Market Microstructure and Market Quality- A case of National Stock Exchange of India

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DECLERATION

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I hereby declare that, the work presented in the thesis entitled "Market Microstructure and Market Quality- A Case of National Stock Exchange of India" has been carried out by me under the supervision of Prof. B. Kamaiah, Department of Economics, University of Hyderabad and to the best of my knowledge no part of this thesis was earlier submitted for the award of any research degree of any University.

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This is to certify that, the research embodied in the present thesis entitled "Market Microstructure and Market Quality- A Case of National Stock Exchange of India" has been carried out by Mr. Rajesh Acharya H under my supervision for the full period prescribed under PhD ordinances of the University and no part of this thesis was earlier submitted for the award of any research degree of any University.

Signature of the Supervisor

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Rajesh Acharya H

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List of Sample Stocks

Symbol	Company Name
ABB	ABB Ltd.
ACC	ACC Ltd.
ARVINDMILL	Arvind Mills Ltd.
APOLLOTYRE	Apollo Tyres Ltd.
ASHOKLEY	Ashok Leyland Ltd.
ASIANPAINT	Asian Paints Ltd.
BAJAJAUTO	Bajaj Auto Ltd.
BHARATFORG	Bharat Forge Ltd.
BHEL	Bharat Heavy Electricals Ltd.
BPCL	Bharat Petroleum Corporation Ltd.
CIPLA	Cipla Ltd.
DRREDDY	Dr. Reddy's Laboratories Ltd.
GLAXO	Glaxosmithkline Pharmaceuticals Ltd.
GRASIM	Grasim Industries Ltd.
HDFC	Housing Development Finance Corporation Ltd.
HDFCBANK	HDFC Bank Ltd.
HEROHONDA	Hero Honda Motors Ltd.
IDBI	IDBI Bank Ltd.
IFCI	IFCI Ltd.
INFOSYSTCH	Infosys Technologies Ltd.
ITC	I T C Ltd.
LICHSGFIN	LIC Housing Finance Ltd.
M&M	Mahindra & Mahindra Ltd.

Symbol	Company Name
MOSERBAER	Moser Baer India Ltd.
NICOLASPIR	Nicholas Piramal India Ltd
NIRMA	Nirma Ltd.
PFIZER	Pfizer Ltd.
PUNJABTRAC	Punjab Tractors Ltd
RANBAXY	Ranbaxy Laboratories Ltd.
RAYMOND	Raymond Ltd.
RELCAPITAL	Reliance Capital Ltd.
RELIANCE	Reliance Industries Ltd.
SAIL	Steel Authority of India Ltd.
SATYAMCOMP	Satyam Computer Services Ltd
SBIN	State Bank of India
SIEMENS	Siemens Ltd.
SUNPHARMA	Sun Pharmaceutical Industries Ltd.
TATAPOWER	Tata Power Co. Ltd.
UNITECH	Unitech Ltd.
WIPRO	Wipro Ltd.

Chapter- 1

Study Background and Research Problem Defined

1.1 Introductory Background

The origin of trading in securities in India dates back to 1793 when East India Company started dealing in loan securities. Later the enactment of the Companies Act in 1850 paved the way for the establishment of organized security trading industry. The present Bombay Stock Exchange (BSE) was established as "The Native Share and Stock Brokers Association" in 1875. To promote the development of stock market in an orderly manner Government of India introduced Securities Contracts (Regulation) Act, 1956. Till the inception of economic reforms, securities markets in India were comprised of regional stock exchanges with BSE as the major stock exchange. Introduction of economic reforms in the early 1990's and establishment of National Stock Exchange of India Limited (NSE) which commenced trading in second half of 1994 heralded a new era in the Indian securities markets.

Since 1992 India has made substantial regulatory, structural, institutional and operational changes in the securities market to bring it on par with international standards. The objectives behind these reforms are to improve market quality in terms of enhancing market liquidity, transparency, facilitating fair trade etc.

SEBI Act, 1992 created Securities and Exchange Board of India (SEBI) as a regulator of securities market for protecting interests of investors and for developing securities market. For protecting the interests of investors, SEBI has issued the Disclosure and Investor Protection (DIP) guidelines which states the requirements for issuers, intermediaries and other market participants. SEBI has also taken the initiative of corporatization and demutualization of stock exchanges, where ownership, management and trading are with different people. NSE and Over the Counter Exchange of India (OTECI) are the first two exchanges to adopt demutualization. Later it was followed by other stock exchanges as well. Demutualization is regarded as a major step in the modernization of Indian securities market.

NSE for the first time in India introduced screen based trading system with nationwide online access. This is done with the objective of enhancing efficiency, liquidity and transparency. This trend has been followed by other stock exchanges and resulted in the disappearance of open outcry system in India. Modern technology like internet has been used extensively to take the trading platform to the premises of brokers and to the individual investors. This led to the equal access to all investors in all regions throughout the country.

To ensure efficient trading settlement, India introduced rolling settlement system. From December 2001 all stocks were placed under rolling settlement system. Initially it started with T+5 settlement period and later it has been reduced to T+3 and T+2.

Derivatives have been introduced in Indian stock market since 2000 to assist the market participants in managing risks. At present market offers index futures and index options on various indexes in NSE and BSE. It also offers single stock futures, options, interest rate derivatives and currency derivatives.

India passed Depositories Act, 1956 for establishment of depositaries in securities. Free transferability of securities of public limited companies and dematerialization of securities has helped in avoiding the settlement risk. India has set up two depositaries viz. National Securities Depository Ltd. (NSDL) and Central Depository Services (India) Limited (CDSL) for facilitating instantaneous electronic transfer of securities.

For protecting the interests of investors market regulators have devised a comprehensive risk management and investor protection system. This includes capital adequacy norms, margin requirements, monitoring of price fluctuations etc. Apart from this establishment of National Securities Clearing Corporation Ltd. (NSCCL) by NSE and Investor Education and Protection Fund (IEPF) were other measures taken to ensure financial settlement and protection of interests of investors.

Integration of Indian securities markets with rest of the world and resultant globalization is a major change that took place in the post reforms period. Permission for Foreign Institutional Investors (FII's) to invest in Indian securities market, setting up of trading terminals abroad, permission for Indian companies to list in foreign stock markets were some of the steps taken to integrate domestic securities markets with rest of the world.

1.2 Market Microstructure

"Market microstructure is the study of the process and outcomes of exchanging assets under explicit trading rules" (Maureen O'Hara, 1995). It deals with the effect of specific trading mechanisms on the price formation process. Trading rules and the trading systems used by a market determines the type of market participants, the kind of instruments that can be traded, the timing, location and how to facilitate the day- to- day trading activities. Interest in the field of market microstructure research is mainly due to rapid changes in the technology, regulatory framework, adoption of new financial instruments, integration of domestic exchanges with the rest of the world, and advancement in internet. In developing countries globalization and competition with other markets led to the rapid changes in security trading industry.

Market microstructure studies the process by which investors latent demands are ultimately translated into prices and volumes. (Madhavan, A. 2000). Market microstructure theory is centered on a basic idea that asset prices need not equal full information expectations of value. It may be due to various frictions in the market. Market microstructure research uses specific trading mechanisms to analyze and model how price setting rules evolve. This helps to analyze the impact of different trading mechanisms on the process of price formation and also regarding the time series properties of prices. Market microstructure research, on the one hand, contributes to our understanding of returns to financial assets, on the other hand, the process by which markets become efficient.

The basic function of a market is to bring buyers and sellers together. This basic function did not change much. But market facility within which trading takes place has been greatly influenced by technology. Securities do not trade at evenly placed intervals throughout the day. Some days some securities may not be traded at all. The very process of trading can have impact on the statistical properties of financial time series. Market microstructure research is extremely useful in analyzing the behavior of markets and prices. This idea has immediate application in the regulation of markets, in designing and formulating new trading mechanisms and of course in making better investment strategies in different markets with different trading mechanisms. New and better insights come from empirical research on the market microstructure. The availability of high frequency data on prices, quotes, and other market information allows better and more realistic investigation of market microstructure impact. It provides an intellectual framework for designing and operating trading systems.

1.3 Research Problem Defined

This research work is an attempt to exclusively examine the impact of various reforms in the security market on market quality. Specifically, an attempt is made to examine the information efficiency, transaction cost and liquidity effects of market reforms. The basic aim of market reforms is to improve market quality. The adoption of new technology like internet is expected to result in faster dissemination of information and presents an equal opportunity to all investors to act on that information. Introduction of new financial instruments like derivatives provides wide range of opportunities for risk management

and facilitates informed trading which in turn results in completeness of the market. Various regulatory changes and establishment of regulatory bodies are expected to result in transparency and reduction in malpractices associated security trading. All these structural changes in the form of reforms are undertaken to improve the quality of security market. To sum up, this study empirically examines various market microstructure changes in NSE upon the quality of the security market.

1.4 Objectives of the Study

In the light of the observations made above, this study evaluates the outcome of changes in market microstructure on market quality as measured by different criteria. More specifically the following are the objectives of the present study:

i) Market microstructure and speed of adjustment: In this objective an attempt is made to examine the impact of changes in market microstructure on speed of adjustment of asset prices to the arrival of information. It shows whether there is underreaction or overreaction in asset prices to the arrival of information.

ii) Market microstructure and private information: An attempt is made to examine the process of incorporation of private information in prices. Based on this criteria market quality will be compared over the years.

iii) Market microstructure and market liquidity: Liquidity effect of changes in market microstructure is examined in this objective. Bid- ask spreads is used as a measure of liquidity.

iv) Market microstructure and transaction cost: Market quality is examined based on implicit cost of security trading. Deviation of transaction prices from random walk is taken as measure of market quality.

1.5 Hypotheses

Keeping the objectives of the study in mind, the following two major hypotheses have been formulated:

i) Introduction of market reforms and resultant changes in market microstructure improves the market quality. Here, the term quality is used to mean informational efficiency, transaction cost and liquidity of the security market.

ii) Introduction of market reforms and resultant changes in market microstructure leads to predictable patterns in returns.

1.6 Justification of the Study

This study assumes significance due to several factors. First, fairly good amount of empirical evidence on market microstructure effects on security trading is available for developed countries stock markets. But for the emerging markets like India, there are

very few studies. India started bringing structural changes in stock market to improve transparency, efficiency, competitiveness and bringing Indian stock markets on par with international standards. India is a major emerging market which is increasingly getting integrated with rest of the world by attracting global investment. So a study of this kind assumes significance to assess the impact of these structural changes on market quality. Second, in Indian context to date there is no comprehensive study in the available literature which examined exclusively the impact of market reforms on market quality. Most of the studies have examined the impact of individual events on market quality. Third, most of the studies which have examined the impact of market microstructure on market quality based on single criteria. Different studies have used different criteria and there are no uniformly accepted single criteria to assess market quality. In this study an attempt is made to bring together most popularly used criterions under one study and assess the impact of market reforms on market quality.

1.7 Methodology of the Study

The study is conducted within the analytical framework of market microstructure and relied mostly on econometric and time series techniques for analysis. Depending upon the objectives the study has used appropriate techniques. Measuring security speed of adjustment is based on ARMA model. This methodology [due to Theobald and Yallup (2004)] has been popular in the literature. It is based on the logic that underreactions and overreactions in prices lead to a particular type of autocorrelations in the return process. Specifically, underreactions lead to positive autocorrelations and overreactions lead to

negative autocorrelations in stock returns. The ARMA model estimated from daily returns is expected to measure speed of adjustment of stock prices to new information from this stand point.

To test the degree of incorporation of private information, autocorrelations and variance ratios are being employed. Framework for this analysis is taken from French and Roll (1986). Earlier empirical works have pointed out difference in the volatility pattern during trading and non trading periods. Based on variance ratios and autocorrelations in daily returns French and Roll (1986) established that incorporation of private information as reason for such a phenomenon. This study examines daytime to overnight returns variance ratios, opening to closing return variance ratios, autocorrelations in daily returns, opening and closing returns. Since opening and closing returns could follow distinct patterns, speed of adjustment in opening and closing prices to new information have also been analyzed.

The liquidity effect of market reforms is analyzed by using bid- ask spreads as a measure of liquidity. This is also a popular method used in the literature for measuring liquidity. Framework for this analysis is taken from Jegadeesh and Subrahmanyam (1993). A log linear regression model with proportionate quoted bid- ask spreads as a dependent variable and determinants of bid ask spreads and dummy variables as independent variables, has been used in this analysis. Determinants of spreads viz. price, volume and return variance are included in the model to account for their influence on bid- ask spreads. Then a dummy variable for each year which takes the value one for that period

and zero for rest of the period has been introduced. Liquidity effects will be analyzed by considering the sign and significance of coefficient of dummy variable.

The impact of market reforms on implicit transaction cost is examined by a bivariate Vector Auto Regressive (VAR) model. This methodology is first advocated by Hasbrouck (1993). It divides the transaction prices into two components viz. random walk component and residual stationary component. Random walk component is identified as efficient price and residual stationary component is identified as pricing error i.e. the difference between actual transaction price and efficient price. The standard deviation of pricing error has been estimated as a proxy for transaction cost. It is based on the assumption that when trade barriers are reduced actual transaction prices closely follow efficient prices. A bivariate VAR model with returns and signed traded volume has been used for estimating the pricing error.

1.8 Nature and Source of Data

The study uses both daily data and high frequency data depending on requirement of different objectives. Daily data is downloaded from the official website of NSE (www.nse-india.com) and high frequency data CD is purchased from NSE. The study is based on 40 companies listed in NSE and are selected on basis of availability of data and market capitalization of companies. The data set consists of daily opening and closing prices, daily traded quantity, daily bid- ask quotes, intraday transaction prices, and intraday traded quantity. The study period ranges from January 1995 to December 2008.

The total period is divided into three sub periods viz. 1995- 1999, 2000- 2003 and 2004-2008 representing different phases in the growth of NSE.

1.9 Scope and Limitations of the Study

This study is based on top 40 companies based on market capitalization which have been listed in NSE since its inception. In spite of the fact that same stocks are listed in BSE, NSE is preferred for two reasons. First, most of the reforms that swept Indian stock markets has been initiated by NSE and later followed by BSE. Second, NSE became largest stock exchange in the country in terms of daily turnover within one year of its commencement of trading and holds this position to this date. This study is based on companies which belong to top 100 companies in terms of market capitalization. So a study which includes all frequently traded companies listed in a stock exchange may give better picture of the subject matter.

1.10 Organization of the Study

The study is organized into seven chapters. The first chapter deals with introduction, background, objectives and hypotheses of the study. The second chapter contains comprehensive review of relevant literature. Chapters three to six deals with four major objectives of the study and their theoretical background, methodological issues and empirical findings. Seventh chapter presents the summary, findings and implications of the study.

Specifically, third chapter deals with measuring market quality through security speed of adjustment coefficients based on ARMA (1, 1) model. It shows the adjustment of security prices to the arrival of information. Fourth chapter presents the analysis of measuring market quality based on incorporation of private information into prices. It is based on variance ratios and autocorrelations in returns. An attempt is made to understand process of speed of adjustment in opening and closing prices.

The fifth chapter deals with measuring market quality through liquidity. Liquidity effects of changes in market microstructure are examined based on daily bid- ask spreads. The study has adopted a log- linear regression model with bid- ask spreads as a dependent variable and determinants of bid- ask spreads as independent variables. To examine the liquidity pattern over the years dummy variable is introduced which takes the value of one for that year and zero for rest of the years. Sixth chapter deals with measuring market quality through implicit transaction cost of stock trading. Transaction cost is measured based on vector autoregressive model. The seventh chapter deals with major findings, implications and conclusion of the study.

Chapter- 2

Review of Relevant Literature

2.1 Introduction

The effect of changes in market microstructure on stock market has been studied extensively across the world. Interest in market microstructure stems from rapid structural, technological and regulatory changes which has affected the security trading industry all over the world. Substantial increase in trading volume, competition between exchanges, regulatory changes, adoption of new technologies, internet, introduction of new financial instruments are some of the major events that took place in security trading industry. Stock market crash of 1987 and increased availability of high frequency data since 1990's also increased the interest in this area. Earlier studies have examined the impact of structural changes on volatility, liquidity, market efficiency, relationship between spot and derivatives markets etc. Since reforms are expected to improve market quality, researchers engaged in exploring implications of such reforms on market quality through various dimensions. However, a general consensus does not exist on implications of reforms on market quality. As a background to the present study, an attempt is made to review relevant literature in this chapter. The review is organized into five sections. The first four sections cover security speed of adjustment, incorporation of private information, liquidity effects, and transaction cost measurement respectively. The last section gives the concluding remarks regarding the overall review of literature.

2.2 Market Microstructure and Security Speed of Adjustment

Based on the price adjustment model given by Amihud and Mendelson (1987), Damodaran (1993) developed an estimator for price adjustment coefficients based on the information contained in return processes. This measure was applied to listed firms on NYSE, AMEX, and over the counter markets. The speed with which stock prices adjust to information has been regarded as a measure of market efficiency. Empirical results confirmed a lagged adjustment to new information. The price adjustment coefficients were significantly less than one for return intervals up to five days. Delayed price adjustment led to positive autocorrelation in the return series. This finding was consistent with Roll (1984) findings, which showed positive autocorrelation at shorter differencing intervals and negative autocorrelation at longer differencing intervals. This study also found overreaction at longer differencing intervals since price adjustment coefficients were significantly greater than one.

A correction was proposed by Brisley and Theobald (1996) for an error in the estimator developed by Damodaran (1993). Empirical results had shown that, the magnitude of error difference was greater at shorter differencing intervals than at longer differencing intervals. Damodaran's (1993) estimator resulted in overestimation of price adjustment coefficient by about 18.4 percent at two day differencing interval and declined to below one percent at longer differencing intervals. It was shown that, Damodaran (1993) estimator of price adjustment coefficient was biased towards one. But, this correction did not change the conclusion of Damodaran (1993) study. Price adjustment coefficients

were less than one at shorter differencing intervals and moves towards one at longer differencing intervals.

While investigating the intertemporal adjustments across stock index futures and cash market, Theobald and Yallup (1998) proposed an estimator of speed of adjustment. Partial adjustment factors were estimated from cross-covariance of returns in cash and futures markets. Estimators were adjusted for non-synchronicities. This study used a sample of UK stock index futures and underlying index data. Empirical results showed that, partial adjustments were fuller at futures markets than cash markets. After adjusting for non synchronicities this phenomenon was reduced. This result was also compared with Damodaran (1993) estimator. It was found that, Damodaran (1993) estimator's performance was poor at shorter differencing intervals.

Fama (1998) examined market efficiency with reference to long term return anomalies and behavioral finance. This study argued that, return anomalies were chance results and overreaction of stock prices to information was as common as underreaction. Evidences of abnormal returns before an event and following the event was as common as reversal following the event. Long term return anomalies can be due to methodology used for the study and such evidence of abnormal returns tends to disappear with changes in methodology. This study finally concluded that, the evidence of long term return anomaly does not suggest abandoning the market efficiency concept.

Based on investor psychology, Daniel *et al.* (1998) attempted to propose a theory of security market underreaction and overreaction. The theory was based on investor over

confidence and biased self attribution. An over confident investor is defined as those who over estimate the precession of their private information signals above the information signals received by general public. This study found that, when over confident investor over weigh the private signal than the public signal leads to stock price overreaction. As public information arrives, price moves closer to full information value. So this study argues that stock prices overreact to private information signals and underreact to public information signals. As far as biased self attribution is concerned, when investors receive confirming public information, their confidence rises but disconfirming news may cause fall in the confidence to a lesser extent. It shows even the arrival of public information can lead to overreaction but such momentum will decline as more and more public information arrives and bring price to the equilibrium level. So, biased self attribution can lead to short run momentum and long term reversals in security prices. These findings are in sharp contrast to earlier studies which attributed positive return autocorrelation to underreaction to new information and negative autocorrelation to overreaction to new information.

A parsimonious model of investor sentiment was proposed by Barberis *et al.* (1998) to explain underreaction of stock prices to news like earnings announcements and overreaction to series of good or bad news. This evidence presents a challenge to market efficiency theory because a superior investor can take advantage of underreaction and overreaction without bearing any additional risk. This study claims that, people tend to pay too much attention to strength of evidence and too little attention to the statistical weight of the news. It assumes that, corporate announcements about earnings information

are of low strength but more statistical weight. This leads to underreaction of prices to earnings information and similar news. A series of good earnings announcements which is news of consistent pattern has more strength but less weight. It leads to overreaction of stock prices to consistent pattern of news. This study has claimed that, their assumptions regarding the strength of news and its statistical weight are reasonable and empirically measurable.

Unified behavioral model was proposed to explain underreaction and overreaction of prices in asset markets by Hong and Stein (1999). The model includes two types of agents; news watchers and momentum traders. Bounded rationality on the part of both agents is assumed, which means each agent is able to process only some subset of publicly available information. Based on privately observed price signals, news watchers forecast future prices but it is not based on the current or past prices. It means news watchers fail to extract other news watchers information revealed through price. Momentum traders make forecasts about future prices based on past price changes. But they do not observe news. If information disseminates gradually across traders, prices tends to underreact in the short run. When there is underreaction, it provides an opportunity to momentum traders to profit by following past trends. Since their strategy depends only on historic prices, it leads to overreaction in the long run. So gradual diffusion of news about fundamental value is primarily responsible for both underreaction and overreaction.

Jegadeesh and Titman (2001) evaluated various alternative explanations for the profitability of momentum strategies. In an earlier work Jegadeesh and Titman (1993)

provided evidence for the profitability of momentum strategies using data from 1965 to 1989. Their study in 2001 has further shown evidence for profitability of momentum strategies in 1990's as well, indicating that results were not data biased. Behavioral models argued that momentum strategies profits were entirely due to bias in the way in which investors interpret information. Delayed overreaction to information pushes the profits of winners above their long term values and that of losers below it. In subsequent periods, stock prices return to their fundamental values and returns of losers exceeds the returns of winners. But others argued that, momentum profits are more due to cross sectional variation in expected returns than any predictable time series pattern. The empirical findings of the entire sample period from 1965 to 1998 of the study published in 2001, showed significant positive returns for first 12 months following formation of a portfolio whereas cumulative returns from 13 to 60 months, returns were negative. This was consistent with the behavioral theories. But return reversals were strong for small firms whereas weak for large firms and return reversal was strong during 1965 to 1982, whereas weaker during 1982 to 1998. This study concluded that behavioral models provide only partial explanation to the profitability of momentum strategies.

The impact of stock market structure on the speed with which new information is incorporated into prices was examined in a study by Maulis and Shivakumar (2002). This study compared the speed of adjustment on NYSE, AMEX and NASDAQ for seasoned equity offering, and showed that, the speed of adjustment was quicker on NASDAQ than NYSE and AMEX for seasoned stock offering announcements. Price adjustment was nearly one hour faster on NASDAQ than NYSE and AMEX. After controlling for

sampling differences, it strengthened the speed advantage of NASDAQ. NYSE and AMEX stocks recorded lower spreads, higher equity capitalization, and greater trading activity. But in spite of all these advantages, NYSE and AMEX had a lesser speed of adjustment over NASDAQ. Based on these findings, this study concluded that differences in the market structure can significantly affect the security speed of adjustment to news.

Productive efficiency of stock exchanges in India was measured by Marisetty (2003) based on price adjustment coefficients. His study covered the individual stocks listed on Bombay Stock Exchange (BSE) and National Stock Exchange (NSE) and their respective indices also. His results confirmed overreaction on both exchanges and overreaction varied from firm to firm. Overreaction in prices gradually reduced with time and full adjustment occurred around 19th day of information arrival. But this study did not find difference in speed of adjustment based on the market capitalization of firms. With reference to indices, it fully adjusted to information on the day of arrival of information itself. It indicates that, firm specific information is being absorbed faster than the company specific information

As a solution to the various limitations of earlier estimators, Theobald and Yallup (2004) developed two measures for determining security speed of adjustment coefficients. Framework for these measures was provided by Amihud and Mendelson (1987) partial adjustment model with noise. The measures of speed of adjustment coefficients developed in this study are functions of autocorrelations in stock returns, since underreactions and overreactions in prices induce autocorrelations in the return series.

Based on this insight, autocovariance ratio and ARMA estimators were proposed in this study. Empirical results confirmed significant underreactions at shorter differencing intervals since speed of adjustment coefficients were significantly less than one. But speed of adjustment was higher than the results found in Damodaran's (1993) study. Theobald and Yallup (2004) results showed that speeds of adjustment increased with increase in differencing intervals and at longer differencing intervals significant overreactions were recorded in a few cases. Comparison of speed of adjustment coefficients between large and small capitalization stocks have shown that, the former had higher speed of adjustment than the latter. Even after adjusting for thin trading effects, large market capitalization stocks had higher speed of adjustment than low market capitalization stocks but speed of adjustment coefficients increased for small market capitalization stocks and speed of adjustment difference between large and small market capitalization stocks reduced.

With regard to Indian stock markets, Poshakwale and Theobald (2004) examined the lead- lag relationship between large and small market capitalization stocks by using data of four stock market indices, two each from Bombay Stock Exchange (BSE) and National Stock Exchange of India (NSE). Empirical results confirmed that lead- lag relationship in returns exists between large and small market capitalization stocks and it was derived from differences in the speed of adjustment. Indices of large market capitalization stocks found to have higher speeds of adjustment coefficients than small market capitalization stocks indices. Thin trading effects further led to the differences in the speed adjustment and lead- lag relation between large and small market capitalization stocks. Speed of

adjustment of security prices have shown underreaction in the beginning and overreaction in later time period and the result was more pronounced for small capitalization stocks indices. This study concluded that, while assessing the lead- lag relationship, it is important to consider both thin trading and differential speed of adjustment for large and small capitalization stocks.

The impact of stock ownership by foreign and domestic institutional investors on speed of adjustment was explored by Park and Chung (2007). Their empirical findings have shown that the speed of adjustment was higher for stocks with high foreign institutional investment than for stocks with low foreign institutional investment. Returns for stocks with high foreign institutional investment led the returns of stocks with low foreign institutional investment. At the same time, speed of adjustment was higher for stocks with high domestic institutional investment than for stocks with low domestic institutional investment, and the returns of the former led the latter. This confirmed foreign institutional investors advantage over domestic institutional investors and domestic institutional investors advantage over individual investors in accessing and processing new information.

From the foregoing review of select studies, it becomes clear that the stock price reaction to news is an important aspect which needs attention in the wake of rapid changes in the market microstructure.

2.3 Market Microstructure and Private Information

The relationship between liquidity and autocorrelations in individual stock returns has been examined by Avramov *et al*. (2006). They argued that predictability at higher frequencies poses a serious challenge to market efficiency hypothesis, and showed that liquidity plays an important role in understanding autocorrelation patterns in stock returns. High turnover stocks exhibited higher negative serial correlation and also low liquidity stocks had more negative serial correlations. These stocks gave highest chance for contrarian trading strategy profits.

Trading mechanisms can have a significant impact on stock returns. Such an empirical investigation was made by Amihud and Mendelson (1986). They compared the open to open and close to close returns on NYSE stocks for which there was a difference in the execution in opening and closing transactions. Opening returns had higher volatility than closing returns and opening returns had more negative and significant autocorrelations than closing returns. This study attributed such a difference in volatility and autocorrelation pattern to differences in trading mechanism for opening and closing transactions.

Stock return variances during trading and non trading hours were examined by French and Roll (1986). The study found that stock return variances were higher during exchange trading hours than non trading hours. Three factors have been identified as responsible for such a difference in volatility, i.e. arrival of public information which is frequent during a business day, arrival of private information through the trading of

informed traders during trading hours and pricing errors. The study concluded that, the arrival of private information is the major factor causing volatility difference in trading and non trading periods.

A study on stock market return volatility during overnight and intraday periods was made by Lockwood and Linn (1990). The study has showed that market volatility was higher during daytime over overnight period. Hourly intraday returns variance has shown an inverse J shaped curve i.e. highest at the open falling until early afternoon and rising as the market moves towards close. Except during the futures period, variance of open to open returns was higher than close to close returns.

The relationship between volatility and serial correlation in stock returns was examined by LeBaron (1992). The study has found that serial correlation changes overtime. The first order autocorrelations in returns were larger for periods of low volatility and smaller during higher volatility periods. This was found in both daily and weekly returns.

The effects of feedback trading on stock return autocorrelation was examined by Sentana and Wadhwani (1992) using a century daily data. The study found that when volatility was low, stock returns showed a positive autocorrelation whereas; when volatility was high stock returns followed negative autocorrelation. It also found that positive feedback trading was greater following price decline than following price rise. This study argued that when some traders follow feedback strategy, it contributed to the serial correlation in returns.

The relationship between trading volume and serial correlation in stock returns was investigated by Campbell *et al.* (1993). The study has found that the first order autocorrelations in daily stock returns was lower on high volume days than on low volume days in case of both stock indexes and individual stock returns.

Pattern of autocorrelation in stock returns around the non trading days was investigated by Bessembinder and Hertzel (1993). The study found that the correlation of returns between first and second day after the weekend or holiday was low and negative, which shows a reversal in prices. It also found high positive return autocorrelation on last day and after weekends and holidays.

Autocorrelation in short horizon returns was examined by Boudockh *et al.* (1994). This study reexamined the autocorrelation patterns in short horizon returns and observed that autocorrelations were overstated in the existing literature. It supported the market efficiency based explanation for the evidence of autocorrelation in returns. They argued that institutional factors are the likely source of the autocorrelations in stock returns.

An examination of the overnight and daytime stock returns dynamics after the market restructuring in 1986 and stock market crash of 1987 in London Stock Market was made by Maulis and Ng (1995). The study found significant changes in daytime and overnight return dynamics. The prior daytime return shocks impact on overnight volatility increased after market restructuring and declined after the crash. The impact of negative daytime return shocks on overnight return volatility declined after market restructuring and increased after market crash. The impact of positive overnight shocks declined and also

impact of positive daytime shock on daytime volatility declined after market restructuring. The impact of positive overnight shocks on daytime return volatility increased after crash.

