Proceedings of the First European Academic Research Conference on Global Business, Economics, Finance and Social Sciences (EAR15Italy Conference) ISBN: 978-1-63415-028-6
Milan-Italy, June 30-July 1-2, 2015, Paper ID: I564

Assessing the Impact of Equity Derivatives Introduction in NSE, India

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Abstract

This article investigates the impact of introduction of equity derivatives in NSE, India, on price and liquidity characteristics of the underlying. First, the effect on price is examined following an event study methodology provided by Brown and Warner (1985), where the significance of the abnormal returns around the event day is examined. Next, the effect of these introductions on liquidity of the underlying is examined by determining the change in the mean levels of liquidity proxies. Five different liquidity proxies have been used for this purpose namely Relative Trading volume, Net Turn-over, Liquidity ratio, Price range and Trading frequency. These liquidity proxies are faced with the problem of serial-correlation. Therefore, the means are computed after fitting standard time-series ARMA (p,q) models. Further, Indian markets are also prone to "expiration day effect". This effect is caused when all the options and futures contracts are executed on the expiration day, where a large number of trading activity is observed. We control for this effect and the change in liquidity is once again assessed. The result on price effect shows significant positive abnormal returns on few days around the event. While, the result on liquidity indicate a general improvement in the level of liquidity post introduction and this is persistent even after controlling for the expiration day effect.

Keywords: *Event study, Abnormal Returns, Market Efficiency, Liquidity Measures*
Field of Research: Finance
JEL classification: *G14, G28, C21, C22*

1. Introduction

Derivatives are one of the most important innovations of the financial industry towards the late twentieth century. The sheer increase in their volume of trade observed in the recent times substantiates their increasing significance. Currently in India, more than 90 % of the trading occurs in the derivatives sector[1]. Their popularity is not only accounted for the leverage and allocation efficiency they provide, but also for the lower margin requirements and lower transaction costs.

However, there is a flip-side associated with these financial instruments. They are believed to promote speculative activities and are blamed for causing market breakdowns. This demands a greater cause for concern as instances like the stock market crash of 1987 in the US (Lee and Ohk, 1992) and the recent global financial crisis of 2008 (Crotty, 2009) illustrate their pitfalls in the modern financial world. Consequently, this has captured a lot of attention of the regulators, practitioners and the academicians alike.

According to the well-known model of options pricing given by Black and Scholes (1973), an option is a redundant security in a perfect market in absence of arbitrage. It can be replicated by portfolios and, risk-less borrowing and hence, theoretically, its introduction should not have any effect on the underlying assets. However, in the real world, when the assumptions of perfect, competitive, and frictionless markets do not hold good, the introduction of an option may affect different characteristics of the underlying asset (Nachman, 1989). In the literature, there exist two strands of theory in terms of the kind of bearing derivatives introduction have on the underlying. One strand talks about derivatives being detrimental to the market called the destabilization theory, while the other talks about them being beneficial called the stabilization theory.

It is suggested that when derivatives are introduced, they may draw traders away from the underlying market to the derivative market, resulting in reduction in liquidity of the underlying, which invariably also affects its price in a negative manner (Subramaniam, 1991). Due to lower margin requirements and leverage provided by these instruments, it is believed to promote speculative activity (Stein, 1987). Insider information is an important aspect when considering the welfare of investors. Derivatives are blamed for offering more channels for an insider to execute his/her trade less aggressively and thus avoiding the risk of getting caught (Biais and Hillion, 1994).

On the other hand, there are theories which suggest that derivatives are indeed beneficial to the underlying financial markets. According to Ross (1976), derivatives increase the opportunity set for an investor and thus allowing him/her to overcome certain trading

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[1] www.nseindia.com

restrictions. e.g.: restrictions on short selling.

Opposing the views that traders migrate from underlying market to derivatives market, Detemple and Seldon (1991) argue that they act as compliment for stocks and not substitute. Some traders (low risk assessing) would still buy stocks and short options, keeping the demand for stocks high. Further, Cao (1999) affirm that derivatives increase the overall in formativeness of the underlying, thus, enabling better information efficiency in the market.

The above arguments portray the contradictory nature of the influence of the derivatives on the underlying market. One can untangle this contradiction only through an empirical investigation. In this regard, the present article attempts to understand the impact of derivatives introduction in the case of Indian market. This is done through examining different characteristics of underlying like price and liquidity through their introduction in NSE, India.

The subsequent sections of the article are organized as follows. In section 2, the previous empirical literature on price and liquidity is reviewed. In this section, only empirical literature pertaining to derivatives introduction on individual equities is summarized. Thus, introduction of derivatives on indices are excluded. Section 3 the methodology and the data used for this research is mentioned. In section 4, the results are discussed and section 5 concludes the article.

