Determinants of liquidity in open electronic limit order book market

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Abstract

In the last decade, many emerging capital markets have undergone drastic changes in terms of market microstructure changes, specifically in secondary markets. One of the policy concerns is the improvement of liquidity in markets. We study the various determinants of liquidity with reference to Indian stock market. There is no consensus on the proxies of liquidity in the financial markets. We calculate impact cost as the proxy for liquidity. It captures the trade size information as well as price information. It is better than highly popular proxy, bid-ask spread, as it provides information beyond the inside quotes. We estimate the fixed effect panel data model to analyse the variation in level as well as volatility of liquidity. We show that 58% of the cross sectional and time series variation is captured by adverse selection risk proxies, inventory risk proxies, and time dummies. Even after controlling the firm specific factors, we still observe the annual and monthly systematic pattern in the liquidity in emerging stock markets.

Keywords: Impact Cost, Panel Data, Limit Order Suppliers, Aderverse Selection Risk and Inventory Risk

JEL codes: G14, C33

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1 Introduction

Over the last decade, there has been a revitalisation of various emerging stock markets through the globe. The policy reforms have been largely characterised by market microstructure changes, revamping the regulatory framework and thereby inheriting international practices (trading, settlement as well as risk containment) in their financial market structure. During the reforms, liquidity of the equity market was a major concern for many economies. In the real market, the concern about liquidity is one of the most important factors in investment decision. There is a growing support for the proposition that liquidity affects the asset price and trading strategies followed by traders. There are many theoretical studies[1] and empirical studies[2] which support the effect of liquidity of transaction costs on assets prices. Portfolio choice[3] is also determined by liquidity of assets. Liquidity of assets is one of the factors which plays a major role in the formulation of optimal trading policy[4] followed by traders. The goal of this paper is to address the determinants of the dynamics of liquidity in the emerging stock market with a reference to India.

Indian equity markets have adopted open electronic limit order book (OELOB) market design. In the open electronic limit order book (OELOB) market liquidity is supplied by limit orders. Liquidity suppliers are not obliged to place limit orders for ever. They have the option to place or cancel limit orders at any point of trading time. This free entry and free exit are the unique feature of this market design. Since there is no designated limit order suppliers at normal or crisis period, the endogenous evolution of liquidity is a quite complex phenomenon in this market. Traders' information level, their liquidity needs and current state of limit order book determine their optimal order placement strategies.

Liquidity can be measured by impact cost in OELOB market. Impact cost can be defined as the percentage change between the weighted average execution price and the pre-trade midpoint price. It tells us that how much extra we have to pay if market is not perfectly liquid market. This proxy serves better a measure than the traditional measure of liquidity - bid-ask spread, since it provides the ex ante information on the price change after trade of a particular quantity at any point of trading time.

[1] Lo, Mamaysky and Wang (2001).
[2] Amihud and Mendelson (1986), Pastor and Stambaugh (2001).
[3] Koren and Szeidl (2002).
[4] Atkinson and Wilmott (1995) .

[Figure 1 about here.]

[Figure 2 about here.]

The above graph shows the cross-sectional evolution of liquidity in the Indian stock market during 1997-2002. There has been a lot of cross-sectional variation in impact cost over the last few years. In the year 2001-2002 many major policy reforms like introduction of rolling settlement and stocks option and stock future and a series of crises happened, making it the worst year in terms of liquidity. These cross-sectional time series variation in liquidity at Indian stock market motivates us to examine following issues;

- Is there any month of year effect in the liquidity?
- How have the level and volatility in liquidity evolved over the years?
- What are the firm specific factors which affect the level of impact cost?
- What are the firm specific factors which affect the volatility of impact cost?

A great many authors have tried to understand the determinants of liquidity in different market design. For the first time, Demesetz (1968) documents about the theory of liquidity supply. Tinic (1972) extends his ideas, and Stoll (1978) provides the rigorous foundation to these issues. Demsetz (1968), Tinic (1972), Tinic and West (1972), Benston and Hagerman (1974), and Stoll (1978) study the determinants of cross-sectional variation in bid-ask at various markets. Mcinish and Wood (1992) finds the intraday J pattern of bid-ask spread. Bessembinder (1994) analyse determinants of time series variation in bid-ask spread in Forex market. Breen, Hodrick, and Korajczyk (2002) document about cross-sectional variation in realized price impact cost, for each month during sample period. After cross-sectional estimation, they report time series mean of estimates. Recently Fahlenbrach and Sandas (2003) apply fixed effect panel data model to analyse the determinants of bid-ask spread in option market.

Krishnamurti and Lim (2000) study cross-sectional variation in liquidity of a set of stocks traded at the Indian equity markets. They measure liquidity as market efficiency coefficient developed by Hasbrouck and Schwartz (1987). Raju, Karande and Taneja (2002) analyse the cross-sectional variation in bid-ask spread. In this paper we have taken impact cost as the measure of liquidity. This proxy is based on the available demand and supply schedules in OELOB market. This proxy

also gives the information how the condition of market changes when desired quantity changes or time changes. Also, whereas both studies focus on narrow sample periods, we cover the relatively large sample period from 1997 to 2002.

Tinic (1972), Chordia, Subrahmanyam, and Anshuman (2001), Domowitz, and Wang (2002) emphasize the significance of level and volatility of liquidity. Thus we make an attempt to explain the cross-sectional time series variation in median impact cost (medianIC) and interquartile range of impact cost (iqrIC) by several observable quantities in financial markets, which proxy for adverse selection risk, inventory risk, share holder heterogeneity. We find that volatility of stock affects liquidity adversely. If Mean turnover ratio that signals the expected order flow in the market, is higher medianIC should be lower. We have tried to capture the heterogeneity in beliefs and uncertainty related to order flow through variation in turnover ratio which is positively related to medianIC. Higher trade duration which indicates the speed of market leads to higher medianIC. We observe that firm-size and dividend yield are negatively related with medianIC. We provide the evidence for the improvement in liquidity on the introduction of stock options since July 2001. Even after controlling the firm specific factors we still observe the annual and monthly systematic pattern in the medianIC. The iqrIC follows almost same pattern.

We employ fixed effect panel data model to analyse the determinants of dynamics of liquidity. The model explains 58% variation in medianIC and 39% in iqrIC. The estimated parameter's signs have the expected signs in most of specifications. The predicted medianIC and iqrIC are strongly correlated with the fixed effects. This signifies the fact that there are some omitted variables which may be correlated with adverse selection risk variables, or inventory risk variables, or shareholder heterogeneity variables. We find the non-linear effect of realised volatility on the medianIC and iqrIC. There is also interaction effect between realised volatility and mean turnover ratio. We observe that the slope coefficients at realised volatility, and standard deviation of turnover ratio are not stable across the years in our sample period.

The paper proceeds as follows. We discuss about market structure and data in section 2. Section 3 describes the how to measure the liquidity. Section 4 summarises the empirical hypotheses to be examined. In section 5 we discuss the methodology adopted to address the above mentioned issues. The results is presented in section 6 and finally section 7 concludes.

2 Market Structure and Data

The electronic equity trading at NSE started on 3rd Nov. 1994. It's growth since then has been phenomenal, from an annual turnover of Rs. 8509 crore in 1995-1996, to Rs. 1,770,458 crore in 2000-2001. It adopted the open electronic limit order book market design. The five best ask quotes and bid quotes are displayed on the trading screen in real time. Once the orders are entered, computer matches them on a price-time priority basis. It follows the anonymous system, in which trader's identity is not revealed. The trading window at NSE is 09:55:00 - 15:30:00, Monday to Friday. The trading cycle in the erstwhile system was Wednesday open - Tuesday close with a T+5 settlement period (Pre - July 2001). This has since been revised to a rolling settlement system.

NSE releases a CD of data every month which contains datasets of everyday trading activity, intra day trades files and limit order book snapshots taken at different time points of a trading day. The sample period is from Jan 1997 to Dec 2002. There are three limit order snapshots taken at 12pm, 1pm and 2pm during years 1997 and 1998, at 11 am, 1pm, and 2pm from 1999 to feb 2000 and since March 2000 limit order data is available at four time points - 11am, 12pm, 1pm, and 2pm. This data consists of complete limit orders stacked on the basis of increasing limit price. All orders are time stamped to seconds. Prices are denominated in Indian currency - Rupees (Rs). The volume is given in number of shares.

The trade files in CD contain all trades in capital market segment of NSE for each trading day. The intra-day trade data is stacked on the basis of increasing time. It reports the trading time up to seconds. For our analysis, we drop the abnormal return from the intraday trade file.

From Centre for Monitoring Indian Economic (CMIE) database we have taken data on daily market capitalisation, quarterly institutional equity holding, daily dividend yield, and traded volume in Rupees for NSE and BSE. On the basis of maximum data availability, we have considered 184 same stocks through out the sample time period.

