

Section-IV

Empirical Results

The descriptive statistics in Table 1 pertaining to skewness and kurtosis indicate that the series is not normally distributed. Further, the Jarque-Bera test statistics for Nifty returns as shown in Table 1 is 21.47668and statistically significant as well as the time series have excess kurtosis.

Table 1: Descriptive Statistics of Nifty return and Nifty Midcap return

Descriptive Statistics for the Period (April 2017 to March 2019)		
Descriptive Statistics	**Nifty 50**	**Nifty Midcap 50**
Mean	0.000466	0.00028
Std. Dev.	0.007106	0.011372
Skewness	-0.300076	-0.338844
Kurtosis	3.82785	4.669172
Jarque-Bera	21.47668	66.66587
Probability	0.000022	0

Source: Computed

The ADF test for presence of unit root in Nifty Index series have been compiled in Table 2. The results show that the series is stochastic at level having a t-statistics of -1.5257 with insignificant probability value. However, the series is deterministic at first difference with a t-statistic of -20.32806 with a significant probability value.

Table 2: Results of Unit Root Test

Augmented Dickey-Fuller Test Statistics				
Indices	**Price at Level**		**Price at First Difference**	
	t-Statistic	Prob.*	t-Statistic	Prob.*
Nifty 50	-1.525727	0.5199	-20.32806	0
Nifty Mid Cap	-2.415917	0.1378	-20.25007	0

Source: Computed

Further, as arequisite diagnostic, heteroscedasticity test is conducted to explore the heteroscedastic behaviour of financial time series data. The F-statistic is 29.0825 with a significant p-value indicate the presence of ARCH effect in Nifty series. The GARCH model is exclusively designed to address the heteroscedastic behaviour of financial time series data. It is designed to provide a volatility measure, which can be used in financial decision making for risk analysis.

Table 3: Heteroscedasticity Test: ARCH

Heteroscedasticity Test: ARCH			
F-statistic	29.08253	Prob.	0
Obs*R-squared	27.56225	Prob.	0

Source: Computed

In consonance with the model specification, it is essential to remove the influence of market-wide factors in order to isolate the impact of expiration day on Nifty Index. Accordingly, a proxy variable which does not have a derivatives segment, and yet captures the market-wide fluctuations caused by different economic indicators like, exchange rate, inflation, growth rates etc. need to be used. The Nifty midcap Index has been used as a proxy to capture the market-wide information effects. In order to estimate the impact of expiration day on spot market volatility, GARCH (1, 1) model has been adopted with Nifty midcap as independent variable. A dummy variable for expiration day has been incorporated in the conditional variance equation. The results of the estimation for the impact of expiration day are presented in Table 4.

Table 4: Estimates of GARCH (1,1) Model

Estimates of GARCH (1, 1) for the period (April 2017 to March 2019)					
Variables	**Description**	**Co-efficient**	**Standard Error**	**Z-statistics**	**Probability**
γ_0	Intercept	0.000358	0.000202	1.771952	0.0764
γ_1	Nifty Midcap	0.466229	0.018288	25.49408	0
α_0	Constant	2.41E-06	1.08E-06	2.226024	0.026
α_1	ARCH	0.049584	0.025338	1.956912	0.0504
α_2	GARCH	0.898704	0.044903	20.0144	0
α_3	Expiration Day Dummy	6.42E-06	3.39E-06	1.893834	0.0482

Source: Computed

The coefficient of the expiration day dummyα_3, is positive (6.42E-06) and there seems to have a marginal increase in volatility and the dummy coefficient is statistically significant, implying that the market volatility is influenced by the expiration of index futures. Moreover, the result is in consonance with the theoretical premise that volatility occurs when market participants such as index arbitrageurs who hold cash positions related to futures positions, unwind their positions at the termination of trading in derivatives contract in order to realize arbitrage profits. Further, the cash settlement feature of index futures and options contracts makes unwinding positions at the termination of futures trading particularly attractive and by doing so, traders can eliminate any basis risk associated with closing out their positions. When such trades happen to be on one side of the market at the close of the contract, a substantial order imbalance in cash market arises. The consequent increase in the number of large buy and sell orders, and the temporary mismatch between these orders, can significantly affect prices and volatility in the underlying cash market.

Conclusion

The present paper examines the expiration day effect on spot market volatility, particularly the effect of index futures expiration on spot market volatility in Indian stock market by using daily return of

CNX Nifty Index from April 2017 to March 2019 excluding holidays when there were no transactions. The GARCH (1, 1) model that captures the heteroscedasticity in prices has been applied to study market volatility by using Nifty midcap index as independent variable in order to remove the influence of market-wide factors on CNX Nifty. The results indicate that the expiration of index futures contract has had a significant impact on market volatility. The spot market volatility has marginally increased on the expiration day of index futures contracts. On the last trading day of index futures contracts, the underlying market volatility has gone up as sufficed by the findings that the expiration day dummy coefficient is positive and statistically significant. The finding that the spot market volatility has marginally increased on the expiration day of index futures contracts can be explained as the result of the behaviour of index arbitrageurs. They hold simultaneous positions in cash market as well as in futures market and unwind their positions at the termination of trading in derivatives contract in order to realize arbitrage profits. When such trades happen to be on one side of the market at the close of the contract, a substantial order imbalance in cash market arises and the temporary mismatch between these orders, can significantly affect prices and volatility in the underlying cash market.

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