Trading by institutional investors can be a factor contributing to serial correlation in daily returns. Such a hypothesis was proposed by Sias and Starks (1997). Their empirical results revealed that for NYSE portfolio and individual security daily returns, autocorrelations were an increasing function of the level of institutional ownership. This finding is consistent with an earlier finding that institutional investors have access to more information and such stocks having higher speeds of adjustment.

Volatility and serial correlation difference in opening and closing returns was examined by Steeley (2005) for the FT- 30 components listed in London Stock Exchange. The evidences showed a higher volatility and negative serial correlation in opening returns whereas lesser volatility and positive autocorrelation in closing returns. This study argued that volatility differences in opening and closing returns cannot be attributed to difference in trading mechanism since stocks included in this study have been traded using same trading mechanism. Further, speed of adjustment of stock prices to new information were estimated for both opening and closing returns and found that opening returns had a tendency towards overreaction whereas closing returns had a tendency towards underreaction.

The implications of the presence of serial correlation in security prices for market efficiency and trading strategies have been examined by McKenzie and Kim (2007). The

study focused on the relationship between volatility and autocorrelation and also the determinants of autocorrelation in general. Empirical evidences showed a negative relationship between volatility and autocorrelation.

The behavior of open-close and close-open return variance ratio and return autocorrelation were examined by Chordia *et al.* (2008). The study found higher open-close variance than close-open return variance in all three tick size regimes. The first order autocorrelation of daily returns has decreased over three tick size regimes. Based on these findings, they argued that higher open-close variance is an indication of increased incorporation private information in prices. Decrease in autocorrelation in returns was seen as decrease in return predictability and miss pricing.

2.4 Market Microstructure and Market Liquidity

Liquidity effects of the introduction of index futures have been examined by Jegadeesh and Subrahmanyam (1993) based on event study methodology. They estimated the bid-ask spreads around the introduction of S&P 500 index futures contracts. After controlling for determinants of spreads, empirical results have shown a significant increase in average spreads i.e. deterioration in liquidity during the post futures period.

Differences in trading mechanisms and market organization can have an impact on liquidity. One such study was undertaken by Graves *et al.* (1994), who examined the impact of differences in market organization on bid- ask spreads. They compared the bid-ask spreads for NYSE and AMEX with NASDAQ and National Market System (NMS)

stocks. Empirical results have shown that the order processing component of the spread was lower for NYSE and AMEX stocks than for NASDAQ and NMS stocks. The inventory cost component which is measured as a percentage of quoted spread was statistically significantly higher for NYSE and AMEX but the difference was insignificant when it was measured as a fraction of price. NASDAQ and NMS stocks had statistically significantly lower adverse selection component than NYSE and AMEX stocks.

Another study regarding liquidity difference in different market structures was done by Huang and Stoll (1996). They have attempted to explain differences in execution cost for dealer and auction markets by comparing NASDAQ and NYSE. Execution cost is defined as the cost to a trader of selling and buying of stocks. They found that, cost of execution was higher in NASDAQ than NYSE by every measure used in the analysis. Quoted spread, effective spread, realized spread, Roll (1984) implied spread and perfect foresight spread measures has been used in this analysis. Authors examined various possible explanations for such difference in two markets. They examined impact of factors like size of the listed stocks, frequency of trading, trading inside the spread, adverse information, market depths and inventory costs, changes in NASDAQ etc as a possible explanation for difference in execution cost. But none of these factors explain the higher execution costs on NADSAQ than on NYSE. Finally authors concluded that, spreads are too high on NASDAQ because there is little incentive to reduce them.

Bessembinder (1997) analyzed the relation between trade execution costs and price rounding practices for NYSE and NASDAQ listed firms. For both NASDAQ and NYSE

both quoted and effective bid- ask spreads were wider for stocks with more frequent rounding of prices and quotations. The relationships between bid- ask spreads and rounding frequencies was stronger for NASDAQ than NYSE. This study found a strong positive relation between execution costs and price rounding frequencies for NASDAQ issues but not for NYSE issues. These findings shows price rounding conventions led to higher execution costs in NASDAQ than NYSE.

An empirical examination of the benefits of multiple trading locations to investors was done by Bessembinder and Kaufman (1997). Stocks listed on NYSE are also traded in five domestic regional stock exchanges. Comparison of average trading costs by exchanges, quoted half spreads were substantially narrower on NYSE than regional exchanges, NSAD and Cincinnati exchange in all categories i.e. small, medium, large stocks and average of all stocks. In terms of effective spreads, lowest effective half spreads was recorded on Cincinnati exchange. When sample was divided in terms of trade size and firm size effective half spreads was almost similar between NYSE and Cincinnati exchange and NYSE had lower spreads in comparison with NSAD and regional exchanges. The price impact of all trades executed at NYSE was significantly higher than all other exchanges which implied that, on an average each NYSE trade moves the subsequent price more than any other exchanges considered in this study. Realized half spreads, which measures price reversals after trade, was significantly lower on NYSE in all firm size and trade size groups.

Entry and exit of market makers and its determinants was analyzed by Wahal (1997). This study on NASDAQ has found that number of market makers is closely related to the

level of trading activity (volume and number of trades), risk (volatility), and price charged for providing service (bid- ask spreads). Increase in trading volume attracts entry and number of shares traded was also positively related entry. Risk can decrease the number of dealers and spreads was positively related with entry. Entry was more likely in securities with larger spreads. End of the trading day quoted spreads decrease following entry. Spreads changes were larger for issues with few market makers and for securities with more market makers also recorded significant changes in spreads. There was no significant change in both volume and number of shares traded following independent entry. But significant decline in both volume and number of shares traded following exit of market makers. Independent entry was associated with decline in the sum of squared returns and exit is associated with increase in volatility.

There were a series of studies in the 1990's regarding avoidance of odd eight quotes by NASDAQ dealers. Christie and Schultz (1994) found that for 70 out of 100 actively traded NASDAQ securities odd eight quotes were not existed. They raised the question whether NASDAQ dealers colluded to maintain wider spreads. This study was followed by various other studies and one such study was made by Barclay (1997). Bid- ask spreads were higher on NASDAQ when market makers avoided odd eight quotes and it declined when these securities moved to NYSE or AMEX. Large difference in effective bid- ask spreads for securities for which market makers avoided odd eight quotes and securities for which market makers used both odd and even eight quotes were almost eliminated when those securities are traded in NYSE or AMEX. When market makers started using both odd and even eight quotes, spreads were small and slightly declined

with listing in other exchanges. This study concluded that odd eight quotes were avoided as a device to increase the bid- ask spreads.

Intraday behavior of bid- ask spreads was analyzed by Abhyankar *et al*. (1997) on London stock exchange. They found that, average bid- ask spreads were highest at the market open, declines to a low level through the trading day and slightly widens again during the market close. Similar pattern in spreads was observed across stocks classified on liquidity basis. In other words, bid- ask spreads shows a U shaped pattern during the trading day. But trading volume is not U shaped. It showed a double humped pattern, one after the market open and another prior to the market close. Return volatility follows a U shape, highest at the open, falls rapidly to a constant and rises slightly during market close.

A series of reforms was introduced in NASDAQ after Christie and Schultz (1994) alleged the tacit collusion among NASDAQ dealers to inflate the bid- ask spreads by avoiding odd eight quotes. Barclay *et al.* (1999) investigated the impact of market reforms on bid-ask spreads. After reforms, quoted and effective bid- ask spreads declined and the reduction was more pronounced for stocks whose spreads were relatively wide before reforms. Similar evidence was found for small stocks also. Average trade size declined after reforms and there was sufficient depth and width in the posted quotes. On the whole reforms produced more competitive and efficient trading system.

Advancement in information and communications technology, automated trading and such other adoption of technology in trading can have an important bearing on liquidity

and trading costs. Domowitz and Steil (1999) have analyzed such an impact on trading costs based on bid- ask spreads. They used quoted and effective spreads for measuring implicit cost of trading and also considered explicit costs. Both costs were lower in electronic systems than the traditional broker system. Analysis of execution costs and commissions have shown that trading was easier in electronic trading system than traditional broker system.

Liquidity as well as trading costs can vary across exchanges. Jones and Lipson (1999) attempted to provide empirical evidences regarding debate over execution cost difference across major US stock exchanges. The execution costs for institutional trades changed a little when firms shifted exchanges and there was no significant change in total cost for any order size. An implementation cost which is measured by bid- ask spreads are relatively small for NYSE. But it will be misleading if it is concluded that transaction costs are less in NYSE because commissions are separately assessed for NYSE and AMEX trades whereas for NASDAQ it was often incorporated in spreads. So transaction cost measure should include both implementation cost as well as commissions.

The impact of market reforms which was implemented on January 1997 by Securities and Exchange Commission on the competitive structure of NASDAQ was investigated by Weston (2000). Based on the comparison of spreads components before and after market reforms found that, decline in spreads was due to either reduction in order processing costs or economic profits. It was observed that new competition arising from limit orders has reduced the NASDAQ market maker rents. It was also found that, market reforms created competitive forces which resulted in similar spreads on NASDAQ and NYSE,

though NYSE spreads were slightly smaller than on NASDAQ. These small differences may be explained by factors such as commissions which are mostly incorporated in NASDAQ spreads whereas paid explicitly on NYSE.

Most of the studies which have analyzed liquidity are around a particular event. There are very few studies which analyzed liquidity over fairly long period of time. One such analysis of liquidity for over the years was made by Chordia *et al.* (2001) who examined aggregate market spreads, depths, and trading activity for US stocks over 11 year period. The study has found a secular downtrend in spreads and an uptrend in depth and volume. They also found that liquidity and trading activity are highly volatile and negatively serially dependent.

Jones and Lipson (2001) analyzed the impact of reducing tick size from eights to sixteenths on execution costs by taking a sample of institutional trades on NYSE based on bid- ask spreads. Empirical findings have shown that quoted and effective spreads declined but realized execution costs for institutional trades increased after switching to sixteenths. Increases in institutional execution costs were more for those who demand liquidity more aggressively. Smaller spreads benefitted the small investors whereas institutional traders execution costs increased.

One major technical change that occurred in the security trading was shift from open outcry system to automated trading system. Venkataraman (2001) attempted to investigate the relative merits of automated and floor trading structures by comparing the trade execution costs of Paris Bourse and New York Stock Exchange (NYSE). This study

compared the execution costs of large and liquid firms across Paris Bourse and NYSE by using quoted, effective and realized bid- ask spreads. Effective spreads were significantly lower for NYSE stocks than Paris Bourse. Execution cost difference remains statistically significant even after controlling for difference in adverse selection, relative tick size etc. Author has pointed that automated trading systems may not be able to fully replicate the benefits of human intermediation on trading floors unless regulators formulate trading rules which are flexible enough to meet the requirements of different types of market participants.

Christie *et al.* (2002) investigated the effects of individual security trading halts and reopening procedures on prices, trading activity, and execution costs. The sample for this study includes 714 news related trading halts on NASDAQ between September 1997 and December 1998. Trading halts are classified as halts initiated prior to the open and trading halts during trading day or intraday periods. Intraday trading halts are further classified as halts reopened with 5 minute and 90 minute quotation period. For empirical exercise dollar inside spreads represents transaction costs, absolute price change and number of quote revisions for volatility, and number of trades and average trade size for volume. This study has found that, volatility and transaction costs after reopen was significantly higher for trading halts reopened with 5 minute quotation than for trading halts reopened with 90 minute quotation. Significant increase in volume and volatility was observed for trading halts reopened next morning with a 90 minute quotation period. But comparatively it was smaller than trading halts associated with 5 minute quotation period. For halts reopened with 5 minute quotation period, spreads increased from pre-

halt level after reopen and returned to pre-halt level within 10 to 15 minutes, whereas for halts with 90 minute quotation period, spreads returned to pre-halt level within 5 minutes. But the magnitude of spreads increase was more in case of halts with 5 minute quotation period than with 90 minute quotation period

Tick size can have an important bearing on liquidity and cost of transaction in a stock market. Bessembinder (2003) compared the trade execution and market quality before and after change to decimal pricing system on NYSE and NASDAQ. Quoted, effective and realized spreads have been used to measure trade execution cost. Significant reduction was found in quoted bid- ask spreads on both NASDAQ and NYSE and largest reduction recorded for heavily traded stocks. Trades completed outside the spread found largest reduction in execution cost than trade completed within the spread. Largest reduction in spreads has been recorded for large capitalization stocks on NASDAQ. So comparison of market quality between NYSE and NASDAQ becomes more sensitive to sample selection, measure of trade execution costs, method of averaging the results etc. On NYSE more trades and more shares received price improvement, whereas on NASDAQ more trades and fewer shares received price improvement. This study found that volume weighted average effective bid– ask spread on NASDAQ after decimalization was not statistically significantly different from pre decimalization measure as well as post decimalization NYSE measure. Small and medium market capitalization stocks had smaller spreads on NYSE than NASDAQ after decimalization. But trade execution costs computed from volume weighted averages across the sample were almost similar for both exchanges.

Ulibarri and Schatzberg (2003) attempted to assess the relative merits of screen based and open outcry trading. They estimated the liquidity costs on Chicago Board of Trade (CBOT), since it initiated parallel trading from September 28, 1998. They found that liquidity costs on screen based trading vary in relation to time and level of open outcry trading. Liquidity costs were least before opening of floor trading sessions. Once both screen based and floor trading operate side by side, intraday spreads had an inverse J shaped curve i.e. spreads were highest following opening of floor trading, declines to a low level and again increases when trading nearing the close. They also found that, average daily bid- ask spreads on screen trading was little higher than floor trading spreads. During the study period, screen trading was not a full- fledged parallel trading; instead it was just a supportive exchange. So this study concluded that empirical results of this study should not be interpreted as inefficiency of screen based trading.

Chung and Chuwonganant (2004) examined impact of tick size and order handling rules on trading costs on NASDAQ. This study has shown that, the effect of tick size change on spreads on NASDAQ depends on changes in order handling rules which was enacted on NASDAQ since 1997. NASDAQ stocks were divided into two groups on the basis of whether tick size change preceded or followed order handling rules change. Empirical results have shown that, tick size change had no impact on spreads of stocks for which tick size change was prior to order handling rules change, whereas, tick size reduction had a significant effect on spreads of stocks which have been subjected to new order handling rule before tick size change.

Van Ness *et al.* (2005) examined trading pattern and trading costs on NASDAQ during the period 1993 to 2002, which witnessed market reforms and tick size changes. They found a steady decline in spreads during the period under study and argued that reduction in spreads was not exclusively caused by either rule changes or tick size reduction. Tick size reduction was introduced when spreads were gradually declining. Significant change in trading pattern was found. The frequency of trading has increased and average trade size reduced. Authors have attributed this change to greater retail participation in stock market trading. Based on the methodology used in Chordia *et al.* (2001), this study analyzed the liquidity and trading activity determinants. Day of the week effect was found; Fridays having higher spreads and lower volume and Tuesdays having lowest spreads and highest volume. Macroeconomic news had little impact on spreads, but key interest changes had direct influence on trading volume and after 2000, macroeconomic changes had an impact on spreads.

Chordia *et al.* (2008) have examined the short horizon return predictability from order flows. They found a secular reduction in average effective bid- ask spreads over the study period from 1993 to 2002. Reduction in spreads was associated with tick size reduction from eights to sixteenths and to decimal tick size regimes. Within each tick size regime trends in spreads did not change significantly in spite of erratic fluctuations in spreads.

From the foregoing review of select studies, it becomes clear that liquidity is not a permanent feature of a financial instrument. Liquidity can change overtime and it can change even within the trading day. So it becomes important to assess the liquidity effects of changes in market microstructure.

2.5 Market Microstructure and Transaction Cost

Various approaches have been used in the market microstructure literature to assess the quality of a stock market through transaction cost measurement. Broadly we can classify these approaches into three categories, quoted bid- ask spreads, effective bid- ask spreads and dynamic models which uses transaction price, trade size etc. Brief reviews of studies which have used the last category of models have been attempted here.

A new approach to transaction cost measurement as a tool to assess quality of a security market has been proposed by Hasbrouck (1993). This method divides the transaction price into random walk component and stationary component. Random walk component is identified as efficient price and residual stationary component as pricing error, which is the difference between transaction price and efficient price. By using vector autoregressive model, standard deviation of pricing error has been estimated. Standard deviation has been regarded as a proxy for market quality based on the assumption when trade barriers are reduced; actual transaction prices closely follow efficient prices.

Comparison of the execution costs on NASDAQ and NYSE for institutional investors was done by Chan and Lakonishok (1997). The execution cost includes market impact cost and commissions, which is measured by evaluating all trades in the trading package against a benchmark price. Empirical findings did not support superior liquidity on NYSE over NASDAQ. Based on a regression model after controlling for firm size, trade size, costs were lower on NASDAQ for trades in relatively small firms whereas costs for trading in large firms were lower on NYSE.

Transaction cost can be different with reference to different investment styles. Such an investigation was done by Keim and Madhavan (1997), transaction costs were found to vary with investment styles and order submission strategy. Both implicit and explicit costs were considered in transaction cost estimation. The implicit cost of a buyer initiated trade is given by the ratio of volume weighted average price of the component trades in the order to the decision price whereas for seller initiated trade it is the negative of the this return. Empirical results have shown that, transaction costs were significantly lower for exchange listed stocks than for NASDAQ. In terms of investment styles, value traders had lower transaction costs than index traders and index traders had lower transaction costs than technical traders. In terms of order types, technical traders relied more on market orders which shows their demand for immediacy whereas value traders relied more on limit orders. Even within a trading strategy, cost differences were found across institutions.

Least transaction cost trading strategies for small liquidity traders in call and continuous markets have been examined by Brooks and Su (1997). Intraday transaction data of NYSE and AMEX has been used in this study. Three trading strategies have been considered: market at open order, an intraday order, and a limit order. Cost savings, defined as purchase price minus opening price for a buy strategy and opening price minus sale price for a selling strategy has been used to assess the relative merits of three strategies. Based on empirical results they proved that a small liquidity trader can significantly reduce the transaction costs by trading at the market open. Market at open consistently performed better than market order or limit order trading during the intraday

trading period. It was mainly because the opening call market brings both informed and uninformed traders together and all will get a single consensus price. For rest of the trading day, it will be a continuous market and small traders will not know about the presence of informed traders. They concluded that even though a well worked out limit order strategy may better perform than market at open trading strategy, opening price proves to be a good benchmark price for any trading strategy analysis. Opening price easily available and it is same for both buyer and seller.

Based on a general equilibrium framework Vayanos (1998) analyzed the impact of transaction costs on asset prices. This study found that price of a stock may increase in its transaction costs. Frequently traded stocks have been found to be less adversely affected by transaction cost increase. Stock prices may decrease when transaction cost of a more liquid and correlated stock decrease. It was also found that stock turnover decreases with increase in transaction cost and turnover increases with increase in the transaction costs of other stocks. Transaction costs found to have small effects on stock prices and large effects on turnover and trading strategies.

As an alternative to the most commonly used bid- ask spreads estimates Lesmond *et al.* (1999) advocated a new method for measuring transaction costs. The proposed model uses daily returns to endogenously estimate the effective transaction costs. It is based on a limited dependent variable specification that endogenously estimates transaction costs through the incidence of zero returns. They found that, for smallest firms nearly 80% of the daily security returns were zero and for largest firms nearly 40% daily returns were zero. The transaction cost estimates varies from 10.3% for small firms and 1.2% for large

firms during 1963 to 1990 for all listed firms of NYSE and AMEX. They found 85% correlation between the proposed model's empirical results and more commonly used spreads based estimates of transaction costs. Transaction cost estimates given by limited variable estimates were smaller than spreads based estimates.

An attempt to provide empirical evidences regarding debate over execution cost difference across major US stock exchanges was made by Jones and Lipson (1999). Volume weighted average execution price for institutional orders in firms that switch exchanges has been used in this study. The execution costs for institutional trades changed a little when firms shifted exchanges and there was no significant change in total cost for any order size. An implementation cost which is measured by bid- ask spreads are relatively small for NYSE. But it will be misleading if it is concluded that transaction costs are less in NYSE because commissions are separately assessed for NYSE and AMEX trades whereas for NASDAQ it was often incorporated in spreads. So transaction cost measure should include both implementation cost as well as commissions.

Schultz (2000) investigated the impact of regulatory and legal pressures on cost of trading on NASDAQ which resulted because of the allegations of tacit collusion among dealers for almost complete absence of odd- eight quotes in 70 out of 100 active stocks by Christie and Schultz (1994). Trading costs were measured by Roll (1984) spreads, declined for all sample stocks and all trade sizes. Decline in trading costs remained even after adjusting for changes in volume, volatility and stock prices. This study concluded that regulatory and legal pressures had a positive impact on trading costs and benefited the investors.

An examination by Domowitz *et al.* (2001) has shown the interaction between cost, liquidity and volatility. The study is based on the panel data for 42 countries. They considered both explicit cost (commission and fees) and implicit cost in total cost estimation. Implicit cost was measured by taking the deviation of transaction price from unperturbed price that would have prevailed if the trade had not occurred. Empirical results have shown wide variation in transaction cost across countries and emerging markets have shown significantly higher costs even after controlling for factors which affect the trading costs. They also found that higher volatility passing through trading costs reduces portfolio's expected return and turnover had negative relation with trading costs.

Transaction cost estimates are sensitive to the methodology used. Bessembinder (2003) analyzed the certain methodological issues relating to measurement of trade execution costs. Trade execution costs were sensitive to the time adjustment made before comparing trades to quotes and method adopted to classify trades as buyer or seller initiated trades. Empirical findings have shown that effective spreads estimates vary with time lag with which trades are compared with quotes and variation was statistically significant. But inferences regarding within and cross market comparisons between NASDAQ and NYSE did not change. In contrast realized spread estimates were not sensitive to the adjustment for trade reporting lags. Trade execution cost estimates obtained using trade direction assigned by Lee and Ready (1991) and Ellis *et al.* (2000) algorithms. Effective spreads estimated using Ellis *et al.* (2000) algorithm was less than Lee and Ready (1991) algorithm. Once again inferences regarding cross market

comparisons between NYSE and NASDAQ were largely same. NYSE had smaller effective spreads than NASDAQ under both methods.

Peterson and Sirri (2003) evaluated the bias in the estimation of trade execution cost using trade and quote data. They found that, trade execution cost estimated by using effective spreads from trade and quote data overestimated the trading costs by 17%. Bias was highest for small trades and trades by large firms. It was attributed to the bias in assigning trade direction and benchmark quote. Accuracy of trade direction algorithms of Lee and Ready (1991) and Ellis *et al.* (2000) was tested. Empirical results confirmed that both algorithms are similar and accuracy improves when lags with which trades are compared with quotes decreased. It was found that, bias was less for relative effective spreads estimates than effective spread estimates.

An examination of the impact of tick size reduction from sixteenths to penny on institutional trading costs on NYSE was conducted by Chakravarty *et al.* (2005). Implementation shortfall approach has been used to measure price impact. Implementation shortfall is measured as weighted average execution price for each order from price at close on the day prior to the decision. They found that, overall trading costs declined after switchover from sixteenths to penny ticks. Trading costs slightly increased for orders executed within the trading day whereas trading costs declined for orders executed over the trading days. Trading costs declined for those had smallest pre-decimal spreads whereas costs increased for stocks with largest pre decimal spreads. They also found that trading costs declined for more patient institutional investors than those who demand immediacy.

A study by Gehrig and Fohlin (2006) attempted to investigate trading costs on Berlin Stock Exchange for period between 1880- 1910. Using Roll's (1984) implicit spreads measure and transaction cost estimator advocated by Lesmond *et al.* (1999), implicit effective spreads and transaction costs has been estimated. These transaction costs results are compared with transaction costs of German markets during 1990- 2000. The overall trading costs fell from 1.16% in 1880 to 0.45% in 1910. Trading cost decline from decade to decade was statistically significant. While comparing the transaction cost values during 1880- 1910 period with modern German markets, it was found that, with exception of estimates for 1880, rest of the transaction cost values fall in between transaction values of German DAX- 30 and MDAX. Authors have argued that, advances in technology have done little for reducing transaction costs of security trading.

Jang *et al.* (2007) attempted to contradict some of the earlier works which concluded that transaction costs have only second order effect on liquidity premium even though these transaction cost affect investment strategies significantly. This study argued that such a conclusion depends on the assumption of constant investment opportunity set. Based on a stochastic regime switching model with transaction cost, they have shown that transaction costs can have a first order effect on liquidity premium and can be important for asset pricing in case of stochastic investment opportunity set.

2.6 Concluding Remarks

From the foregoing review of select studies, it becomes clear that changes in market microstructure can have a significant impact on market quality. There is also lack of

consensus regarding the outcome of similar events in different markets. Different criterions were used to examine market quality. Regarding Indian securities markets there are very few studies which assessed the impact of changes in the market microstructure on market quality. From the review of literature this study selected four criteria viz. speed of adjustment, private information, liquidity, and transaction cost to assess the impact of changes in market microstructure on market quality over the years.

Chapter- 3

Market Microstructure and Security Speed of Adjustment

3.1 Introduction

The process by which security prices adjust to the release of new information is an area of study which has received more attention in finance in recent times. The interest is whether prices adjust in a rapid and unbiased manner to the arrival of new information. An efficient market is one in which information with economic content is expected to be quickly reflected in prices in an unbiased manner.

The efficiency of price discovery process of a security market can be assessed through the analysis of speed of price adjustment process. Speed with which security prices adjust to its intrinsic values to a large extent depends on the structure of the market and level of technology used. Due to changes in market microstructure in terms of regulatory and procedural changes and improvement in the speed of information dissemination and processing of new information can be done much faster than before. Market microstructure impact on security speed of adjustment can be assessed by measuring whether there is underreaction or overreaction in security prices while adjusting to its intrinsic values. Based on this measure, on the one hand, relative efficiency of different markets with different trading mechanisms can be compared and on the other hand, even changes in speed of adjustment of the same market can be compared to assess changes in market quality over the years. Thus security speed of adjustment gives us the extent of

underreaction or overreaction or full adjustment of prices to the arrival of new information.

To understand how prices become efficient we need to know about the process by which the adjustment occurs. Different market structures can affect speed of adjustment differently and understanding how the price process behaves may provide insights regarding how markets should be structured and regulated. So the speed of price reaction to news is of interest not only to investors and market microstructure researchers, but also to stock exchanges facing increased competition from foreign markets. The competitive position of stock exchanges can be significantly changed not only by trading costs, but also by transparency of prices. So the issue is relevant to market regulators as well.

3.2 Theoretical Background

Study of how asset prices adjust to the release of new information has been in focus in the finance literature for quite a long time. The market efficiency theory developed by Fama (1970, 1991) argued that the semi- strong efficient market is the one in which prices quickly and in an unbiased way reflects the public information. Later different frameworks have been developed to analyze the behavior of asset prices to the arrival of new information. Brown and Jennings (1989), and Grundy and McNichols (1989) have developed models to explain price adjustment process from a rational expectations framework. When traders are heterogeneously informed, spot prices and volume contain private information and traders have rational expectations about the relationship between prices and signals.

DeBondt and Thaler (1985, 1987) advanced overreactions hypothesis based on empirical findings which showed weak form of inefficiency. Past losers outperformed past winners i.e. thirty-six months after portfolio formation, the losing stocks have earned about 25% more than the winning stocks. They interpreted this finding as behavioral hypothesis of investor overreaction. Empirical findings supporting underreaction hypothesis were documented by Michaely *et al.* (1995), Bernard and Thomas (1989). Market behaved differently to different news, underreacting to earnings announcements and overreacting to dividend omissions. Jegadeesh and Titman (1999, 2001) have reported some anomalies in stock market price behavior. Buying past winners and selling past losers generated significant positive returns over three to twelve month holding periods. These types of confronting findings led to the development of alternative theoretical frameworks to explain the price adjustment process.

Subsequently behavioral models were developed in the literature to provide explanations for empirical findings regarding underreactions, overreactions and other anomalies observed in the price adjustment process. Barberis *et al.* (1998) proposed a model of investor sentiment which explains how investors form expectations about future earnings. Theory is based on the presumption that people pay too much attention to the strength of evidence and too little attention to its statistical weight. This leads to overreaction and underreaction in stock prices. Daniel *et al.* (1998) proposed a theory of stock market underreaction and overreaction based on the concept of investor overreaction and biased self attribution. They argued that investors tend to overreact to private information signals whereas they tend to underreact to public information signals. Later Hong and

Stein (1999) developed a unified theory of underreaction, momentum trading and overreaction. In this theory, market consists of news watchers and momentum traders. News watchers possess private information but fail to acquire information possessed by other news watchers through prices. Therefore prices underreact in the short run and leads to profitability of momentum trading strategies which is based on trend chasing. This invariably leads to overreaction in the long run. Finally, Hirshleifer (2001) who surveyed the behavioral model of asset pricing has argued that expected returns on securities are determined by risk and miss valuation and psychology based asset pricing models are better suited to capture the process of price adjustment.

The problem of determining security speed of adjustment towards intrinsic values has been addressed by various studies. Amihud and Mendelson (1987) advocated a partial adjustment with noise model in which prices partially adjusts to intrinsic values with noise. But they did not develop an estimator for speed of adjustment. Based on this premise Damodaran (1993) suggested an estimator for speed of adjustment of security prices. Later on Brisley and Theobald (1996), Theobald and Yallup (1998) have contributed for developing an estimator of speed of adjustment. The most recent work relating to developing an estimator for speed of adjustment has been done by Theobald and Yallup (2004) based on ARMA model.

3.3 Methodology

Following Amihud and Mendelson (1987), the stochastic process for observed price and intrinsic values are given by partial adjustment with noise model. The actual or observed

prices are assumed to adjust to their intrinsic values incompletely. The extent of adjustment is given by the speed of adjustment factor. The intrinsic value series is assumed to follow random walk. The following two equations give us the specifications for observed or actual series and intrinsic or fundamental series.

$$\Delta P_{(t)} = \pi\{V_{(t)} - P_{(t-1)}\} + u_{(t)} \quad (3.1)$$

$$\Delta V_{(t)} = \mu + e_{(t)} \quad (3.2)$$

In the above equations $\Delta P_{(t)}$ is change in the logarithmic actual prices. π is the speed of adjustment coefficient which will be within (0, 2) for non explosive series. $u_{(t)}$ is the white noise term, $\Delta V_{(t)}$ is change in the logarithmic intrinsic values. μ is the mean of intrinsic value series which follows random walk process and $e_{(t)}$ is innovations in logarithmic intrinsic values which will be serially uncorrelated in efficient markets. π =1 when prices fully adjust, whereas, π >1 when there is overreaction, and π <1 when there is underreaction.