3 Measurement of Liquidity

The concept of liquidity is well understood in the literature. In a seminal paper Kyle (1985) proposed the three concepts of liquidity viz, tightness, depth and resiliency. Tightness is defined as the difference between the trade price and the efficient price. This is measured by the bid-ask spread. In case of perfect liquidity with respect to tightness, the spread would be zero and traders

can buy or sell at the same price. Depth is defined as the absorptive power of order queues at every price grid. There would be infinite depth available at the market price in the perfectly liquid market. Resiliency is defined as the speed of the convergence to efficient price from the price level which has been brought by trade execution. If there is no information impact on price, price would bounce back to the old price which was available before the random shocks or the transaction of a large orders. Alternatively, in case of information impact during the trading process, price will attain new the efficient price eventually. Hence in highly liquid market, with respect to resiliency, price moves back immediately to their efficient level.

There is no the consensus on quantitative measure of liquidity. There are several proxies of liquidity and they are classified as either measures of friction or activity. The friction measures are those proxies which capture the price concession for immediacy. for example bid-ask spread etc. Activity measures reflect the extent of trading. for example ask depth. Liquidity proxies can also be grouped under ex post measure and ex ante measure. Ex-ante measure can be computed prior to the trade. For example bid-ask spread. Ex-ante measure indicates the opportunity cost of not trading. It predicts the future order flows, as traders know the trading cost before placing orders. This in turn affects the trading strategies. This measure may predict the future liquidity. In contrast, ex post measure captures liquidity information after a trade has been executed. for example effective spread. It helps in describing the characterisation of financial markets. It lacks the ability to predict the future liquidity, since it can not tell absorptive power of market if one executes trades right now. Hence it is advantageous for traders to use ex ante measure of liquidity.

Traditional measures of liquidity like number of transactions, turnover rate or daily volume only capture the volume of transactions. These are the ex-post measures of liquidity. In recent times, bid-ask spread has been used as proxy for liquidity. This proxy serves better than traditional measure as it provides the information on the cost of trade, if transaction is executed immediately. Bid-ask spread is the difference between the best available price to sell and buy a given quantity of assets. As quantity does not enter in computation of this proxy, it does not provide any information about the depth of the financial market. This proxy does not reflect the liquidity supply beyond the inside quotes. Although this proxy is an ex ante measure of liquidity, it is not suitable to measure the liquidity for large orders. Other set of proxies like ask/bid depth only indicate about the depth available at any particular price. These proxies do not reflect how much price will change after the trade. Effective spread is better measure than bid-ask spread, because it is not restricted to the inside quotes, but is an ex post measure of liquidity. All these proxies

are measured at a given point of time. In literature a different kind of proxy - volume duration which reflects the time cost of transaction a given quantity of securities, has been introduced. This measures how much time it will take to trade a given quantity of securities. Though it provides important information about time cost, it is ex post measure of liquidity.

A better proxy of liquidity should

- provide the ex ante information on the price change after trade of a particular quantity at any point of trading time.
- indicate how measurements change when desired quantity changes or time changes.

Liquidity of stock and market overall can also be measured by impact cost (Irvine, Benston, and Kandel (2000), Domowitz and Wang (2002), Coppejans, Domowitz and Madhavan (2001)) if whole limit order book of open electronic limit order book (OELOB) market is available. The impact cost (henceforth IC) combines both price and quantity information. It is ex ante measure of liquidity at a given quantity. The impact cost can be calculated as the percentage difference between the weighted average execution price and the pre-trade midpoint

$$\text{impact cost} = \frac{\sum p_i q_i - P_m Q}{P_m Q} \tag{1}$$

where $\sum q_i = Q$, there are q_i stocks at p_i price and P_m is the the midpoint of the bid-ask spread at the time of the trade. Irvin, Benston and Kandel (2000) define the cost of round trip as the sum of impact cost of ask side and impact cost of bid side.

$$\text{Cost of Round Trip} = \text{Impact cost of Ask side} + \text{Impact cost of Bid side} \tag{2}$$

3.1 Calculation of Impact Cost

- First of all, we calculate the mid point (P_m) which is the average of best bid price and best ask price.
- We compute the number of shares that corresponds to the rupees amount R.

$$\text{Number of shares (Q)} = \frac{R}{P_m} \tag{3}$$

- On using expression (1), we get the impact cost at a particular trading size. We compute the impact cost for both sides (ask and bid) of order book.

- For each week we estimate the mean, median, standard deviation and interquartile range of impact cost computed at trade size of Rs 10000. We have chosen Rs 10000, because it is the mean trade size. In table 1 we report the cross-sectional time series mean of medianIC and iqrIC.

In the calculation of IC, one may face missing data problem. There are following situations when one can not get the value of IC at particular trade size.

- Limit orders may not be available after certain trade size at given point of time.
- There may not be a single active limit order available at given point of time.

We drop the negative impact cost and missing data.

[Table 1 about here.]

4 The Determinants of Impact Cost

In OELOB market, the evolution of liquidity is influenced by the heterogeneous valuation of asset and time, asymmetry information level, costly inventory management, and degree of risk aversion. Many of these factors can not be quantified in equity markets. To assess the effects of these factors, we should infer from the measurable quantities. We present following factors which determine the impact cost.

Volatility: Limit orders are the free option. Their option value is more when volatility of stock is more as traders can pick up mispriced limit orders before limit order suppliers cancel or update the limit orders. It may happen that limit order suppliers do not manage their orders continuously, because there is an opportunity cost for the active management of limit orders (Harris 2003). In order to minimize the option value, limit order suppliers increase the impact cost when volatility is more. There is a strong correlation between the volatility and uncertainty about the fundamental values. There is higher chance that limit orders are mispriced and exposed to adverse selection risk when the fundamental values changes quickly. Hence it may be the case that adverse selection risk is larger for volatile stocks and limit order suppliers demand more price concessions. We expect the volatility of stocks to be positively correlated with impact cost. Since in the time of higher volatility, hedgers always have to adjust their positions more, they trade more. This leads to more liquidity in the market (Harris 2003).

For each week we estimate the realised volatility from high frequency data. We discretise the high frequency price data at half an hour interval and calculate the return. We have chosen this interval to minimize the biasness due to microstructural effects and small sample size[5]. By applying the following formula (Andersen et al. (2000)), we compute the realised volatility.

$$\sigma_{\mathrm{i}}^{\mathrm{w}} = \{\frac{1}{\mathrm{n}-1}\sum_{\mathrm{j}=1}^{\mathrm{n}}(\mathrm{r}_{\mathrm{j}}^{\mathrm{w}} - \bar{\mathrm{r}}^{\mathrm{w}})^2\}^{1/2} \tag{4}$$

where $\sigma_{\mathrm{i}}^{\mathrm{w}}$ is the realised volatility of stock i for week w. $\mathrm{r}_{\mathrm{j}}^{\mathrm{w}}$ is the return series sampled at half an hour period during trading days of the week w and $\bar{\mathrm{r}}^{\mathrm{w}}$ is the mean return during the week w.

We have also consider the relative importance of systematic and unsystematic risk and estimate them from the market model. The market model is

$$\mathrm{R}_{\mathrm{i,t}} = \alpha_{\mathrm{i}} + \beta_{\mathrm{i}}\mathrm{R}_{\mathrm{m,t}} + \epsilon_{\mathrm{i,t}} \tag{5}$$

Now

$$\sigma_{\mathrm{i}}^2 = \beta_{\mathrm{i}}^2\sigma_{\mathrm{m}}^2 + \sigma_{\epsilon}^2 \tag{6}$$

Where $\beta_{\mathrm{i}}^2\sigma_{\mathrm{m}}^2$ is systematic risk and σ_{ϵ}^2 is unsystematic risk.

At each half an hour interval we compute the market index return. We have taken NIFTY as the market index. We estimate $\beta_{\mathrm{i}}^2\sigma_{\mathrm{m}}^2$ and σ_{ϵ}^2 from the regression results of equation (5).

Trading activity: Limit order suppliers are able to control their inventories comfortably when the stocks are highly traded. They face smaller inventory risk. The execution probability of limit orders are large in actively traded stocks. When many market orders compete for the immediacy, timing option value of limit order is negligible. Hence limit order suppliers demand less price concession.

Traded volume and trade duration are used proxy for the traded activity. We measure the traded volume in term of turnover ratio. We calculate turnover ratio at the interval of every half an hour. We estimate the mean and standard deviation for each week. Here mean turnover ratio captures the expected order flow and limit order suppliers can expect to trade this much amount. Hence we expect that impact cost is negatively related to the mean value of turnover ratio. Variation in turnover ratio shows the heterogeneity among traders belief and uncertainty related to order flow. If the variation in turnover is higher, limit order suppliers face higher inventory risk and higher

[5]Andersen et al. (2001) suggest that the return may be sampled between 15 minutes and 2 hours.

execution risk. We expect that the standard deviation of turnover ratio should be negatively affect the liquidity.

Firm size: Larger firms are followed by many analysts and press. Since large firms are more informationally active (Conard et al. (1991), Chordia et al. (2000)), we expect less asymmetric information problem in the case of larger firms and they tend to have smaller relative impact costs than do smaller firm stocks. We measure the firm size as the average market capitalisation for each week.