2. Literature Review

2.1 Effect on Price

The literature dwells on two aspects, one being the examination of announcement of derivatives introduction called the “announcement effect”, and the other being the actual derivatives introduction itself. The initial empirical investigations on the effect of derivatives introduction on the price of the underlying have been largely from the US markets. Options were first listed in US in the Chicago board of options exchange (CBOE) in 1973. One of the earliest studies was conducted by Conrad (1989), providing the evidence that call options listing had a positive impact on the price, while put options did not have any effect. This result was further confirmed by others like Detemple and Jorion (1990), W. Kim and Young (1991), Broughton and Smith (1997) and, Sorescu (2000). However, they note an inverse effect from having a positive impact during 1973 to 1980 to negative post 1980. This is attributed to other events around 1980 like the introduction of options on index and the regulatory changes (Detemple and Jorion, 1990; Sorescu, 2000).

The literature on announcement effect emerges mainly from the US market. First, Conrad (1989) found that announcements had no impact on the price of the underlying. This was further confirmed by Detemple and Jorion (1990) except for the sub sample of option listings between 1975 and 1982 where a significant positive price effect was found. Broughton and

Smith (1997) warn that contamination of announcement of option listing with other types of announcement causes confounding effect leads to biased results. Thus after reassessing the same sample of Detemple and Jorion (1990) by removing the contaminated samples, they found no change in the prices due to announcements.

There are a few studies emerging from the European Markets. A study on the UK market by Watt, Yadav, and Draper (1992) suggests a temporary increase before options listing and a steady decline post listing. Stucki and Wasserfallen (1994) in a study on the Swiss markets found a permanent and significant increase consistent with earlier US studies. Gjerde and Saettam (1995) found no change except some positive price effect on the day of listing, in a study on the Norwegian markets. Alkeback and Hagelin (1998) also found no price effect in a study on the Swedish markets. Contrary to other European studies, Kabir (2000) found a decline in prices post options listings in a study on the Netherlands market.

The study on the Indian market was conducted by Chaturvedula and Kamaiah (2008), on announcement of derivatives introduction. Using 169 announcements of derivatives introduction in NSE, India, they found that price of the underlying significantly increased. Their study employs a method of treating simultaneous introduction as independent events. It is advised to form equally weighted portfolio due to the conspicuous problem of cross-sectional correlation in case of simultaneous introductions (Conrad, 1989). Furthermore, there are no studies assessing the impact of actual derivatives listing on the individual securities in the Indian context. Against this backdrop, the current article focuses on assessing the impact of actual equity derivative listings on the price of the underlying stocks.

2.2 Effect on Liquidity

The empirical literature on liquidity incorporates predominantly trading volume and bid-ask spreads as liquidity measures. The effect on liquidity is assessed by comparing the values of these measures for the pre and the post listing periods. The methodology generally includes a cross-sectional analysis (across stocks) comparing the pre and post periods or individual stock analysis with longitudinal (time series) regression having a categorical dummy variable (used for indicating the pre and the post periods). Like the effect on price, the initial studies on effect of liquidity also evolve mostly from the US markets. The earliest paper was by Hayes and Tennenbaum (1979), who found a significant increase in trading Volume of optioned stocks as compared to non-optioned stocks called the controlled group.

Similar results of increase in trading volume was obtained by Skinner (1989), Long, Schinski, and Officer (1994), Ho and Liu (1997) and Kumar, Sarin, and Shastri (1998). Further Long et al. (1994) found that the increase in trading volume was more for smaller firms and medium sized firms as compared to larger firms, as options provide more marketability and liquidity to smaller sized firms. Damodaran and Lim (1991) report that even though the absolute trading volume showed an increase, the evidence on market adjusted trading volume (controlling for market index) has been mixed.

Studies on the US markets using Bid-ask Spreads as a measure for liquidity largely indicate a decrease in the spreads (Damodaran and Lim (1991) and Kumar et al. (1998)). Fedenia and Grammatikos (1992) analysed the options listed on stocks traded in NYSE and OTC markets and found that bid-ask spreads decreased for NYSE stocks but increased for OTC traded stocks. Kim and Diltz (1999) also found a decline in bid ask spreads following options listing. But this decline vanished when price, trading volume and return variance of the firms were taken into consideration.

Chamberlain, Cheung, and Kwan (1993) in a study on Canadian markets found no change in either bid-ask spreads or trading volume of the stocks after the options introduction. Another study on the Canadian markets by Chaudhury and Elfakhani (1997) on option de-listing effect, found that de-listing of options caused a decrease in trading volume.

The studies on the European markets include Gjerde and Saettam (1995), who observed a decrease in bid-ask spreads and an increase in trading volume after analyzing option listings on the Norwegian market. Alkeback and Hagelin (1998) found a decline in bid-ask spread, but trading volume largely remained unchanged in a study on the Swedish market. Sahlstrom (2001) found that bid-ask spreads declining for optioned stocks while it increased for non-optioned stocks in a study on the Finland market.

Literature on the Indian market include Bodla and Jindal (2008) and Sadath and Kamaiah (2009). Bodla and Jindal (2008) studied the initial 21 derivative listings using Trading volume. Their findings suggest that trading volume remained unchanged post derivatives listing, but Compounded Annual Growth Rate (CAGR) of trading volume showed a decline. Sadath and Kamaiah (2009) use bid-ask spreads to assess the initial listing of 28 stock futures. They found that bid-ask spreads declined post futures listing indicating improvement in liquidity.