3.3.1 The ARMA Estimator

Equation (3.1) can be rewritten after first differencing and rearranging

$$R_{(t)} = (1 - \pi)R_{(t-1)} + \pi\Delta V_{(t)} + \Delta u_{(t)} \quad (3.3)$$

By substituting for $\Delta V_{(t)}$ from equation (3.2), equation (3.3) becomes

$$R_{(t)} = \pi\mu + (1 - \pi)R_{(t-1)} + \pi e_{(t)} + u_{(t)} - u_{(t-1)} \quad (3.4)$$

The autocorrelations induced by underreactions or overreactions are reflected in an ARMA (1, 1) process. The price adjustment effects will be reflected in AR (1) coefficient, which gives us the estimated speed of adjustment coefficient. The AR component will be stationary if $|1 - \pi| < 1$ or $0 < \pi < 2$. When $\pi = 1$ adjustment is full, the process will be MA (1) process. In that case noises like bid- ask bounce will drive the return process. When non-synchronicities like thin trading are present, its effect can be captured by having moving average of higher order. Like earlier, autoregressive component gives speed of adjustment $(1- \pi)$ and moving average component reflects thin trading effects.

In this study, ARMA model has been used for estimating security speed of adjustment coefficients. A number of estimators have been developed to measure speed of adjustment of security prices [See Damodaran (1993), Brisley and Theobald (1996), and Theobald and Yallup (1998)]. As mentioned by Theobald and Yallup (2004), all these estimators suffer from certain limitations. For example, Theobald and Yallup (1998) estimator does not provide estimates of total speed of adjustment coefficients. Damodaran (1993), and Brisley and Theobald (1996) estimators do not have readily available sampling distributions and as a result test of significance is not possible. They also subject to thin trading effects and require prices to fully reflect all information at a specified return interval. So, it will not give the opportunity of testing for the possibility of underreactions and overreactions at longer differencing intervals.

The ARMA estimator overcomes the problems faced by earlier estimators. The estimator is a function of autocorrelation. Underreactions and overreactions leads to a particular type of autocorrelation in the return series. Underreactions lead to positive autocorrelation and overreactions lead to negative autocorrelation in the return series. The ARMA estimator advocated by Theobald and Yallup (2004) is based on this insight. The ARMA estimator, unlike earlier estimators, provides total speed of adjustment coefficients and has a sampling distribution for test of significance. Thin trading effects are incorporated through higher order moving average terms and finally this model does not require prices to fully adjust to information at any specified differencing interval. So it can be used for measuring underreaction or overreaction at higher return differencing intervals as well. The ARMA model thus overcomes some of the deficiencies of earlier models.

This study proposes to use ARMA (1, 1) model for measuring security speed of adjustment. Lag lengths are chosen based on the ACF's and PACF's. Since most of the companies figure in top 100 companies based on market capitalization, thin trading is not a problem as they are frequently traded. This also gives justification for confining to ARMA (1, 1) model.

3.4 Empirical Results

The analysis of the effects of changes in market microstructure on security speed of adjustment is conducted by using daily closing prices of 40 companies listed in NSE since January 1995 to December 2008. The entire study period is divided into three parts

viz. 1995- 1999, 2000- 2003 and 2004- 2008 by considering specific developments in NSE. Empirical results are listed as follows: Table 3.1 presents the summary statistics for selected companies for all three sub periods. Table 3.2 shows sample average of security speed of adjustment coefficients as given by ARMA (1, 1) model. Table 3.3 contains average security speed of adjustment coefficients for large market capitalization stocks as given by ARMA (1, 1) model. Table 3.4 shows the average security speed of adjustment coefficients for small market capitalization stocks as given by ARMA (1, 1) model. Finally, figures from 3.1 to 3.5 show ARMA (1, 1) security speed of adjustment results for all individual companies included in the study.

Table 3.1 shows the summary statistics of returns i.e. mean and standard deviation of sample companies. Daily mean return is very close to zero, as expected in case of daily returns. Standard deviation of returns does not follow any systematic pattern over three sub periods. There is no continuous increase or decline in standard deviation over the years. To assess the average sample speed of adjustment, mean π and standard deviation π of sample companies are estimated. Table 3.2 shows average ARMA (1, 1) result for sample companies. It has shown very high speed of adjustment to fundamental or intrinsic values. Results have shown neither continuous underreaction nor overreaction. During 1995- 1999 for first day return difference interval mean π is about 0.95, which is not statistically significantly different from one, shows full adjustment towards fundamental values. Standard deviation π is very less, which shows very less difference in individual companies results in comparison with standard deviation of π associated with later differencing intervals. On second day, mean π is about 1.3, which is

statistically significantly different from one, shows overreaction in prices. For subsequent return differencing intervals mean π is around one and are not statistically significantly different from one, which is defined as full adjustment. For 2000-2003 the pattern of price adjustment is almost same except for overreaction in prices at higher differencing intervals. During the last period i.e. 2004-2008 up to fifth day differencing interval, speed of adjustment coefficients are not significantly different from one, which means full adjustment. Like second period there is slight overreaction at higher differencing intervals as speed of adjustment coefficients are statistically significantly more than one.

To find out whether there is difference in security speed of adjustment for large and small market capitalization stocks, companies are classified into two categories of 20 companies each. In this classification large capitalization stocks comprises 20 companies which are mostly constituents of Nifty and remaining 20 companies which are called as low market capitalization stocks comprises mostly Nifty Junior constituent stocks. Table 3.3 shows ARMA (1, 1) model estimates for large market capitalization stocks. Mean π estimated from large market capitalization stocks are about as same as that of mean π of the all companies. The findings regarding mean π and standard deviation π of all companies are reflected in this classification based on market capitalization. Table 3.4 shows ARMA (1, 1) model estimates for small market capitalization stocks. In this case also for all sub periods, the pattern of speed of adjustment of the entire sample is reflected in this classification as well. There is no significant difference in the speed of adjustment coefficients for small and large market capitalization stocks.

Figures 3.1 to 3.5 show the trends in the security speed of adjustment coefficients of ARMA (1, 1) model for individual companies in all three periods viz. 1995-1999, 2000-2003, and 2004-2008. Results do not follow any systematic pattern over the three periods. For the purpose of evaluation companies are grouped on the basis of number of days for which security speed of adjustment coefficients (π) are statistically significantly not different from one. Out of 40 companies, 12 companies viz. Arvind Mills Ltd, Bharath Forge Ltd, Bharath Heavy Electricals Ltd, IFCI Ltd, LIC Housing Finance Ltd, Pfizer Ltd, Punjab Tractors Ltd, Satyam Computer Services Ltd, Reliance Capital Ltd, State Bank of India, Siemens Ltd, and Wipro Ltd did not record any major change in the security speed of adjustment coefficients over three periods. Among 12 companies, Satyam Computer Services Ltd recorded poor figures in security speed of adjustment coefficients over all three periods in comparison with other companies in this category. Bharath Forge Ltd, LIC Housing Finance Ltd, Pfizer Ltd, Reliance Capital Ltd, and Wipro Ltd have recorded better security speed of adjustment coefficients and rest of the companies have reasonably good security speed of adjustment coefficients.

A total eight companies have experienced slight deterioration in the security speed of adjustment coefficients during the second period i.e. 2000-2003 in relation to the first and the third periods i.e. 1995-1999 and 2004-2008 respectively. ABB Ltd, Ashok Leyland Ltd, Asian Paints Ltd, Bajaj Auto Ltd, Housing Development Finance Corporation Ltd, Mahindra & Mahindra Ltd, Nicolas Primal India Ltd, and Nirma Ltd recorded better security speed of adjustment coefficients for the first and the third period in relation to the second period, and the third period is little better than the first period for a few

companies. Five companies viz. Bharat Petroleum Corporation Ltd, Hero Honda Motors Ltd, Steel Authority of India Ltd, Sun Pharmaceutical Industries Ltd, and Tata Power Co. Ltd have recorded deterioration in the security speed of adjustment coefficients continuously over all three periods. For another set of eight companies viz. Moser Baer India Ltd, Ranbaxy Laboratories Ltd, ACC Ltd, Cipla Ltd, Glaxosmithkline Pharmaceuticals Ltd, Grasim Industries Ltd, Infosys Technologies Ltd, and ITC Ltd recorded lower speed of adjustment in the second and the third period in comparison with first period. In this case speed of adjustment is about same in the second and the third period. Only two companies viz. Raymond and Reliance Industries Ltd recorded continuous increase in speed of adjustment in all the three periods. Apart from this four companies viz. Apollo Tyres Ltd, Dr. Reddy's Laboratories Ltd, HDFC Bank Ltd, and Industrial Development Bank of India Ltd have recorded better speed of adjustment in the third period in comparison with the first and the second periods, which are about equal. Only Unitech Ltd recorded better speed of adjustment for the first and the second period over the third period. In this case the first and the second period results are about same.

From the analysis of individual companies it becomes clear that, market microstructure changes did not result in any systematic pattern in security speed of adjustment coefficients. Even though there is no systematic pattern over the years, most companies recorded better speed of adjustment to fundamental values in all three periods.

Empirical results of this study have been compared with earlier studies on Indian stock market. Marisetty (2003) has found overreaction of stock prices before adjusting to the

intrinsic values. He also found that information adjustment in Indian stock market is very slow. Findings of this study are in sharp contrast to the findings of Marisetty (2003). This study did not find any systematic pattern of either underreaction or overreaction. It is a combination of both underreaction as well as overreaction at shorter as well as longer differencing intervals for individual companies. Marisetty (2003) did not find this fact mainly due to the methodology used. Damodaran's (1993) estimator requires prices to fully adjust to information at 20 days differencing interval and there is no readily available sampling distribution. So it precludes the possibility of accounting underreaction or overreaction at longer differencing intervals and hypothesis testing.

There is a similarity between the findings of this study and that of Marisetty (2003) in respect of adjustment of firm specific and market wide news. Marisetty (2003) found that market wide news is being absorbed faster than firm specific news. In this study also speed of adjustment coefficients for individual companies showed significant underreaction and overreaction at both lower and higher differencing intervals. But security speed of adjustment coefficients across companies is not significantly different from one, which represents full adjustment.

Poshakwale and Theobald (2004) analyzed lead lag relationship between large and small market capitalization stocks indices. They found significant differences in security speed of adjustment estimated from BSE and NSE indices for small and large capitalization stocks. In this study, mean π estimated from cross section of companies did not show any such differences.

3.5 Conclusion

Based on the empirical results, the following broad conclusions emerge from the study. First, market microstructure changes did not produce any systematic or predictable pattern in return process over the years as measured for three periods. Significant underreaction and overreaction along with full adjustment are observed at both shorter as well as longer differencing intervals. Second, there is no clear improvement in speed of adjustment for sample companies. A few companies witnessed improvement, deterioration for few others and no change in the speed of adjustment pattern for rest of the companies. Overall the speed of adjustment results is similar for all three sub periods. Third, the security speed of adjustment is fast as measured by the mean π for cross section of companies and also there is evidence of market wide information being adjusted quickly than firm specific information. This is shown by security speed of adjustment coefficients of individual companies and average of these coefficients across companies. Fourth, there is no conclusive evidence on speed of adjustment differences among small and large market capitalization stocks. Mean π estimated for two categories based on market capitalization did not show much difference for these two categories. This may be due to the fact that sample stocks are frequently traded, since most companies are index constituents of Nifty and Nifty Junior which mostly represents top 100 companies based on market capitalization. Fifth, the overall results of this study do not contradict market efficiency hypothesis, since no systematic pattern is found in this study. Prices are speedily adjusting towards intrinsic values as shown by full sample mean π values.

Table 3.1: Summary Statistics.

Company	1995- 1999		2000- 2003		2004- 2008	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
ABB	-0.000705	0.025606	0.000937	0.024087	0.000818	0.052537
ACC	-0.00222	0.073262	-9.20E-05	0.029594	0.001373	0.022451
ARVINDMILL	3.72E-05	0.033747	0.000414	0.034922	-0.001624	0.074641
APOLLOTYRE	-0.001579	0.028896	0.000963	0.03798	0.000284	0.030206
ASHOKLEY	-0.00042	0.03459	0.000879	0.033783	-0.001723	0.077617
ASIANPAINT	-0.000296	0.030335	-0.000131	0.02686	0.001182	0.016562
BAJAJAUTO	-0.000604	0.024833	0.001157	0.022186	0.000836	0.020135
BHARATFORG	0.000512	0.032937	0.000846	0.034361	-0.000799	0.05394
BHEL	0.000178	0.032037	0.000811	0.030422	0.001609	0.033066
BPCL	2.67E-06	0.027927	0.00012	0.040653	0.00013	0.024728
CIPLA	0.000533	0.039516	-0.000101	0.025124	-0.001843	0.061893
DRREDDY	0.001015	0.028301	-0.000053	0.035549	-0.00067	0.030298
GLAXO	0.000294	0.031649	-0.000319	0.022352	0.000556	0.019532
GRASIM	-0.00051	0.027167	0.000827	0.027723	0.00128	0.021528
HDFC	-0.001808	0.067743	0.000787	0.032353	0.001487	0.022505
HDFCBANK	0.001083	0.02787	0.000763	0.023209	0.001546	0.022683
HEROHONDA	0.001233	0.034143	-0.000989	0.057274	0.000416	0.021189
IDBI	-0.000967	0.027812	0.00044	0.035384	0.000966	0.036076
IFCI	-0.00126	0.027602	0.0004	0.043741	0.001693	0.044061
INFOSYSTCH	0.002927	0.040533	-0.00103	0.042677	-0.001155	0.052149

Table 3.1: (continued)

Company	1995- 1999		2000- 2003		2004- 2008	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
ITC	0.000439	0.026732	0.000327	0.024059	-0.001553	0.085142
LICHSGFIN	-0.00064	0.031227	0.001802	0.026133	0.000561	0.025754
M&M	0.000134	0.030538	-0.000153	0.03266	0.000782	0.031481
MOSERBAER	0.002382	0.043495	-7.75E-05	0.044453	-0.000129	0.031016
NICOLASPIR	0.000416	0.030923	4.17E-05	0.022446	-0.000791	0.0552
NIRMA	0.0002	0.025185	-0.000501	0.027484	-0.000541	0.030038
PFIZER	0.000757	0.029171	-0.000665	0.030012	0.00037	0.019034
PUNJABTRAC	0.000869	0.030193	-0.001554	0.042611	0.000228	0.020782
RANBAXY	0.000258	0.029154	9.30E-05	0.029359	-0.000951	0.030796
RAYMOND	-0.001156	0.035698	0.001161	0.027154	0.000633	0.023899
RELCAPITAL	-0.000327	0.033217	5.91E-05	0.033987	0.002935	0.033725
RELIANCE	-0.000306	0.034314	0.000821	0.023876	0.001615	0.022137
SAIL	-0.001206	0.04114	0.001351	0.038213	0.001686	0.033013
SATYAMCOMP	0.002778	0.040178	-0.001871	0.065717	0.000186	0.031874
SBIN	1.58E-05	0.026925	0.00079	0.023168	0.001431	0.023251
SIEMENS	-5.60E-05	0.030845	0.000673	0.024598	0.000576	0.058038
SUNPHARMA	0.001601	0.029352	-0.001123	0.051065	0.000699	0.028997
TATAPOWER	-0.002377	0.068879	0.001404	0.028592	0.001513	0.02687
UNITECH	-0.000884	0.029201	0.001058	0.032027	0.001376	0.136977
WIPRO	0.001251	0.078236	-0.00045	0.044264	-0.001205	0.047056

Table 3.2: Average security speed of adjustment coefficients: ARMA (1, 1) model.

Differencing intervals in days	1995-1999		2000-2003		2004-2008	
	Mean π	Standard Deviation π	Mean π	Standard Deviation π	Mean π	Standard Deviation π
1	0.950956	0.060628	0.947163	0.055447	0.960789	0.06328
2	1.332386*	0.367305	1.321839*	0.339568	1.129912	0.446988
3	1.073241	0.343663	1.12251	0.315768	0.903888	0.316824
4	0.977374	0.496116	1.292913	0.53983	1.170686	0.652593
5	1.074999	0.377133	1.204345	0.406679	0.918519	0.519782
6	1.092465	0.480342	1.173539	0.599099	1.247368*	0.704561
7	1.024082	0.449349	1.082071	0.50937	0.995605	0.535704
8	1.074233	0.63283	1.327694*	0.581258	1.246598*	0.739887
9	0.863479	0.520592	0.975904	0.516655	0.919768	0.56599
10	1.004164	0.632759	1.217812*	0.654249	1.214908*	0.654632
11	1.031692	0.54396	0.987493	0.544493	1.016201	0.600972
12	1.145268	0.621885	1.298578*	0.590348	1.02168	0.704439
13	0.911922	0.514085	1.082635	0.61387	0.898074	0.498472
14	1.079903	0.616542	1.086906	0.621864	1.281973*	0.567392
15	1.217463*	0.587331	1.105839	0.529024	0.969188	0.571806
16	1.042378	0.59282	1.224373	0.616224	1.152671	0.663262
17	0.995439	0.535207	1.099974	0.528614	0.99582	0.550171
18	0.971252	0.517113	1.158927	0.576968	0.944819	0.623346
19	1.019142	0.527757	1.119494	0.554657	1.049815	0.533087
20	0.924206	0.580996	1.173036	0.543296	1.155344	0.610936
21	1.084109	0.613675	1.137293	0.498622	1.084377	0.541206
22	0.806367	0.576942	1.063815	0.708158	1.178322	0.573294
23	1.094834	0.575302	1.025941	0.596242	1.099603	0.589204
24	0.915866	0.590165	1.194805	0.62314	1.105582	0.556232
25	1.046899	0.498378	1.096645	0.546006	1.07821	0.521241

* Statistically significantly different from one at 10% level significance.

Table 3.3: Average security speed of adjustment coefficients for large market capitalization stocks: ARMA (1, 1) model.

Differencing intervals in days	1995-1999		2000-2003		2004-2008	
	Mean π	Standard Deviation π	Mean π	Standard Deviation π	Mean π	Standard Deviation π
1	0.954828	0.073246	0.942889	0.064555	0.966719	0.057781
2	1.270916	0.40746	1.279225	0.381987	1.088649	0.473333
3	0.961488	0.282771	1.201592	0.393734	0.897817	0.385299
4	0.99092	0.501839	1.152151	0.57467	1.341758*	0.65736
5	0.963607	0.289964	1.156869	0.338645	1.011444	0.569664
6	1.167828	0.551376	1.013885	0.662043	1.222211	0.712292
7	0.985308	0.455963	1.015728	0.525245	0.925067	0.574558
8	0.925933	0.60645	1.318867*	0.592697	1.030594	0.814611
9	0.796702	0.491696	0.962811	0.551117	0.813168	0.626779
10	0.943476	0.638783	1.243912	0.682059	1.196195	0.77489
11	0.764139	0.392136	0.980491	0.558118	0.846837	0.629902
12	1.10444	0.575622	1.274863	0.662579	0.824244	0.717537
13	1.026812	0.602549	0.989157	0.641635	0.764762	0.575438
14	0.995187	0.591084	1.124545	0.659854	1.327723*	0.609124
15	1.001108	0.564827	0.969446	0.526729	0.90826	0.615847
16	1.038802	0.610238	1.099967	0.601924	1.125331	0.766188
17	0.962348	0.56994	1.111599	0.539268	0.940646	0.590197
18	1.012024	0.490328	1.164202	0.585055	0.991247	0.697145
19	1.142763	0.509361	1.10531	0.573693	0.935011	0.62647
20	0.990775	0.604044	1.219808	0.52829	1.113657	0.697038
21	1.099169	0.600323	1.076843	0.520833	1.043637	0.675907
22	0.9104	0.634575	1.145928	0.696339	1.135658	0.666684
23	1.092051	0.56854	0.985385	0.577486	0.9529	0.679943
24	0.938179	0.596356	1.143973	0.670193	1.041103	0.700791
25	0.955411	0.518895	1.145305	0.538631	1.03021	0.548373

* Statistically significantly different from one at 10% level significance.

Table 3.4: Average security speed of adjustment coefficients for small market capitalization stocks: ARMA (1, 1) model.

Differencing intervals in days	1995-1999		2000-2003		2004-2008	
	Mean π	Standard Deviation π	Mean π	Standard Deviation π	Mean π	Standard Deviation π
1	0.947085	0.04635	0.951437	0.045877	0.95486	0.069332
2	1.393857*	0.320857	1.364453*	0.294864	1.171174	0.427182
3	1.184994	0.369018	1.043429	0.190982	0.909958	0.239802
4	0.963827	0.502978	1.433674*	0.475618	0.999614	0.616794
5	1.186391	0.426312	1.251821	0.4691	0.825594	0.460294
6	1.017101	0.397024	1.333194*	0.494738	1.272524	0.714316
7	1.062856	0.450987	1.148413	0.497416	1.066142	0.498467
8	1.222534	0.638704	1.336521*	0.584851	1.462603	0.601546
9	0.930256	0.552399	0.988996	0.493784	1.026369	0.490687
10	1.064852	0.637216	1.191711	0.641852	1.23362	0.527683
11	1.299245*	0.550348	0.994495	0.544932	1.185564	0.533085
12	1.186096	0.677485	1.322294*	0.524566	1.219115	0.649356
13	0.797033	0.389388	1.176113	0.586016	1.031387	0.376141
14	1.164619	0.644799	1.049267	0.596148	1.236223	0.534202
15	0.869328	0.616361	1.242232	0.507793	1.030115	0.532964
16	1.045954	0.590721	1.348778*	0.620125	1.180011	0.560687
17	1.028529	0.510718	1.088348	0.531486	1.050994	0.516299
18	0.93048	0.552236	1.153653	0.583915	0.898392	0.554096
19	0.895522	0.529239	1.133678	0.549484	1.16462	0.403868
20	0.857636	0.564519	1.126263	0.567609	1.197032	0.525937
21	1.069049	0.641989	1.197744	0.481012	1.125117	0.37534
22	0.702333*	0.507714	0.981702	0.728208	1.220986	0.475742
23	1.097616	0.59675	1.066498	0.626711	1.246306	0.452728
24	0.893554	0.598525	1.245637	0.585188	1.170062	0.36771
25	1.138387	0.472186	1.047986	0.562874	1.126211	0.502117

* Statistically significantly different from one at 10% level significance.

Figure 3.1: Security speed of adjustment coefficients for ABB, ACC, ARVINDMILL, APOLLOTYRE, ASHOKLEY, ASIANPAINT, BAJAJAUTO, and BHARATFORG.

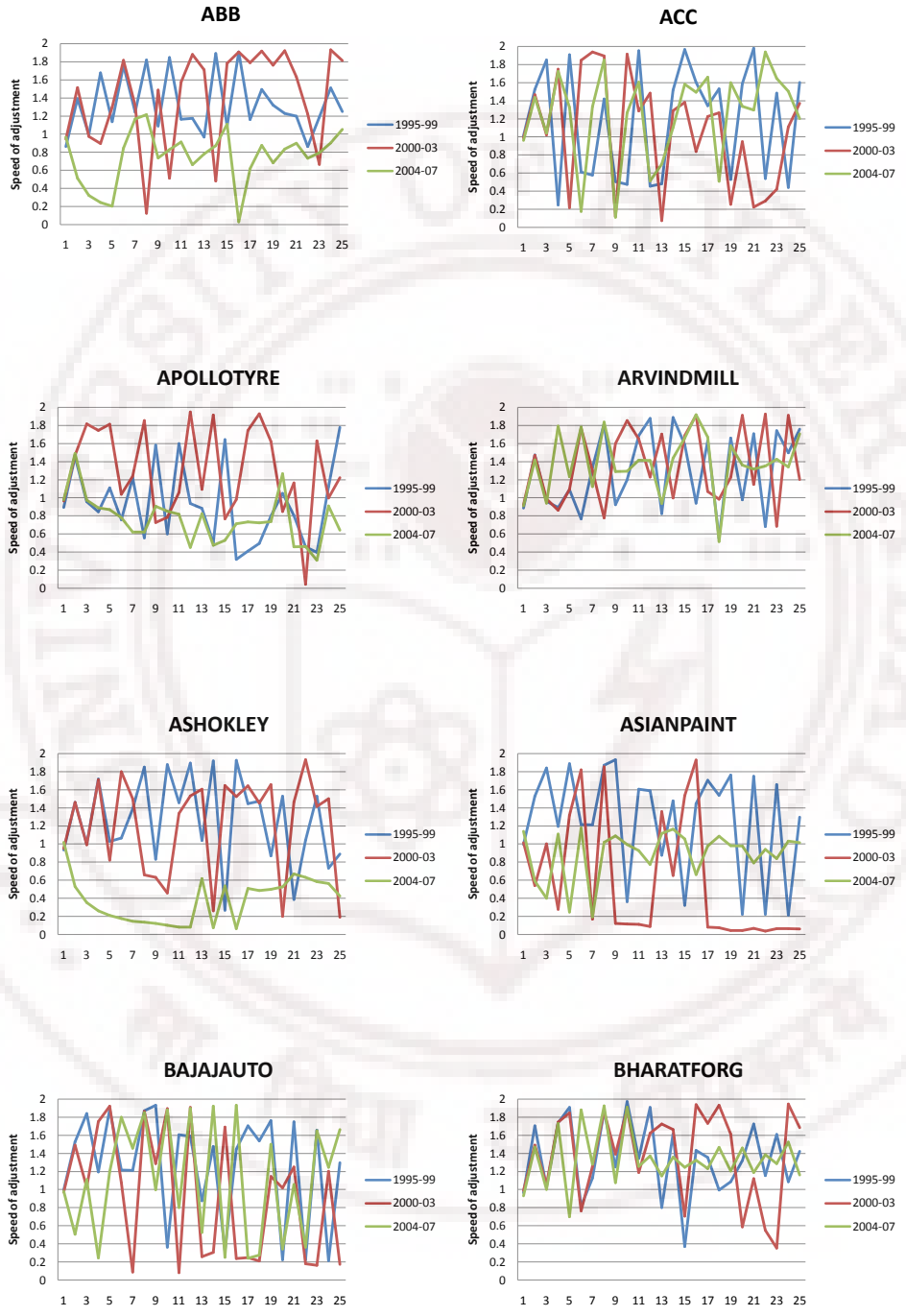


Figure 3.2: Security speed of adjustment coefficients for BHEL, BPCL, CIPLA, DRREDDY, GLAXO, GRASIM, HDFC, and HDFCBANK.

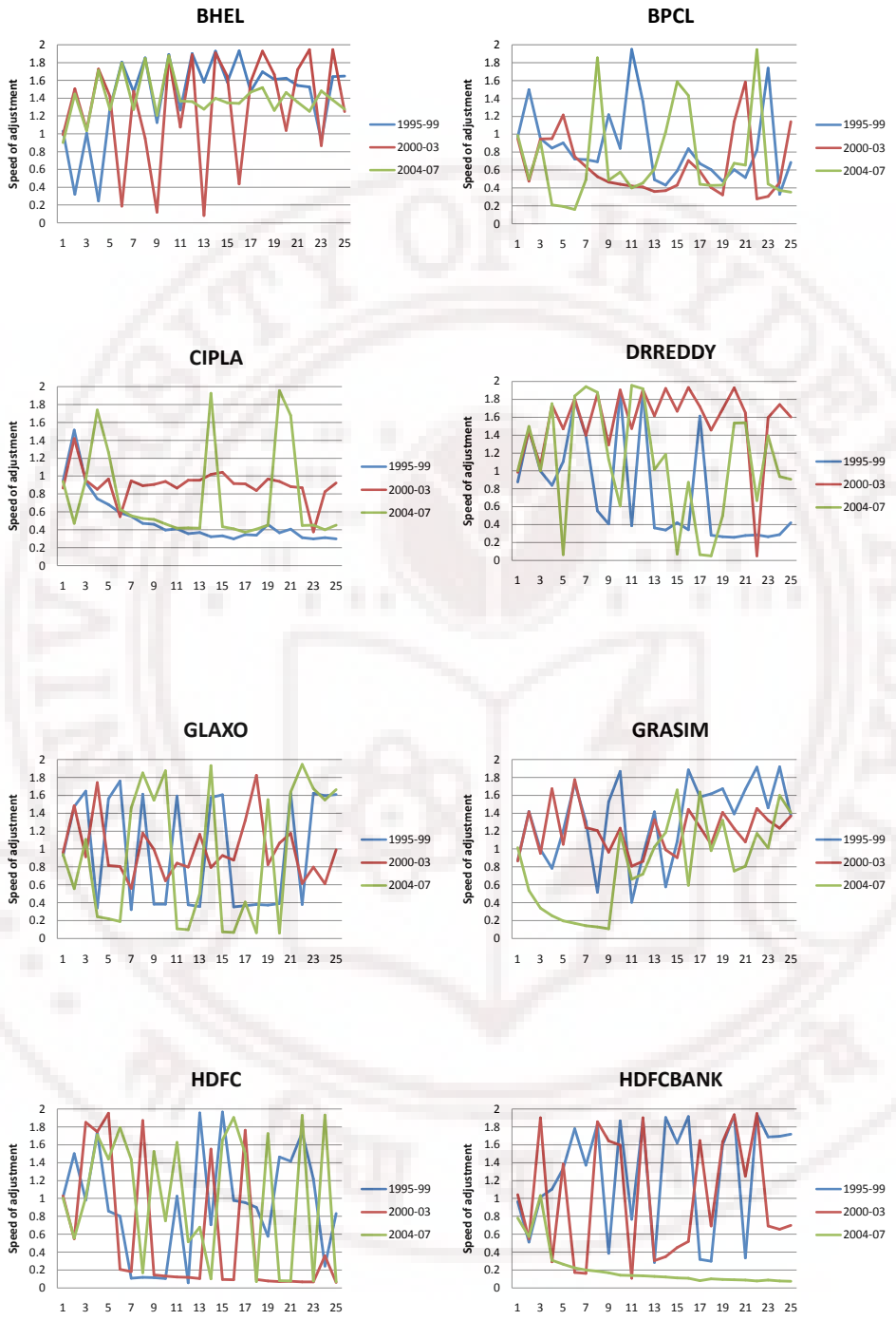


Figure 3.3: Security speed of adjustment coefficients for HEROHONDA, IDBI, IFCI, INFOSYSTCH, ITC, LICHSGFIN, M&M, and MOSERBAER.