Stock price trend: Bagwell (1991) shows that traders do not sell those stocks whose price has appreciated in recent past, because they have gained the capital. On the contrary they sell the stocks whose price has fallen in recent past. Hence the number of noise traders in the former case may be lesser than latter case. We expect that liquidity is adversely affected if there is an upward price trend. It may be the case that there are traders who sell winners too early and rides losers too long (Odean (1998)). In the upward market optimistic expectation sets in and that leads to higher traded volume and lower impact cost. In the bearish market since the cost of carrying inventory is more and price concession is high, we expect liquidity may dry up when there is downward trend in price. We measure it by the moving average of weekly return for four lags.

The portfolio rebalancing: Recent price movement whether it is positive or negative may induce the non-information based trading due to portfolio rebalancing (Constantinides 1986). We measure it by taking the absolute value of percentage price change with four lags, $(P_{t-1} - P_{t-5})/P_{t-5}$.

The dividend yield: When dividend yield is high, it may attract more noise traders that leads to larger traded volume. We expect that the high dividend yield effects liquidity positively if there is less adverse selection risk. We take the average dividend yield for each week.

The presence of option of firm's securities: Limit order suppliers can hedge the firm specific risk through option trading. In this case they may demand less amount of impact cost. The order fragmentation (Bernhardt and Hughson (1997)) by traders between spot market and option market may lead to higher impact cost. We take a dummy variable equal to unity if the option instruments are present for firms, otherwise equal to zero.

The extent of institutional holding of firm equity: Institutional holders put more effort to acquire the information about the firm, because they are more investment savvy. They have resources and expertise to decipher information and monitor the firms they invest in. They can improve

corporate values and corporate governance. Management at these firms are to be more accountable for their actions. This, in turn, may spark the confidence of noise traders, prompting them to trade in these stocks. The extent of institutional holdings are positively related with liquidity (Hodrick (1999)). We measure the institutional holding as the percentage of the firm's equity held by institutional investors at the end of quarter.

Competition between NSE and BSE: Many stocks at NSE are also listed at BSE. In order to gain a larger market share in term of traded volume liquidity at NSE may increase. If the traded volume is higher at NSE with respect to BSE, impact cost at NSE is lower. Impact cost at NSE can never be zero at the equilibrium. When traders can split the orders between the NSE and BSE, limit orders suppliers earn the strictly non zero profits (Bernhardt et al (1997)). Here traded volume is measured in Rs million unit. We compute the ratio of traded volume at NSE to traded volume at BSE.

Months of year Effects: Apart from above mentioned factors, trading strategies may be affected by some unobserved factors which may vary across the months of the year. Portfolio managers may do window dressing at the end of the quarters or at the end of the tax years (Lakonishok et al. (1991), Jansson (1988)). This leads to non-information based trading. Months before or after earning announcements or government of India budget announcement or macroeconomic announcements may have different liquidity pattern. We capture this effect by taking dummy variables for the months of year.

Yearly Pattern: In last decade, many policy reforms like introduction of rolling settlements, derivatives etc. have taken place. Table reports the list of major events on India's equity market.

[Table 2 about here.]

These policy reforms may have impact on the liquidity of stock markets. Indian equity markets also face a following major crises over the years.

- CRB Mutual Fund scam in 1997.
- Market Manipulation involving three stocks (BPL, Sterlite, Videocon) in 1998.
- Dismissal of a BSE president, the dismissal of all elected directors on the Bombay Stock Exchange and the Calcutta Stock Exchange, and payment failures on the Calcutta Stock Exchange in 2001.

- UTI mutual fund fiasco in 2001.
- Ketan Parikh scam in 2001.

Each of these crises may adversely affect the liquidity in the market. These may keep away the uninformed traders and small investors from the equity markets, because they may consider securities markets as dangerous investment avenues. Hence liquidity may dry in the market. We take year dummies to capture the years effects.

The table reports the list of variables.

[Table 3 about here.]

5 Methodology

5.1 Industrial pattern with time dummies

Time dummies refer to month dummy and year dummy. We take industry classification at two digit level. Whole sample is grouped in 28 industries. We estimate the pooled OLS with industries dummy and time dummies for medianIC to test the hypothesis that diversified companies may have lowest liquidity, because they are less riskier and no traders may value the asset value of a well diversified corporation.

5.2 Fixed Effect Panel Data Model

We treat the cross-section and time series of stock's impact cost as a panel. We estimate the following fixed effects model for the impact cost of all stocks.

$$\mathrm{Y_{i,t}} = \mathrm{X_{i,t}}\beta + \mathrm{u_i} + \mathrm{e_{i,t}} \tag{7}$$

where $\mathrm{Y_{i,t}} \; \epsilon \; \{\mathrm{medianIC_{i,t}}, \;\; \mathrm{iqrIC_{i,t}}\}$. Since we face missing data problem, the panel regressions are estimated for an unbalanced panel.

5.2.1 Month of year effects and yearly pattern

To capture the month of year effects and yearly pattern in median impact cost and interquartile range of impact cost, we do the fixed effect panel data regression (7) where $X_{i,t}$ include the months

dummy and year dummy.

$$\mathrm{Y_{i,t}} = \alpha + \sum_{\mathrm{k}\epsilon\{98,99,00,01,02\}} \beta_{\mathrm{k}}\mathrm{year_k} + \sum_{\mathrm{j}\epsilon\{01,\ldots,06,09,\ldots,12\}} \gamma_{\mathrm{j}}\mathrm{m_j} + \mathrm{u_i} + \mathrm{e_{i,t}} \tag{8}$$

Here we have kept base year 1997, so that we can observe the systematic pattern, if any. Since major policy reforms and market microstructure changes have happened during July 2001, we choose July as the base month.

5.2.2 Panel fixed effects regression with firm specific factors and time dummies

We test the effect of the firm specific factors - realised volatility, mean turnover ratio, standard deviation of turnover ratio, trade duration, market capitalisation, dividend yield, competition index, stock price trend, portfolio rebalancing, option dummy on impact cost, apart from time dummies. In regression (7) now $X_{i,t}$ include the firm specific factors and time dummies.

$$\begin{aligned}\mathrm{Y_{i,t}} = \alpha + \sum_{\mathrm{k}\epsilon\{98,99,00,01,02\}} \kappa_{\mathrm{k}}\mathrm{year_k} + \sum_{\mathrm{j}\epsilon\{01,\ldots,06,09,\ldots,12\}} \gamma_{\mathrm{j}}\mathrm{m_j} + \beta_1\mathrm{realised\_vol_{i,t-1}} \\ +\beta_2\mathrm{mean\_turnratio_{i,t-1}} + \beta_3\mathrm{Std\_turnratio_{i,t-1}} + \beta_4\mathrm{trade\_duration_{i,t-1}} \\ +\beta_5\mathrm{marketcap_{i,t-1}} + \beta_6\mathrm{dividend\_yield_{i,t-1}} + \beta_7\mathrm{Comp\_index_{i,t-1}} \\ +\beta_8\mathrm{stock\_prtrend^{+}_{i,t}} + \beta_9\mathrm{stock\_prtrend^{-}} + \beta_{10}\mathrm{port\_balancing_{i,t-1}} \\ +\beta_{11}\mathrm{option} + \mathrm{u_i} + \mathrm{e_{i,t}}\end{aligned} \tag{9}$$

To observe the relative importance of systematic risk and unsystematic risk in the determination of medianIC and iqrIC, we do the above regression by taking $\mathrm{sysrisk_{i,t-1}}$ and $\mathrm{unrisk_{i,t-1}}$ and other variables except realised volatility.