Thus, it is evident from the previous literature that the nature of the impact of these instruments is unique to each market. It should also be noted that the literature largely stems from the developed markets, while that from the developing markets like India is limited. The present study tries to contribute to the existing literature by using a more comprehensive sample of derivatives introduction spanning from January 2003 to March 2014 while adopting five different liquidity measures. These liquidity measures include Relative Trading volume, Net Turn-over, Liquidity ratio, Price range and Frequency of trade. Since these measures exhibit the property of serial correlation, the current study incorporates a new method of computing mean after fitting standard time series ARMA (p,q) models, apart from the usual (ergodic) mean which is typically followed in the literature. Furthermore, this study attempts to understand the “expiration day effect” which is prominent in the Indian markets (Vipul, 2005) and the change in the liquidity measures are reassessed after controlling for the effect.

3. Methodology

3.1 Effect on Price

The effect on price or the change in price of the underlying stocks is measured in terms of abnormal returns. The significance of these abnormal returns is determined following the standard event study methodology given by Brown and Warner (1985). An estimation window of -160 to -31 days and an event window of +/-30 days relative to the event day ‘0’ has been chosen, as in the case of Conrad (1989).

The stocks having derivatives introductions on same calendar dates are clubbed together to form equally weighted portfolios. This is done in order to account for the cross-sectional correlation in their returns. Since the returns of individual stocks are examined around the event date, returns of the stocks with the same event date are expected to be correlated. This violates the independence assumption required for the subsequent t-test used to detect significance of the abnormal returns. Our sample comprises 24 different introduction dates; hence, 24 equally weighted portfolios are formed.

Consider an event window of size $-K$ to $+K$ days relative to the event day '0' and estimation period of $-T$ to $-K-1$. Different abnormal returns are computed as follows:

a. Mean Adjusted abnormal returns:

$$AR_{i,t} = R_{i,t} - \bar{R}_i \qquad \text{For } t = -K, K \qquad \ldots (1)$$

Where $AR_{i,t}$ is the abnormal returns of i^{th} stock on t^{th} day,

$R_{i,t}$ is the returns of i^{th} stock on t^{th} day,

And $\bar{R}_i$ is the average return calculated during estimation window as

$$\bar{R}_i = \frac{1}{T-K-1} \sum_{t=-T}^{-(K+1)} R_{i,t}$$

b. Market adjusted abnormal return:

$$AR_{i,t} = R_{i,t} - R_{m,t} \qquad \text{For } t = -K, K \qquad \ldots (2)$$

Where $R_{m,t}$ is the returns of market index on t^{th} day,

c. Market Model abnormal return:

The returns of i^{th} stock/portfolio are first regressed on a benchmark market index during the estimation window.

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,,t} \qquad \text{For } t = -T, -K-1$$

Once the parameters of the regression α_i and β_i are estimated, they are used to compute the abnormal returns during the event window using the following expression:

$$AR_{i,t} = R_{i,t} - \hat{\alpha}_i - \hat{\beta}_i R_{m,t} \qquad \text{For } t = -K, K \qquad \ldots (3)$$

Where $\hat{\alpha}_i$ and $\hat{\beta}_i$ are respective estimates of the parameter α_i and β_i of the market model regression

Average abnormal return $\overline{AR}_t$ for N stocks/portfolios is defined as

$$\overline{AR}_t = \frac{1}{N}\sum_{i=1}^{N} AR_{i,t}$$

Cumulative Average abnormal return $\overline{CAR}_t$ for N stocks/portfolios is defined as

$$\overline{CAR}_k = \sum_{t=s}^{s+k-1} \overline{AR}_t$$

Under null hypothesis, the Brown and Warner (1985) t-test statistic on a day 't' is given by

$$t(SAR) = \left(\sum_{i=1}^{N} SAR_{it}\right)\frac{1}{\sqrt{N}}$$

Where $SAR_{it}$are the standardised Abnormal Returns given by:

$$SAR_{it} = \frac{AR_{it}}{S_i(AR)}$$

Where $S_i(AR)$ is the standard deviation of the abnormal returns of stock 'i' in the estimation period.

Similarly, the t-test statistic for the average Cumulative Abnormal Returns (CAR) on a day 't' is given by

$$t(SCAR) = \left(\sum_{i=1}^{N} SCAR_{ik}\right)\frac{1}{\sqrt{N}}$$

Where $SCAR_{it}$ are the standardised Cumulative Abnormal Returns given by:

$$SCAR_{ik} = \left(\sum_{t=s}^{s+k-1} SAR_{it}\right)\frac{1}{\sqrt{k}}$$

3.2 Effect on Liquidity

Liquidity, although is an important attribute of an asset, is an ambiguous concept as there is no formal definition for it. One simple way of defining it is the ease of converting an asset from one form to another with minimum loss of value. Kyle (1985) first defined liquidity in terms of three dimensions namely tightness, resiliency and depth. Tightness is the cost of a round-trip transaction, usually measured in terms of bid-ask spreads. Resilience is the speed with which the price of an asset bounces back to its original state after a random shock. And depth is the size of a transaction required to change the price of an asset by one unit. In the current study, due to limited availability of data, five different measures have been used. They are defined as follows.