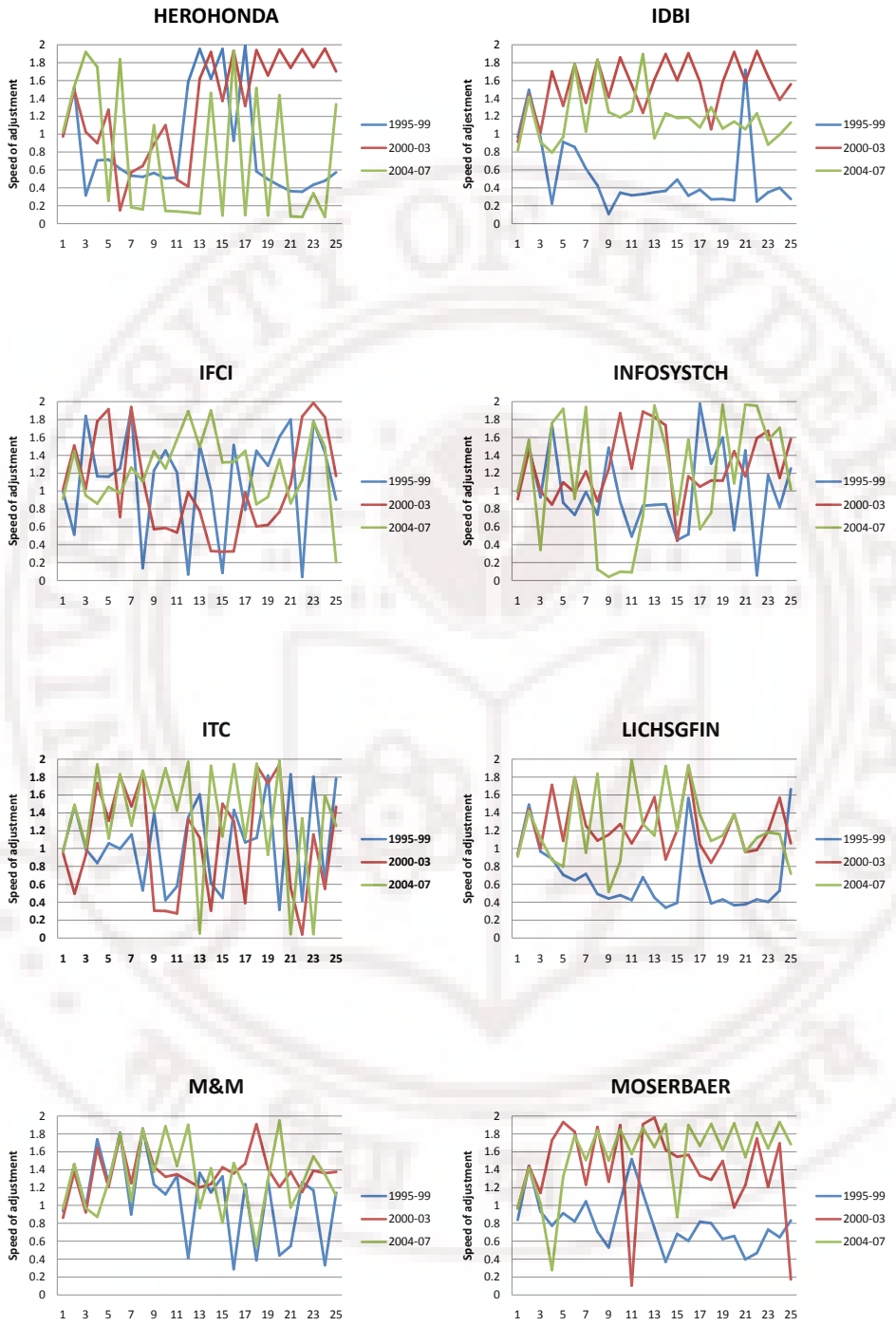


Figure 3.4: Security speed of adjustment coefficients for NICOLASPIR, NIRMA, PFIZER, PUNJABTRAC, RANBAXY, RAYMOND, RELCAPITAL, and RELIANCE.

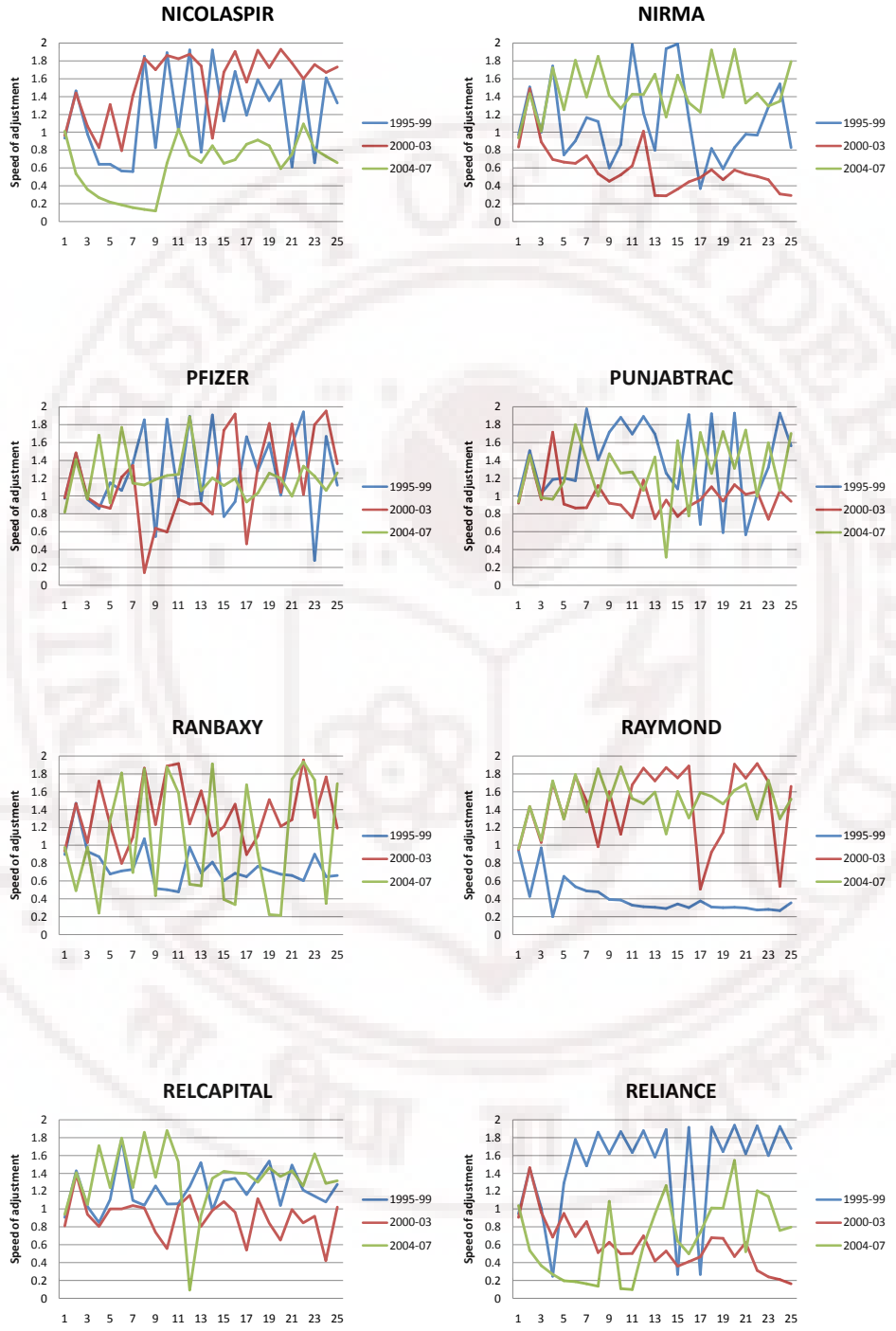
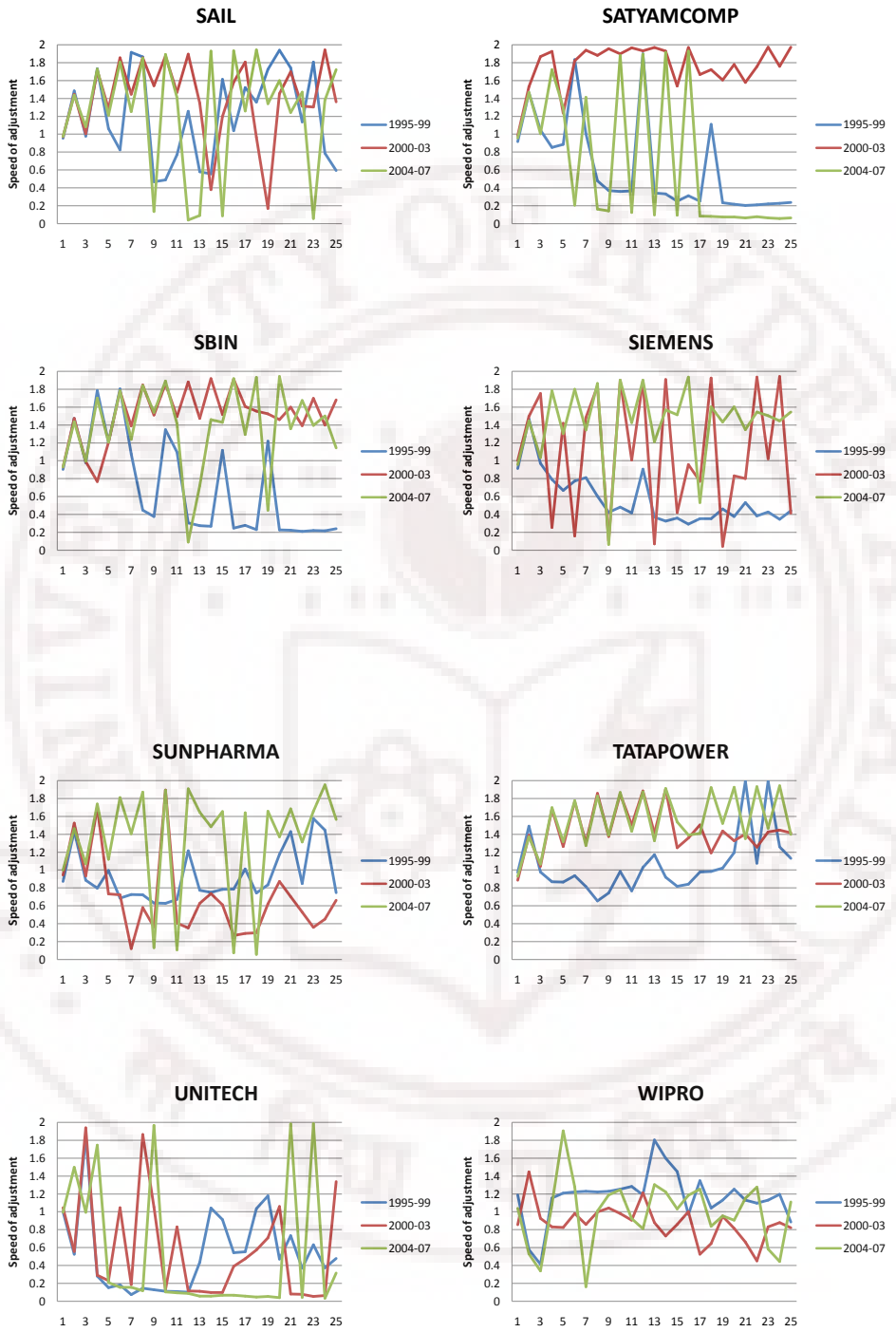


Figure 3.5: Security speed of adjustment coefficients for SAIL, SATYAMCOMP, SBIN, SIEMENS, SUNPHARMA, TATAPOWER, UNITECH, and WIPRO.



Chapter- 4

Market Microstructure and Private Information

4.1 Introduction

Efficient market hypothesis states that a market is efficient if it fully reflects all available information. Once information arrives, market prices of securities adjust to reflect new information immediately without bias. This eliminates the opportunity of making risk free profits for speculators after covering transaction costs. Fama (1970, 1991) argued lack of return predictability as a criterion for market efficiency. The week form of efficiency [Fama (1970)] exists if prices reflect all information in past prices. Fama (1991) changed this category to include not just future return predictability from past returns but also to include more general area of tests of return predictability.

There are a few studies which found some evidence of return predictability from past returns on daily, weekly and monthly data. Fama (1965) found 23 out of 30 Dow Jones Industrial Average stocks had significant positive first order autocorrelations in daily returns. This finding was supplemented by Fisher (1966) who showed that the autocorrelations in returns of a well diversified portfolio was significantly positive and greater than that of individual returns. Lo and MacKinlay (1988) found positive first order autocorrelations in the weekly returns of portfolios and autocorrelations was stronger for portfolios of smaller stocks. This finding was supported by Conard and Kaul (1988), who also found that weekly returns were positively autocorrelated and

autocorrelations were stronger for portfolios of smaller stocks. In a more recent study Chordia *et al*. (2008) analyzed return predictability and informational efficiency based on variance ratios and autocorrelations taking cue from the study of French and Roll (1986).

4.2 Theoretical Background:

Oldfield and Rogalski (1980) argued that, contrary to the conventional theory which assumes that same return process operates over trading as well as non- trading periods, there are ample reasons to believe it to be different during open and closed periods. Even though there are no transactions on nights, weekends, holydays, share price may change from close to open on the next trading day. This shows the revised expectations on the part of investors regarding the profitability of the firm. Due to this, equity returns are more volatile during exchange trading hours than during closed hours.

Differences in daytime and overnight volatility patterns have been examined in several studies. Initially Fama (1965) examined the behavior of security prices. Later Granger and Morgenstern (cited in French and Roll, 1986, pp. 5), Oldfield and Rogalski (1980) and Christie (cited in French and Roll, 1986, pp. 5) have also analyzed the daytime and overnight volatility pattern.

French and Roll (1986) advanced three possible explanations for higher daytime volatility over overnight volatility. First, due to the arrival of public information, second, due to the arrival of private information during trading hours, and third, trading induced noises like miss reaction or mispricing by investors. They rejected public information

hypothesis as a possible reason for higher daytime volatility because variance ratios were not significantly different on business days on which market was closed. To determine the relative importance of private information hypothesis and trading induced noise hypothesis as possible reasons for higher daytime volatility, they used first order autocorrelations in daily returns. Based on that, they concluded that arrival of private information is the primary reason responsible for higher daytime return volatility in comparison with overnight volatility.

In this study by using autocorrelations and variance ratios an attempt is made to study the process of incorporation of private information and possibility of return predictability in daily returns. Dynamics in the daytime and overnight returns is also explored in this study.

4.3 Methodology

This study attempts to explore incorporation of private information based on variance ratios and return autocorrelation. Variance ratio of daytime to overnight return has been estimated to show the degree to which information is incorporated into prices and to show the difference in the time series properties of opening and closing returns. Daytime, overnight returns and variance ratio of daytime to overnight returns are estimated in the following manner:

$$Daytime\ return = \ Log\ close_t - Log\ open_t.$$

$$Overnight\ return = \ Log\ open_t - Log\ close_{t-1}$$

$$Variance\ ratio = Daytime\ return\ variance \div Overnight\ return\ variance$$

Autocorrelations in the daily returns is estimated as follows:

$$\hat{\rho}_{\tau,r} = \sum_{t=1}^{n-\tau} (r_t - \bar{r})\,(r_{t+\tau} - \bar{r}) \,/\, \sum_{i=1}^{n} (r_t - \bar{r})^2, \quad \tau > 0 \qquad (4.1)$$

where $\bar{r}$ is the sample mean of all *n* observations and $\hat{\rho}$ is the stochastic process of data.

Opening returns, closing returns and variance ratio of opening to closing returns are estimated as follows:

$$Opening\ return = Log\ open_t - Log\ open_{t-1}$$

$$Closing\ return = Log\ close_t - Log\ close_{t-1}$$

$$Variance\ ratio = Daytime\ return\ variance \div Overnight\ return\ variance$$

First order autocorrelations in returns from opening and closing prices are estimated to show the possibility of return predictability. To further investigate into the pattern of opening and closing returns, speed of adjustment of security prices has been estimated to show the reaction of opening and closing prices to new information. Speed of adjustment has been estimated by using ARMA (1, 1) model for first day return differencing interval.

This analysis is based on the fact that market microstructure theory considers the degree to which private information is reflected in prices. But market efficiency theory confines only to lack of return predictability. The stock returns may not be predictable on the basis

of past public information but it may reflect the varying degrees of private information in it. So quality of a market can be assessed by considering not just return predictability but also based on the degree to which it reflects private information.

The study proposes to use variance ratios of daytime to overnight returns to provide some evidence regarding informational efficiency. This is in line with study made by French and Roll (1986) who related these ratios to incorporation of information into prices. To provide further evidence to distinguish between private information and mispricing as reason for difference in daytime and overnight return volatility, the study proposes to use first order autocorrelations in daily returns. French and Roll (1986) argued that autocorrelations are positively related to mispricing or market microstructure noise. The speed of adjustment pattern in opening and closing returns is estimated by using ARMA (1, 1) model.

The study is based on daily opening and closing prices collected from NSE for period between 1995- 2008 and consists 40 companies. The study period is divided into 3 parts i.e. 1995-1999, 2000- 2003, and 20004-2008, which represents different phases in the growth of NSE.

4.4 Empirical Results

In this section empirical results of the study are presented. Tables 4.1 to 4.3 show the variance ratio of daytime to overnight returns and first order autocorrelations in daily returns calculated as the log first difference of closing prices. Tables 4.4 to 4.6 show the

variance ratio of opening to closing returns and autocorrelations in daily opening and closing returns. Tables 4.7 to 4.9 give speed of adjustment of security prices to intrinsic values is shown for first day return differencing interval.

As shown in tables 4.1 to 4.3 variance ratios of daytime to overnight return is greater than one for 28 out of 40 companies in 1995- 1999, 32 companies in 2000- 2003, and 25 companies in 2004- 2008 period. This shows higher volatility when market is open than market is closed for majority of stocks in all three periods. First order autocorrelations in daily returns show the serial dependence in prices. Out of 40 companies, 19 companies in 1995-1999, 14 companies in 2000-2003, and 13 companies in 2004- 2008 have significant first order autocorrelation coefficients. In most cases, first order autocorrelation coefficient has positive sign and also the size of the autocorrelation coefficient is very small. Higher daytime variance in comparison with overnight variance for majority of stocks and less number of companies with significant but small autocorrelation coefficients in daily returns can be treated as an evidence for increased incorporation of private information during trading hours.

There are few studies which examined the dynamics in opening and closing returns. In this section an attempt is made to examine such a pattern in NSE. Tables 4.4 to 4.6 show variance ratios of opening to closing returns and autocorrelations in returns estimated from opening and closing prices. Variance ratio for all companies in all three sub periods is greater than one. This clearly shows variance in opening returns is higher than closing returns. There is a distinct pattern in first order autocorrelation in opening and closing returns. In opening returns out of 40 companies, 18 companies in 1995- 1999, 32

companies in 2000- 2003, and 35 companies in 2004- 2008 have significant autocorrelations. All significant autocorrelations in all three periods are negative. In contrast to this, the closing returns show a declining trend in first order autocorrelation coefficients. Out of 40 companies, 19 companies in 1995- 1999, 14 companies in 2000- 2003, and 13 companies in 2004- 2008 have significant autocorrelation coefficients. In most cases significant autocorrelations are associated with positive sign. First order autocorrelation coefficients in both opening and closing returns are small and opening returns having slightly larger autocorrelations coefficients than closing returns.

To further probe into the pattern in the first order autocorrelations in the opening and closing returns, speed of adjustment of opening and closing prices to new information has been estimated for first day return differencing interval. Tables 4.7 to 4.9 show speed of adjustment coefficients in opening and closing returns for the three periods. In 1995- 1999 for 18 companies speed of adjustment coefficient is greater than one in opening returns whereas only five companies in closing returns have values greater than one. In 2000- 2003, 15 companies in opening returns and six companies in closing returns and in 2004- 2005, 15 companies in opening returns and nine companies in closing returns have values of speed of adjustment greater than one. The results do not show a clear-cut overreaction in opening prices over closing prices. But there exists some signs of higher speed of adjustment in opening prices than in the closing prices. Such a possibility can be seen in the autocorrelation patterns in opening and closing returns as the former has more negative autocorrelation whereas more positive autocorrelation is recorded in the latter.

Since autocorrelation coefficients are small in both opening and closing returns, it did not result in overreaction in opening prices and underreaction in closing prices.

4.5 Conclusion

From the forgoing empirical analysis, the following broad conclusions emerge from this study. First, increased incorporation of private information as shown by higher daytime variance in comparison with overnight variance and a small decline in the autocorrelations in daily returns are noted. Second, higher volatility in opening returns over closing returns and more significant negative autocorrelations in opening returns compared to less significant positive autocorrelations are noted in closing returns. Third, there is evidence of overreaction in opening prices and underreaction in closing prices as shown by autocorrelation pattern in opening and closing returns as well as by speed of adjustment coefficients measured from opening and closing returns. Overall, it can be concluded that there is no significant improvement in market quality over the years, even though there is a marginal decline in autocorrelations in the daily returns over the years.

Table 4.1: Variance ratio of daytime to overnight returns and first order autocorrelations in daily returns for the period 1995- 1999.

Company	Variance ratio	Autocorrelation
ABB	1.638656	0.137 (0)
ACC	0.14613	-0.01 (0.734)
ARVINDMILL	1.664715	0.108 (0)
APOLLOTYRE	2.148044	0.092 (0.001)
ASHOKLEY	1.972514	0.069 (0.016)
ASIANPAINT	0.735734	-0.085 (0.003)
BAJAJAUTO	1.583374	0.001 (0.969)
BHARATFORG	1.424422	0.039 (0.171)
BHEL	2.430035	0.029 (0.322)
BPCL	1.561296	0.03 (0.305)
CIPLA	0.532187	0.054 (0.056)
DRREDDY	2.342187	0.078 (0.006)
GLAXO	0.997569	0.018 (0.523)
GRASIM	2.112997	0.133 (0)
HDFC	0.105335	0.006 (0.829)
HDFCBANK	2.290734	0.037 (0.213)
HEROHONDA	0.869629	0.019 (0.522)
IDBI	2.047365	0.032 (0.29)
IFCI	2.38133	-0.027 (0.349)
INFOSYSTCH	0.008665	0.014 (0.618)
Values in parentheses shows probability value of Q statistic.		

Table 4.1 (continued)

Company	Variance ratio	Autocorrelation
ITC	3.358584	0.031 (0.268)
LICHSGFIN	1.817289	0.032 (0.258)
M&M	1.250417	0.066 (0.02)
MOSERBAER	1.453632	0.163 (0)
NICOLASPIR	1.385191	0.07 (0.019)
NIRMA	0.884097	0.02 (0.492)
PFIZER	1.332816	0.041 (0.151)
PUNJABTRAC	0.75625	0.002 (0.952)
RANBAXY	0.906749	0.098 (0.001)
RAYMOND	1.58528	0.075 (0.009)
RELCAPITAL	2.43697	0.098 (0.001)
RELIANCE	1.216262	0.045 (0.11)
SAIL	2.923536	0.006 (0.815)
SATYAMCOMP	1.1532	0.088 (0.002)
SBIN	3.455777	0.059 (0.038)
SIEMENS	1.752292	0.089 (0.002)
SUNPHARMA	1.963086	0.13 (0)
TATAPOWER	0.130191	0.018 (0.521)
UNITECH	1.122935	-0.055 (0.06)
WIPRO	0.133387	-0.186 (0)
Values in parentheses shows probability value of Q statistic.		

Table 4.2: Variance ratio of daytime to overnight returns and first order autocorrelations in daily returns for the period 2000- 2003.

Company	Variance ratio	Autocorrelation
ABB	1.924649	0.044 (0.166)
ACC	5.929565	0.014 (0.665)
ARVINDMILL	3.403889	0.038 (0.224)
APOLLOTYRE	2.552256	0.084 (0.008)
ASHOKLEY	2.792676	0.053 (0.094)
ASIANPAINT	0.662786	-0.014 (0.658)
BAJAJAUTO	1.862299	0.033 (0.299)
BHARATFORG	2.17316	0.026 (0.411)
BHEL	5.005292	0.013 (0.686)
BPCL	1.387186	0.05 (0.113)
CIPLA	2.120437	0.135 (0)
DRREDDY	1.018007	0.013 (0.674)
GLAXO	2.734397	0.051 (0.104)
GRASIM	3.240809	0.138 (0)
HDFC	0.98372	-0.03 (0.341)
HDFCBANK	2.485031	-0.046 (0.147)
HEROHONDA	0.27206	0.027 (0.392)
IDBI	1.310023	0.087 (0.006)
IFCI	1.594843	0.005 (0.885)
INFOSYSTCH	1.58093	0.087 (0.006)
Values in parentheses shows probability value of Q statistic.		

Table 4.2 (continued)

Company	Variance ratio	Autocorrelation
ITC	3.056068	0.037 (0.239)
LICHSGFIN	2.02897	0.076 (0.015)
M&M	2.976677	0.151 (0)
MOSERBAER	1.425495	0.032 (0.314)
NICOLASPIR	1.475968	0.057 (0.071)
NIRMA	1.615995	0.168 (0)
PFIZER	0.742922	0.019 (0.546)
PUNJABTRAC	0.512179	0.081 (0.011)
RANBAXY	1.427865	0.056 (0.074)
RAYMOND	2.115971	0.051 (0.105)
RELCAPITAL	3.042772	0.188 (0)
RELIANCE	2.889452	0.098 (0.002)
SAIL	3.18848	0.101 (0.003)
SATYAMCOMP	0.587682	0.015 (0.626)
SBIN	4.14754	0.064 (0.041)
SIEMENS	1.879131	0.021 (0.509)
SUNPHARMA	0.465121	0.045 (0.152)
TATAPOWER	3.247193	0.114 (0)
UNITECH	0.961843	-0.045 (0.169)
WIPRO	2.94234	0.142 (0)
Values in parentheses shows probability value of Q statistic.		

Table 4.3: Variance ratio of daytime to overnight returns and first order autocorrelations in daily returns for the period 2004- 2008.

Company	Variance ratio	Autocorrelation
ABB	0.329075	0.001 (0.961)
ACC	2.649248	0.061 (0.032)
ARVINDMILL	0.19864	0.027 (0.332)
APOLLOTYRE	3.702491	0.092 (0.002)
ASHOKLEY	0.203404	-0.007 (0.812)
ASIANPAINT	1.576789	-0.088 (0.002)
BAJAJAUTO	3.131707	0.031 (0.316)
BHARATFORG	0.313541	0.03 (0.287)
BHEL	1.315757	0.058 (0.041)
BPCL	2.844275	0.041 (0.142)
CIPLA	0.223354	0.027 (0.327)
DRREDDY	0.938526	-0.009 (0.762)
GLAXO	2.169552	0.032 (0.255)
GRASIM	3.275947	0.013 (0.646)
HDFC	3.280284	0.042 (0.134)
HDFCBANK	2.405614	-0.005 (0.862)
HEROHONDA	2.426139	-0.001 (0.959)
IDBI	4.356785	0.12 (0)
IFCI	0.265845	0.079 (0.005)
INFOSYSTCH	0.241307	-0.034 (0.232)
Values in parentheses shows probability value of Q statistic.		

Table 4.3 (continued)

Company	Variance ratio	Autocorrelation
ITC	0.09135	0.009 (0.744)
LICHSGFIN	3.853454	0.127 (0)
M&M	1.30079	0.102 (0)
MOSERBAER	2.377081	0.052 (0.066)
NICOLASPIR	0.314491	-0.041 (0.175)
NIRMA	0.946152	0.035 (0.222)
PFIZER	1.552462	0.11 (0)
PUNJABTRAC	1.772529	0.111 (0)
RANBAXY	1.213374	0.037 (0.189)
RAYMOND	1.932939	0.035 (0.21)
RELCAPITAL	4.750834	0.082 (0.004)
RELIANCE	1.610015	0.041 (0.145)
SAIL	4.173713	0.043 (0.131)
SATYAMCOMP	1.232676	-0.006 (0.83)
SBIN	2.615035	0.076 (0.007)
SIEMENS	0.339457	0.049 (0.081)
SUNPHARMA	0.977177	-0.013 (0.651)
TATAPOWER	3.185398	0.058 (0.04)
UNITECH	0.152541	-0.006 (0.838)
WIPRO	0.572242	-0.05 (0.079)
Values in parentheses shows probability value of Q statistic.		

Table 4.4: Variance ratio of open to close returns and first order autocorrelations in opening and closing returns for the period 1995-1999.