5.2.3 Panel fixed effects regression with institutional equity holding

Since we have the data on institutional equity holding during the time period of 2000-2002, we take a subsample to observe the effect of extent of institutional equity holding. We distinguish the institutional investors among Foreign institutional investors, Banks and Mutual fund to check the relative strength on the determination of medianIC and iqrIC. We try to estimate the following

unbalanced fixed effect panel data model.

$$\begin{aligned}\mathrm{Y_{i,t}} = \alpha + \sum_{\mathrm{k}\epsilon\{98,99,00,01,02\}} \kappa_{\mathrm{k}}\mathrm{year_k} + \sum_{\mathrm{j}\epsilon\{01,\ldots,06,09,\ldots,12\}} \gamma_{\mathrm{j}}\mathrm{m_j} + \beta_1\mathrm{realised\_vol_{i,t-1}} \\ +\beta_2\mathrm{mean\_turnratio_{i,t-1}} + \beta_3\mathrm{Std\_turnratio_{i,t-1}} + \beta_4\mathrm{trade\_duration_{i,t-1}} \\ +\beta_5\mathrm{marketcap_{i,t-1}} + \beta_6\mathrm{dividend\_yield_{i,t-1}} + \beta_7\mathrm{Comp\_index_{i,t-1}} \\ +\beta_8\mathrm{stock\_prtrend^{+}_{i,t}} + \beta_9\mathrm{stock\_prtrend^{-}} + \beta_{10}\mathrm{port\_balancing_{i,t-1}} \\ +\beta_{11}\mathrm{option} + \beta_{12}\mathrm{FII_{i,t-1}} + \beta_{13}\mathrm{Banks_{i,t-1}} \\ +\beta_{14}\mathrm{Mutual\_Funds_{i,t-1}u_i} + \mathrm{e_{i,t}}\end{aligned} \tag{10}$$

5.2.4 Non-linear effect of realised volatility

We also try to find out the non-linear effect of realised volatility on the determination of medianIC and iqrIC. We include quadratic form of realised volatility in $X_{i,t}$ as an additional explanatory variables. We estimate the unbalanced fixed effect panel data model given below.

$$\begin{aligned}\mathrm{Y_{i,t}} = \alpha + \sum_{\mathrm{k}\epsilon\{98,99,00,01,02\}} \kappa_{\mathrm{k}}\mathrm{year_k} + \sum_{\mathrm{j}\epsilon\{01,\ldots,06,09,\ldots,12\}} \gamma_{\mathrm{j}}\mathrm{m_j} + \beta_1\mathrm{realised\_vol_{i,t-1}} \\ +\beta_2\mathrm{mean\_turnratio_{i,t-1}} + \beta_3\mathrm{Std\_turnratio_{i,t-1}} + \beta_4\mathrm{trade\_duration_{i,t-1}} \\ +\beta_5\mathrm{marketcap_{i,t-1}} + \beta_6\mathrm{dividend\_yield_{i,t-1}} + \beta_7\mathrm{Comp\_index_{i,t-1}} \\ +\beta_8\mathrm{stock\_prtrend^{+}_{i,t}} + \beta_9\mathrm{stock\_prtrend^{-}} + \beta_{10}\mathrm{port\_balancing_{i,t-1}} \\ +\beta_{11}\mathrm{option} + \beta_{12}\mathrm{FII_{i,t-1}} + \beta_{13}\mathrm{Banks_{i,t-1}} + \beta_{14}\mathrm{Mutual\_Funds_{i,t-1}} \\ +\beta_{15}\mathrm{realised\_vol^2_{i,t-1}} + \mathrm{u_i} + \mathrm{e_{i,t}}\end{aligned} \tag{11}$$

5.2.5 Interaction effect between realised volatility and mean turnover ratio

The impact of volatility on medianIC and iqrIC is not always economically significant. When the mean turnover ratio is quite high the impact of volatility may be quite low, as there are a great number of noise traders in the market who momentarily move the price away from the fundamental value. Limit order suppliers are not afraid of this transitory volatility. In order to capture this effect, we include the interaction term between realised volatility and mean turnover ratio. We

estimate the following model.

$$\begin{aligned} \mathrm{Y_{i,t}} = \alpha + \sum_{\mathrm{k}\epsilon\{98,99,00,01,02\}} \kappa_{\mathrm{k}}\mathrm{year_k} + \sum_{\mathrm{j}\epsilon\{01,\ldots,06,09,\ldots,12\}} \gamma_{\mathrm{j}}\mathrm{m_j} + \beta_1\mathrm{realised\_vol_{i,t-1}} \\ +\beta_2\mathrm{mean\_turnratio_{i,t-1}} + \beta_3\mathrm{Std\_turnratio_{i,t-1}} + \beta_4\mathrm{trade\_duration_{i,t-1}} \\ +\beta_5\mathrm{marketcap_{i,t-1}} + \beta_6\mathrm{dividend\_yield_{i,t-1}} + \beta_7\mathrm{Comp\_index_{i,t-1}} \\ +\beta_8\mathrm{stock\_prtrend^{+}_{i,t}} + \beta_9\mathrm{stock\_prtrend^{-}} + \beta_{10}\mathrm{port\_balancing_{i,t-1}} \\ +\beta_{11}\mathrm{option} + \beta_{12}\mathrm{FII_{i,t-1}} + \beta_{13}\mathrm{Banks_{i,t-1}} + \beta_{14}\mathrm{Mutual\_Funds_{i,t-1}} \\ +\beta_{15}\mathrm{realised\_vol_{i,t-1}} \times \mathrm{mean\_turnratio_{i,t-1}} + \mathrm{u_i} + \mathrm{e_{i,t}} \end{aligned} \tag{12}$$

5.2.6 Stability of Slope coefficients at realised volatility, mean turnover ratio, standard deviation of turnover ratio and traded duration

It may be the case that the slope coefficients at realised volatility, mean turnover ratio, standard deviation of turnover ratio and trade duration in regression (7) are not stable over the years. It may happen that the impact of these variables are different across different months of year. We test these hypotheses by estimating following model.

$$\begin{aligned} \mathrm{Y_{i,t}} = \alpha + \sum_{\mathrm{k}\epsilon\{98,99,00,01,02\}} \kappa_{\mathrm{k}}\mathrm{year_k} + \sum_{\mathrm{j}\epsilon\{01,\ldots,06,09,\ldots,12\}} \gamma_{\mathrm{j}}\mathrm{m_j} + \beta_1\mathrm{realised\_vol_{i,t-1}} \\ +\beta_2\mathrm{mean\_turnratio_{i,t-1}} + \beta_3\mathrm{Std\_turnratio_{i,t-1}} + \beta_4\mathrm{trade\_duration_{i,t-1}} \\ +\beta_5\mathrm{marketcap_{i,t-1}} + \beta_6\mathrm{dividend\_yield_{i,t-1}} + \beta_7\mathrm{Comp\_index_{i,t-1}} \\ +\beta_8\mathrm{stock\_prtrend^{+}_{i,t}} + \beta_9\mathrm{stock\_prtrend^{-}} + \beta_{10}\mathrm{port\_balancing_{i,t-1}} \\ + \sum_{\mathrm{k}\epsilon\{98,99,00,01,02\}} \mathrm{year_k} * (\theta_{\mathrm{k}}\mathrm{realised\_vol_{i,t-1}} + \eta_{\mathrm{k}}\mathrm{mean\_turnratio_{i,t-1}}) \\ + \sum_{\mathrm{k}\epsilon\{98,99,00,01,02\}} \mathrm{year_k} * (\lambda_{\mathrm{k}}\mathrm{Std\_turnratio_{i,t-1}} + \pi_{\mathrm{k}}\mathrm{trade\_duration_{i,t-1}} \\ + \sum_{\mathrm{j}\epsilon\{01,\ldots,06,09,\ldots,12\}} \mathrm{m_j} * (\rho_{\mathrm{j}}\mathrm{realised\_vol_{i,t-1}} + \sigma_{\mathrm{j}}\mathrm{mean\_turnratio_{i,t-1}}) \\ + \sum_{\mathrm{j}\epsilon\{01,\ldots,06,09,\ldots,12\}} \mathrm{m_j} * (\phi_{\mathrm{j}}\mathrm{Std\_turnratio_{i,t-1}} + \vartheta_{\mathrm{j}}\mathrm{trade\_duration_{i,t-1}}) \\ +\beta_{11}\mathrm{option} + \mathrm{u_i} + \mathrm{e_{i,t}} \end{aligned} \tag{13}$$

5.3 Robustness Checks

For the robustness check, we form the five subsamples on the basis of the firm size. We do all the above regressions for each subsample. Alternatively we also perform robustness check on balanced panel with three different specifications:

- The first specification allows for a single autocorrelation coefficient for the residuals in all groups, but no heteroscedasticity.
- The second specification permits for different autocorrelation coefficients for each group and no heteroscedasticity.
- The third specification allows for both group specific autocorrelation and heteroscedasticity in the residuals.

6 Results

[Table 4 about here.]

Table 3 shows the industries ranked on the basis of decreasing medianIC. We have taken Health and Social Work industry as a base industry for pooled OLS regression with industry dummies and time dummies. On the basis of liquidity level, the diversified firms are third and computers and related activities firms are second. Unlike Diversified industry and Computer and Related activities, Post and Telecommunication industry includes only one firm (MTNL) from our sample, therefore having least average medianIC.

[Table 5 about here.]

Table 4 reports the regression result when we only take time dummies as the explanatory variables. For each regression we report the parameter estimates and parentheses contain the standard errors. The double stars stand for the significance at 1% and single stars is for the significance at 5%. The mean of medianIC of years 1998, 1999, 2000, 2001 and 2002 are different from the mean of base year 1997. They capture the effect of policy changes and scams during these years. In fact illiquidity in term of medianIC has increased from 1997 till 2001, in a systematic manner. The liquidity in year 2001 was worst, due to various policy changes and series of scams during year 2001 which we have already describe in section 4. There are months of year effects also. The average medianIC of the months January, March, April and October are quite higher than base month July and rests are significantly lower. The pattern in iqrIC is almost similar as medianIC.