Table 1: Definitions of Liquidity Measures (Chatterjee and Mukhopadhyay, 2013)

Number	**Measure**	**Definition**
1	Relative Trading Volume	(Total shares traded on a given day)/ (total number of outstanding shares)
2	Net Turn-over	Total monetary value of the shares traded on a given day
3	Liquidity Ratio	(Absolute value of price change)/(Relative Trading volume on a given day)
4	Price Range	(Highest price - lowest price) /(average price on a given day)
5	Trading Frequency	Number of trades for a stock on a given day

The liquidity measures for each stock are observed for 200 days prior and 200 days after the event. The analysis is done by comparing the means of these observed values of the liquidity measures for the pre and the post period, excluding an event window. This event window is fixed around the event day in order to eliminate extraneous noise generated due to the announcement of introduction and other related information. Here, instead of choosing a single event window, three different event windows of sizes +/-10, +/-20 and +/-30 days are used. This is done to examine whether the size of the event window has any impact on the results.

The means of the liquidity measures for each stock in the pre and post periods are obtained using two different techniques namely the usual (ergodic) mean and time series mean. Consider the liquidity measure L_t, the usual (ergodic) mean is computed for the pre and the post periods as shown below in (4) and (5):

$$\hat{\mu}_{\text{pre}} = \frac{1}{200-T} \sum_{t=-200}^{-T-1} L_t \quad \ldots (4)$$

$$\hat{\mu}_{\text{post}} = \frac{1}{200-T} \sum_{t=T+1}^{200} L_t \quad \ldots (5)$$

Where T takes the value 10, 20 and 30

Note that the implicit assumption behind using the usual (ergodic) mean is that the observations are independent and non-stationary. However, a careful scrutiny of the independence assumption of the liquidity measures revealed that they were auto-correlated. Further, the series were also found to be stationary. Hence, standard time series ARMA (p,q) models were fitted to these liquidity measures for the pre and the post periods (as given in (6)). And the parameters of the ARMA (p,q) process are estimated by applying method of maximum likelihood.

Consider an ARMA (p,q) process

$$L_t = \phi_0 + \phi_1 L_{t-1} + \phi_2 L_{t-2} + \cdots + \phi_p L_{t-p} + \epsilon_t + \theta_1 \epsilon_{t-1} + \theta_2 \epsilon_{t-2} + \cdots + \theta_q \epsilon_{t-q} \quad \ldots (6)$$

The estimated mean for this ARMA (p,q) process is given by

$$\hat{\mu} = \frac{\hat{\phi}_0}{1 - \hat{\phi}_1 - \hat{\phi}_2 - \cdots - \hat{\phi}_p} \quad \ldots (7)$$

The means are computed for the pre and the post period for the liquidity measures and are then tested for change following both parametric (t-test) and non-parametric tests (Wilcoxon signed rank and sign test).

3.3 Expiration day effect

An abnormal trading activity observed during expiration of options and futures contract is known as expiration day effect. This effect arises when the traders holding underlying stocks as cover simultaneously liquidate their positions. Previous literature on expiration day effect by Vipul (2005) suggests that Indian markets are prone to this effect. Presuming the change in the mean level of liquidity measures could be attributed to this effect, it is controlled and the results are re-examined.

In the National Stock Exchange of India (NSE), the far-month contracts expire on the last Thursday of every month and final settlements take place. Any abnormal trading activity should be observed on that particular day. First, in order to determine the stocks which exhibit this behaviour, we fit an ARMA model with a dummy variable used for identifying expiration day as shown in (8).

$$L_t = \phi_0 + \phi_1 L_{t-1} + \phi_2 L_{t-2} + \cdots + \phi_p L_{t-p} + \epsilon_t + \theta_1 \epsilon_{t-1} + \theta_2 \epsilon_{t-2} + \cdots + \theta_q \epsilon_{t-q} + \beta D \quad \ldots (8)$$

Where *D* is the dummy variable, taking the value 1, for last Thursdays of the month in the post derivatives introduction period and 0 on all other days.

The stocks which exhibited expiration day effect were identified by examining the significance of the dummy variable. The observations for those liquidity measures on the expiration days were then removed. And the means (both usual and time series) were again computed and compared following same methodology as earlier.

3.4 Data

India has two major stock exchanges namely the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE). NSE despite its existence from 1992, is leading the century old BSE in terms of daily turnover and number of trades, for both equities as well as derivative segment. This study considers the data from the NSE.

Initially, NSE introduced futures on index NIFTY on June 12, 2000. Subsequently, options and futures on individual equities were introduced on July 2, 2001 and November 9, 2001 respectively. Post January 31, 2003 both options and futures are introduced simultaneously for the same stocks. This is collectively referred to as derivatives and this also marks the beginning period of our sample of stocks. The sample used for this study constitutes derivatives introduction spanning from January 31, 2003 till March 13, 2014 comprising of 258 stocks. After removing stocks with other contemporaneous events like inclusion/exclusion of them in the Index (NIFTY), Mergers and Acquisitions, relisting etc., eventually led us to a sample of 240 stocks.