Company	Variance ratio	Autocorrelation-Opening returns	Autocorrelation-Closing returns
ABB	1.34869	0.007 (0.798)	0.137 (0)
ACC	1.090793	-0.007 (0.801)	-0.01 (0.734)
ARVINDMILL	1.481031	-0.059 (0.037)	0.108 (0)
APOLLOTYRE	1.493308	-0.033 (0.242)	0.092 (0.001)
ASHOKLEY	1.43802	-0.105 (0)	0.069 (0.016)
ASIANPAINT	1.289692	-0.085 (0.003)	-0.085 (0.003)
BAJAJAUTO	1.224013	-0.046 (0.104)	0.001 (0.969)
BHARATFORG	1.438356	-0.114 (0)	0.039 (0.171)
BHEL	1.182752	-0.046 (0.112)	0.029 (0.322)
BPCL	1.313375	-0.036 (0.215)	0.03 (0.305)
CIPLA	1.134532	-0.011 (0.686)	0.054 (0.056)
DRREDDY	1.328748	-0.012 (0.669)	0.078 (0.006)
GLAXO	1.228557	-0.078 (0.006)	0.018 (0.523)
GRASIM	1.382652	-0.051 (0.073)	0.133 (0)
HDFC	1.070683	-0.028 (0.32)	0.006 (0.829)
HDFCBANK	1.401243	-0.068 (0.021)	0.037 (0.213)
HEROHONDA	1.387941	-0.094 (0.001)	0.019 (0.522)
IDBI	1.248384	-0.048 (0.113)	0.032 (0.29)
IFCI	1.35298	-0.149 (0)	-0.027 (0.349)
INFOSYSTCH	1.214215	-0.05 (0.084)	0.014 (0.618)
Values in parentheses shows probability value of Q statistic.			

Table 4.4 (continued)

Company	Variance ratio	Autocorrelation-Opening returns	Autocorrelation-Closing returns
ITC	1.214172	-0.019 (0.499)	0.031 (0.268)
LICHSGFIN	1.339974	-0.073 (0.011)	0.032 (0.258)
M&M	1.422933	-0.081 (0.004)	0.066 (0.02)
MOSERBAER	1.497217	-0.028 (0.342)	0.163 (0)
NICOLASPIR	1.426273	-0.067 (0.025)	0.07 (0.019)
NIRMA	1.396969	-0.153 (0)	0.02 (0.492)
PFIZER	1.403334	-0.073 (0.011)	0.041 (0.151)
PUNJABTRAC	1.360133	-0.118 (0)	0.002 (0.952)
RANBAXY	1.166748	0.018 (0.517)	0.098 (0.001)
RAYMOND	1.324934	-0.013 (0.65)	0.075 (0.009)
RELCAPITAL	1.421229	-0.04 (0.155)	0.098 (0.001)
RELIANCE	1.154799	-0.032 (0.263)	0.045 (0.11)
SAIL	1.352546	-0.091 (0.001)	0.006 (0.815)
SATYAMCOMP	1.38756	-0.022 (0.449)	0.088 (0.002)
SBIN	1.22561	-0.044 (0.117)	0.059 (0.038)
SIEMENS	1.407188	-0.066 (0.021)	0.089 (0.002)
SUNPHARMA	1.480265	-0.039 (0.173)	0.13 (0)
TATAPOWER	1.04817	0.018 (0.521)	0.018 (0.521)
UNITECH	1.386496	-0.17 (0)	-0.055 (0.06)
WIPRO	1.053014	-0.204 (0)	-0.186 (0)
Values in parentheses shows probability value of Q statistic.			

Table 4.5: Variance ratio of open to close returns and first order autocorrelations in opening and closing returns for the period 2000-2003.

Company	Variance ratio	Autocorrelation-Opening returns	Autocorrelation-Closing returns
ABB	2.305253	-0.261 (0)	0.044 (0.166)
ACC	1.250506	-0.063 (0.045)	0.014 (0.665)
ARVINDMILL	1.488638	-0.089 (0.005)	0.038 (0.224)
APOLLOTYRE	1.62406	-0.134 (0)	0.084 (0.008)
ASHOKLEY	1.335102	-0.091 (0.004)	0.053 (0.094)
ASIANPAINT	1.892659	-0.257 (0)	-0.014 (0.658)
BAJAJAUTO	2.197841	-0.268 (0)	0.033 (0.299)
BHARATFORG	1.710814	-0.176 (0)	0.026 (0.411)
BHEL	1.266051	-0.081 (0.011)	0.013 (0.686)
BPCL	1.211683	-0.018 (0.56)	0.05 (0.113)
CIPLA	1.618042	-0.114 (0)	0.135 (0)
DRREDDY	1.390258	-0.13 (0)	0.013 (0.674)
GLAXO	1.613976	-0.199 (0)	0.051 (0.104)
GRASIM	1.666329	-0.114 (0)	0.138 (0)
HDFC	1.283401	-0.123 (0)	-0.03 (0.341)
HDFCBANK	1.566222	-0.229 (0)	-0.046 (0.147)
HEROHONDA	1.115056	-0.035 (0.265)	0.027 (0.392)
IDBI	1.58147	-0.05 (0.113)	0.087 (0.006)
IFCI	2.482404	-0.318 (0)	0.005 (0.885)
INFOSYSTCH	1.29042	-0.029 (0.354)	0.087 (0.006)
Values in parentheses shows probability value of Q statistic.			

Table 4.5 (continued)

Company	Variance ratio	Autocorrelation-Opening returns	Autocorrelation-Closing returns
ITC	1.547166	-0.175 (0)	0.037 (0.239)
LICHSGFIN	1.820086	-0.184 (0)	0.076 (0.015)
M&M	1.454622	-0.062 (0.05)	0.151 (0)
MOSERBAER	1.453958	-0.175 (0)	0.032 (0.314)
NICOLASPIR	2.390621	-0.255 (0)	0.057 (0.071)
NIRMA	2.2699	-0.239 (0)	0.168 (0)
PFIZER	1.532627	-0.162 (0)	0.019 (0.546)
PUNJABTRAC	1.320152	-0.065 (0.038)	0.081 (0.011)
RANBAXY	1.39314	-0.132 (0)	0.056 (0.074)
RAYMOND	1.991657	-0.195 (0)	0.051 (0.105)
RELCAPITAL	1.480113	0.015 (0.645)	0.188 (0)
RELIANCE	1.87016	-0.182 (0)	0.098 (0.002)
SAIL	1.531434	-0.091 (0.006)	0.101 (0.003)
SATYAMCOMP	1.125874	-0.053 (0.094)	0.015 (0.626)
SBIN	1.319462	-0.099 (0.002)	0.064 (0.041)
SIEMENS	1.897034	-0.226 (0)	0.021 (0.509)
SUNPHARMA	1.272521	-0.053 (0.095)	0.045 (0.152)
TATAPOWER	1.580217	-0.104 (0.001)	0.114 (0)
UNITECH	2.127164	-0.276 (0)	-0.045 (0.169)
WIPRO	1.498309	-0.04 (0.21)	0.142 (0)
Values in parentheses shows probability value of Q statistic.			

Table 4.6: Variance ratio of open to close returns and first order autocorrelations in opening and closing returns for the period 2004-2008.

Company	Variance ratio	Autocorrelation-Opening returns	Autocorrelation-Closing returns
ABB	1.329772	-0.122 (0)	0.001 (0.961)
ACC	1.922848	-0.253 (0)	0.061 (0.032)
ARVINDMILL	1.188709	-0.097 (0.001)	0.027 (0.332)
APOLLOTYRE	1.450915	-0.137 (0)	0.092 (0.002)
ASHOKLEY	1.047005	-0.047 (0.099)	-0.007 (0.812)
ASIANPAINT	2.333155	-0.351 (0)	-0.088 (0.002)
BAJAJAUTO	1.406806	-0.192 (0)	0.031 (0.316)
BHARATFORG	1.204626	-0.096 (0.001)	0.03 (0.287)
BHEL	1.185852	-0.068 (0.017)	0.058 (0.041)
BPCL	1.638962	-0.226 (0)	0.041 (0.142)
CIPLA	1.157035	-0.057 (0.041)	0.027 (0.327)
DRREDDY	1.370912	-0.174 (0)	-0.009 (0.762)
GLAXO	1.869209	-0.266 (0)	0.032 (0.255)
GRASIM	1.399896	-0.193 (0)	0.013 (0.646)
HDFC	1.194627	-0.126 (0)	0.042 (0.134)
HDFCBANK	1.596761	-0.27 (0)	-0.005 (0.862)
HEROHONDA	1.719923	-0.264 (0)	-0.001 (0.959)
IDBI	1.381822	-0.087 (0.002)	0.12 (0)
IFCI	1.325445	-0.108 (0)	0.079 (0.005)
INFOSYSTCH	1.082742	-0.034 (0.232)	-0.034 (0.232)
Values in parentheses shows probability value of Q statistic.			

Table 4.6 (continued)

Company	Variance ratio	Autocorrelation-Opening returns	Autocorrelation-Closing returns
ITC	1.040299	-0.034 (0.232)	0.009 (0.744)
LICHSGFIN	1.36963	-0.083 (0.003)	0.127 (0)
M&M	1.282855	-0.057 (0.043)	0.102 (0)
MOSERBAER	1.450112	-0.136 (0)	0.052 (0.066)
NICOLASPIR	1.154287	-0.071 (0.017)	-0.041 (0.175)
NIRMA	2.295089	-0.245 (0)	0.035 (0.222)
PFIZER	2.391104	-0.262 (0)	0.11 (0)
PUNJABTRAC	1.88563	-0.21 (0)	0.111 (0)
RANBAXY	1.262976	0.037 (0.189)	0.037 (0.189)
RAYMOND	1.972748	-0.279 (0)	0.035 (0.21)
RELCAPITAL	1.224196	-0.09 (0.001)	0.082 (0.004)
RELIANCE	1.673612	-0.203 (0)	0.041 (0.145)
SAIL	1.354249	-0.153 (0)	0.043 (0.131)
SATYAMCOMP	1.286059	-0.138 (0)	-0.006 (0.83)
SBIN	1.589935	-0.176 (0)	0.076 (0.007)
SIEMENS	1.1549	-0.074 (0.009)	0.049 (0.081)
SUNPHARMA	1.628485	-0.262 (0)	-0.013 (0.651)
TATAPOWER	1.419398	-0.136 (0)	0.058 (0.04)
UNITECH	1.06966	-0.035 (0.218)	-0.006 (0.838)
WIPRO	1.181306	-0.109 (0)	-0.05 (0.079)
Values in parentheses shows probability value of Q statistic.			

Table 4.7: Security speed of adjustment coefficients estimated from daily closing and opening returns for first day return differencing interval- 1995- 1999

Company	Opening Returns	Closing Returns	Company	Opening Returns	Closing Returns
ABB	1.763654	0.864143	ITC	1.820968	0.96974
ACC	0.028274	1.011135	LICHSGFIN	1.122494	0.937316
ARVINDMILL	0.910931	0.89323	M&M	0.7261	0.935554
APOLLOTYRE	0.418773	0.886168	MOSERBAER	1.451533	0.838594
ASHOKLEY	0.965532	0.933138	NICOLASPIR	0.575785	0.933372
ASIANPAINT	0.912746	0.994605	NIRMA	0.914906	0.972321
BAJAJAUTO	1.740163	0.994605	PFIZER	0.654369	0.974996
BHARATFORG	1.216604	0.964954	PUNJABTRAC	1.041251	0.997049
BHEL	0.887827	1.031884	RANBAXY	0.413167	0.897515
BPCL	0.113209	0.971256	RAYMOND	1.690262	0.935914
CIPLA	1.623795	0.944753	RELCAPITAL	0.730735	0.905051
DRREDDY	0.651375	0.876616	RELIANCE	0.662949	0.948299
GLAXO	1.631158	0.926253	SAIL	0.590748	0.953609
GRASIM	1.150852	0.868399	SATYAMCOMP	0.171006	0.915177
HDFC	0.954165	1.013658	SBIN	1.357776	0.904186
HDFCBANK	0.859313	0.963556	SIEMENS	1.472589	0.912508
HEROHONDA	1.199021	0.982089	SUNPHARMA	0.24693	0.87326
IDBI	1.106756	0.968444	TATAPOWER	1.453441	0.973997
IFCI	0.901642	0.996174	UNITECH	1.093183	1.00118
INFOSYSTCH	0.522336	0.98683	WIPRO	1.248493	1.186716

Table 4.8: Security speed of adjustment coefficients estimated from daily closing and opening returns for first day return differencing interval- 2000-03.

Company	Opening Returns	Closing Returns	Company	Opening Returns	Closing Returns
ABB	0.956275	0.945915	ITC	1.047675	0.949667
ACC	0.518095	0.989524	LICHSGFIN	0.878415	0.925658
ARVINDMILL	0.680458	0.965122	M&M	0.62442	0.861888
APOLLOTYRE	0.757287	0.920418	MOSERBAER	0.99952	0.967457
ASHOKLEY	0.984413	0.949763	NICOLASPIR	0.897233	0.962722
ASIANPAINT	1.131828	1.014512	NIRMA	1.431529	0.835409
BAJAJAUTO	0.974356	0.971559	PFIZER	0.733355	0.982094
BHARATFORG	0.996942	0.986732	PUNJABTRAC	1.065469	0.920234
BHEL	0.613528	0.990468	RANBAXY	1.437632	0.938232
BPCL	0.51331	0.952029	RAYMOND	0.731301	0.951188
CIPLA	0.907499	0.867421	RELCAPITAL	1.588094	0.812734
DRREDDY	0.51012	0.984796	RELIANCE	1.055541	0.906302
GLAXO	1.361832	0.956004	SAIL	0.763583	0.972656
GRASIM	1.040366	0.865113	SATYAMCOMP	1.195075	0.984582
HDFC	0.504117	1.029675	SBIN	0.827131	0.931757
HDFCBANK	0.966348	1.043902	SIEMENS	1.073254	1.000623
HEROHONDA	1.604082	0.974004	SUNPHARMA	1.460851	0.944275
IDBI	0.578376	0.912124	TATAPOWER	0.819139	0.887042
IFCI	1.212025	1.01951	UNITECH	0.869102	1.045535
INFOSYSTCH	1.600895	0.91063	WIPRO	0.937366	0.857255

Table 4.9: Security speed of adjustment coefficients estimated from daily closing and opening returns for first day return differencing interval- 2004-08.

Company	Opening Returns	Closing Returns	Company	Opening Returns	Closing Returns
ABB	0.927619	0.969172	ITC	0.816291	0.965752
ACC	1.051303	0.96208	LICHSGFIN	0.478109	0.910691
ARVINDMILL	1.411499	0.979153	M&M	1.741886	0.967396
APOLLOTYRE	0.945397	0.910189	MOSERBAER	0.802479	0.966751
ASHOKLEY	0.748947	1.018892	NICOLASPIR	0.586761	1.012755
ASIANPAINT	1.030277	1.140424	NIRMA	0.849092	0.938851
BAJAJAUTO	1.131515	0.982635	PFIZER	0.966778	0.819854
BHARATFORG	1.19071	0.93158	PUNJABTRAC	0.988386	0.932241
BHEL	0.509796	0.901978	RANBAXY	0.91172	0.977962
BPCL	1.082563	0.986672	RAYMOND	1.05116	0.963702
CIPLA	1.402325	0.938968	RELCAPITAL	0.86929	0.940593
DRREDDY	1.051247	1.002087	RELIANCE	0.849075	1.037895
GLAXO	0.948919	0.941718	SAIL	0.811215	0.975924
GRASIM	1.066396	1.016073	SATYAMCOMP	0.66779	0.956437
HDFC	0.334985	1.003489	SBIN	0.805899	0.930876
HDFCBANK	1.054892	0.781085	SIEMENS	1.218122	0.956638
HEROHONDA	0.772461	1.026542	SUNPHARMA	1.142098	0.999736
IDBI	0.667968	0.817219	TATAPOWER	0.530416	0.929971
IFCI	1.083739	0.912301	UNITECH	0.430825	0.994219
INFOSYSTCH	0.373366	0.990773	WIPRO	0.720265	1.040288

Chapter – 5

Market Microstructure and Market Liquidity

5.1 Introduction

Liquidity in the context of financial markets means how easy it is to buy and sell a financial instrument without causing any significant change in its price. In other words, it is the ability to trade large size quickly, at low cost whenever one wants to trade. Liquidity can be understood in three dimensions. First, immediacy which refers to how quickly trades of a given size and cost can be arranged. Second, width which refers to the cost of trading. Third, depth which refers to the size of trade that can be arranged.

Liquidity is important to all market participants. Traders need liquidity because it reduces the cost of implementing their trading strategies. Liquidity is important for exchanges because it helps in attracting traders from other markets. Regulators also want liquidity because it leads to smooth functioning of the markets. Normally dealers, limit order traders offer liquidity and traders who demand immediacy take liquidity. In this study bid- ask spreads has been used as a measure of liquidity.

5.2 Bid- Ask Spreads

Different approaches have been used in the literature to measure liquidity. One important and most extensively used measure of liquidity in market microstructure research is bid-

ask spreads. Bid- ask spreads on a security represents the difference between the best available quote to sell the security and the best available quote to buy the same security. The impatient traders buy at the ask price and sell at the bid price. Thus, the size of bid-ask spread is a measure of the liquidity of the market. The trader initiating the transaction represents the demand side of liquidity and the counterparty of the transaction represents the supply side of liquidity. Traders who place market orders are demanders of liquidity whereas traders who place limit orders are suppliers of liquidity. The spread is the compensation dealers and limit order traders receive for offering liquidity.

The spreads is an important factor for both traders as well as dealers. Traders order submitting strategy depends on bid- ask spreads. When spread is wide limit order trading strategy is attractive whereas when spread is narrow market order submitting strategy becomes attractive. Dealers also consider bid- ask spreads to decide to offer liquidity or not. When spread is narrow dealing may not be profitable and dealers may quit trading whereas wider spreads may attract the dealers to enter the market since dealing becomes profitable. The bid- ask spread for a security can change overtime depending on the order flows for the security and the arrival of the information about the security in the market.

5.2.1 Bid- Ask Spreads in an Order Driven Market

In an order driven market traders use orders to convey their bids and ask or offer to either brokers or automated trading system. The highest bid price is the best bid and lowest ask or offer is the best ask price. The bid- ask spread is the difference between best ask and best bid and it is called as inside spread. Both buyers and sellers can offer liquidity to the

market and take liquidity from market. Buyers offer liquidity when their bid gives chances for others to sell and sellers offer liquidity when their offers give chances for others to buy. In other words, traders who submit limit orders offer liquidity and those who submit market orders take liquidity.

5.2.2 Components of Bid- Ask Spreads

For the purpose of analysis bid- ask spreads can be divided into two components; transaction cost spread component and adverse selection spread component. The transaction cost spread component is the compensation dealers receive for covering normal costs of doing business. If all traders know instrument values exactly, transaction cost component constitutes the entire spread. Transaction cost spread component is also called as transitory spread component because price changes associated with this component regularly reverse.

When there is information asymmetry dealers widen the spreads to cover the loss they would incur while trading with informed traders. This widening of the spread over transaction cost is called adverse selection spread component. By widening spreads dealers recover from uninformed traders what they lose to informed traders. Adverse selection spread component is called permanent spread component since they do not systematically reverse.

5.3 Theoretical Background

Demsetz (1968) analyzed bid- ask spreads as a transaction cost incurred by traders for immediacy. After this study two broad categories of theories of bid- ask spreads have been developed in the finance literature viz. information based models and inventory based models. Information based models have been developed by Bagehot (1971), Copeland and Galai (1983), Easly and O'Hara (1987), and Glosten and Milgrom (1985). They argued that bid- ask spreads arises because of information asymmetry between market makers and informed traders or because of the presence of traders who have superior information. The informed traders buy when they know that current stock price is too low and sell when they know that it is too high. Informed traders have the option of not to trade also but market traders do not have that option. The loss faced by the market makers while trading with informed traders is offset by the gain made by trading with liquidity traders who do not have any superior information. Based on this framework these models suggest that there may be higher spreads for high priced stocks and for highly volatile stocks.

The second class of models is called as inventory based models developed by Garman (1976), Stoll (1978), Ho and Stoll (1981, 1983), and Berkman (1992). Market maker faces the complex problem of balancing the random deviations in outflows and inflows. This class of models argues that bid- ask spreads is the cost incurred by dealers in maintaining a required level of inventory to face the uncertain order flow. Ho and Stoll (1983) divided the risk of market makers into two categories: uncertainty of return on

inventory and uncertainty of new orders. Based on this inventory models it is argued that bid- ask spreads will be positively related to return variance, price of the asset and negatively related to the level of trading activity.

5.4 Methodology

The analysis of liquidity effects of market reforms is based on bid- ask spreads. To analyze the trends in spreads over the years and its response to various market microstructure changes the study has adopted a log linear regression model which is similar to the specification in Stoll (1978), and Jegadeesh and Subrahmanyam (1993). In this model bid- ask spreads is the dependent variable and determinants of spreads and dummy variables are independent variables to capture the effects of market microstructure changes for each year. Earlier studies like Benston and Hagerman (1974), and Stoll (1978) have shown that changes in bid- ask spreads to a large extent are explained by changes in variables such as price level, trading volume and volatility. After controlling for these variables, there is a good reason to attribute residual changes in spreads to changes in market microstructure and that is captured through dummy variables. The variables included in the model are defined as follows:

Proportionate Spread

Proportionate spread is the dependent variable in the model. It is also called as average daily quoted spread, which is measured as:

$$Proportionate\ Spread = \frac{Ask\ Price - Bid\ Price}{Midpoint\ of\ Bid\ and\ Ask\ Price}$$

Price Level

Daily closing prices have been taken to represent the price level. It is an independent variable in the model. Negative relationship is expected between proportionate spread and price level. Since proportionate spread is estimated as quoted spreads divided by midpoint of prices, higher the price means lower will be the proportionate spread.

Volume

Daily traded quantity is taken as volume which is another independent variable in the model. There is no unanimous opinion in the existing literature regarding the relationship between quoted spreads and volume. Easley and O'Hara (1992) predicted a positive relationship between volume and spreads saying that market maker uses abnormal trading volume to infer the presence of informed traders. Contrary to this Harris and Raviv (1993) suggested a negative relation between volume and spreads pointing that volume shocks show lack of consensus among market participants and as a result increased volume results in increased liquidity trading.

Variance

Daily return variance is yet another independent variable in the model. It is estimated from intraday data. Return is estimated as log first difference from intraday prices and

variance of this return is used as proxy for volatility in this model. Positive relation is expected between variance and spreads, i.e. higher the variance larger the spreads or deterioration in liquidity.

Dummy Variables

Finally, to assess the trends in bid- ask spreads after accounting for its determinants, the study has included a dummy variable for each year except for first year i.e. 1999. First year is not included to avoid the case of perfect multicollinearity. For rest of the years i.e. from 2000 to 2005, each year is assigned a dummy variable which takes the value of one for that year and zero for rest of the period. Sign and significance of dummy variable coefficients are of primary concern here. Significant and negative sign indicates improvement in liquidity over the years after controlling for the effects of variables which are regarded as the primary determinants of spreads.

The specification of the model is as follows:

$$LNSPRD_{it}=a_0+a_1 LNPRC_{it}+a_2 LNVOL_{it}+a_3 LNVAR_{it}+a_4 D2000_t+a_5 D2001_t+a_6 D2002_t +a_7 D2003_t+a_8 D2004_t+a_9 D2005_t+e_{it},$$

i= 1,……,N and t=1, ….7.

In the above specification $LNSPRD_{it}$ is the natural logarithm of the average quoted proportionate spread, $LNPRC_{it}$ is the natural logarithm of the daily closing prices, $LNVOL_{it}$ is the natural logarithm of the daily trading volume, and $LNVAR_{it}$ is the natural

logarithm of the daily return variance estimated from intraday prices for security i and period t. The number of stocks in the regression is denoted as N and t= 1,…,7 denotes period from 1999 to 2005, total 7 years. Coefficients from a_4 to a_9 are associated with dummy variables which are assigned the value of one for that year or zero otherwise and year 1999 is the base period of comparison. The primary interest in this regression specification is the coefficients of dummy variables which indicate how spreads changed over the years after accounting for other determinants of spreads. Heteroscedasticity and autocorrelation consistent standard errors have been estimated to take care of possible violation of assumptions of linear regression.

5.5 Empirical Results

From tables 5.1 to 5.7 summary statistics i.e. mean values of proportionate spreads, depths, standard deviation, price level, and traded quantity are given. Mean value of proportionate spreads does not show any clear cut pattern in terms of continuous improvement or deterioration. There are no significant changes in the values of spreads. Depth has increased over the years for most of the stocks. Mean value of daily standard deviation do not show any clear cut pattern of increment or decline. Daily traded quantity also has increased for good number of companies. Table 5.8 shows the results of log linear regression model. In this model, three determinants of spreads have been considered viz. price, variance and volume. The relationship between proportionate spreads and price is expected to be negative. Out of 40 companies covered in this study, 29 companies have a significant negative relationship between proportionate spreads and

price of the share at 5% level of significance. For 11 companies viz. Ashock Lelyand, Asian Paints, Bajaj Auto, HDFC, IFCI, LIC Housing Finance, Nirma, Pfizer, Ranbaxy, Unitech, and Wipro the relationship is insignificant. No company is having significant positive relationship between proportionate spreads and price.

With reference to variance and spreads, the relationship is expected to be positive. In this study all companies have a significant positive relationship between proportionate spreads and daily variance.

The relationship between volume and proportionate spreads is expected to be both positive and negative. [Positive according to Easley and O'Hara (1992) and negative according to Harris and Raviv (1993)]. In this study the empirical results are mixed. Total six companies viz. Arvind Mill, Asian Paints, Infosys, ITC, Sail, Satyam Computer have shown a positive and significant relationship between proportionate spreads and volume. A group of seven companies' viz. ACC, Apollo Tyres, Ashock Lelyand, Bforge, Reliance Capital, TATA Power, and Unitech, has shown a significant negative relationship between these two variables. In case of 27 companies the relationship between volume and proportionate spreads is insignificant.

The main issue of interest in this analysis is the trends in bid- ask spreads over the years after controlling for its determinants. Out of the 40 companies covered in this study, only five companies viz. ACC, Cipla, Infosys, Nirma, and Satyam Computer have recorded a continuous improvement in liquidity over the years during the study period as measured by bid ask spreads. Nearly 11 companies viz. DrReddys, Glaxo, Grasim, ITC, Moserbaer,

Pfizer, Punjab Tractor, Reliance Capital, SBI, Siemens, and Sun Pharma have recorded a deterioration in liquidity as shown by the bid- ask spreads. Another set of 10 companies viz. ABB, Asian Paints, BHEL, Hero Honda, IDBI, M&M, Raymond, Sail, TATA Power, and Unitech shows mixed results. During the study period there is improvement in liquidity for some years and deterioration for some other years. For rest of 14 companies which are considered in this study the coefficients of dummy variables are statistically insignificant at 5% level of significance.

5.6 Conclusion

The study has examined the liquidity effects of market microstructure changes in NSE. It has been investigated by using bid- ask spreads as a measure of liquidity. From the analysis of bid- ask spreads, the following broad conclusion emerges from this study. First, it becomes quite clear that market microstructure changes did not result in significant improvement in liquidity. For majority of the stocks the coefficient of dummy variables are either insignificant or presents mixed results, which do not give a clear picture regarding the trends in bid- ask spreads. Second, among 16 companies which have significant coefficients of dummy variables only five companies have shown an improvement in liquidity as against 11 companies showing deterioration in it. For a majority of 24 stocks, variation in bid- ask spreads has been explained largely by the determinants of bid- ask spreads included in the model.

Table 5.1: Mean value of spreads, depths, standard deviation, price level, and traded quantity for the year 1999.

Company	Spread	Depth	Standard Deviation	Price Level	Traded quantity
ABB	0.05145	4160.744	0.001209	411.1793	30970.44
ACC	0.055379	31904.17	0.00032	607.7431	1820655
ARVINDMILL	0.066788	23106.15	0.001072	109.6799	359142.3
APOLLOTYRE	0.084302	67249	0.041928	32.41555	329695
ASHOKLEY	0.078365	59555.81	0.00094	82.99646	279626.8
ASIANPAINT	0.059695	22676.47	0.001645	318.2571	15341.52
BAJAJAUTO	0.04937	32680.12	0.000625	501.8037	166650.1
BHARATFORG	0.092201	32949.74	0.003539	138.526	40596.5
BHEL	0.049953	91567.73	0.000504	249.6528	480565.7
BPCL	0.060826	14628.04	0.00132	258.1937	103589.1
CIPLA	0.061693	9258.154	0.001656	1782.663	24028.16
DRREDDY	0.047392	37996.55	0.000509	960.4219	116693.7
GLAXO	0.044697	40302.37	0.000451	742.7768	140145.1
GRASIM	0.060104	16402.24	0.001085	287.1675	198606.8
HDFC	0.056642	1946.192	0.001097	1520.732	113472.1
HDFCBANK	0.070146	40631.45	0.001157	83.58583	178009.6
HEROHONDA	0.055382	12783.13	0.001101	1023.815	15549.3
IDBI	0.066429	44587.17	0.434302	35.12756	184948.9
IFCI	0.095463	83016.47	0.504473	12.89154	173610.7
INFOSYSTCH	0.046576	22423.41	0.000564	5221.001	95034.85

Table 5.1 (Continued).

Company	Spread	Depth	Standard Deviation	Price Level	Traded quantity
ITC	0.032906	236811.6	0.000147	902.552	1575752
LICHSGFIN	0.07115	46078.9	0.015184	38.72854	133359.2
M&M	0.059878	19020.33	0.001269	302.4069	121948.3
MOSERBAER	0.066379	58176	0.001912	123.0449	280276.1
NICOLASPIR	0.061012	3900.667	0.103275	432.8988	16092.72
NIRMA	0.115128	4233.154	0.160202	466.0482	5463.78
PFIZER	0.05189	4661.423	0.001131	1053.114	15963.88
PUNJABTRAC	0.042627	6366.551	0.001536	1193.768	12597.83
RANBAXY	0.06304	53216.65	0.000659	749.4085	1690501
RAYMOND	0.072457	161421.4	0.021539	80.24626	743885.1
RELCAPITAL	0.066782	27633.22	0.00125	51.60138	263024.9
RELIANCE	0.046723	751885.9	0.00429	177.7451	8599486
SAIL	0.170201	538555.6	0.00191	8.04311	1859907
SATYAMCOMP	0.036908	207197.7	0.000186	1320.747	2527845
SBIN	0.044831	391726.2	0.000204	218.7764	5384414
SIEMENS	0.065619	15962.38	0.001071	302.1315	160112.1
SUNPHARMA	0.056564	8908.551	0.001784	730.5213	33889.5
TATAPOWER	0.060947	21946.4	0.001073	78.76535	107050.7
UNITECH	0.077979	4101.513	0.007352	44.71634	4044.488
WIPRO	0.056817	1916.513	0.001925	3318.276	17304.51

Table 5.2: Mean value of spreads, depths, standard deviation, price level, and traded quantity for the year 2000.