Table 5 documents the results of panel fixed effects regression with firm specific factors and time dummies of medianIC and of iqrIC. The first column reports the results for medianIC and in the second column for iqrIC. For each regression we report the parameter estimates and parentheses

contain the standard errors. The double stars stand for the significance at 1% and single stars is for the significance at 5%.

For medianIC the parameters on the volatility are positive, statistically and economically significant. It is consistent with our predictions. The medianIC increase when the level of volatility increases.

There are three explanatory variables for trading activity: mean turnover ration, standard deviation of turnover ratio, and trade duration. Each has the expected sign. They are economically and statistically significant. For the higher mean turnover ratio, the medianIC and iqrIC will be lower. If the uncertainty about the order flow rises the impact cost increases. For the stock when trade duration is large, medianIC and iqrIC are also large, as the there is higher probability the limit orders will be mispriced.

For the larger firm size the medianIC is lower, as there is less information asymmetry. The parameter is statistically significant. The sign at the dividend yield parameter is negative and statistically significant. Competitive pressure from BSE leads the medianIC at NSE lower in order to draw large traded volume.

There is asymmetric response to market trend. medianIC is lower in upward market and it increases in the downtrend market. In upward market it may happen that individual investors have greater tendency to sell the assets that have appreciated in value (Odean (1998)). In upward market optimistic expectation leads to higher traded volume and lower medianIC. Portfolio balancing has contrary sign than expected. The introduction of option for stocks has improved the liquidity of the stock market. Breen, Hodrick, Korajczyk (2001) and Fahlenbrach and Sandas (2003) have also found similar results.

The parameters of year dummies and month dummies are statistically significant. The parameter sign of March dummy and October dummy are positive. The Budget of the Government of India is announced in the last week of February and the companies announce their earning results in the month of March. It might be that the higher uncertainty in the month of March may have lead to higher medianIC.

The parameter's sign for the regression of iqrIC follows the similar pattern as of the medianIC.

The table 5 reports for the null hypotheses of all parameters being jointly equal to zero below the panel A. The F test rejects the null hypothesis. The overall R^2 is 85% for medianIC and 75%

for iqrIC. The between R^2 is over 95% for medianIC and 96% for iqrIC. The within R^2 is 58% for medianIC and 39% for iqrIC. The F test reported in this table reject the null hypothesis that the fixed effects are jointly equal to zero for medianIC and iqrIC. These finding indicates that a pooled cross-section and time -series regression for impact cost leads to biased inference. The correlations between predicated medianIC and predicted iqrIC with fixed effects are 0.27 and 0.46 respectively. This observation leads to this conclusion that all the variation in medianIC and iqrIC are fully accounted by chosen predetermined variables and time dummies.

[Table 6 about here.]

[Table 7 about here.]

Table 7 reports the results of panel fixed effect regression with systematic risk and unsystematic risk. The weight of firm specific risk is much more higher than market wide risk. Both systematic and unsystematic risk are positively related with medianIC. The parameters of both of them are statistically significant, but coefficient of unsystematic risk is more economically important.

We document the results of panel fixed effects regression with taking institutional holding as one of the explanatory variable in table 6. The pattern of signs of parameters are similar to the table 5. The parameter at FII is statistically significant, but negative whereas like banks and mutual fund's parameter are negative. It captures the additional influence that institutional holding have on liquidity (Bagwell 1992). Breen, Hodrick, and Korajcyk (2001) report similar finding too. The notable finding of this table is that the almost for all the months medianIC is less than the July medianIC. It captures the fact that major policy changes have started during July 2001.

Table 8 documents the results of panel fixed effect regression with quadratic form of realised volatility. The parameter at quadratic term of realised volatility is positive and statistical significant. We infer that there is non-linear effect of realised volatility in the determination of medianIC and iqrIC.

[Table 8 about here.]

[Table 9 about here.]

Table 9 reports the results of panel fixed effect with interaction effect between realised volatility and mean turnover ratio. The parameter at the interaction term is negative statistically significant.

This result tells us that the impact of volatility on medianIC is not always economically significant. When the mean turn over ratio is quite high the impact of volatility is quite low, as there is a great number of noise traders in the market who momentarily move the price away from the fundamental value. Limit order suppliers are not afraid of this transitory volatility.

[Table 10 about here.]

We find that estimated slope coefficient at realised volatility is not stable over the years. Its variation is statically significant. In comparison to year 1997, realised volatility in the years 1998, 1999, 2000, 2001 and 2002 have greater impact. Realised volatility has major impact on mediaIC in the year 2001. Mean turnover ratio has greater impact of medianIC in the year 1998. Standard deviation of turnover ratio has different degree of impact on medianIC over the years. In the year 1999, the effect of trade duration is lesser on medianIC, On average there is no statistically significant month of year effect on the estimated slope coefficients at realised volatility, mean turnover ratio, standard deviation of turnover ratio and trade duration. For brevity, we do not report table for this result.

We do the same panel fixed effects regressions for subsample. We have formed the subsample on the basis of market capitalisation. Results are almost similar.

We consider the panel GLS regression with heteroscedasticity and group specific autocorrelation coefficients. In table 10 the parameter sign's pattern is similar to fixed effect results. Here upward stock price trend is positively statistically significant. Most of the parameters of month dummies are statistically insignificant, but parameter of month March dummy is costively statistically significant. Competition Index between NSE and BSE takes the positive sign, that is inconsistent.

[Table 11 about here.]

7 Conclusions

The evolution of liquidity in OELOB market is complex phenomenon. The liquidity is endogenously determined in this market. Limit order suppliers face the adverse risk and the inventory risk. They increase the impact cost if there is an acute adverse selection problem. For example in a volatile market impact cost is more. We find that the signs of the parameters (almost) are consistent with the the theory. Our methodology - fixed effect regression is superior than pooled

cross-sectional and time series regression, as it takes care of omitted variable problem which is not observable, but is correlated with the other explanatory variables.

We have not considered the effect of the fundamental volatility and transitory volatility. This can be done by taking ARFIMA model of realised volatility. One can also find interesting result on deciphering the relative importance of market wide risk in traded volume and firm specific risk in traded volume. These are our future endeavours.

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List of Figures

Figure 1:

Time Series Plot of cross-sectional mean of Median Impact Cost

This figure presents the time series plot of cross-sectional mean of median impact cost. From intra day limit order data we compute the impact cost at Rs. 10000 for each stock. We calculate the median of impact cost for each stock for each week. Then we compute the cross-sectional mean of these median impact cost.

