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Volatility Clustering Due To Derivatives Trading In Indian Stock Market: An Analysis Of Expiration Day Effects

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Abstract

One aspect of derivative trading which is related to its undesirable side effects on equity markets deserves a special mention. This is related to presence of abnormal volume, return or volatility during pre-expiration and expiration period. These effects are known in the literature as expiration day effects. Many researchers have pointed towards significant changes in these variables around expiration of derivative contracts. The most common explanations include the unwinding of delta positions as well as index arbitrage, which is executed by arbitrageurs with sophisticated computer algorithms. The present paper analyses the expiration effects of financial derivatives in Indian stock market.

1. Introduction

One more aspect of derivative trading which is related to its undesirable side effects on equity markets deserves a special mention. This is related to presence of abnormal volume, return or volatility during pre-expiration and expiration period. These effects are known in the literature as expiration day effects. Many researchers have pointed towards significant changes in these variables around expiration of derivative contracts. The most common explanations include the unwinding of delta positions as well as index arbitrage, which is executed by arbitrageurs with sophisticated computer algorithms. High amount of trading with the help of computer technology benefits a small number of institutional investors. Individual investors mostly lose in the process. Hence, the policy makers and regulators are interested in knowing the expiration effects.

Stock index futures contracts have an underlying stock index. They are generally cash settled on the expiration day. This is because physical delivery of the underlying index requires having positions in each of the underlying shares, which may be very costly and difficult to arrange in practice. The settlement rules differ from exchange to exchange: some settle at closing prices, some at open prices, some according to the Volume Weighted Average Price of a certain period of time during the day and some at an auction price. As the delivery period of the contract is approached, the futures price converges to the spot price of the underlying asset. When the expiration is reached, the futures price equals or is very close to the spot price.

2. Review of Literature

Volume, volatility, return shocks and return/volatility reversals are the most common expiration day effects documented. According to Stoll and Whaley (1997), expiration day effects may arise and depend on a combination of factors including: the existence of index arbitrage opportunities; the cash settlement feature of index options and futures; stock market procedures for accommodating the unwinding of arbitrage positions in the cash index; and manipulation activities.

Most researchers find high volume on expiration days and they attribute this effect to large unwindings that take place on these days. Empirical evidence shows that high volume with hedging based trading is associated with a higher probability of return reversals on subsequent periods (Llorente et.al. 2002; Campbell et.al. 1993). The argument goes that short-term reversals are the result of market making activities (Stoll, 1978; Hu and Stoll, 1983; Grossman and Miller, 1988; Andrade et.al., 2008).

In order to summarize the impact of expiration day on return, volume and volatility in foreign and Indian markets we present a brief review of studies done in last decade as follows:

Most of the studies mentioned above have found an expiration day volume effect, which refers to an abnormally high volume on and around expiration days (Dobano, 2011; Fung and Yung, 2009; Illueca and Lafuente, 2006; Alkebck and Hagelin, 2004; Stoll and Whaley, 1986, 1987, 1991; Pope and Yadav, 1992). This hike in volume is attributable to the unwinding of delta positions at the expiration. Alkebck and Hagelin (2004) attribute this to longer settlement period.

A few studies find abnormally high volatility of the spot index during expiration days (Illueca and Lafuente, 2006; Chow et. al., 2003; Stoll and Whaley, 1997). Then there are studies which observe a tendency in the spot index to fall or rise during expiration days and reverse back the next day of trading, suggesting severe order imbalances during the expiration day. For example, Illueca and Lafuente (2006) and Stoll and Whaley (1986, 1987, 1990 and 1991) find that the underlying index tends to fall on expiration days and reverse on the subsequent day. The magnitude of the reversal is around 0.4 percent. On the other hand, Chamberlain et.al. (1989) find that the cash index tends to go up during the last half-an-hour of trading and reverse on the next day's morning. Lien and Yang (2003) reported high returns on account of change in settlement method from cash to physical delivery.