Company	Spread	Depth	Standard Deviation	Price Level	Traded quantity
ABB	0.058845	17770.33	0.001201	225.5248	30279.38
ACC	0.058923	338368.5	0.000453	135.8438	2838868
ARVINDMILL	0.065154	20993.54	0.004618	107.7738	104222.5
APOLLOTYRE	0.1451	74859.13	0.00246	13.057	152568
ASHOKLEY	0.073394	47485.94	0.001486	64.258	115388.2
ASIANPAINT	0.04763	4464.333	0.001566	344.8824	14190.11
BAJAJAUTO	0.043057	18711.38	0.001119	335.183	102993.7
BHARATFORG	0.064016	4229.487	0.003139	158.5114	10383.38
BHEL	0.064882	138857.2	0.00051	134.6876	782667.4
BPCL	0.065149	28333.35	0.001198	221.4974	84782.48
CIPLA	0.064327	16678.76	0.000982	938.104	88785.24
DRREDDY	0.060577	19628.41	0.000709	1360.006	93749.89
GLAXO	0.060602	20903	0.000849	467.4204	59165.98
GRASIM	0.062278	29766.05	0.000767	285.9262	196322.3
HDFC	0.061884	34828.19	0.000634	459.2474	218538.6
HDFCBANK	0.058272	43392.29	0.0008	236.4084	153435.8
HEROHONDA	0.052661	5168.538	0.001658	938.1254	12704.84
IDBI	0.06497	68386.26	0.109451	38.7664	220546.3
IFCI	0.170379	91227.09	0.826271	7.4804	106895.5
INFOSYSTCH	0.044967	44379.58	0.000268	8337.181	457647.6

Table 5.2 (Continued).

Company	Spread	Depth	Standard Deviation	Price Level	Traded quantity
ITC	0.046524	120911.7	0.00033	760.8212	865460.4
LICHSGFIN	0.06737	37375.03	0.001886	29.1066	54626.15
M&M	0.062044	66268.65	0.000632	265.5648	253721.9
MOSERBAER	0.073143	85002.87	0.000649	349.2324	395111
NICOLASPIR	0.054401	2846.09	0.002295	448.5978	9222.864
NIRMA	0.055947	5699.654	0.001615	918.944	34428.88
PFIZER	0.059525	4593.256	0.003247	752.8474	10858.12
PUNJABTRAC	0.059437	18789.23	0.00069	513.88	30739.04
RANBAXY	0.055706	85984.01	0.000437	700.5136	703348.1
RAYMOND	0.065028	99016.51	0.03486	84.0846	499272.9
RELCAPITAL	0.067769	203448.8	0.000513	121.4868	1285700
RELIANCE	0.035573	716047.2	0.000171	325.4982	6982792
SAIL	0.130017	683846	0.001919	7.2722	1119250
SATYAMCOMP	0.055967	139426.2	0.000222	2249.792	7175575
SBIN	0.044676	247349.1	0.000283	204.5334	1780729
SIEMENS	0.061888	12111.03	0.001247	334.209	53348.2
SUNPHARMA	0.072835	14627.17	0.001365	814.616	46497.28
TATAPOWER	0.070096	39294.76	0.001348	73.6306	100733.4
UNITECH	0.081043	3067.218	0.007669	39.33091	1995.813
WIPRO	0.061458	39232.19	0.000552	3378.679	336791.5

Table 5.3: Mean value of spreads, depths, standard deviation, price level, and traded quantity for the year 2001.

Company	Spread	Depth	Standard Deviation	Price Level	Traded quantity
ABB	0.055421	47089.83	0.001328	238.281	37791.7
ACC	0.045961	911513.2	0.000215	146.206	2881748
ARVINDMILL	0.068962	112128.3	0.000845	59.67843	66814.51
APOLLOTYRE	0.151316	203068.1	0.108197	9.082056	171640.1
ASHOKLEY	0.077065	188796.8	0.000951	60.14133	152485.2
ASIANPAINT	0.052427	14679.6	0.001825	261.3355	17931.47
BAJAJAUTO	0.061239	62573.04	0.000596	282.1841	118363.5
BHARATFORG	0.072886	41957.3	0.001413	73.63024	25913.07
BHEL	0.062575	438714.1	0.000334	153.4577	756510.2
BPCL	0.073602	114457.2	0.000589	178.2629	217344.8
CIPLA	0.053106	38487.46	0.000487	1098.452	99718.8
DRREDDY	0.042018	31267.2	0.000361	1358.146	231662.4
GLAXO	0.054395	36297.61	0.000574	345.0524	51789.35
GRASIM	0.053771	152076.5	0.00034	296.7694	360091.5
HDFC	0.0575	42810.15	0.000608	632.5508	76193.94
HDFCBANK	0.056192	73222.63	0.000504	230.3502	115464.3
HEROHONDA	0.05483	17351.57	0.000971	312.5379	118653.4
IDBI	0.068918	322113.2	0.097305	24.8371	166681.8
IFCI	0.228388	309053.4	0.547322	4.519355	108698.4
INFOSYSTCH	0.04204	75471.19	0.000144	4083.822	630227.5

Table 5.3 (Continued).

Company	Spread	Depth	Standard Deviation	Price Level	Traded quantity
ITC	0.037617	200501.9	0.000168	757.8946	635739.9
LICHSGFIN	0.072844	119623.1	0.001251	36.47359	63896.69
M&M	0.06218	277530.1	0.00035	105.1663	400526.8
MOSERBAER	0.068495	82020.68	0.000626	252.422	166935.7
NICOLASPIR	0.052005	7489.429	0.001474	275.2899	5708.008
NIRMA	0.060025	18096.77	0.001459	423.7889	17981.13
PFIZER	0.050444	16013.61	0.001037	488.9265	6887.968
PUNJABTRAC	0.059514	46739.52	0.000956	178.0661	33498.19
RANBAXY	0.046681	129877.7	0.000251	599.419	781581.9
RAYMOND	0.059298	328264.8	0.008581	100.679	182205.6
RELCAPITAL	0.064565	514023	0.000303	60.74355	636662.4
RELIANCE	0.036044	755853	0.000147	335.3052	3910779
SAIL	0.212523	3140126	0.00242	5.610081	972724.3
SATYAMCOMP	0.051574	1243095	0.00013	222.5079	12246947
SBIN	0.049822	472561.6	0.000245	209.5569	980145
SIEMENS	0.051822	51669.63	0.000645	221.0544	32836.71
SUNPHARMA	0.055515	25408.19	0.000775	562.831	24572.44
TATAPOWER	0.071925	266294	0.000543	122.223	510115.8
UNITECH	0.079068	2819.583	0.007836	37.77847	2370.947
WIPRO	0.048321	88182.3	0.000299	1635.124	1058141

Table 5.4: Mean value of spreads, depths, standard deviation, price level, and traded quantity for the year 2002.

Company	Spread	Depth	Standard Deviation	Price Level	Traded quantity
ABB	0.063407	23423.52	0.000934	255.7618	27861.46
ACC	0.051605	236029.5	0.000271	152.5384	818773.5
ARVINDMILL	0.09569	20565.52	0.001722	100.4671	187734.7
APOLLOTYRE	0.129299	276494.8	0.001568	18.71494	542963.6
ASHOKLEY	0.09154	70408.1	0.000909	92.95299	157164.2
ASIANPAINT	0.056808	9368.915	0.002015	320.2263	15878.18
BAJAJAUTO	0.05528	26846.61	0.000496	459.9295	96650.06
BHARATFORG	0.107682	20162.67	0.001952	148.8016	52340.46
BHEL	0.059293	139183	0.000425	167.3309	556372
BPCL	0.060896	97671.82	0.000736	253.7791	1555688
CIPLA	0.046291	16679.43	0.000588	982.4412	40992.35
DRREDDY	0.049496	39853.57	0.000244	917.6388	162411.9
GLAXO	0.057118	20251.61	0.000562	356.9371	30512.82
GRASIM	0.049939	42634.17	0.000495	305.0122	96717.33
HDFC	0.05206	31811.23	0.000581	620.4151	59526.01
HDFCBANK	0.05956	41577.45	0.000709	216.7582	84569.94
HEROHONDA	0.058682	43368.21	0.000583	304.3813	254021.7
IDBI	0.108596	128903.3	0.001633	18.11474	292978.6
IFCI	0.154221	176987.4	0.70671	4.587251	403930.2
INFOSYSTCH	0.047077	48720.46	0.000169	3754.146	634681.3

Table 5.4 (Continued).

Company	Spread	Depth	Standard Deviation	Price Level	Traded quantity
ITC	0.041894	47587.38	0.00022	666.3189	302715.3
LICHSGFIN	0.09415	112842.4	0.001235	68.97092	102340.4
M&M	0.071836	100077.3	0.000463	102.1853	544046.8
MOSERBAER	0.08616	35920.93	0.000613	246.2779	114595.7
NICOLASPIR	0.064474	6193.549	0.001137	246.4108	7376.124
NIRMA	0.07643	4182.939	0.00234	251.2476	4567.12
PFIZER	0.070272	4385.793	0.00164	440.9827	4916.956
PUNJABTRAC	0.069779	16048.55	0.001501	149.0209	105019.9
RANBAXY	0.04296	67698.76	0.000205	772.11	363206.5
RAYMOND	0.09169	16442.59	0.001709	102.6504	20225.43
RELCAPITAL	0.089758	116741.2	0.000724	51.78825	191378.4
RELIANCE	0.040424	288816.5	0.000179	279.1285	3265388
SAIL	0.115106	762828.3	0.002548	7.352789	3232685
SATYAMCOMP	0.053742	1002424	0.000135	249.2962	14914166
SBIN	0.052331	189089.8	0.000313	234.8902	781256.3
SIEMENS	0.074732	14724.6	0.001547	275.8876	20772.35
SUNPHARMA	0.055687	8551.256	0.000782	592.5201	12791.39
TATAPOWER	0.06503	82248.5	0.000529	112.802	283508.2
UNITECH	0.091205	10582.55	0.006044	49.5242	2444.232
WIPRO	0.054628	65722.16	0.000178	1507.825	606035

Table 5.5: Mean value of spreads, depths, standard deviation, price level, and traded quantity for the year 2003.

Company	Spread	Depth	Standard Deviation	Price Level	Traded quantity
ABB	0.068225	16019.92	0.001407	401.0965	39040.7
ACC	0.05153	102625.9	0.000167	177.3589	2004486
ARVINDMILL	0.075631	24977.02	0.000533	168.0191	224288.6
APOLLOTYRE	0.088927	235644.9	0.00059	38.15256	1974109
ASHOKLEY	0.077906	31722.14	0.006323	150.4264	245121.4
ASIANPAINT	0.083293	5803.488	0.002341	338.2819	24002.06
BAJAJAUTO	0.035377	21875.64	0.000506	660.4356	156304.8
BHARATFORG	0.058129	16819.35	0.000657	394.9057	61735.94
BHEL	0.046524	75521.56	0.000435	303.9805	708919.6
BPCL	0.053554	179200	0.000107	284.8884	1382750
CIPLA	0.048832	9285.714	0.000283	896.7504	101079.4
DRREDDY	0.038554	20887.75	0.000141	1055.194	194963
GLAXO	0.059912	14892.55	0.00056	390.5246	48563.09
GRASIM	0.043361	22002.49	0.000532	538.0191	287617.8
HDFC	0.051843	21423.11	0.000758	435.4594	204292.9
HDFCBANK	0.059027	46687.02	0.000513	270.0425	232245
HEROHONDA	0.054298	75706.83	0.000253	273.6541	649841.9
IDBI	0.094128	141750.5	0.025897	34.89921	1454576
IFCI	0.175612	352204.4	0.581952	9.774606	3993791
INFOSYSTCH	0.027921	41518.1	6.18E-05	4011.872	756297.9

Table 5.5 (Continued).

Company	Spread	Depth	Standard Deviation	Price Level	Traded quantity
ITC	0.036927	34148.33	0.000132	754.4844	326430.7
LICHSGFIN	0.078773	32173.58	0.000912	119.5248	310088.5
M&M	0.067082	96576.82	0.000286	189.4236	1090816
MOSERBAER	0.060784	92509.26	0.00025	308.4004	380061.7
NICOLASPIR	0.086883	7598.94	0.001366	358.7457	47733.09
NIRMA	0.071468	3620.5	0.002409	310.837	20639.45
PFIZER	0.061082	5574.94	0.000925	394.6506	36218.35
PUNJABTRAC	0.061294	24923.49	0.000521	166.8552	90569.83
RANBAXY	0.034436	43483.5	0.000118	808.7616	635070.7
RAYMOND	0.09764	10708.62	0.001251	126.0896	162233.8
RELCAPITAL	0.077962	101556.2	0.000408	70.93976	1262541
RELIANCE	0.036006	298211.4	6.15E-05	360.7604	5230559
SAIL	0.101538	1187670	0.000965	24.08031	24750619
SATYAMCOMP	0.035186	720455.7	6.21E-05	233.4407	13770036
SBIN	0.033917	226228.4	9.70E-05	378.9185	3446499
SIEMENS	0.083231	8972.095	0.001074	436.5486	23987.16
SUNPHARMA	0.079713	11016.29	0.00338	410.4768	44279.73
TATAPOWER	0.059426	124100.6	0.000352	166.3563	1033009
UNITECH	0.093429	2602.464	0.008403	55.38068	5236.574
WIPRO	0.042226	40280.92	9.87E-05	1215.694	606021.9

Table 5.6: Mean value of spreads, depths, standard deviation, price level, and traded quantity for the year 2004.

Company	Spread	Depth	Standard Deviation	Price Level	Traded quantity
ABB	0.07804	9203.438	0.00127	751.1575	26942.14
ACC	0.050948	211758.6	0.000128	264.3955	2343014
ARVINDMILL	0.080492	16343.03	0.000663	218.9035	86974
APOLLOTYRE	0.087356	216530.6	0.000355	71.29843	2873468
ASHOKLEY	0.068439	64202.64	0.00261	131.6063	1990300
ASIANPAINT	0.074351	16093.33	0.001203	311.1195	31203.41
BAJAJAUTO	0.061531	19923.25	0.00061	945.9368	158853.4
BHARATFORG	0.076873	14851.83	0.000753	772.1831	30094.67
BHEL	0.04674	47448.8	0.000519	577.6961	714445.8
BPCL	0.055326	65282.51	0.000254	402.513	892719.5
CIPLA	0.063345	10056.86	0.000465	603.8217	360526.1
DRREDDY	0.050038	18624.33	0.000401	897.1927	224817.2
GLAXO	0.074582	13582.16	0.000741	638.6549	39389.31
GRASIM	0.05169	19101.25	0.000463	1105.909	284840.6
HDFC	0.067073	31392.68	0.000485	630.8409	315391.2
HDFCBANK	0.069537	54584.08	0.000408	392.7356	324912.4
HEROHONDA	0.104761	68329.36	0.000273	469.1512	765040.1
IDBI	0.086414	390791.1	0.000399	69.23445	3090044
IFCI	0.11747	2036497	0.000554	10.65591	5360352
INFOSYSTCH	0.040865	26850.2	0.000107	3478.24	866789.6

Table 5.6 (Continued).

Company	Spread	Depth	Standard Deviation	Price Level	Traded quantity
ITC	0.045995	31746.24	0.000275	1070.021	334057.3
LICHSGFIN	0.072351	38472.63	0.000633	168.2797	153574.5
M&M	0.044485	87950.96	0.000307	455.4815	1622518
MOSERBAER	0.085636	62083.7	0.000593	242.9974	314196.8
NICOLASPIR	0.08186	8173.1	0.029161	848.6654	29846.06
NIRMA	0.102787	11731.93	0.000877	326.8876	10246.76
PFIZER	0.084607	9899.913	0.001497	488.847	26412
PUNJABTRAC	0.101555	13305.89	NA	201.739	56174.94
RANBAXY	0.047782	50316.95	0.000198	1030.234	485749.9
RAYMOND	0.085517	32622.39	0.000852	219.7939	87741.15
RELCAPITAL	0.066885	259021.1	0.000226	135.3789	1248095
RELIANCE	0.036735	343368.7	8.79E-05	513.2173	6820176
SAIL	0.078036	2368896	0.000231	41.35039	28284044
SATYAMCOMP	0.043535	504179.7	7.38E-05	345.4287	7565506
SBIN	0.037974	198076.6	8.21E-05	530.0892	4171308
SIEMENS	0.092228	8078.688	0.001133	1027.551	14904.25
SUNPHARMA	0.066919	15564.83	0.000767	518.4669	104661.5
TATAPOWER	0.053531	137100.5	0.000189	324.762	2010912
UNITECH	0.114009	13281.48	0.003296	143.4732	20728.83
WIPRO	0.043827	27919.19	0.000229	1061.258	742738.4

Table 5.7: Mean value of spreads, depths, standard deviation, price level, and traded quantity for the year 2005.

Company	Spread	Depth	Standard Deviation	Price Level	Traded quantity
ABB	0.059271	9539.192	0.001043	1453.257	39452.3
ACC	0.03299	166552.1	0.00014	420.7944	982750.7
ARVINDMILL	0.060595	16299.56	0.000797	273.5618	74684.65
APOLLOTYRE	0.064368	254440.3	0.00033	123.9849	1882017
ASHOKLEY	0.095605	1282921	0.000639	26.11394	4435660
ASIANPAINT	0.066786	11139.09	0.000898	432.9988	34996.69
BAJAJAUTO	0.039874	15069.81	0.000476	1407.472	149770.7
BHARATFORG	0.069517	8150.346	0.00094	897.907	238388.7
BHEL	0.03662	32060.03	0.000356	988.2958	274358.6
BPCL	0.044453	49447.76	0.000317	392.6865	444730.2
CIPLA	0.06043	79382.32	0.000252	322.456	643710.2
DRREDDY	0.054552	20276.86	0.000354	788.3209	187342.5
GLAXO	0.06501	13356.99	0.00278	832.0685	52751.84
GRASIM	0.03063	13180.49	0.000335	1246.017	145977.8
HDFC	0.046203	39512.73	0.000379	884.6255	374797.7
HDFCBANK	0.049102	35093.58	0.000339	612.1297	382321.6
HEROHONDA	0.046441	44865.67	0.00045	633.9305	319817.6
IDBI	0.07243	322576.9	0.000409	101.7677	2996268
IFCI	0.114134	3164696	0.000568	14.06514	11266923
INFOSYSTCH	0.037492	85306.68	0.000284	2328.25	957741.5

Table 5.7 (Continued).

Company	Spread	Depth	Standard Deviation	Price Level	Traded quantity
ITC	0.036918	29694.54	0.000233	1122.578	2761886
LICHSGFIN	0.061742	46835.72	0.000725	221.5018	215897.8
M&M	0.036625	57182.68	0.000287	502.789	670144.5
MOSERBAER	0.08162	87247.08	0.000516	217.5367	210888.7
NICOLASPIR	0.078602	55927.33	0.000481	259.4375	211876.2
NIRMA	0.083939	6380.346	0.001531	407.7968	24463.04
PFIZER	0.065671	7245.026	0.001609	772.591	16808.83
PUNJABTRAC	0.072661	70260.45	0.000615	187.8749	186329.9
RANBAXY	0.040854	44330.01	0.000203	781.6271	969377.9
RAYMOND	0.066192	23167.47	0.000789	355.7653	84321.33
RELCAPITAL	0.066247	111268.5	0.000361	303.7124	4683007
RELIANCE	0.035208	379513	8.33E-05	656.648	5671366
SAIL	0.058401	2682059	0.000461	57.55598	12988482
SATYAMCOMP	0.033207	245978.2	0.000113	500.5153	3850956
SBIN	0.028594	159491.8	8.29E-05	750.6761	2585894
SIEMENS	0.063122	7277.731	0.001082	2154.093	44114.9
SUNPHARMA	0.076249	24554.69	0.000551	570.5076	98983.42
TATAPOWER	0.040158	75228.85	0.000293	402.7833	556545.6
UNITECH	0.087135	6606.051	0.004259	524.1884	10078.03
WIPRO	0.043399	53256.69	0.000234	586.0835	814141.1

Table 5.8: Estimates of log linear regression model.

Coefficients	ABB	ACC	APOLLOTYRE	ARVINDMILL	ASHOKLEY
Constant	2.935201 (0.0012)	6.696193 (0)	-1.40919 (0.0095)	-1.37176 (0.0003)	-1.31999 (0.0013)
Price	-1.01289 (0)	-1.36498 (0)	-0.26386 (0.0785)	-0.40634 (0.0004)	-0.1783 (0.108)
Variance	0.072172 (0)	0.085326 (0)	0.065125 (0)	0.07018 (0)	0.093345 (0)
Volume	0.015401 (0.2619)	-0.04432 (0.0919	-0.02092 (0.181)	0.032141 (0.0845)	-0.04651 (0.0025)
D2000	-0.68802 (0)	-2.48406 (0)	0.051598 (0.5555)	0.253691 (0.0868)	-0.05568 (0.3494)
D2001	-0.50978 (0)	-2.21385 (0)	0.093774 (0.1069)	0.284302 (0.0544)	0.015162 (0.7946)
D2002	-0.4922 (0.0004)	-2.21955 (0)	0.368647 (0)	0.099148 (0.5292)	0.144487 (0.0472)
D2003	-0.29047 (0.0072)	-2.29519 (0)	0.270098 (0.0199)	-0.03319 (0.7222)	0.021041 (0.8458)
D2004	0.598235 (0)	-1.73759 (0)	0.374773 (0.0981)	0.066854 (0.197)	-0.08036 (0.6875)
D2005	0.736564 (0)	-1.69447 (0)	0.131214 (0.569)	-0.03925 (0.7166)	0.396265 (0.0001)
R^2	0.468265	0.577466	0.516927	0.76479	0.434613
Adjusted R^2	0.450671	0.563485	0.500943	0.757008	0.415905
F-statistic	26.61476 (0)	41.30387 (0)	32.3402 (0)	98.26829 (0)	23.23178 (0)
Values in the parentheses show the probability value of 't' statistic.					

Table 5.8 (Continued).

Coefficients	ASIANPAINT	BAJAJAUTO	BHARATFORG	BHEL	BPCL
Constant	-5.48646 (0)	-1.83726 (0.0928)	-0.73086 (0.221)	4.280315 (0)	0.330661 (0.5964)
Price	0.410663 (0.0765)	-0.23114 (0.174)	-0.32344 (0.0215)	-1.26987 (0)	-0.67061 (0)
Variance	0.038409 (0)	0.078033 (0)	0.075941 (0)	0.09075 (0)	0.090238 (0)
Volume	0.030459 (0.0247)	-0.00384 (0.8359)	-0.04133 (0.0029)	-0.04012 (0.103)	0.02018 (0.2524)
D2000	-0.41947 (0.0002)	-0.09888 (0.195)	-0.18161 (0.137)	-0.42996 (0.0008)	0.048436 (0.2907)
D2001	-0.17131 (0)	0.140723 (0.1866)	-0.06224 (0.3727)	-0.19563 (0.0772)	-0.0577 (0.4469)
D2002	-0.06919 (0.0898)	0.106464 (0.0288)	0.294673 (0.0001)	-0.27497 (0.0058)	-8.46E-07 (1)
D2003	0.290139 (0)	-0.27395 (0)	-0.0806 (0.6377)	-0.33083 (0)	-0.12033 (0.1286)
D2004	0.098451 (0.0979)	0.221283 (0.0708)	0.370718 (0.2637)	0.768168 (0)	0.197935 (0.0494)
D2005	-0.02117 (0.7508)	-0.16247 (0.2059)	0.32125 (0.4216)	0.90416 (0)	0.030741 (0.737)
R^2	0.571044	0.60824	0.538258	0.619411	0.462406
Adjusted R^2	0.556851	0.595278	0.52298	0.606818	0.444618
F-statistic	40.23313 (0)	46.92259 (0)	35.23044 (0)	49.18696 (0)	25.99534 (0)
Values in the parentheses show the probability value of 't' statistic.					

Table 5.8 (Continued).

Coefficients	**CIPLA**	**DRREDDY**	**GLAXO**	**GRASIM**	**HDFC**
Constant	1.957534 (0.0365)	0.999034 (0.4478)	-0.78655 (0.5075)	3.257844 (0.0089)	-2.44009 (0.2525)
Price	-0.7124 (0)	-0.67277 (0.0009)	-0.42111 (0.0256)	-1.21517 (0)	-0.11392 (0.6811)
Variance	0.057332 (0)	0.093806 (0)	0.078898 (0)	0.071849 (0)	0.071768 (0)
Volume	-0.01188 (0.4513)	-0.01893 (0.3237)	0.003209 (0.8393)	-0.00526 (0.8519)	-0.00915 (0.4882)
D2000	-0.11493 (0.0228)	0.620586 (0.0002)	0.19406 (0.0244)	0.570385 (0)	0.158136 (0.7204)
D2001	-0.07637 (0.1406)	0.40148 (0.0204)	0.139038 (0.0695)	0.628788 (0.0001)	0.09892 (0.8116)
D2002	-0.1763 (0.0001)	0.36796 (0.0016)	0.121624 (0.3381)	0.529813 (0.0002)	0.066355 (0.8581)
D2003	-0.28148 (0)	0.139743 (0.1878)	0.17457 (0.2308)	0.531837 (0.0016)	0.119711 (0.8193)
D2004	0.168187 (0.002)	0.534396 (0.0025)	0.508405 (0)	1.923458 (0)	0.260516 (0.4919)
D2005	-0.75709 (0)	0.372527 (0)	0.431897 (0)	1.669711 (0.0011)	-0.082 (0.806)
R^2	0.503013	0.500442	0.595369	0.485161	0.4215
Adjusted R^2	0.486569	0.483912	0.581932	0.468063	0.402288
F-statistic	23.6596 (0)	30.27565 (0)	44.3052 (0)	28.37531 (0)	21.93921 (0)
Values in the parentheses show the probability value of 't' statistic.					

Table 5.8 (Continued).

Coefficients	HDFCBANK	HEROHONDA	IDBI	IFCI	INFOSYSTCH
Constant	-1.77122 (0.0072)	0.756598 (0.5402)	-2.02068 (0)	-1.43279 (0.001)	-1.42276 (0.1913)
Price	-0.19851 (0.2139)	-0.62376 (0.0011)	-0.14882 (0.1513)	-0.16163 (0.2681)	-0.51157 (0)
Variance	0.082996 (0)	0.071095 (0)	0.082666 (0)	0.08483 (0)	0.075757 (0)
Volume	-0.00714 (0.5031)	0.003187 (0.8669)	-0.00415 (0.8309)	-0.01887 (0.5544)	0.173871 (0)
D2000	-0.10397 (0.6653)	0.187426 (0.0693)	-0.04628 (0.2638)	0.557597 (0)	-0.08281 (0.5473)
D2001	-0.13536 (0.5665)	0.133171 (0.0679)	0.057279 (0.2328)	0.775947 (0)	-0.31849 (0.0211)
D2002	-0.07014 (0.7562)	-0.304 (0.0275)	0.464203 (0)	0.348284 (0.1166)	-0.36173 (0.001)
D2003	-0.01953 (0.9319)	-0.43684 (0.0244)	0.344643 (0)	0.48544 (0.0074)	-0.78818 (0)
D2004	0.084381 (0.7771)	-0.24044 (0.0125)	0.16032 (0.0513)	0.183116 (0.1829)	-0.32698 (0.006)
D2005	-0.23504 (0.5126)	-0.24722 (0.0007)	0.009392 (0.9354)	0.142701 (0.3353)	-0.85822 (0)
R^2	0.531712	0.232742	0.577362	0.507428	0.543049
Adjusted R^2	0.516217	0.207262	0.563378	0.490443	0.527929
F-statistic	34.31542 (0)	9.134004 (0)	41.28638 (0)	29.87466 (0)	35.91666 (0)
Values in the parentheses show the probability value of 't' statistic.					

Table 5.8 (Continued).

Coefficients	**ITC**	**LICHSGFIN**	**M&M**	**MOSERBAER**	**NICOLASPIR**
Constant	5.713543 (0.0005)	-2.04549 (0)	2.453079 (0.0034)	-0.63843 (0.2181)	0.247417 (0.8538)
Price	-1.51348 (0)	-0.10948 (0.4246)	-0.98003 (0)	-0.56232 (0.0001)	-0.56354 (0.014)
Variance	0.09025 (0)	0.083404 (0)	0.113422 (0)	0.168484 (0)	0.084085 (0)
Volume	0.039984 (0.0666)	-0.00941 (0.5473)	-0.03719 (0.1366)	-0.00537 (0.8561)	-0.0068 (0.6999)
D2000	0.238399 (0)	0.009494 (0.8552)	0.162583 (0.0056)	0.648771 (0.0216)	-0.02887 (0.5728)
D2001	0.238543 (0)	0.065728 (0.078)	0.037108 (0.7096)	0.493366 (0.0209)	-0.05386 (0.2902)
D2002	0.190148 (0.0045)	0.200404 (0.0005)	-0.16427 (0.2169)	0.91953 (0.0009)	-0.03409 (0.7599)
D2003	0.028447 (0.7101)	0.115331 (0.1798)	-0.12008 (0.4188)	0.433802 (0.024)	0.314499 (0.0035)
D2004	0.729027 (0)	-0.09699 (0.6694)	0.405744 (0.0031)	0.889123 (0.0011)	0.63005 (0.0002)
D2005	0.849305 (0)	-0.23502 (0.3155)	0.42755 (0.0092)	0.738631 (0.0007)	0.168753 (0.1438)
R^2	0.473782	0.490548	0.616375	0.445461	0.5292
Adjusted R^2	0.456371	0.473691	0.603634	0.427045	0.513622
F-statistic	27.2107 (0)	29.10081 (0)	48.37982 (0)	24.18829 (0)	33.97114 (0)
Values in the parentheses show the probability value of 't' statistic.					