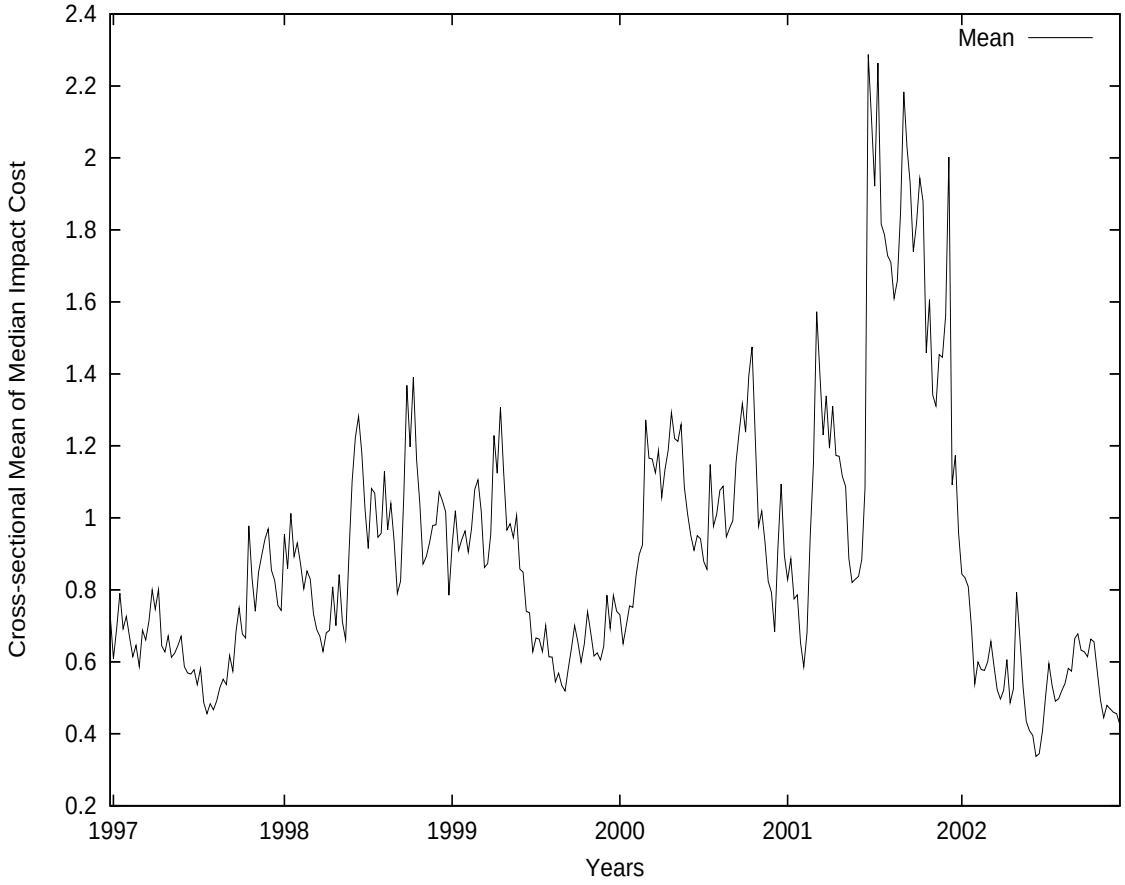
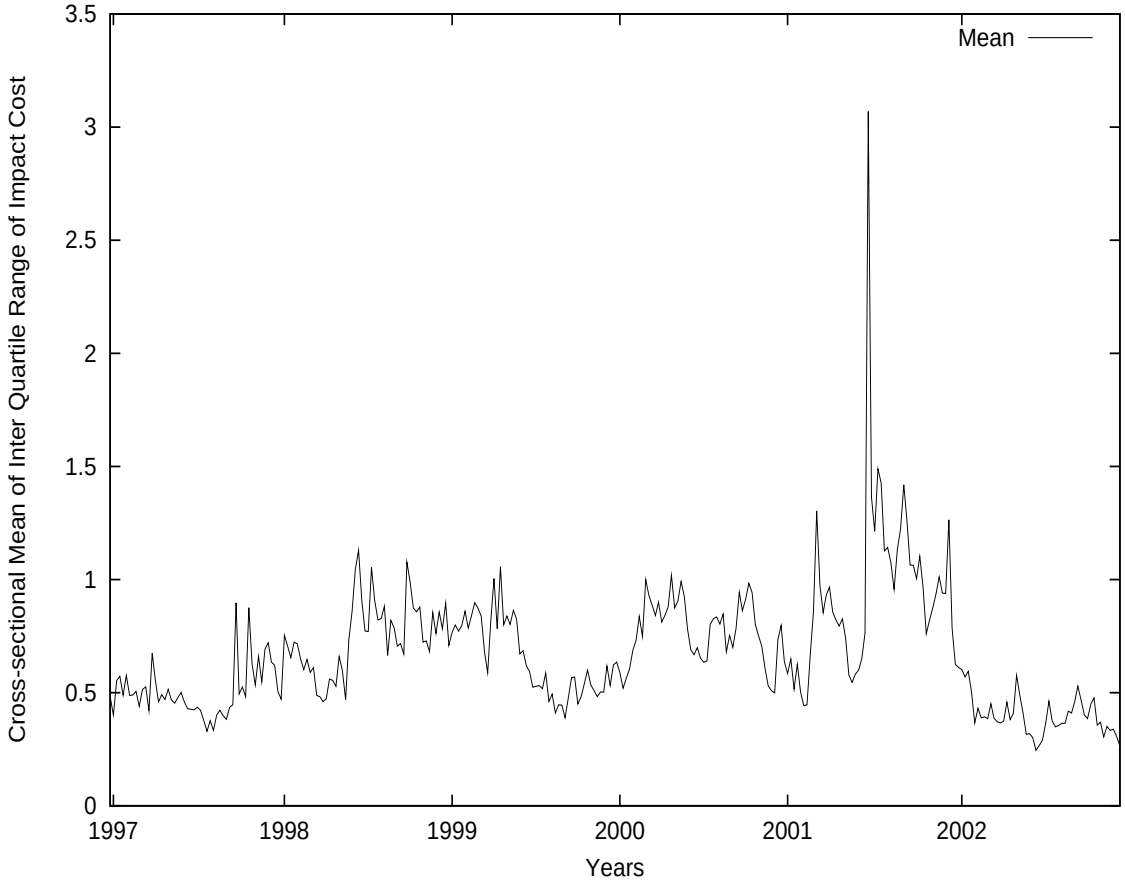


Figure 2:

Time Series Plot of cross-sectional mean of Inter Quartile Range of Impact Cost

This figure presents the time series plot of cross-sectional mean of inter quartile range of impact cost. From intra day limit order data we compute the impact cost at Rs. 10000 for each stock. We calculate the inter quartile range of impact cost for each stock for each week. Then we compute the cross-sectional mean of these inter quartile range of impact cost.



List of Tables

Table 1:

Summary Statistics

This table reports the time series cross sectional summary statistics of the variables.

Variable	Obs	Mean	Std. Dev.
MedianIC (%)	57686	.9029884	1.597169
iqrIC	57686	.6704484	1.150779
Realised Volatility	57275	129.0728	131.186
Mean Turnover Ratio	57439	.000178	.0007478
Std. Turnover Ratio	57439	.0001806	.0006079
Trade Duration (Seconds)	57424	585.1106	883.3441
Marketcap (Rs. crore)	57684	1724.613	5107.459
Dividend Yield	57684	3.862347	4.07562
Stock price trend	57658	-.0042391	.1868895
Traded volume (Rs million) at BSE	57237	55.64544	306.8809
Traded volume (Rs million) at NSE	57237	67.21039	387.225
Institutional Holding (%)	16856	20.62256	14.9869
FII Holding (%)	16856	4.28875	6.968075
Bank Holding (%)	16856	10.95831	11.23933
Mutual Holding (%)	16856	5.375222	4.448693

Table 2:

Chronology of events on Indian equity market

This table reports the chronology of major events on Indian equity market.

Date	Event
Apr 1996	National Securities Clearing Corporation (NSCC) commenced operations.
8 Nov 1996	National Securities Depository Ltd. (NSDL) commerenced operations.
1999	Securities law modified to enable derivative trading.
12 Jun 2000	Start of equity index futures trading.
4 Jun 2001	Start of equity index options trading.
2 Jul 2001	Major stocks moved to rolling settlement.
2 Jul 2001	start of stock option markets.
2 Jul 2001	Index based market wide circuit breaker system.
2 Jul 2001	VaR 99% based margins system.

Table 3:

List of Variables

This table notes the variables which are used in our analysis.

Panel A: The dependent variables	
medianIC	log of weekly median of impact cost
iqrIC	log of weekly interquartile range of impact cost
Panel B: The predetermined explanatory variables and dummy variables	
realised_vol	log of realised volatility of previous week
sysrisk	log of systematic risk at previous week
unrisk	log of unsystematic risk at previous week
mean_turnratio	log of weekly mean of turnover ratio of previous week
Std_turnratio	log of weekly standard deviation of turnover ratio of previous week
trade_duration	log of mean of trade duration per week of previous week
marketcap	log of mean market capitalisation per week of previous week
dividend_yield	mean dividend yield per week of the previous week
Comp_index	Competition index between NSE and BSE of previous week
stock_prtrend^{+}	Positive moving average for four lags
stock_prtrend^{-}	Negative moving average for four lags
port_balancing	Price movement of previous week
option	option dummy
NIFTY	Market index (NIFTY) dummy
FII	FII quarterly holding (in percentage)
Banks	Banks quarterly holding (in percentage)
Mutual_Funds	Mutual Funds quarterly holding (in percentage)
year97	Year 1997 dummy
year98	Year 1998 dummy
year99	Year 1999 dummy
year00	Year 2000 dummy
year01	Year 2001 dummy
year02	Year 2002 dummy
m01-m12	Months (Jan - Dec) dummy
Ind_dum	Industry dummy

Table 4:

OLS Regression with Industry Dummies and Time Dummies.

This table shows the various industries ranked on the basis of decreasing impact cost. We estimate the pooled OLS regression with industry dummies and time dummies. Health and Social Work Industry is choosen the base industry.

Manufacture of Radio and Television
Other Business Activities
Manufacture of Textiles
Manufacture of Basic Metals
Manufacture of Paper and Paper Products
Wholesale Trade and Commission Trade
Manufacture of Motor vehicles and Trailers
Hotels and Restaurants
Water Transport
Construction
Health and Social Work Industry
Crude Petroleum and Natural Gas
Manufacture of Chemicals and Chemical Products
Manufacture of Rubber and Plastic Products
Manufacture of Electrical Machinery
Manufacture of Machines and Equipment
Financial Intermediation
Electricity, Gas, Steam and Hot Water
Manufacture of Fabricated Metal Products
Manufacture of Other Non-metalmedianIC Minerals
Manufacture of Medical products
Manufacture of Food Products
Manufacture of Other Transport Equipments
Manufacture of Coke, Refined Petroleum Products
Tanning and Dressing of Leather
Diversified
Computers and Related Activities
Post and Telecommunication

Table 5:

Panel Regressions with Time Dummies Only

This table reports the results of estimated panel fixed effects model with time dummies only. Year 1997 is the base year and July is the base month. We report the parameter estimates and parentheses contain the standard errors. The double stars stand for the significance at 1% and single star is for the significance at 5%.

	medianIC		iqrIC	
Year 1998	0.156	(0.007)**	0.149	(0.009)**
Year 1999	0.065	(0.007)**	0.108	(0.009)**
Year 2000	0.161	(0.007)**	0.196	(0.009)**
Year 2001	0.191	(0.007)**	0.209	(0.009)**
Year 2002	-0.338	(0.007)**	-0.345	(0.009)**
Jan	0.032	(0.009)**	-0.007	(0.011)
Feb	-0.021	(0.009)*	0.004	(0.011)
Mar	0.062	(0.009)**	0.054	(0.011)**
Apr	0.036	(0.009)**	0.004	(0.011)
May	-0.022	(0.009)*	-0.029	(0.011)**
Jun	-0.055	(0.009)**	-0.064	(0.011)**
Aug	-0.086	(0.009)**	-0.117	(0.011)**
Sept	-0.059	(0.009)**	-0.049	(0.011)**
Oct	0.077	(0.009)**	0.064	(0.011)**
Nov	-0.062	(0.009)**	-0.103	(0.011)**
Dec	-0.047	(0.009)**	-0.076	(0.011)**
Constant	-0.772	(0.007)**	-1.111	(0.009)**
Observations	57686		57633	
Number of Stock	184		184	
R-squared	0.11		0.08	

Table 6:

Fixed effects regression with firm specific factors and time dummies.