Contrary to these findings, Lien and Yang (2003), Felixson (2002) and Bollen and Whaley (1999) found insignificant volume and volatility effects. Kan (2001) finds insignificant price reversal and volatility on expiration day. He attributed this to short selling restrictions and absence of computerized trading system in Hong Kong. Indeed, while the volume effect has been mostly acknowledged, the above results regarding price effects and volatility effects are relatively mixed. Our study is concentrating on an emerging market, India, and hence, we look at the work done on expiration effect in India to analyze how it differs from the studies reviewed above and also identify the gap areas which will form the basis for the current study.

Although expiration-day effects have been one of the widely studied market anomalies still researchers are not unanimous about its exact source and implications. Most of the published research work in the past has focused on developed markets (Dobano, 2011; Fung and Yung, 2009; Illueca and Lafuente, 2006; Ni,Pearson, and Poteshman, 2005; Lien and Yang, 2005, 2003; Chamberlin, Cheung and Kwan, 1989; Chen and Williams, 1994 ; Pope and Yadav, 1992; Schlag, 1996). However, in the last two decades the emerging markets, with their liberalization policies have gained significance both for researchers and investors the world over (Debasish, 2010; Maniar, Bhatt and Maniyar, 2009; Chung and Hseu, 2008; Vipul, 2005; Kan, 2001; Bollen and Whaley, 1999; Karolyi, 1996). Since, these markets have gone through many changes in their macro and micro structure; they provide a good opportunity to understand the importance of market structure, practices and policies in price discovery process. Previous research on expiration-day effects in India has generally found that spot trading volume is abnormally high at expiration and some studies found that the volatility increases as the expiration date comes nearer. Others studies have found no significant effect on volatility. The impact on price is also mixed and not conclusive. Most of the Indian researchers have used a small time period of 4-6 years except Debasish (2010). Debasish (2010) took a long period of nine years and divided into two parts. He could prove significant expiration effect in terms of high volume, price distortions and high volatility for first period (2001-05) only. For second period (2005-09), the results did not show significant effect on all variables.

3. Objective of the Study

The main objective of the present paper is to capture the expiration day effect of the financial derivatives.

4. Methodology

4.1 Data Collection

NSE started equity trading in 1994 and derivative trading in 2000. Since the inception of derivative trading NSE established itself as the market leader in the futures and options segment.

Its benchmark Index, S&P CNX Nifty, is a well diversified index consisting of 50 liquid stocks; hence the study considers Nifty as a proxy for the Indian stock market and uses its time series data to see the impact of derivative trading on stock market volatility. Daily closing prices for a total period of 21 years from 2000-2021 have been collected from the website of NSE.

4.2 Method used

In the present study, the impact of derivative expiration on spot market return, volume and volatility has been seen by using the same strategy as explained above. To begin with, regression method is applied to analyse the impact of derivative expiration on spot market volume. Further, to study the impact on spot return and volatility, both symmetric and asymmetric GARCH models have been used. These models have also been applied on spot market data of near month contracts. To capture the patterns efficiently, the impact of expiration day (Expday) and the day after expiration day (Nextday) on volume, return and volatility is evaluated. The positive (negative) sign and magnitude of coefficient of Expday and Nextday in regression equation and GARCH equations will point out whether these days increase (decrease) the spot volume, return and volatility. The use of Nextday dummy helps us to identify reversal in price, volume or volatility. In case, the volume, returns or volatility are positive (negative) on expiry day and negative (positive) on next day then this means there is positive reversal in volume, return and volatility otherwise the reversal is negative. Further, a positive reversal implies that the changes in variables are solely due to effect of derivative expiration and investors unwind their positions whereas a negative reversal implies that the changes in variables are due to flow of information to the market and investor is undecided and want to roll over their positions in anticipation of better prospects. Following Bhaumik and Bose (2007), we have taken the Thursday prior to expiry day as our Non-Expiration (Nexpday) day. We compare the impact of expiration day with that of non-expiration day to give conclusive results.