Table 5.8 (Continued).

Coefficients	NIRMA	PFIZER	PUNJABTRAC	RANBAXY	RAYMOND
Constant	-4.37481 (0.0145)	-3.93909 (0)	-1.53359 (0.0007)	-1.62423 (0.0896)	-1.34604 (0.0198)
Price	0.393695 (0.2194)	0.076082 (0.4726)	-0.31011 (0)	-0.24236 (0.1469)	-0.31699 (0.0243)
Variance	0.018065 (0)	0.049836 (0)	0.080426 (0)	0.073419 (0)	0.068543 (0)
Volume	-0.01632 (0.3699)	0.020031 (0.1661)	0.011873 (0.401)	-0.00215 (0.9155)	-0.00056 (0.9701)
D2000	-1.13617 (0.001)	0.200257 (0.0004)	0.206368 (0.0003)	-0.04261 (0.6686)	-0.04623 (0.2123)
D2001	-0.96108 (0.0005)	0.096186 (0.1041)	0.041038 (0.7033)	-0.14084 (0.226)	-0.01072 (0.8992)
D2002	-0.29973 (0.0001)	0.507951 (0)	0.210993 (0.0574)	-0.22953 (0.0971)	0.375008 (0)
D2003	-0.34131 (0.0005)	0.380466 (0.0004)	0.137733 (0.2592)	-0.40277 (0.0003)	0.512382 (0)
D2004	-0.20445 (0.109)	0.586499 (0)	0.611264 (0)	-0.08477 (0.6485)	0.376728 (0.0201)
D2005	-0.30297 (0.0001)	0.29812 (0)	0.272684 (0.0149)	-0.22638 (0.2419)	0.248495 (0.2499)
R^2	0.462463	0.539439	0.717574	0.599725	0.649387
Adjusted R^2	0.444676	0.5242	0.708229	0.586481	0.637785
F-statistic	26.00126 (0)	35.39822 (0)	76.78699 (0)	45.2815 (0)	55.97593 (0)
Values in the parentheses show the probability value of ‘t’ statistic.					

Table 5.8 (Continued).

Coefficients	RELCAPITAL	RELIANCE	SAIL	SATYAMCOMP	SIBN
Constant	0.221493 (0.654)	-1.31603 (0.3681)	-1.09354 (0.0049)	-2.40187 (0.0264)	2.47184 (0.0158)
Price	-0.69855 (0)	-0.53862 (0.0924)	-0.68171 (0.0003)	-0.54253 (0)	-1.23071 (0)
Variance	0.069157 (0)	0.072639 (0)	0.094957 (0)	0.082144 (0)	0.107308 (0)
Volume	-0.03044 (0.0079)	0.047592 (0.1423)	0.067638 (0.0086)	0.156198 (0)	0.033522 (0.2878)
D2000	0.699978 (0)	0.177246 (0.5796)	-0.17534 (0.0003)	0.837706 (0)	0.336083 (0.0021)
D2001	0.522983 (0)	0.19249 (0.5857)	0.235531 (0)	-0.29878 (0.0212)	0.422057 (0.0001)
D2002	0.566356 (0)	0.323321 (0.2839)	-0.40772 (0)	-0.396 (0.0161)	0.509676 (0)
D2003	0.495185 (0)	0.180875 (0.499)	-0.28372 (0.001)	-0.69692 (0.0001)	0.398695 (0.0127)
D2004	0.796322 (0)	0.372709 (0.4406)	0.001088 (0.9974)	-0.47235 (0.0006)	1.096189 (0.001)
D2005	0.919737 (0)	0.37722 (0.4122)	-0.09212 (0.8106)	-0.4057 (0.0004)	0.919685 (0.0078)
R^2	0.500604	0.291495	0.814599	0.68766	0.632804
Adjusted R^2	0.48408	0.268051	0.808442	0.677325	0.620609
F-statistic	30.29536 (0)	12.43408 (0)	132.2997 (0)	66.53839 (0)	51.89175 (0)
Values in the parentheses show the probability value of ‘t’ statistic.					

Table 5.8 (Continued).

Coefficients	SIEMENS	SUNPHARMA	TATAPOWER	UNITECH	WIPRO
Constant	-0.44821 (0.6019)	-0.44821 (0.6019)	-0.76126 (0.0614)	-2.08301 (0.0001)	-4.56714 (0.0011)
Price	-0.4184 (0.0036)	-0.4184 (0.0036)	-0.39238 (0.0001)	-0.08414 (0.5637)	0.075477 (0.6723)
Variance	0.059401 (0.0007)	0.059401 (0.0007)	0.104643 (0)	0.000831 (0.7001)	0.076789 (0.0001)
Volume	-0.02197 (0.3679)	-0.02197 (0.3679)	-0.03066 (0.091)	-0.02329 (0.0981)	0.045077 (0.3162)
D2000	0.397301 (0.0003)	0.397301 (0.0003)	0.065094 (0.1017)	-0.00671 (0.9154)	-0.08207 (0.7074)
D2001	0.208729 (0.0595)	0.208729 (0.0595)	0.22032 (0.0001)	-0.01412 (0.8206)	-0.29381 (0.2537)
D2002	0.235544 (0.0461)	0.235544 (0.0461)	0.190605 (0.0001)	0.087102 (0.1596)	-0.04488 (0.8835)
D2003	0.260483 (0.0001)	0.260483 (0.0001)	0.171424 (0.0004)	0.181993 (0.003)	-0.17484 (0.5671)
D2004	0.401997 (0.0013)	0.401997 (0.0013)	0.173692 (0.1984)	0.491731 (0.0017)	-0.22622 (0.4493)
D2005	0.473739 (0)	0.473739 (0)	-0.08599 (0.5353)	0.337217 (0.246)	-0.00184 (0.9966)
R^2	0.215662	0.215662	0.669549	0.180289	0.260012
Adjusted R^2	0.189709	0.189709	0.658615	0.152864	0.235527
F-statistic	8.309899 (0)	8.309899 (0)	61.23539 (0)	6.57383 (0)	10.61927 (0)
Values in the parentheses show the probability value of 't' statistic.					

Chapter- 6

Market Microstructure and Transaction Cost

6.1 Introduction

A key measure of the efficiency of a financial market is the cost of trading. Transaction costs are prevalent in almost all financial markets. The presence of transaction costs significantly changes the investment strategies and even a small increase in transaction cost can dramatically decrease the frequency of trade. Constantinides (1986) showed that demand for assets is sensitive to transaction costs. Investors accommodate large transaction costs by drastically reducing the frequency and volume of trade. In addition to the explicit costs of executing a security transaction such as commission, traders incur implicit costs which are not easily identifiable as explicit costs. Implicit transaction cost can be inferred as the difference between actual transaction price and a benchmark price which is regarded as efficient in some sense or through bid- ask spreads. Traditionally transaction cost estimation aimed at measuring implicit costs of trading for buyer or a seller with regard to a particular transaction. But from market microstructure perspective measurement of transaction cost for market as a whole arises because the comparative analysis of markets need measures of average transaction costs for determining markets or regulatory structures under which costs are minimum.

Transaction cost measurement is important for traders, brokers, exchanges, regulators and such other market participants. For traders transaction cost measurement is important

because it makes execution of their trades expensive and has a significant bearing on total returns. It becomes more important for traders who trade regularly and in large sizes. To assess their investment strategies and to device an optimal strategy, traders should pay attention to transaction cost of security trading. Brokers need transaction cost measurement to assess their own performance, to reduce shortcomings in their strategies and to ensure better services to their clients. Exchanges normally undertake transaction cost measurement to assess the average quality of markets for various securities. They use these estimates to assess the performance of various market participants. For authorities entrusted with regulating job, transaction cost helps to assess the quality of markets and to design policies which would result in lower transaction costs. In general transaction cost is the major concern of all market participants since it has a direct bearing on them.

6.2 Theoretical Background

Transaction cost studies can be broadly divided into two categories. The first category of studies viewed transaction cost as the difference between transaction price and a benchmark price which is regarded as efficient. The second category of studies is based on bid- ask spreads. Earlier studies have used various benchmarks for comparison with actual transaction price viz. the volume weighted daily average price by Berkowitz *et al.* (1988), daily high and low and closing prices by Beebower (1989), midpoint of the prevailing bid- ask quotes by Perold (cited in Harris, 2005, pp 424), and random walk by Hasbrouck (1993).

Demsetz (1968) included bid- ask spreads as a component of transaction cost since it represents the cost of immediacy. Branch and Freed (1977) explored the determinants of bid- ask spreads. Cohen *et al.* (1981), Conroy *et al.* (1990), Neal (1992), McInish and Wood (1992), and Bharadwaj and Brooks (1992) have used bid- ask spreads in transaction cost estimation. Roll (1984) developed an estimator for effective bid- ask spreads from daily market prices.

Empirical studies regarding the performance of market reforms and regulatory changes are usually based on bid- ask spreads. But there are certain problems in using bid- ask spreads for measuring transaction cost. Grossman and Miller (1988) argued that spreads could not serve as a valid measure of cost of transaction because it is simply the charge levied for executing the order. Further they argued that buy and sell orders do not arrive simultaneously. Price may change between purchase and sale of a security by the market maker. Therefore, for a trader, current quoted spread cannot serve as a precise measure of cost of transacting.

Generally bid- ask spreads is identified as having two components i.e. transaction cost component and adverse selection cost component. Transaction cost component is the part of spread that arises due to normal cost of doing business, whereas adverse selection cost is the part of spreads that compensates the market maker for loss incurred while trading with informed traders. Therefore it is not appropriate to use bid- ask spreads as a measure of transaction cost since it also includes adverse selection cost. Bid- ask spreads is also regarded as not a good measure of transaction cost for large trades when it is executed in batches. Finally, bid- ask spreads does not show whether price paid is close to

fundamental values or not. In such circumstances comparing transaction prices to a benchmark price provides better estimates of transaction cost.

6.3 Transaction Cost Components

The total cost of a security transaction can be broadly divided in to three categories; explicit costs, implicit costs, and missed trade opportunity costs. Explicit costs of security transaction include broker's commission, fees paid to the exchanges, taxes paid to the government etc. These costs are easily identifiable and measurable as well. Under implicit costs price impact of a trade is included. Implicit costs results when traders demand immediacy and pay more than fundamental value of a security while buying and receive less than the fundamental value while selling. Missed trade opportunity costs are the costs of a foregone trade. The failure of traders to execute their orders according to their strategy in time results in missed trade opportunity costs. Among these three cost components, explicit costs can be easily measured without any bias. Difficulty arises in the case of implicit cost and missed trade opportunity costs. For implicit costs, there is necessity of proxy for price if the trade had not taken place, whereas, for missed trade opportunity cost, a proxy for price is needed if the trade had actually taken place. In this study the focus is on measuring average implicit transaction cost of security trading.

6.4 Methodology

The methodology used in the present study is based on the logic of dividing the non-stationary time series into random walk component and residual stationary component.

When applied to transaction prices, random walk component is identified as efficient price and residual stationary component is termed as pricing error. The pricing error i.e. deviation of actual transaction prices from random walk is taken as implicit transaction cost. The pricing error shows how closely actual transaction price follows random walk.

For the purpose of assessing market quality standard deviation of pricing error (σ_s) is used as a summary measure of market quality. It measures how closely the transaction price follows the efficient price. Standard deviation of pricing error (σ_s) is taken as proxy for market quality is based on the premise that as trading barriers are reduced transaction price should follow efficient price i.e. random walk closely.

6.4.1 Estimation Procedure

Hasbrouck (1993) vector autoregressive framework has been used to measure transaction cost as a proxy for market quality. This method formulates logarithm of the observed transaction prices at time "t" as the sum of two components:

$$p_t = m_t + s_t \qquad (6.1)$$

where, m_t is efficient price which is defined as the value of a security which reflects all public information available at time "t" and private information that can be inferred from security transaction up to that time, s_t is defined as the deviation between efficient price and the actual transaction price and it is termed as pricing error which is central to this method. "t" is assumed as index transaction or brief interval of natural time

It is based on two assumptions:

i) The efficient price follows random walk:

$$m_t = m_{t-1} + w_t \quad (6.2)$$

Where w_t are uncorrelated increments, E(w_t) = 0, E(w_t^2)=σ²w and E(w_t, w_τ)=0 for τ≠o

ii) The pricing error is a zero mean covariance stationary process.

Vector autoregressive (VAR) model has been used for the derivation of σ_s. It provides a framework which is general enough to capture unspecified lagged dependencies. A bivariate VAR is adopted which involves trades and price change.

$$r_t = a_1 r_{t-1} + a_2 r_{t-2} + \ldots + b_1 x_{t-1} + b_2 x_{t-2} + \ldots v_{1t} \quad (6.3)$$

$$x_t = c_1 r_{t-1} + c_2 r_{t-2} + \ldots + d_1 x_{t-1} + d_2 x_{t-2} + \ldots v_{2t}$$

where, r_t is the price change in the log form i.e. first differences of the natural logarithm of actual transaction prices, x_t represents trade volume which is signed to be positive if the agent who initiates trade is buyer and negative if the agent who initiates the trade is seller, or, x_t is a column vector of explanatory variables and "b" are conformable matrices. v_{1t} and v_{2t} are innovations. The innovations are zero mean and serially uncorrelated

Tick test has been used to classify trades as buyer initiated or seller initiated trades. Under tick rule, trades will be classified by comparing trade price to its preceding trade price. Tick test classifies trades into four categories; an uptick, downtick, zero uptick and zero downtick. If a trade price is above the preceding trade price, trade is classified as an uptick and as downtick, if trade price is less than the preceding trade price. When trade price is equal to preceding trade price, it is called as zero tick. If the last price change was an uptick before zero tick, trade will be classified as zero uptick whereas zero downtick, if the last price change before zero tick was a downtick. Finally a trade will be classified as buy, if it occurs at uptick or zero uptick and as sell if it occurs at downtick or zero downtick.

VAR is transformed to obtain a VMA representation which expresses the variables in terms of current and lagged disturbances:

$$r_t = a_0^* v_{1,t} + a_1^* v_{1,t-1} + a_2^* v_{1,t-2} + \ldots + b_0^* v_{2,t} + b_1^* v_{2,t-1} + b_2^* v_{2,t-2} + \ldots \quad (6.4)$$

$$x_t = c_0^* v_{1,t} + c_1^* v_{1,t-1} + c_2^* v_{1,t-2} + \ldots + d_0^* v_{2,t} + d_1^* v_{2,t-1} + d_2^* v_{2,t-2} + \ldots..$$

For present calculation only r_t equation in (6.4) is used. The underlying random walk decomposition model is (6.1), but with an expanded representation of the pricing error:

$$s_t = \alpha_0 v_{1,t} + \alpha_1 v_{1,t-1} + \ldots + \beta_0 v_{2,t} + \beta_1 v_{2,t-1} + \ldots + \eta_t + \gamma_1 \eta_{t-1} + \ldots, \quad (6.5)$$

where η_t is disturbance orthogonal to all components of v_t.

The variance of the random walk component may be computed as:

$$\sigma_w^2 = [\mathrm{E}\ a_i^* \quad \mathrm{E}b_i^*\ ]\ \mathrm{cov(v)} \begin{bmatrix} \mathrm{E}a_i^* \\ \mathrm{E}b_i^* \end{bmatrix} \tag{6.6}$$

By using BN restriction ($\eta_t = \gamma_1 = \ldots = 0$), values of α, β are computed as follows :

$$\alpha_j = -\sum_{k=j+1}^{\infty} a_k^*, \qquad \beta_j = -\sum_{k=j+1}^{\infty} b_k^* \tag{6.7}$$

The pricing error variance σ_s^2 may be computed as:

$$\sigma_s^2 = \sum_{j=0}^{\infty} \begin{bmatrix} \alpha_j & \beta_j \end{bmatrix}\ \mathrm{cov(v)} \begin{bmatrix} \alpha_j \\ \beta_j \end{bmatrix} \tag{6.8}$$

The standard deviation of pricing error is calculated by taking square root of variance which shows how closely a transaction price follows the efficient price.

6.5 Empirical Results

Implicit transaction cost of security trading is estimated using VAR approach. It is estimated as the pricing error standard deviation. Intraday data of prices and trades have been used in this study. The study has covered 40 companies listed in NSE and the study period covers from January 1999 to December 2005. Empirical results are presented as follows: Tables 6.1 to 6.7 shows the summary statistics for selected companies during the

study period. Table 6.8 shows the monthly average percentage of pricing error standard deviation (σ_s*100) for all companies in the sample. An attempt is made to find out differences in transaction costs for small and large market capitalization stocks. Tables 6.9 and 6.10 shows the percentage of pricing error standard deviation (σ_s*100) for large and small market capitalization stocks respectively.

Summary statistics i.e. mean and standard deviation of returns is shown in Tables 6.1 to 6.7 for all sample stocks during the study period. Mean value estimated from intraday data is very small which is expected in case of high frequency data. Values are both positive and negative. Standard deviation of returns estimated from intraday data does not show any systematic pattern either in terms of increase or decrease. Table 6.8 shows the transaction cost estimates for all individual sample stocks and sample average from 1999 to 2005. Appropriate lag lengths for VAR and VMA specifications are selected based on Akaike Information Criterion (AIC) and Schwarz Information Criterion (SIC). Implicit transaction cost estimated as pricing error standard deviation is interpreted as the money spent over the fundamental value of a security. The average transaction cost of the sample stocks is at a reasonably low level in comparison with estimates of Hasbrouck (1993). For 1999 it is about 0.22 where as it was 0.33 in Hasbrouck (1993) study during 1989. Over the years there is decline in the average transaction cost estimates but the decline is very small. From 1999 to 2000 there is a reduction of about 0.1 where as for rest of the time period the year on year is negligible. On the whole the comparison of 1999 estimates with 2005, there is small decline in the transaction cost estimates. Comparison of the standard deviation estimated from returns and pricing error standard

deviation shows that companies with higher standard deviation in returns tends to have higher pricing error standard deviation.

The study has divided the 40 sample stocks into two categories viz. large and small market capitalization stocks consisting 20 companies each. This is done to facilitate a comparison of transaction cost estimates in these categories. Tables 6.9 and 6.10 show the transaction cost estimates for large and small market capitalization stocks respectively. As shown in the table, only for the year 1999 there is difference of 0.2 in the transaction cost for large and small market capitalization stocks. Earlier empirical works [for example Hasbrouck (1993) and Lesmond *et al.* (1999)] also have shown that large market capitalization stocks having lower transaction cost over small market capitalization stocks. But difference is very small. For subsequent years the difference is becoming less and less. For the last four years i.e. from 2002 to 2005 there is no much difference in the full sample average, averages of large and small market capitalization stocks transaction cost estimates.

6.6 Conclusion

The study is undertaken to evaluate the effect of changes in market microstructure on the quality of the market as measured by transaction cost. Procedural, regulatory and technological changes were brought to improve transparency, liquidity and to ensure better market quality. Transaction cost is used as one of the measure of market quality. Results show that changes in the market microstructure did not result in substantial changes in terms of improving market quality. Transaction cost declined only during

initial years. But the decline is very small. The study also did not find much difference in between the transaction costs of large and small market capitalization stocks.

This study can be extended in various ways. For example, comparison of transaction costs at different time periods for same stocks within the trading day. Such information will shed more light on the impact of market microstructure on security trading. Average transaction costs estimates ideally include all stocks transacted in that market.

Table 6.1: Summary Statistics: 1999

Company	Mean	Standard Deviation	Company	Mean	Standard Deviation
ABB	-8.24E-07	0.001209	ITC	6.54E-07	0.000147
ACC	9.37E-07	0.00032	LICHSGFIN	2.70E-06	0.015184
ARVINDMILL	-2.79E-06	0.001072	M&M	7.39E-06	0.001269
APOLLOTYRE	2.90E-06	0.041928	MOSERBAER	1.10E-05	0.001912
ASHOKLEY	-1.70E-06	0.00094	NICOLASPIR	6.77E-05	0.103275
ASIANPAINT	-1.48E-05	0.001645	NIRMA	3.03E-05	0.160202
BAJAJAUTO	-8.93E-07	0.000625	PFIZER	-3.33E-07	0.001131
BHARATFORG	-6.68E-06	0.003539	PUNJABTRAC	3.26E-05	0.001536
BHEL	-9.58E-08	0.000504	RANBAXY	2.02E-06	0.000659
BPCL	-7.63E-06	0.00132	RAYMOND	-1.17E-06	0.021539
CIPLA	3.24E-05	0.001656	RELCAPITAL	6.79E-07	0.00125
DRREDDY	1.69E-06	0.000509	RELIANCE	3.99E-07	0.00429
GLAXO	2.65E-07	0.000451	SAIL	3.15E-06	0.00191
GRASIM	-1.16E-06	0.001085	SATYAMCOMP	8.42E-07	0.000186
HDFC	8.87E-06	0.001097	SBIN	7.58E-07	0.000204
HDFCBANK	3.67E-06	0.001157	SIEMENS	-5.87E-06	0.001071
HEROHONDA	4.53E-06	0.001101	SUNPHARMA	2.07E-05	0.001784
IDBI	-2.61E-07	0.004343	TATAPOWER	-1.05E-05	0.001073
IFCI	-2.87E-06	0.005044	UNITECH	-4.20E-05	0.007352
INFOSYSTCH	7.65E-06	0.000564	WIPRO	6.90E-05	0.001925

Table 6.2: Summary Statistics: 2000

Company	Mean	Standard Deviation	Company	Mean	Standard Deviation
ABB	5.40E-06	0.001201	ITC	-1.06E-07	0.00033
ACC	3.46E-07	0.000453	LICHSGFIN	-5.42E-07	0.001886
ARVINDMILL	-4.00E-06	0.004618	M&M	-1.06E-06	0.000632
APOLLOTYRE	-6.77E-06	0.00246	MOSERBAER	1.10E-06	0.000649
ASHOKLEY	-6.60E-06	0.001486	NICOLASPIR	-5.03E-05	0.002295
ASIANPAINT	-1.00E-05	0.001566	NIRMA	1.10E-05	0.001615
BAJAJAUTO	8.39E-07	0.001119	PFIZER	-2.91E-05	0.003247
BHARATFORG	-3.73E-05	0.003139	PUNJABTRAC	9.71E-07	0.00069
BHEL	1.15E-06	0.00051	RANBAXY	1.15E-06	0.000437
BPCL	-3.44E-07	0.001198	RAYMOND	2.26E-06	0.03486
CIPLA	1.95E-06	0.000982	RELCAPITAL	6.87E-07	0.000513
DRREDDY	-3.55E-07	0.000709	RELIANCE	-1.94E-09	0.000171
GLAXO	4.82E-06	0.000849	SAIL	-2.84E-07	0.001919
GRASIM	8.48E-07	0.000767	SATYAMCOMP	-2.22E-07	0.000222
HDFC	1.83E-06	0.000634	SBIN	4.11E-07	0.000283
HDFCBANK	2.48E-06	0.0008	SIEMENS	2.38E-06	0.001247
HEROHONDA	9.36E-06	0.001658	SUNPHARMA	4.58E-06	0.001365
IDBI	1.60E-06	0.001094	TATAPOWER	8.47E-06	0.001348
IFCI	-3.23E-06	0.008262	UNITECH	0.000139	0.007669
INFOSYSTCH	1.10E-06	0.000268	WIPRO	2.06E-06	0.000552

Table 6.3: Summary Statistics: 2001

Company	Mean	Standard Deviation	Company	Mean	Standard Deviation
ABB	-2.27E-08	0.001328	ITC	1.60E-07	0.000168
ACC	1.95E-07	0.000215	LICHSGFIN	4.33E-06	0.001251
ARVINDMILL	-3.35E-06	0.000845	M&M	5.23E-07	0.00035
APOLLOTYRE	-6.23E-06	0.108197	MOSERBAER	2.65E-07	0.000626
ASHOKLEY	3.94E-06	0.000951	NICOLASPIR	-5.04E-06	0.001474
ASIANPAINT	-4.13E-06	0.001825	NIRMA	-1.23E-05	0.001459
BAJAJAUTO	2.26E-06	0.000596	PFIZER	-2.94E-06	0.001037
BHARATFORG	1.18E-06	0.001413	PUNJABTRAC	-2.79E-06	0.000956
BHEL	-2.33E-07	0.000334	RANBAXY	-1.34E-07	0.000251
BPCL	2.15E-06	0.000589	RAYMOND	8.72E-07	0.008581
CIPLA	4.53E-07	0.000487	RELCAPITAL	4.48E-07	0.000303
DRREDDY	2.55E-07	0.000361	RELIANCE	3.39E-07	0.000147
GLAXO	-1.77E-06	0.000574	SAIL	2.93E-06	0.00242
GRASIM	6.15E-07	0.00034	SATYAMCOMP	-3.13E-07	0.00013
HDFC	5.68E-07	0.000608	SBIN	7.73E-07	0.000245
HDFCBANK	1.28E-06	0.000504	SIEMENS	6.04E-07	0.000645
HEROHONDA	2.87E-07	0.000971	SUNPHARMA	2.88E-06	0.000775
IDBI	1.93E-06	0.0097305	TATAPOWER	1.11E-06	0.000543
IFCI	6.08E-07	0.005473	UNITECH	-0.000216	0.007836
INFOSYSTCH	-2.43E-07	0.000144	WIPRO	7.37E-07	0.000299

Table 6.4: Summary Statistics: 2002

Company	Mean	Standard Deviation	Company	Mean	Standard Deviation
ABB	6.32E-06	0.000934	ITC	6.25E-07	0.00022
ACC	5.61E-07	0.000271	LICHSGFIN	7.95E-06	0.001235
ARVINDMILL	-7.26E-06	0.001722	M&M	1.57E-06	0.000463
APOLLOTYRE	8.76E-06	0.001568	MOSERBAER	5.23E-07	0.000613
ASHOKLEY	-4.10E-07	0.000909	NICOLASPIR	1.81E-06	0.001137
ASIANPAINT	3.20E-07	0.002015	NIRMA	1.39E-05	0.00234
BAJAJAUTO	1.93E-06	0.000496	PFIZER	-1.91E-05	0.00164
BHARATFORG	2.92E-05	0.001952	PUNJABTRAC	-2.42E-06	0.001501
BHEL	4.78E-07	0.000425	RANBAXY	4.61E-07	0.000205
BPCL	2.48E-06	0.000736	RAYMOND	1.86E-07	0.001709
CIPLA	-5.53E-07	0.000588	RELCAPITAL	-1.02E-06	0.000724
DRREDDY	5.48E-07	0.000244	RELIANCE	3.57E-07	0.000179
GLAXO	3.61E-06	0.000562	SAIL	3.62E-06	0.002548
GRASIM	1.68E-07	0.000495	SATYAMCOMP	-2.32E-07	0.000135
HDFC	-1.71E-06	0.000581	SBIN	9.99E-07	0.000313
HDFCBANK	-4.89E-07	0.000709	SIEMENS	2.75E-05	0.001547
HEROHONDA	1.78E-06	0.000583	SUNPHARMA	2.76E-06	0.000782
IDBI	-8.06E-06	0.001633	TATAPOWER	-7.26E-07	0.000529
IFCI	-2.28E-05	0.0070671	UNITECH	0.000153	0.006044
INFOSYSTCH	-4.84E-07	0.000169	WIPRO	6.56E-08	0.000178

Table 6.5: Summary Statistics: 2003

Company	Mean	Standard Deviation	Company	Mean	Standard Deviation
ABB	6.28E-06	0.001407	ITC	1.67E-07	0.000132
ACC	-5.45E-07	0.000167	LICHSGFIN	-7.20E-07	0.000912
ARVINDMILL	-1.79E-06	0.000533	M&M	-9.44E-07	0.000286
APOLLOTYRE	-8.24E-07	0.00059	MOSERBAER	1.06E-06	0.00025
ASHOKLEY	-1.01E-06	0.006323	NICOLASPIR	-5.17E-06	0.001366
ASIANPAINT	-2.64E-07	0.002341	NIRMA	1.10E-05	0.002409
BAJAJAUTO	1.67E-07	0.000506	PFIZER	-6.90E-06	0.000925
BHARATFORG	3.07E-06	0.000657	PUNJABTRAC	-1.27E-06	0.000521
BHEL	3.98E-07	0.000435	RANBAXY	3.19E-07	0.000118
BPCL	3.57E-07	0.000107	RAYMOND	-5.73E-07	0.001251
CIPLA	-8.33E-07	0.000283	RELCAPITAL	-2.21E-06	0.000408
DRREDDY	6.68E-07	0.000141	RELIANCE	-2.26E-07	6.15E-05
GLAXO	-7.47E-07	0.00056	SAIL	3.69E-08	0.000965
GRASIM	3.17E-07	0.000532	SATYAMCOMP	1.90E-08	6.21E-05
HDFC	1.56E-06	0.000758	SBIN	-9.56E-08	9.70E-05
HDFCBANK	1.17E-06	0.000513	SIEMENS	1.50E-06	0.001074
HEROHONDA	-7.54E-07	0.000253	SUNPHARMA	-3.62E-05	0.00338
IDBI	-5.22E-07	0.025897	TATAPOWER	-1.46E-07	0.000352
IFCI	-3.64E-06	0.0058195	UNITECH	-2.55E-05	0.008403
INFOSYSTCH	3.97E-08	6.18E-05	WIPRO	1.08E-07	9.87E-05