4. Results and Discussion

4.1 Price

Results on the impact of derivatives listing on the price of the underlying are displayed from tables 3 to 8 of the Appendix. Tables 3, 5and 7 display the results for abnormal returns computed using equations (1), (2) and (3) i.e. mean-adjusted, market-adjusted and market-model abnormal returns respectively. Similarly, tables 4, 6and 8 display the corresponding results of their Cumulative abnormal returns. For each day during the event window, average abnormal returns of the 24 stocks/portfolios are reported in the second column. Numbers of positive abnormal returns on a given day are displayed in the third column. The Brown and Warner (1985) t-statistic and its corresponding p-values for average abnormal returns are provided in last two columns. The days showing abnormal returns at 5% level of significance are summarized in the table below.

Table 2: days with significant abnormal returns

Abnormal Returns	**Positive (days)**	**Negative (days)**
Mean Adjusted	-2, 29	11
Cumulative Mean Adjusted	1,2,3,4,5,6,7,8,9,10	
Market Adjusted	-3, -2, 29	11
Cumulative Market Adjusted	-2,-1,0,1,2,3,4,5,6,7,8,9,10,11,12,13,14,15,16	
Market Model	-3,-2	11
Cumulative Market Model	-2,-1,0,1,2,3,4,5,6,7,8,9,10	

From the above table it is understood that mean adjusted, market adjusted and market model abnormal returns indicate positive abnormal returns only for two or three days around the event. However, the significance of the positive cumulative abnormal returns cannot be ignored. The significant positive abnormal returns are continuous, starting from 2 days before the event to few weeks post the event. The average cumulative abnormal returns between days -5 and +5 for the mean adjusted, market adjusted and market model are 4.3%, 3.2% and 3.1% respectively. Also, it should be noted that no negative abnormal returns are apparent in the cumulative abnormal returns.

The days -3, -2 having positive abnormal returns around the event day indicating a positive signal being sent to the market through announcement of listings. This may also be due to dealers and specialist building up their inventory in anticipation of future trades. On the flipside, this also gives arbitrageurs an opportunity to exploit the market and make riskless profits.

4.2 Liquidity

The results on the impact of derivatives on the liquidity measures of the underlying are displayed from tables 9 to 11 in the Appendix. The Tables indicate the results of the paired test performed for the pre and the post periods using the usual (ergodic) mean and time series mean with different event window sizes. Against each liquidity measure, the corresponding significance level of the paired tests is reported through their p-values. Finally, whether the liquidity measure used has increased or decreased or remained unchanged following derivatives introduction has been mentioned.

Table 9 reports the results computed considering an event window of +/- 10 days. First, for the usual mean (ergodic mean) the order flow characteristics namely Relative Trading volume, Trading Frequency and Net Turnover have increased, indicating improvement in liquidity. Liquidity ratio indicates the amount of price change for a given transaction size, is an equivalent proxy for market depth. The decline in this is again a good sign of improvement in liquidity. Price range, which indicates intra-day price spread, has increased suggesting a contrary view about the same. However, when one looks at the results obtained through time series mean, like earlier, the order flow parameters show an increase but both liquidity ratio as well as price range shows a decrease. This affirms that there is an overall improvement in liquidity as the evidence from all the measures is consistent. In Tables 10 and 11 an event window of +/- 20 and +/- 30 days are considered respectively. The conclusions drawn from the tables 10 and 11 are on the same lines as that of table 9, hence are not summarized individually.

It can also be inferred that using different sizes for the event window does not impact the result. Hence it is confirmative that liquidity has increased post derivatives listings. Further, the increase in the trading volume and net turn-over also contradicts the belief that derivative drive traders away from the underlying.

Next, the effect of expiration day on the change in the liquidity measures is examined. Tables 12 through 14 display the results for the change in the liquidity measures using the event windows +/-10, +/-20 and +/-30 respectively. Although the expiration day effect had a significant impact on a number of stocks[2], the results are exactly identical to the earlier analysis even after controlling for it. Thus, it can be concluded that there is a general improvement in the liquidity post the derivatives listing even after controlling for the expiration day effect. Further, it should also be noted that results obtained from time series mean provides more consistent evidence about the same.

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[2]Eg: 63 out of 240 stocks had significant expiration day effect for Relative Trading volume

5. Conclusion

The impact of financial derivatives on the underlying market is a much debated theme. This debate has gained more significance especially post the global financial crisis. The theoretical literature has remained inconclusive as there are arguments suggesting both the beneficial aspects as well as the unfavourable ones. Consensus can be drawn only based on empirical findings and this was the objective of the current study.

First, the impact of derivatives introduction on the price is examined. The result indicates a significant positive price effect, especially around the event dates. This is consistent with earlier conclusion on announcement effect by Chaturvedula and Kamaiah (2008). The magnitude of positive abnormal returns indicates the market perceiving this as good news. However, this also provides an opportunity for arbitrageurs to make riskless gains.