5. Empirical Results and Discussion

5.1 Comparison of Volume-Return and Volume-Volatility Relation

The relationship between spot volume-return and volume-volatility has been compared in pre-derivative and post-derivative period using symmetric and asymmetric GARCH models estimated with equations 1.1 and 1.2, and the results are shown in Table I and II. Proxy variables have not been taken to analyse the volume-return-volatility relationship.

$$Rtn_t^{nfty} = a + bRtn_{t-1}^{nfty} + cLnVol_t + \varepsilon_t$$
……….(1.1)

$$\sigma_t^2 = \phi + \sum_{k=1}^{q} \beta_k \sigma_{t-k}^2 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \delta_1 Rtn_{t-1}^{nftynxt} + \delta_2 Rtn_{t-1}^{s\&p500} + gLnVol_t$$
……….(1.2)

Table I: Relation between Volume-Return and Volume-Volatility (pre derivative period)

	Garch(1,1) Ged Dist.	TGarch(1,1) Ged Dist.	EGarch(1,1) Ged Dist.	PGarch(1,1) Ged Dist.
Nifty(-1)	0.0389	0.0712**	0.0524	0.0695*
Lnvol	0.0089***	0.0109***	0.098***	0.0119***
Alpha	0.0738***	0.0032	0.1328**	0.0339*
Gamma	–	0.0854**	-0.0763*	0.1944*
Beta	0.9217***	0.9175***	0.9483***	0.9082***
Lnvol	-4.01E-06*	-5.04E-06***	-0.1328**	-0.0019***
LogL	2287.62	2217.89	2303.31	2266.72
RMSE	–	–	0.021387	0.020888
MAE	–	–	0.01268	0.011836
MAPE	–	–	328.47	297.45

Source: own computations
Note: *** denotes significant at 1 p.c. level of significance
** denotes significant at 5 p.c. level of significance
* denotes significant at 10 p.c. level of significance

Table II: Relation between Volume-Return and Volume-Volatility (post derivative period)

	Garch(1,1) Ged Dist.	TGarch(1,1) Ged Dist.	EGarch(1,1) Ged Dist.	PGarch(1,1) Ged Dist.
Nifty(-1)	0.0521**	0.0535**	0.0589**	0.0533**
Lnvol	0.0010**	0.0009**	0.0007	0.0008*
Alpha	0.1328***	0.0472*	0.2143***	0.1449***
Gamma	–	0.2387***	-0.1762***	0.8377***
Beta	0.8233***	0.7837***	0.9404***	0.8022***
Lnvol	2.42E-05	5.05E-05**	0.0674***	0.0006***
LogL	7456.3	7477.48	7488.5	7496.35
RMSE	0.016459	0.016454	0.016452	0.016448
MAE	0.010589	0.010586	0.010587	0.010583
MAPE	154.21	158.55	156.72	151.88

Source: own computations
Note: *** denotes significant at 1 p.c. level of significance
** denotes significant at 5 p.c. level of significance
* denotes significant at 10 p.c. level of significance

The pre-derivative period has been taken from January 2, 1997 to June 9, 2000 as the Nifty volume series was available from January 2, 1997. During pre derivative period, very highly significant and positive impact of volume on returns has been noticed whereas the impact of volume on volatility is highly significant but negative. When a comparison has been made with the earlier results, it was found that addition of volume into GARCH return and volatility equations have reduced the persistence of volatility. The introduction of volume series in GARCH return and volatility equations has altered the GARCH process during the post derivative period. When a comparison has been made with the earlier results, it is observed it has, to some extent, decreased α and increased β. This implies that it has slightly increased the persistence of volatility.

Both volume-return and volume-volatility links are significant in post-derivative period. This evidence suggests that it may be possible to use lagged values of volume to predict future stock returns and volatility. A positive relationship has been found in volume and return in both periods however, the magnitude is smaller in post-derivative period which implies that prices have become less speculative in this period. The relation between volume and volatility is negative in pre-derivative period whereas in post-derivative period it has become positive. From this, it may be inferred that the emergence of derivative products affects the information role of volume in forecasting future returns and volatility. One probable justification is that using the number of trades as a proxy for volume reveals the fact that traders are taking larger spot positions after the introduction of derivative trading due to improved risk sharing prospects.