This table reports the results of estimated panel fixed effects model with time dummies and firm specific factors. Year 1997 is the base year and July is the base month. We report the parameter estimates and parentheses contain the standard errors. The double stars stand for the significance at 1% and single star is for the significance at 5%.

Panel A				
	medianIC		iqrIC	
Realised Volatility	0.446	(0.004)**	0.433	(0.006)**
Mean Turnover Ratio	-0.071	(0.003)**	-0.095	(0.004)**
Std. Turnover Ratio	29.449	(3.510)**	33.830	(5.235)**
Trade Duration	0.211	(0.003)**	0.205	(0.004)**
Market Cap	-0.200	(0.004)**	-0.176	(0.006)**
Dividend Yield	-0.012	(0.001)**	-0.012	(0.001)**
Competition Index	-0.003	(0.002)	-0.005	(0.002)*
Stock Price Trend (+)	-0.195	(0.028)**	-0.311	(0.041)**
Stock Price Trend (-)	-0.110	(0.016)**	-0.097	(0.024)**
Portfolio Rebalancing	0.246	(0.023)**	0.392	(0.034)**
Option Dummy	-0.129	(0.010)**	-0.038	(0.015)*
Year 1998	0.128	(0.005)**	0.120	(0.008)**
Year 1999	0.228	(0.005)**	0.275	(0.008)**
Year 2000	0.218	(0.006)**	0.252	(0.008)**
Year 2001	0.199	(0.006)**	0.222	(0.009)**
Year 2002	-0.031	(0.006)**	-0.051	(0.009)**
Jan	-0.016	(0.006)*	-0.047	(0.010)**
Feb	0.003	(0.006)	0.026	(0.009)**
Mar	0.026	(0.006)**	0.021	(0.009)*
Apr	-0.004	(0.006)	-0.038	(0.009)**
May	-0.043	(0.006)**	-0.050	(0.009)**
Jun	-0.040	(0.006)**	-0.050	(0.009)**
Aug	-0.064	(0.006)**	-0.098	(0.009)**
Sept	-0.025	(0.006)**	-0.019	(0.009)*
Oct	0.007	(0.006)	-0.005	(0.009)
Nov	-0.080	(0.006)**	-0.122	(0.009)**
Dec	-0.022	(0.006)**	-0.053	(0.009)**
Constant	-3.527	(0.038)**	-4.164	(0.057)**
Panel B				
		medianIC		iqrIC
Number of obs		55418	55384	
Number of groups		184	184	
Avg obs per group		301	301	
R-sq				
	within	0.5778	0.3866	
	between	0.9518	0.9560	
	overall	0.8493	0.7502	
corr(u(i),Xb)		0.2660	0.4606	
F test for all u(i) = 0		66.05	36.34	

Table 7:

Panel Fixed effects regression with Institutional holding.

This table reports the results of estimated panel fixed effects model with time dummies , institutional holding and other firm specific factors . Year 2000 is the base year and July is the base month. We report the parameter estimates and parentheses contain the standard errors. The double stars stand for the significance at 1% and single star is for the significance at 5%.

Panel A				
	medianIC		iqrIC	
Realised Volatility	0.377	(0.007)**	0.345	(0.010)**
Mean Turnover Ratio	-0.095	(0.006)**	-0.103	(0.008)**
Std. Turnover Ratio	13.688	(6.080)*	7.502	(8.966)
Trade Duration	0.164	(0.006)**	0.150	(0.009)**
Market Cap	-0.360	(0.014)**	-0.320	(0.021)**
Dividend Yield	-0.003	(0.002)*	-0.006	(0.002)**
Competition Index	-0.015	(0.004)**	-0.010	(0.006)
Stock Price Trend (+)	-0.372	(0.060)**	-0.469	(0.088)**
Stock Price Trend (-)	-0.113	(0.040)**	-0.129	(0.059)*
Portfolio Rebalancing	0.278	(0.048)**	0.488	(0.070)**
Option Dummy	-0.079	(0.021)**	0.007	(0.031)
FII	-0.011	(0.002)**	-0.003	(0.003)
Banks	-0.001	(0.001)	-0.000	(0.001)
Mutual	-0.001	(0.002)	-0.001	(0.003)
Year 2001	0.011	(0.028)	0.111	(0.041)**
Year 2002	-0.228	(0.028)**	-0.185	(0.042)**
Jan	0.017	(0.015)	-0.056	(0.022)*
Feb	0.013	(0.013)	0.020	(0.020)
Mar	-0.078	(0.013)**	-0.121	(0.019)**
Apr	-0.080	(0.011)**	-0.132	(0.016)**
May	-0.080	(0.010)**	-0.103	(0.015)**
Jun	-0.106	(0.011)**	-0.166	(0.017)**
Aug	-0.151	(0.011)**	-0.228	(0.017)**
Sept	-0.025	(0.011)*	-0.073	(0.017)**
Oct	-0.090	(0.010)**	-0.155	(0.015)**
Nov	-0.110	(0.011)**	-0.185	(0.016)**
Dec	-0.031	(0.012)**	-0.113	(0.018)**
Constant	-2.002	(0.115)**	-2.514	(0.170)**
Panel B				
		medianIC		iqrIC
Number of obs		16359	16346	
Number of groups		183	183	
Avg obs per group		89	89	
R-sq				
	within	0.5901	0.3945	
	between	0.9248	0.9236	
	overall	0.8470	0.7621	
corr(u(i),Xb)		-0.3744	0.0289	
F test for all u(i) = 0		25.47	1949	

Table 8:

Panel regression with systematic risk and unsystematic risk

This table reports the results of estimated panel fixed effects model with time dummies and firm specific factors. Year 1997 is the base year and July is the base month. We report the parameter estimates and parentheses contain the standard errors. The double stars stand for the significance at 1% and single star is for the significance at 5%.

Panel A				
	medianIC		iqrIC	
Systematic Risk	0.026	(0.002)**	0.014	(0.003)**
Unsystematic Risk	0.425	(0.005)**	0.441	(0.007)**
Mean Turnover Ratio	-0.068	(0.003)**	-0.096	(0.005)**
Std. Turnover Ratio	19.706	(3.509)**	23.817	(5.382)**
Trade Duration	0.196	(0.003)**	0.185	(0.005)**
Market Cap	-0.179	(0.004)**	-0.153	(0.006)**
Dividend Yield	-0.011	(0.001)**	-0.010	(0.001)**
Competition Index	0.001	(0.002)	-0.001	(0.003)
Stock Price Trend (+)	-0.246	(0.031)**	-0.344	(0.048)**
Stock Price Trend (-)	-0.081	(0.019)**	-0.091	(0.030)**
Portfolio Rebalancing	0.264	(0.026)**	0.373	(0.040)**
Option Dummy	-0.165	(0.010)**	-0.086	(0.015)**
Year 1998	0.130	(0.006)**	0.106	(0.009)**
Year 1999	0.225	(0.006)**	0.251	(0.009)**
Year 2000	0.205	(0.006)**	0.221	(0.010)**
Year 2001	0.190	(0.007)**	0.211	(0.010)**
Year 2002	-0.047	(0.007)**	-0.072	(0.010)**
Jan	-0.027	(0.007)**	-0.052	(0.011)**
Feb	0.004	(0.007)	0.021	(0.010)*
Mar	0.027	(0.007)**	0.033	(0.010)**
Apr	-0.005	(0.007)	-0.035	(0.010)**
May	-0.044	(0.007)**	-0.057	(0.010)**
Jun	-0.044	(0.007)**	-0.055	(0.010)**
Aug	-0.072	(0.007)**	-0.110	(0.010)**
Sept	-0.035	(0.007)**	-0.025	(0.010)*
Oct	-0.005	(0.007)	-0.003	(0.010)
Nov	-0.088	(0.007)**	-0.131	(0.010)**
Dec	-0.026	(0.007)**	-0.056	(0.010)**
Constant	-3.506	(0.042)**	-4.271	(0.064)**

Panel B			
		medianIC	iqrIC
Number of obs		43196	43173
Number of groups		183	183
Avg obs per group		236	236
R-sq			
	within	0.5799	0.3800
	between	0.9499	0.9534
	overall	0.8478	0.7412
corr(u(i),Xb)		0.2749	0.4534
F test for all u(i) = 0		57.13	30.74

Table 9:

Panel regression with quadratic form of realised volatility

This table reports the results of estimated panel fixed effects model with time dummies , firm specific factors and quadratic form of reaslised volatility. Year 1997 is the base year and July is the base month. We report the parameter estimates and parentheses contain the standard errors. The double stars stand for the significance at 1% and single star is for the significance at 5%.