Next, the impact of derivatives listing on the liquidity is examined. Apart from using the usual mean (ergodic mean), this study also incorporates a method of extracting means of the liquidity measures using their time series models to overcome serial-correlation. While the results from both the means by and large infer the same, the time series mean provide a more consistent evidence with all the liquidity measures consistently implying an overall improvement in the liquidity. The increase in the trading volume and net turn-over is also in contrast to the belief that derivative driving traders away from the underlying. Lastly, the phenomenon of expiration day effect is examined. Although, this effect is observed in few stocks, the overall change in liquidity is not influenced by it. Thus it can be inferred that derivatives have been beneficial in terms of Liquidity of the underlying in case of their introduction in NSE, India.

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Appendix

A. Table 3: Mean Adjusted Abnormal returns

days	Mean adjusted Average AR	No. of positives (Out of 24)	t-statistic	P-value
-30	-0.004	10	-1.037	0.311
-15	0.005	15	0.615	0.544
-10	-0.002	10	-0.970	0.342
-9	0.001	12	-0.061	0.952
-8	-0.002	9	-0.732	0.471
-7	-0.001	14	-0.676	0.506
-6	-0.003	12	-1.120	0.274
-5	0.002	12	0.753	0.459
-4	-0.003	11	-0.040	0.968
-3	0.009	18	2.053	0.052
-2	0.022	18	5.382	0.000***
-1	0.003	12	0.599	0.555
0	0.001	14	0.774	0.447
1	0.004	16	1.753	0.093
2	-0.002	12	0.044	0.965
3	0.004	14	1.118	0.275
4	0.000	11	-0.033	0.974
5	0.003	13	0.810	0.426
6	0.001	13	0.030	0.977
7	-0.002	9	-1.203	0.241
8	0.002	14	0.823	0.419
9	-0.005	11	-1.060	0.300
10	0.006	18	1.013	0.322
11	-0.008	10	-2.123	0.045**
15	-0.005	10	-0.976	0.339
29	0.010	15	2.341	0.028**
30	-0.007	12	-1.318	0.201

- ‘*’significance at 10%, ‘**’ significance at 5%, ‘***’ significance at 1%

Table 4: Mean Adjusted Cumulative Abnormal returns

days	Mean adjusted Cumulative Average AR	No. of positives (Out of 24)	t-statistic	P-value
-30	-0.004	10	-1.037	0.311
-15	0.015	15	0.043	0.966
-10	0.021	13	0.530	0.601
-9	0.022	13	0.505	0.619
-8	0.020	13	0.341	0.736
-7	0.019	12	0.196	0.847
-6	0.016	14	-0.032	0.974
-5	0.018	14	0.116	0.909
-4	0.015	14	0.106	0.916
-3	0.024	16	0.492	0.627
-2	0.046	17	1.483	0.152
-1	0.049	17	1.567	0.131
0	0.049	17	1.681	0.106
1	0.054	17	1.964	0.062*
2	0.052	17	1.942	0.065*
3	0.056	17	2.105	0.046**
4	0.056	17	2.069	0.050**
5	0.059	18	2.175	0.040**
6	0.060	17	2.150	0.042**
7	0.057	16	1.927	0.066*
8	0.060	15	2.034	0.054*
9	0.055	13	1.840	0.079*
10	0.061	14	1.976	0.060*
15	0.044	14	1.320	0.200
30	0.036	13	0.567	0.576

- ‘*’significance at 10%, ‘**’ significance at 5%, ‘***’ significance at 1%

Table 5: Market Adjusted Abnormal returns

days	Market adjusted Average AR	No. of positives (Out of 24)	t-statistic	P-value
-30	-0.002	12	-0.264	0.794
-15	0.005	13	1.491	0.149
-10	-0.001	14	-0.332	0.743
-9	0.001	16	0.239	0.813
-8	0.000	13	-0.108	0.915

-7	0.003	15	0.794	0.435
-6	-0.001	13	-0.583	0.565
-5	-0.001	10	0.082	0.936
-4	-0.001	12	0.372	0.713
-3	0.008	17	3.048	0.006***
-2	0.022	19	7.475	0.000***
-1	0.003	12	1.447	0.161
0	-0.002	12	-0.259	0.798
1	0.001	14	0.709	0.485
2	-0.001	13	0.081	0.936
3	0.003	12	1.025	0.316
4	-0.001	10	-0.432	0.670
5	0.001	12	0.391	0.700
6	0.001	12	0.057	0.955
7	-0.001	10	-0.790	0.438
8	-0.001	10	0.226	0.823
9	-0.005	10	-1.439	0.164
10	0.004	14	0.745	0.464
11	-0.007	6	-2.246	0.035**
15	-0.006	12	-1.636	0.115
29	0.008	13	2.193	0.039**
30	-0.004	11	-0.923	0.365