3.1.6 Analysis of Expiration Effect (Post-Derivative Period 2000-2021)

3.1.6.1 Impact of Derivative Expiration on Spot Volume

The effects of expiration day (monthly) and its next day on the trading volume of the Nifty index has been captured using the regression model whose results are given as under:

$$LnVol_t = 1.976 + 0.7845\ LnVol_{t-1} + 0.1289\ ExpDay$$

$$LnVol_t = 1.233 + 0.8021\ LnVol_{t-1} + 0.1455\ NextDay$$

Where

Lnvolt = the logarithm of trading volume on day t,

$Lnvol_{t-1}$ = the volume on previous day.

Expday and Nextday = the dummies for expiration day and its next day respectively.

The coefficients of the dummies for both expiration day and its next day are positive and significant (1%) and the magnitude is higher in case of next day. This shows that expiration period increases the spot volume and that there is no reversal in volume during this period. We could not find the presence of autocorrelation and heteroscedasticity in the volume data hence OLS is an appropriate method.

Further, the impact of non-expiration day (N exp Day) on spot volume is as follows:

$$LnVol_t = 2.118 + 0.8992\ LnVol_{t-1} - 0.0183\ N\ exp\ Day$$

Here, the coefficient of non-expiry day is negative and insignificant. Therefore, it can be concluded that derivative expiration has a significant positive effect on the volume of Nifty.

3.1.6.2 Impact of Derivative Expiration on Spot Return and Volatility

Table III Descriptive Statistics for Expiry, Next and Non Expiry day

	Expiry Day	Next Day	Non-Expiry

			Day
Mean	0.0036	0.0039	0.0009
Std.Dev.	0.0128	0.0143	0.0086
Skewness	-0.2329	-0.4109	0.5021
Kurtosis	3.6063	4.7532	6.8146
Jarque Bera	20.34***	9.65**	327.60***
No. of Obs.	232	231	231

Source: own computation

Table IV Expiry day Impact

	Garch(1,1) Ged Dist.	TGarch(1,1) Ged Dist.	EGarch(1,1) Ged Dist.	PGarch(1,1) Ged Dist.
Nifty(-1)	0.0476***	0.0621***	0.0405**	0.0488***
Expday	0.0035***	0.0039***	0.0041***	0.0038***
Expday*Lnvol	0.0002***	0.0002***	0.0002***	0.0002***
Alpha	0.1512***	0.0644***	0.1439***	0.1326***
Gamma	–	0.1930***	-0.0508***	0.5422***
Beta	0.8659***	0.8126***	0.9482***	0.8426***
Expday	5.48E-06	4.57E-06*	0.4088***	0.0031**
Expday*Lnvol	2.44E-06	3.02E-06*	0.0377***	0.0002**
LogL	7200.77	7208.54	7191.34	7211.69
RMSE	0.021798	0.021773	0.021764	0.021742
MAE	0.011382	0.011359	0.011344	0.011333
MAPE	183.86	176.35	172.19	161.95

Source: own computations

Note: *** denotes significant at 1 p.c. level of significance

** denotes significant at 5 p.c. level of significance

* denotes significant at 10 p.c. level of significance

Table III contains the basic variations in returns of expiry day, its next day and non-expiry day. The mean and unconditional variance of returns is highest during next days and lowest during non-expiration days. The skewness statistics indicates higher probability of getting higher returns on next day compared to expiry day. Its positive value during non-expiration days indicates high probability of receiving lower returns. The kurtosis and JB statistics indicate that next day returns are more normal than expiry day returns while returns are exceedingly non-normal throughout non-expiry days. To assess the impact of expiry day and its volume on spot return and volatility we expand the GARCH return and volatility equations with corresponding dummies.

GARCH Return Equation for effect of Expiry day

$$Rtn_t^{nfty} = a + bRtn_{t-1}^{nfty} + c\ expday + d\ expday\ LnVOL + \varepsilon_t \quad \text{……… (1.3)}$$

GARCH Volatility Equation for effect of Expiry day

$$\sigma_t^2 = \phi + \sum_{k=1}^{q} \beta_k \sigma_{t-k}^2 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + g\ expday + h(expday\ volume)$$
………..(1.4)

Similar equations have been framed for next day and non expiry day. The impact of the three variables has been evaluated in all the three asymmetric models and the results are presented in Tables IV, V and VI respectively.