Panel A				
	medianIC		iqrIC	
Realised Volatility	0.254	(0.022)**	0.307	(0.033)**
Square of Realised volatility	0.021	(0.002)**	0.014	(0.003)**
Mean Turnover Ratio	-0.072	(0.003)**	-0.096	(0.004)**
Std. Turnover Ratio	28.902	(3.509)**	33.474	(5.235)**
Trade Duration	0.208	(0.003)**	0.203	(0.004)**
Market Cap	-0.199	(0.004)**	-0.176	(0.006)**
Dividend Yield	-0.012	(0.001)**	-0.012	(0.001)**
Competition Index	-0.003	(0.002)	-0.005	(0.002)*
Stock Price Trend (+)	-0.200	(0.028)**	-0.315	(0.041)**
Stock Price Trend (-)	-0.106	(0.016)**	-0.094	(0.024)**
Portfolio Rebalancing	0.249	(0.023)**	0.395	(0.034)**
Option Dummy	-0.137	(0.010)**	-0.043	(0.015)**
Year 1998	0.126	(0.005)**	0.119	(0.008)**
Year 1999	0.226	(0.005)**	0.274	(0.008)**
Year 2000	0.214	(0.006)**	0.249	(0.008)**
Year 2001	0.193	(0.006)**	0.218	(0.009)**
Year 2002	-0.037	(0.006)**	-0.054	(0.009)**
Jan	-0.014	(0.006)*	-0.046	(0.010)**
Feb	0.004	(0.006)	0.026	(0.009)**
Mar	0.027	(0.006)**	0.022	(0.009)*
Apr	-0.004	(0.006)	-0.037	(0.009)**
May	-0.043	(0.006)**	-0.050	(0.009)**
Jun	-0.040	(0.006)**	-0.049	(0.009)**
Aug	-0.065	(0.006)**	-0.099	(0.009)**
Sept	-0.026	(0.006)**	-0.020	(0.009)*
Oct	0.006	(0.006)	-0.005	(0.009)
Nov	-0.080	(0.006)**	-0.123	(0.009)**
Dec	-0.022	(0.006)**	-0.052	(0.009)**
Constant	-3.081	(0.063)**	-3.872	(0.094)**
Panel B				
		medianIC		iqrIC
Number of obs		55418	55384	
Number of groups		184	184	
Avg obs per group		301	301	
R-sq				
	within	0.5784	0.3868	
	between	0.9542	0.9574	
	overall	0.8510	0.7510	
corr(u(i),Xb)		0.2862	0.4720	
F test for all u(i) = 0		60.71	34.36	

Table 10:

Panel regression with interaction effect between realised volatility and mean turnover ratio.

This table reports the results of estimated panel fixed effects model with time dummies , firm specific factors and interaction term between realised volatility and mean turnover ratio. Year 1997 is the base year and July is the base month. We report the parameter estimates and parentheses contain the standard errors. The double stars stand for the significance at 1% and single star is for the significance at 5%.

Panel A				
	medianIC		iqrIC	
Realised Volatility	0.201	(0.022)**	0.320	(0.033)**
Realised volatility * Mean Turnover Ratio	-0.023	(0.002)**	-0.011	(0.003)**
Mean Turnover Ratio	0.037	(0.010)**	-0.045	(0.015)**
Std. Turnover Ratio	30.137	(3.507)**	34.155	(5.235)**
Trade Duration	0.212	(0.003)**	0.206	(0.004)**
Market Cap	-0.198	(0.004)**	-0.175	(0.006)**
Dividend Yield	-0.012	(0.001)**	-0.012	(0.001)**
Competition Index	-0.002	(0.002)	-0.005	(0.002)
Stock Price Trend (+)	-0.182	(0.028)**	-0.306	(0.041)**
Stock Price Trend (-)	-0.111	(0.016)**	-0.097	(0.024)**
Portfolio Rebalancing	0.265	(0.023)**	0.401	(0.035)**
Option Dummy	-0.139	(0.010)**	-0.042	(0.015)**
Year 1998	0.127	(0.005)**	0.120	(0.008)**
Year 1999	0.231	(0.005)**	0.276	(0.008)**
Year 2000	0.219	(0.006)**	0.253	(0.008)**
Year 2001	0.199	(0.006)**	0.222	(0.009)**
Year 2002	-0.029	(0.006)**	-0.050	(0.009)**
Jan	-0.016	(0.006)*	-0.047	(0.010)**
Feb	0.003	(0.006)	0.026	(0.009)**
Mar	0.029	(0.006)**	0.023	(0.009)*
Apr	-0.003	(0.006)	-0.037	(0.009)**
May	-0.042	(0.006)**	-0.050	(0.009)**
Jun	-0.039	(0.006)**	-0.049	(0.009)**
Aug	-0.065	(0.006)**	-0.098	(0.009)**
Sept	-0.026	(0.006)**	-0.020	(0.009)*
Oct	0.007	(0.006)	-0.005	(0.009)
Nov	-0.080	(0.006)**	-0.123	(0.009)**
Dec	-0.023	(0.006)**	-0.053	(0.009)**
Constant	-2.414	(0.105)**	-3.652	(0.157)**
Panel B				
		medianIC		iqrIC
Number of obs		55418	55384	
Number of groups		184	184	
Avg obs per group		301	301	
R-sq				
	within	0.5788	0.3868	
	between	0.9539	0.9570	
	overall	0.8510	0.7508	
corr(u(i),Xb)		0.2877	0.4596	
F test for all u(i) = 0		62.26	34.96	

Table 11:

Panel GLS regression with heteroscedasticity and group specific autocorrelation coefficients.

This table reports the results of estimated panel GLS with time dummies , firm specific factors. In the general specification we allow heteroscedasticity and group specific autocorrelation coefficients. The panel is balanced here. Year 1997 is the base year and July is the base month. We report the parameter estimates and parentheses contain the standard errors. The double stars stand for the significance at 1% and single star is for the significance at 5%.

		medianIC	iqrIC	
Realised Volatility	0.294	(0.004)**	0.386	(0.007)**
Mean Turnover Ratio	-0.122	(0.003)**	-0.115	(0.004)**
Std. Turnover Ratio	35.798	(3.059)**	41.848	(6.744)**
Trade Duration	0.121	(0.003)**	0.167	(0.004)**
Market Cap	-0.222	(0.002)**	-0.177	(0.003)**
Dividend Yield	-0.004	(0.001)**	-0.000	(0.001)
Competition Index	0.014	(0.002)**	0.008	(0.003)**
Stock Price Trend (+)	0.094	(0.027)**	0.045	(0.047)
Stock Price Trend (-)	-0.091	(0.019)**	-0.112	(0.034)**
Portfolio Rebalancing	0.209	(0.026)**	0.317	(0.047)**
Option Dummy	-0.149	(0.009)**	-0.044	(0.014)**
Year 1998	0.083	(0.021)**	0.043	(0.027)
Year 1999	0.208	(0.021)**	0.226	(0.026)**
Year 2000	0.133	(0.021)**	0.175	(0.027)**
Year 2001	0.051	(0.021)*	0.132	(0.027)**
Year 2002	-0.143	(0.021)**	-0.076	(0.027)**
Jan	-0.001	(0.021)	-0.026	(0.031)
Feb	0.064	(0.021)**	0.036	(0.031)
Mar	0.064	(0.021)**	0.038	(0.030)
Apr	0.013	(0.021)	-0.001	(0.030)
May	-0.044	(0.020)*	-0.050	(0.030)
Jun	-0.017	(0.021)	-0.064	(0.031)*
Aug	-0.060	(0.021)**	-0.065	(0.031)*
Sept	-0.007	(0.021)	-0.009	(0.030)
Oct	-0.016	(0.020)	0.004	(0.030)
Nov	-0.063	(0.021)**	-0.132	(0.030)**
Dec	-0.019	(0.022)	-0.040	(0.032)
Constant	-2.859	(0.035)**	-4.075	(0.052)**
Number of Obs	29988		28152	
Number of groups	98		92	
Number of time periods	306		306	
Wald chi2(27)	63174.47		37304.53	