- ‘*’significance at 10%, ‘**’ significance at 5%, ‘***’ significance at 1%

Table 6: Market Adjusted Cumulative Abnormal returns

days	Market adjusted Cumulative Average AR	No. of positives (Out of 24)	t-statistic	P-value
-30	-0.002	12	-0.264	0.794
-15	0.012	14	0.790	0.438
-10	0.012	11	0.934	0.360
-9	0.013	12	0.963	0.345
-8	0.013	10	0.920	0.367
-7	0.016	15	1.062	0.299
-6	0.015	12	0.924	0.365
-5	0.014	13	0.922	0.366
-4	0.013	15	0.977	0.339
-3	0.022	16	1.535	0.138
-2	0.044	18	2.896	0.008***
-1	0.046	18	3.112	0.005***
0	0.044	19	3.015	0.006***
1	0.045	19	3.093	0.005***

2	0.045	19	3.060	0.006***
3	0.047	17	3.190	0.004***
4	0.046	19	3.071	0.005***
5	0.047	19	3.093	0.005***
6	0.048	19	3.061	0.006***
7	0.047	16	2.892	0.008***
8	0.046	15	2.891	0.008***
9	0.041	14	2.627	0.015**
10	0.045	16	2.711	0.012**
11	0.038	15	2.332	0.029**
12	0.036	14	2.215	0.037**
13	0.035	13	2.099	0.047**
14	0.037	14	2.230	0.036**
15	0.032	14	1.965	0.062*
16	0.030	13	1.844	0.078*
17	0.025	12	1.676	0.107
30	0.023	11	0.960	0.347

- '*' significance at 10%, '**' significance at 5%, '***' significance at 1%

Table 7: Market Model Abnormal returns

days	**Marmod adjusted Average AR**	**No. of positives (Out of 24)**	**t-statistic**	**P-value**
-30	-0.003	13	-0.545	0.591
-15	0.005	14	1.387	0.179
-10	-0.003	12	-1.008	0.324
-9	0.001	15	0.295	0.771
-8	0.000	12	-0.348	0.731
-7	0.001	13	0.148	0.884
-6	-0.001	12	-0.801	0.431
-5	0.000	11	0.318	0.753
-4	-0.001	11	0.446	0.660
-3	0.008	16	2.718	0.012**
-2	0.020	18	7.284	0.000***
-1	0.002	12	1.190	0.246
0	0.000	11	0.134	0.894
1	0.002	13	0.997	0.329
2	0.000	13	0.371	0.714
3	0.002	10	1.078	0.292
4	-0.002	13	-0.813	0.424
5	0.000	11	0.210	0.835
6	0.002	14	0.314	0.756
7	-0.001	10	-1.058	0.301

8	0.000	11	0.459	0.650
9	-0.005	9	-1.686	0.105
10	0.002	14	0.252	0.803
11	-0.008	6	-2.698	0.013**
12	-0.002	10	-0.964	0.345
15	-0.007	10	-1.831	0.080*
16	-0.002	9	-0.797	0.434
28	0.002	13	-0.526	0.604
29	0.006	12	1.795	0.086*
30	-0.005	12	-1.278	0.214

- '*' significance at 10%, '**' significance at 5%, '***' significance at 1%

Table 8: Market Model Cumulative Abnormal returns

days	Marmod adjusted Cumulative Average AR	No. of positives (Out of 24)	t-statistic	P-value
-30	-0.003	13	-0.545	0.591
-15	0.005	15	0.036	0.972
-10	0.003	12	0.177	0.861
-9	0.004	12	0.236	0.816
-8	0.004	12	0.158	0.876
-7	0.005	13	0.185	0.855
-6	0.004	12	0.021	0.984
-5	0.003	14	0.083	0.935
-4	0.002	12	0.167	0.869
-3	0.010	14	0.678	0.505
-2	0.031	16	2.018	0.055*
-1	0.033	17	2.202	0.038**
0	0.032	16	2.190	0.039**
1	0.034	16	2.332	0.029**
2	0.034	15	2.361	0.027**
3	0.036	13	2.511	0.020**
4	0.034	13	2.337	0.029**
5	0.034	14	2.339	0.028**
6	0.036	15	2.359	0.027**
7	0.035	14	2.156	0.042**
8	0.035	12	2.202	0.038**
9	0.030	12	1.908	0.069*
10	0.032	14	1.924	0.067*
11	0.024	13	1.484	0.151
15	0.016	12	1.065	0.298

30	-0.001	9	-0.164	0.871

- '*' significance at 10%, '**' significance at 5%, '***' significance at 1%

B. Changes in the Liquidity measures computed using usual mean and time series mean

Table 9: Considering an event window of +10 and – 10 days

+/-10days	Usual mean					Time Series mean			
Measures	**t-test p-value**	**Wilcoxon test p.value**	**Sign test-p.value**	**increase/ decrease**		**t-test p-value**	**Wilcoxon test p.value**	**Sign test-p.value**	**increase/ decrease**
Relative TV	0.031**	0.000***	0.005***	increase		0.047**	0.045**	0.023**	increase
Net Turn over	0.003***	0.000***	0.000***	increase		0.001***	0.000***	0.000***	increase
Price Range	0.000***	0.000***	0.144	increase		0.098*	0.568	0.651	decrease
Liquidity Ratio	0.948	0.035**	0.011**	decrease		0.836	0.025**	0.032**	decrease
Trading Frequency	0.000***	0.000***	0.000***	increase		0.240	0.000***	0.002***	increase