Table IV shows that the impact of expiry day and its volume is highly significant (1%) and positive on both spot return and volatility. The addition of expiry day dummy into the GARCH volatility equation has changed the GARCH process i.e., it has decreased the impact of recent news and increased the persistence of volatility. The comparison of leverage coefficient shows that the dummy has reduced the asymmetric effect of volatility.

Table V Impact of next day on return and volatility

	Garch(1,1) Ged Dist.	TGarch(1,1) Ged Dist.	EGarch(1,1) Ged Dist.	PGarch(1,1) Ged Dist.
Nifty(-1)	0.0414**	0.0528***	0.0217	0.0366*
Nextday	0.0037***	0.0048***	0.0049***	0.0042***
Nextday*Lnvol	0.0003***	0.0003***	0.0003***	0.0003***
Alpha	0.1628***	0.0756**	0.1439***	0.1377***
Gamma	–	0.1907***	-0.0442**	0.5459***
Beta	0.8554***	0.8076***	0.9644***	0.8767***
Nextday	6.3E-05*	5.13E-05**	0.4329***	0.0033***
Nextday*Lnvol	3.06E-05*	3.77E-05**	0.0441***	0.0003***
LogL	7261.07	7266.94	7247.87	7270.85
RMSE	0.021939	0.021883	0.021888	0.021883
MAE	0.011435	0.011398	0.011400	0.011398
MAPE	178.93	153.07	154.97	152.73

Source: own computations

Note: *** denotes significant at 1 p.c. level of significance
** denotes significant at 5 p.c. level of significance
* denotes significant at 10 p.c. level of significance

The comparison of Tables IV and V shows that the impact of next day on return and volatility is stronger than the expiry day, suggesting persistence of an upward pressure where no price or volatility reversal is happening. Hence, the expiration period is profitable for Indian market participants. Further, the volumes are also higher on next day as compared to expiry day which are partially responsible for high returns and volatility during expiration period. The results in Table VI reveals that impact of non-expiration is positive & insignificant on returns while it is negative & insignificant on volatility. This implies that Indian market experiences significant expiration effects in terms of high returns, volumes and volatility.

Table VI: Impact of non expiry day on return and volatility

	Garch(1,1)	TGarch(1,1)	EGarch(1,1)	PGarch(1,1)

	Ged Dist.	Ged Dist.	Ged Dist.	Ged Dist.
Nifty(-1)	0.0439**	0.0397**	0.0189	0.0307
NExpday	0.0004	0.0002	0.0003	0.0002
NExpday*Lnvol	4.33E-05	2.12E-05	9.49E-06	1.78E-05
Alpha	0.1621***	0.0706**	0.1238***	0.1232***
Gamma	–	0.1784***	-0.0193	0.4074***
Beta	0.8332***	0.7879***	0.9616***	0.8632***
NExpday	-1.88E-05	-2.04E-05	0.0577	-0.0005
NExpday*Lnvol	-8.83E-07	-1.61E-06	0.0044	-3.56E-05
LogL	6787.09	6673.51	6213.78	6088.36

Source: own computations

Note: *** denotes significant at 1 p.c. level of significance

** denotes significant at 5 p.c. level of significance

* denotes significant at 10 p.c. level of significance

Conclusion

The analysis of post-derivative for expiration effect indicates that return, volume and volatility are high on expiry day, all these variables further increase on next day, indicating continuation of upward pressure. This indicates negative price, volume and volatility reversal. The volume on expiry and next days is partially responsible for high returns and volatility on these days. Although, Indian government has tried to implement physical settlement but it is yet to take off, hence, the cash settlement feature of derivatives may be contributing to high returns during these days. Increase in returns on both expiry and next day could also be due to flow of new information into the market which implies that Indian market is weakly efficient, Fama (1970). According to Stoll and Whaley (1997), if the underlying market is deep and if suppliers of liquidity are quick to respond to selling or buying pressure, the price effects of large arbitrage unwinding will be small. The results of our study indicate significant effect on price which means that the market mechanisms in India are not well designed to offset surprise imbalances and there is a need to further increase the depth of markets.

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