- ‘*’ significance at 10%, ‘**’ significance at 5%, ‘***’ significance at 1%

Table 10: Considering an event window of +20 and –20 days

+/-20days	Usual mean					Time Series mean			
Measures	**t-test p-value**	**Wilcoxon test p.value**	**Sign test-p.value**	**increase/ decrease**		**t-test p-value**	**Wilcoxon test p.value**	**Sign test-p.value**	**increase/ decrease**
Relative TV	0.034**	0.001***	0.007***	increase		0.169	0.031**	0.023**	increase
Net Turn over	0.003***	0.000***	0.000***	increase		0.029**	0.001***	0.016**	increase
Price Range	0.000***	0.000***	0.033**	increase		0.022**	0.618	0.948	decrease
Liquidity Ratio	0.944	0.083*	0.033**	decrease		0.252	0.022**	0.061*	decrease
Trading Frequency	0.001***	0.000***	0.000***	increase		0.047**	0.002***	0.011**	increase

- ‘*’ significance at 10%, ‘**’ significance at 5%, ‘***’ significance at 1%

Table 11: Considering an event window of +30 and –30 days

+/-30days	Usual mean					Time Series mean			
Measures	**t-test p-value**	**Wilcoxon test p.value**	**Sign test- p.value**	**increase/ decrease**		**t-test p-value**	**Wilcoxon test p.value**	**Sign test- p.value**	**increase/ decrease**
Relative TV	0.034**	0.001***	0.007***	increase		0.024**	0.001***	0.001***	increase
Net Turn over	0.003***	0.000***	0.000***	increase		0.057*	0.001***	0.000***	increase
Price Range	0.000***	0.000***	0.033**	increase		0.396	0.261	0.272	unchanged
Liquidity Ratio	0.944	0.083*	0.033**	decrease		0.037**	0.046	0.137	decrease
Trading Frequency	0.001***	0.000***	0.000***	increase		0.018**	0.000***	0.000***	increase

- ‘*’ significance at 10%, ‘**’ significance at 5%, ‘***’ significance at 1%

C. Changes in the Liquidity measures recomputed after capturing the “expiration day effect”

Table 12: considering an event window of +/-10 days

+/-10days	Usual mean					Time Series mean			
Measures	**t-test p-value**	**Wilcoxon test p.value**	**Sign test- p.value**	**increase/ decrease**		**t-test p-value**	**Wilcoxon test p.value**	**Sign test- p.value**	**increase/ decrease**
Relative TV	0.031**	0.001***	0.008***	increase		0.057*	0.064*	0.046**	increase
Net Turn over	0.003***	0.000***	0.000***	increase		0.004***	0.000***	0.001***	increase
Price Range	0.000***	0.000***	0.232	increase		0.081*	0.531	0.595	decrease
Liquidity Ratio	0.948	0.036**	0.011**	decrease		0.889	0.031**	0.033**	decrease
Trading Frequency	0.001***	0.000***	0.000***	increase		0.228	0.000***	0.002***	increase

- ‘*’ significance at 10%, ‘**’ significance at 5%, ‘***’ significance at 1%

Table 13: Considering an event window of +20 and –20 days

+/-20days	Usual mean					Time Series mean			
Measures	**t-test p-value**	**Wilcoxon test p.value**	**Sign test-p.value**	**increase/ decrease**		**t-test p-value**	**Wilcoxon test p.value**	**Sign test-p.value**	**increase/ decrease**
Relative TV	0.035**	0.001***	0.005***	increase		0.299	0.051*	0.046**	increase
Net Turn over	0.004***	0.000***	0.000***	increase		0.082*	0.003***	0.017**	increase
Price Range	0.000***	0.000***	0.024**	increase		0.019**	0.561	1.000	decrease
Liquidity Ratio	0.944	0.083*	0.033**	decrease		0.278	0.021**	0.033**	decrease
Trading Frequency	0.001***	0.000***	0.000***	increase		0.055*	0.004***	0.017**	increase

- ‘*’ significance at 10%, ‘**’ significance at 5%, ‘***’ significance at 1%

Table 14: Considering an event window of +30 and –30 days

+/-30days	Usual mean					Time Series			
Measures	**t-test p-value**	**Wilcoxon test p.value**	**Sign test-p.value**	**increase/ decrease**		**t-test p-value**	**Wilcoxon test p.value**	**Sign test-p.value**	**increase/ decrease**
Relative TV	0.044**	0.002***	0.017**	increase		0.023**	0.001***	0.001***	increase
Net Turn over	0.005***	0.000***	0.000***	increase		0.063*	0.001***	0.000***	increase
Price Range	0.000***	0.000***	0.084*	increase		0.336	0.337	0.425	unchanged
Liquidity Ratio	0.892	0.136	0.144	unchanged		0.053*	0.029***	0.084*	decrease
Trading Frequency	0.001***	0.000***	0.001***	increase		0.013*	0.000***	0.000***	increase

- ‘*’ significance at 10%, ‘**’ significance at 5%, ‘***’ significance at 1%