Table 6.6: Summary Statistics: 2004

Company	Mean	Standard Deviation	Company	Mean	Standard Deviation
ABB	-2.58E-07	0.00127	ITC	6.74E-07	0.000275
ACC	9.55E-08	0.000128	LICHSGFIN	-4.81E-07	0.000633
ARVINDMILL	-1.23E-06	0.000663	M&M	7.01E-07	0.000307
APOLLOTYRE	-8.03E-08	0.000355	MOSERBAER	-2.05E-07	0.000593
ASHOKLEY	-9.07E-07	0.00261	NICOLASPIR	-5.03E-06	0.029161
ASIANPAINT	-1.12E-06	0.001203	NIRMA	-1.60E-06	0.000877
BAJAJAUTO	-6.20E-07	0.00061	PFIZER	-4.44E-06	0.001497
BHARATFORG	-2.72E-06	0.000753	PUNJABTRAC	NA	NA
BHEL	1.03E-06	0.000519	RANBAXY	-1.76E-07	0.000198
BPCL	6.54E-07	0.000254	RAYMOND	-2.94E-06	0.000852
CIPLA	-2.64E-07	0.000465	RELCAPITAL	5.71E-07	0.000226
DRREDDY	-8.07E-07	0.000401	RELIANCE	4.56E-08	8.79E-05
GLAXO	1.46E-06	0.000741	SAIL	3.76E-07	0.000231
GRASIM	6.56E-07	0.000463	SATYAMCOMP	6.87E-08	7.38E-05
HDFC	-3.39E-07	0.000485	SBIN	2.94E-07	8.21E-05
HDFCBANK	1.32E-07	0.000408	SIEMENS	-7.05E-06	0.001133
HEROHONDA	4.87E-07	0.000273	SUNPHARMA	3.45E-07	0.000767
IDBI	6.84E-07	0.000399	TATAPOWER	8.03E-07	0.000189
IFCI	7.35E-07	0.000554	UNITECH	-1.68E-05	0.003296
INFOSYSTCH	2.33E-07	0.000107	WIPRO	-1.62E-07	0.000229

Table 6.7: Summary Statistics: 2005

Company	Mean	Standard Deviation	Company	Mean	Standard Deviation
ABB	-1.39E-06	0.001043	ITC	-3.19E-07	0.000233
ACC	9.70E-09	0.00014	LICHSGFIN	-8.02E-07	0.000725
ARVINDMILL	2.12E-06	0.000797	M&M	-7.04E-07	0.000287
APOLLOTYRE	-6.22E-07	0.00033	MOSERBAER	-1.88E-07	0.000516
ASHOKLEY	-8.78E-07	0.000639	NICOLASPIR	-1.67E-06	0.000481
ASIANPAINT	5.69E-06	0.000898	NIRMA	-1.17E-05	0.001531
BAJAJAUTO	-6.86E-07	0.000476	PFIZER	-1.67E-06	0.001609
BHARATFORG	4.40E-06	0.00094	PUNJABTRAC	-5.60E-07	0.000615
BHEL	-3.94E-07	0.000356	RANBAXY	-1.08E-06	0.000203
BPCL	-8.45E-07	0.000317	RAYMOND	-3.33E-06	0.000789
CIPLA	-1.09E-06	0.000252	RELCAPITAL	3.62E-07	0.000361
DRREDDY	-1.01E-06	0.000354	RELIANCE	-1.43E-07	8.33E-05
GLAXO	-2.71E-06	0.00278	SAIL	-3.15E-07	0.000461
GRASIM	-2.58E-07	0.000335	SATYAMCOMP	-4.09E-07	0.000113
HDFC	-1.63E-07	0.000379	SBIN	-7.64E-08	8.29E-05
HDFCBANK	5.06E-08	0.000339	SIEMENS	-9.96E-07	0.001082
HEROHONDA	-1.03E-07	0.00045	SUNPHARMA	-2.02E-06	0.000551
IDBI	-3.63E-07	0.000409	TATAPOWER	-8.92E-07	0.000293
IFCI	5.55E-07	0.000568	UNITECH	-4.18E-05	0.004259
INFOSYSTCH	-2.30E-07	0.000284	WIPRO	-7.13E-07	0.000234

Table 6.8: Percentage of pricing error standard deviation (σ_s*100): All companies

Company/ year	1999	2000	2001	2002	2003	2004	2005
ABB	0.102078	0.089676	0.069483	0.065185	0.08621	0.084098	0.060573
ACC	0.023825	0.034088	0.014395	0.017705	0.012142	0.095093	0.009813
ARVINDMILL	0.082569	0.455368	0.065893	0.012995	0.043167	0.053025	0.058234
APOLLOTYRE	1.956349	0.185051	0.479583	0.117974	0.043312	0.024275	0.055741
ASHOKLEY	0.076121	0.09995	0.071518	0.074049	0.225208	0.009407	0.039686
ASIANPAINT	0.133862	0.098489	0.118511	0.114791	0.137025	0.084594	0.065459
BAJAJAUTO	0.171117	0.088622	0.044561	0.035892	0.047787	0.036059	0.028686
BHARATFORG	0.307771	0.20995	0.117251	0.160816	0.046672	0.060204	0.054376
BHEL	0.038735	0.037593	0.025484	0.003925	0.032306	0.047951	0.021265
BPCL	0.101124	0.094675	0.045174	0.055488	0.006954	0.016221	0.021632
CIPLA	0.125383	0.068761	0.038123	0.039087	0.022071	0.032377	0.017441
DRREDDY	0.039573	0.053462	0.027052	0.017175	0.010861	0.026776	0.022111
GLAXO	0.036734	0.065394	0.041325	0.040183	0.037436	0.055069	0.272165
GRASIM	0.092183	0.058418	0.025595	0.034609	0.047681	0.029753	0.020714
HDFC	0.092982	0.074694	0.045372	0.041177	0.064349	0.034685	0.023494
HDFCBANK	0.090914	0.058558	0.038247	0.053626	0.036935	0.029533	0.021303
HEROHONDA	0.094108	0.119595	0.074631	0.004152	0.020022	0.019525	0.023852
IDBI	0.21166	0.574456	0.447214	0.122212	0.258979	0.029609	0.028794
IFCI	0.02835	0.379737	0.220681	0.200005	0.276043	0.030782	0.032355
INFOSYSTCH	0.048393	0.018413	0.009991	0.012241	0.004663	0.007573	0.010599

Table 6.8 (Continued)

Company/ year	1999	2000	2001	2002	2003	2004	2005
ITC	0.017386	0.024172	0.01201	0.016533	0.00944	0.020279	0.016347
LICHSGFIN	1.50622	0.13339	0.100274	0.097668	0.058753	0.043355	0.052347
M&M	0.103209	0.048059	0.026567	0.03403	0.019291	0.023595	0.019796
MOSERBAER	0.150761	0.048964	0.043703	0.04683	0.017811	0.041563	0.036269
NICOLASPIR	0.538517	0.148068	0.111624	0.076321	0.120324	1.011632	0.034649
NIRMA	0.888819	0.133293	0.119163	0.158445	0.116589	0.063949	0.112601
PFIZER	0.089399	0.025592	0.072367	0.172188	0.057494	0.072862	0.074456
PUNJABTRAC	0.124583	0.053968	0.073028	0.027752	0.044482	NA	0.047256
RANBAXY	0.052047	0.033124	0.018305	0.015984	0.009072	0.014843	0.013997
RAYMOND	0.21518	0.34641	0.84476	0.106587	0.07821	0.061797	0.059513
RELCAPITAL	0.09756	0.037676	0.022865	0.05859	0.031411	0.017101	0.027131
RELIANCE	0.188229	0.011738	0.009511	0.012941	0.004187	0.006227	0.005141
SAIL	0.127043	0.108807	0.047972	0.123539	0.056771	0.013446	0.037698
SATYAMCOMP	0.014081	0.015001	0.008345	0.009128	0.00387	0.005198	0.00805
SBIN	0.014563	0.019298	0.017541	0.024158	0.007457	0.005047	0.005602
SIEMENS	0.089549	0.082859	0.160474	0.113216	0.070149	0.08791	0.074723
SUNPHARMA	0.136806	0.097291	0.055238	0.059107	0.331918	0.058128	0.038731
TATAPOWER	0.084946	0.09897	0.040277	0.119583	0.026891	0.012703	0.007027
UNITECH	0.625915	0.601681	0.413956	0.453221	0.649576	0.253163	0.216626
WIPRO	0.172887	0.040983	0.021427	0.012137	0.007114	0.168739	0.014924
Average	0.227288	0.12435	0.105987	0.074031	0.079516	0.058692	0.044779

Table 6.9: Percentage of pricing error standard deviation (σ_s*100): Large market capitalization stocks.

Company/ Year	1999	2000	2001	2002	2003	2004	2005
ABB	0.102078	0.089676	0.069483	0.065185	0.08621	0.084098	0.060573
BHEL	0.038735	0.037593	0.025484	0.003925	0.032306	0.047951	0.021265
CIPLA	0.125383	0.068761	0.038123	0.039087	0.022071	0.032377	0.017441
GRASIM	0.092183	0.058418	0.025595	0.034609	0.047681	0.029753	0.020714
HDFC	0.092982	0.074694	0.045372	0.041177	0.064349	0.034685	0.023494
HDFCBANK	0.090914	0.058558	0.038247	0.053626	0.036935	0.029533	0.021303
HEROHONDA	0.094108	0.119595	0.074631	0.004152	0.020022	0.019525	0.023852
INFOSYSTCH	0.048393	0.018413	0.009991	0.012241	0.004663	0.007573	0.010599
ITC	0.017386	0.024172	0.01201	0.016533	0.00944	0.020279	0.016347
RANBAXY	0.052047	0.033124	0.018305	0.015984	0.009072	0.014843	0.013997
RELCAPITAL	0.09756	0.037676	0.022865	0.05859	0.031411	0.017101	0.027131
RELIANCE	0.188229	0.011738	0.009511	0.012941	0.004187	0.006227	0.005141
SAIL	0.127043	0.108807	0.047972	0.123539	0.056771	0.013446	0.037698
SATYAMCOMP	0.014081	0.015001	0.008345	0.009128	0.00387	0.005198	0.00805
SBIN	0.014563	0.019298	0.017541	0.024158	0.007457	0.005047	0.005602
SIEMENS	0.089549	0.082859	0.160474	0.113216	0.070149	0.08791	0.074723
SUNPHARMA	0.136806	0.097291	0.055238	0.059107	0.331918	0.058128	0.038731
TATAPOWER	0.084946	0.09897	0.040277	0.119583	0.026891	0.012703	0.007027
UNITECH	0.625915	0.601681	0.413956	0.453221	0.649576	0.253163	0.216626
WIPRO	0.172887	0.040983	0.021427	0.012137	0.007114	0.168739	0.014924
Average	0.115289	0.084865	0.057742	0.063607	0.076105	0.047414	0.033262

Table 6.10: Percentage of pricing error standard deviation (σ_s*100): Small market capitalization stocks.

Company/Year	1999	2000	2001	2002	2003	2004	2005
ACC	0.023825	0.034088	0.014395	0.017705	0.012142	0.095093	0.009813
ARVINDMILL	0.082569	0.455368	0.065893	0.012995	0.043167	0.053025	0.058234
APOLLOTYRE	1.956349	0.185051	0.479583	0.117974	0.043312	0.024275	0.055741
ASHOKLEY	0.076121	0.09995	0.071518	0.074049	0.225208	0.009407	0.039686
ASIANPAINT	0.133862	0.098489	0.118511	0.114791	0.137025	0.084594	0.065459
BAJAJAUTO	0.171117	0.088622	0.044561	0.035892	0.047787	0.036059	0.028686
BHARATFORG	0.307771	0.20995	0.117251	0.160816	0.046672	0.060204	0.054376
BPCL	0.101124	0.094675	0.045174	0.055488	0.006954	0.016221	0.021632
DRREDDY	0.039573	0.053462	0.027052	0.017175	0.010861	0.026776	0.022111
GLAXO	0.036734	0.065394	0.041325	0.040183	0.037436	0.055069	0.272165
IDBI	0.21166	0.574456	0.447214	0.122212	0.258979	0.029609	0.028794
IFCI	0.02835	0.379737	0.220681	0.200005	0.276043	0.030782	0.032355
LICHSGFIN	1.50622	0.13339	0.100274	0.097668	0.058753	0.043355	0.052347
M&M	0.103209	0.048059	0.026567	0.03403	0.019291	0.023595	0.019796
MOSERBAER	0.150761	0.048964	0.043703	0.04683	0.017811	0.041563	0.036269
NICOLASPIR	0.538517	0.148068	0.111624	0.076321	0.120324	1.011632	0.034649
NIRMA	0.888819	0.133293	0.119163	0.158445	0.116589	0.063949	0.112601
PFIZER	0.089399	0.025592	0.072367	0.172188	0.057494	0.072862	0.074456
PUNJABTRAC	0.124583	0.053968	0.073028	0.027752	0.044482	NA	0.047256
RAYMOND	0.21518	0.34641	0.84476	0.106587	0.07821	0.061797	0.059513
Average	0.339287	0.163849	0.154232	0.084455	0.082927	0.061797	0.056297

Chapter- 7

Summary and Findings

7.1 Introduction

Over the past 15 years Indian securities trading industry has undergone structural changes which had far reaching consequences and these changes encompass various regulatory and procedural changes, adoption of new technology and introduction of new financial instruments for trading. The basic motivation behind these changes has been to improve the quality of the security market and to raise the standard of Indian securities trading industry to international level.

Establishment of NSE constitutes as a unique event in the history of Indian securities trading industry. Major reforms in Indian securities market were initiated in NSE and later followed by other stock exchanges. Capital market segment in NSE started its operations in November 1994 and since then it has witnessed remarkable changes in its market microstructure. In January 2000 internet trading in the capital market segment was started. In June same year derivatives trading in index futures had started. It was followed by commencement of trading in index options in June 2001, options on individual securities in July 2001 and futures on individual securities in November 2001. In the subsequent years derivative contracts were extended to other indexes and more individual securities. Apart from these, Investor grievance cell, NSCCL, first Clearing Corporation and Investor Protection Fund were established in 1995. Settlement

Guarantee Fund in 1996 and various other regulatory changes in the security market were introduced.

The present study analyses the impact of various reforms brought in the Indian securities market upon the quality of the market. To be specific, this study analyses the price adjustment and liquidity effect of market reforms. Advancement in technology viz. introduction of internet trading in the capital market segment, advancement in print and electronic media had facilitated faster dissemination of information to traders. Investors could get news quickly and react to such news through their trading strategies irrespective of location barriers. This could have a positive impact on price adjustment process. Introduction of new instruments viz. derivatives could be used for hedging and is expected to have positive impact on liquidity in the system. Various regulatory measures which are undertaken in the security market are expected to improve transparency. More transparent and efficient system could attract more traders from within the country and from other countries as well. This could also have a positive impact on price adjustment and liquidity. Keeping all these issues in mind, this study aims to empirically evaluate the impact of such changes in the market microstructure on market quality i.e. process of price adjustment and liquidity over the years.

The security speed of adjustment is analyzed by using ARMA model which has been used in the literature since 2004. The basic underlying model is partial adjustment with noise contributed by Amihud and Mendelson (1987). The ARMA model was adopted to measure speed of adjustment for the first time by Theobald and Yallup (2004) and later used by Poshakwale and Theobald (2004), Steely (2005) and others. It measures the

degree of underreaction or overreaction in prices. The theory behind this methodology is that underreaction and overreaction in stock prices induce a particular type of autocorrelations in the return process. To be specific, underreactions leads to positive autocorrelations and overreactions leads to negative autocorrelations. Accordingly, the behavior of security prices to the arrival of information is examined in this study.

To analyze the pattern in the security speed of adjustment over the years, the study divides the total period into three sub periods namely, 1995- 1999, 2000- 2003 and 2004-2008. These sub periods represent different phases in the growth of NSE. By comparing the security speed of adjustment coefficients of sample companies in the three sub periods, inferences regarding whether speed of adjustment has improved or not has been confirmed. At the same time by comparing the security speed of adjustment coefficients with other markets quality differences are also assessed.

Efficient market hypothesis states that a market is efficient if it fully reflects publically available information. This eliminates the possibility of risk free profits for speculators and momentum traders. Basically it argues lack of return predictability as a criterion for market efficiency. Future returns may not be predictable from past returns but it may reflect varying degrees of private information in it. Based on variance ratio of daytime to overnight return and first order autocorrelations in daily returns, an attempt is made to analyze the process of incorporation of private information. This study also attempted to show the differences in the properties of opening and closing prices through variance ratio of opening to closing returns and first order autocorrelations in daily opening and closing prices. To further investigate into the pattern of opening and closing prices,

security speed of adjustment differences in opening and closing prices is also examined in this study.

If market reforms are to have a beneficial impact on market quality, an improvement in market liquidity should be discernable. To examine such an effect, bid- ask spreads is taken as a measure of liquidity. A log- linear regression model is used to estimate the liquidity effects of market reforms. The specification of the model is similar to the one used by Jegadeesh and Subrahmanyam (1993) to examine the liquidity effects of introduction of S&P 500 index futures contracts on the underlying securities. In the employed model, proportionate bid- ask spreads is independent variable and determinants of spreads are independent variables. The inclusion of determinants of spreads as independent variables has been supported by the earlier studies [e.g. Benston and Hagerman (1974) and Stoll (1978)]. In addition to these, a dummy variable has been assigned which takes the value of one for that particular year and zero for rest of the years. Dummy variables are assigned to each year except the first year i.e. 1999 to avoid the problem of perfect multicollinearity. Based on the sign and statistical significance of coefficients of dummy variables, any changes in the bid- ask spreads over the years could be attributed to changes in market microstructure.

Bivariate Vector Autoregressive (VAR) model has been used for analyzing the transaction cost in the security market. The transaction price is decomposed into two components viz. random walk component and stationary component. The random walk component is identified as efficient price or fundamental price and stationary component i.e. difference between efficient price and actual transaction price is termed as pricing

error. The pricing error is central to this study which is regarded as a natural measure of market quality. When trade barriers are reduced, transaction price is expected to follow efficient price closely. VAR model with return and signed trading volume i.e. positive sign for a buyer initiated trade and negative sign for a seller initiated trade have been used as variables. The pricing error standard deviation which is which is estimated from VAR model is regarded as a proxy for transaction cost.

This study is based on 40 sample companies which are listed in NSE since 1995. Sample companies are selected based on market capitalization. NSE is the data source of this study i.e. daily data is downloaded from the official website of NSE and high frequency data CD is purchased from NSE. The study covers the period from January 1995 to December 2008. The data used in his study includes daily opening prices, closing prices, daily trading volume, daily bid- ask quotes, intraday price and volume in the spot market.

7.2 Main Findings

The main findings of the study are as follows:

i) The analysis of the security speed of adjustment throws light on the impact of changes in market microstructure on the price adjustment process. First, the introduction of various reforms in NSE has not resulted in significant improvement in the security speed of adjustment of the sample stocks. Empirical evidences clearly show that there is no significant difference in the speed of adjustment coefficients for all three sub periods. Second, the study did not find significant difference between the security speed of

adjustment of small and large market capitalization stocks. Trends and patterns in security speed of adjustment coefficients of sample average are reflected in the small and large market capitalization categories also. Third, there is some evidence regarding market wide news being absorbed faster than company specific news. This is shown by the difference in the security speed of adjustment coefficients of individual companies and sample averages of the same. Finally, this study confirms that changes in the market microstructure have not resulted in any predictable patterns in terms of persistent underreaction or overreaction. It has also shown high speed of adjustment to intrinsic or fundamental values.

ii) Even though market is efficient from the point of view lack of return predictability, it may reflect varying degrees of information. Through variance ratio and first order autocorrelation coefficients, the process of incorporation of private information is analyzed. Empirical results have shown higher return variance during daytime over overnight period and first order autocorrelations in daily returns is largely insignificant for majority of stocks. This shows incorporation of private information during trading hours. The autocorrelation coefficients do not indicate clear cut improvement in terms of reduction in mispricing. The study has further probed into the details regarding possible difference in the price behavior in opening and closing prices. The results revealed a higher variance in returns estimated from opening prices over closing returns. Opening returns were found to have significant negative autocorrelation in majority cases whereas closing returns have significant positive autocorrelation in a few cases. Taking cue from this, the study has examined the difference in security speed of adjustment in opening and

closing returns and found higher speed of adjustment in opening returns than in the closing returns. But the results do not show a clear-cut overreaction in opening returns over closing returns.

iii) An attempt is made to examine the liquidity effects of changes in the market microstructure. The mean bid- ask spreads of the sample stocks did not change much over the years during the study period and the minor changes are explained by the determinants of spreads to a large extent. From this, it can be inferred that changes in market microstructure did not result in significant improvement in liquidity. The dummy variable included in the log- linear regression model to capture the liquidity effects of changes in the market microstructure is largely insignificant and even in those cases in which it is significant does not show a clear pattern of either improvement or deterioration. This implies that changes in the market microstructure have not resulted in significant changes in liquidity present in the market.

iv) The analysis of impact of changes in the market microstructure on the transaction cost of security trading shows that there is no significant change in the implicit transaction cost. Except for reduction in transaction cost in the first two years, for rest of the study period transaction cost is almost similar. This study also did not find clear difference in the transaction cost for small and large market capitalization stocks. On the whole the percentage of pricing error standard deviation is at a level which is consistent with studies relating to developed markets.

v) On the whole the study points out that change in the market microstructure did not result in any predictable pattern in returns. It also shows that the empirical results of security speed of adjustment and transaction cost are very much comparable to the results of studies relating to developed markets. But it is quite clear that during the study period, the market did not register significant improvement in quality of market.

The study is based on following two hypotheses:

i) Changes in market microstructure in terms of various regulatory, procedural and technological changes results in improvement in market quality.

ii) Changes in market microstructure leads to predictable pattern in returns.

The overall results of this study reject both the hypotheses. The empirical evidences have established that market quality did not improve during the study period and it did not result in any predictable patterns in returns behavior so that a sophisticated investor could exploit it to make risk free profits.

7.3 Implications of the Study

i) This study provides a comprehensive analysis of the impact of changes in market microstructure on market quality in NSE. Results of this study confirm that the absolute quality of Indian stock market is at a high level and can be compared with developed markets in the world. This evidence should be of interest to various market participants

particularly to investors in general and foreign individual and institutional investors in particular.

ii) Empirical evidences of this study also confirm that there is no significant improvement in the market quality over the years. Various market quality measures used in this study showed no remarkable improvement in market quality over the years. This finding complements the findings of Chordia *et al.* (2008) which showed that apart from tick size change, most of other changes in market microstructure did not result in permanent improvement in liquidity. From eights to sixteenths and further down to decimal tick size regimes, their study found significant improvement in liquidity and within each tick size regime level of liquidity was mostly stable. There are erratic fluctuations in bid- ask spreads but none of these fluctuations resulted in a permanent shift in liquidity. As far as NSE is concerned, since its inception it has same tick size and it did not make any changes to tick size in capital market segment.

iii) The results of the security speed of adjustment and transaction cost should encourage participation of more people in stock market trading like domestic and foreign investors, individual and institutional investors. Since 2000 there has been rapid increase in total traded quantity and reduction in the average trade size, which is clearly an indication of increased participation in stock market trading. The results of this study are quite close to the results of similar studies relating to the developed markets.

iv) This study has also found that changes in the market microstructure did not result in any predictable pattern in the stock price behavior. There is neither underreaction nor

overreaction as shown by security speed of price adjustment and trends in price adjustment hold similar in all time periods. This could be taken as evidence in support of market efficiency.

7.4 Direction for Future Research

This study can be extended and complemented in various ways. First, this study is based on stocks listed in NSE since 1995 which are selected based on market capitalization. Most of the sample stocks included in this study belong to the category of top 100 companies based on market capitalization. Before generalizing the findings of this study, it may be interesting to take another sample of companies consisting of low market capitalization category. The results of such a study can be compared with present study. Second, NSE started its operation with a better market structure from the beginning itself. It is the first stock exchange to start with screen based trading as well as the first exchange to have demutualised organizational structure. This could be the reason for not finding significant improvement in market quality since it started with better market structure. So a similar study on BSE and comparing the market quality of two leading markets in India may give better insights regarding market quality over time as well as across markets. Third, this study has concentrated only on changes in market quality over time. Similar study can be taken up to examine other important aspects like volatility over time. Such a study might be equally important to regulators, investors and other market participants as well. Fourth, market quality can change over time. It can also change within the trading day. So a study examining changes in market quality on an

hourly basis within the trading day may give interesting results. Such a finding may be of importance to various market participants. Hence research based on intraday data can throw light on these interesting aspects of security market transaction.

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Market Microstructure and Market Quality- A Case of National Stock Exchange of India

Reply to the comments of external examiner

1) Why not regress speed of adjustment coefficients on their market capitalizations, just to get an alternative perspective on the relation between the speed of adjustment and market capitalization?

The relationship between market capitalization and speed of adjustment is quite well established in the empirical literature. Almost all cited studies regarding speed of adjustment have found large market capitalization stocks having higher speed of adjustment than the small capitalization stocks. To specifically try it in the form of regression, for each firm there are only three sets of speed of adjustment coefficients corresponding to three time periods. So, technically it is not possible to estimate regression equation to test the relationship between speed of adjustment of firms and market capitalization.

2) Is it possible to ferret out why some firms recorded decrease in the security speed of adjustment coefficient and some increase?

Comparison of speed of adjustment result shows that only five companies have recorded deterioration in speed of adjustment where as two companies recorded improvement. Majority of the companies did not show any systematic pattern in speed of adjustment over the years. Since the basic motive of the study is to find out impact of structural changes on speed of adjustment and since most of the stocks did not show any systematic

pattern, this study did not go to the extent of exploring the firm specific factors which could be responsible for this trend. But by looking at the nature of companies which have recorded deterioration belongs to sectors like power, auto, steel etc might give some insight on this aspect. Because during the study period especially institutional investment has seen a gradual shift towards sectors like information technology, finance from more traditional sectors.

3) How about checking how stocks reacted to specific event(s) by taking the CAR (Cumulative Abnormal Return) following the event(s) and analyzing whether these CARs recently reduced after microstructure changes?

As per the suggestion given by the examiner, an attempt has been made to look at the Cumulative Abnormal Return (CAR) for individual companies around specific events. In stock market trading, abnormal returns are the differences between a single stock or portfolio's performance in regard to the average market performance over a set period of time. Usually a broad index is used as a reference for the average market performance. In this case Nifty index is used as a reference for the average market performance. Cumulative abnormal return, or CAR, is the sum of all abnormal returns up to time. If there is no abnormal return, then CAR equals zero.

Three events viz. introduction of internet trading (February 2000), index futures (June 2000), and index options (June 2001) have been taken for the analysis. An estimation window of six months before and six months after the event has been selected which excludes the month in which the event has occurred. Around the introduction of internet trading CAR decreased for 13 companies whereas increased for four companies. Total 11

companies have recorded negative abnormal return before the event and positive abnormal return after the event. At the same time, 11 companies have recorded positive abnormal return before the event and negative abnormal return after the event.

Around the introduction of index futures, 10 companies recorded reduction in abnormal return whereas six companies recorded increase in abnormal return. Total 16 companies have recorded negative abnormal return before the event and positive abnormal return after the event. In the same manner, seven companies have recorded positive abnormal return before the event and negative abnormal return after the event.

In case of index options, 12 companies experienced reduction in abnormal return whereas eight companies recorded increase in abnormal return. Total 10 companies have recorded negative abnormal return before the event and positive abnormal return after the event and 10 companies have recorded positive abnormal return before the event and negative abnormal return after the event.

4) Would it not be good to use the Multiple Variance Ratio Test proposed by Chow and Denning (Journal of Econometrics 1993) for tables 4.1 to 4.3?

The study has incorporated the Chow- Denning (1993) variance ratio test as suggested by the examiner to test for return predictability. Variance ratio test has been conducted on daytime, overnight, opening and closing returns. If the variance ratio test statistic falls between -1.96 to +1.96, it accepts the Random Walk Hypothesis (RWH) at 5% level of significance.

The variance ratio test conducted on daily return i.e. from closing prices, shows that for 23 companies RWH is not rejected at 5% level of significance in the first period i.e. from 1995- 1999. In the second period i.e. 2000- 2003 for 19 companies RWH is not rejected and for final period from 2004- 2008, for 23 companies RWH is not rejected. Variance ratio test also supports the findings based on autocorrelation i.e. market quality has not changed considerably over a period of time.

5) Generally, does the extent of autocorrelation for a particular firm in daily returns as well as returns estimated from opening and closing prices change over time, and if it does, in which direction?

The extent of autocorrelation in opening returns has increased over the years. In opening returns, 18 companies in the first period, 32 companies in the second period, and 35 companies in the third have shown significant negative autocorrelation. But in the closing return which is also considered as the daily return has shown a declining trend. Total 19 companies in the first period, 14 companies in the second period and 13 companies in the third period have significant positive autocorrelation.

6) Are firms' autocorrelation of daily returns and their autocorrelation estimated from opening and closing prices correlated?

Relationship between autocorrelations in opening and closing returns shows a specific pattern. Opening returns have larger autocorrelation coefficients which are negative and significant in most cases. Whereas in closing returns, the size of the autocorrelation

coefficients are smaller, mostly positive and significant in less cases in comparison with opening returns.

7) Is it too narrow to define "market quality" merely by looking at variance ratios and autocorrelations?

The study has adopted incorporation of private information as one criteria for market quality along with speed of adjustment, liquidity and transaction cost. Further, this methodology has been extensively used in the literature; the most recent is a study by Chordia *et al.* (2008) published in Journal of Financial Economics. To further strengthen the methodology, Chow- Denning (1993) variance ratio test has been incorporated to check for random walk in the return series.

8) Are there any sector specific effects of microstructure changes on liquidity?

The study did not find clear cut evidence of sector specific effects of microstructure changes on liquidity in the sample considered for the present study. Different companies from same sector have shown improvement in liquidity, deterioration as well as insignificant change over time.

9) Do some Indian studies not point out that there has been improvement in liquidity in recent times (possibly due to microstructure changes)? If yes, the current thesis should be liken those findings with its own?

There are some studies which have examined the liquidity effects around a particular event viz. introduction of single stock futures. But in this study an attempt is made to see

whether liquidity has improved over a period of time. The study has identified a series of changes in market structure and selected a sample of mostly large sized and frequently traded stocks to check the effect of liquidity over a period of time.

10) Is it not worth looking at the standard deviation of bid- ask spreads?

The study has initially reported the mean values of the variables used in the liquidity model. As per the suggestion given by the examiner, I incorporated variance of proportionate spreads from 1999 to 2005. It shows that variance has been changing over time and relatively smaller variance has been recorded in 2005 in comparison with 1999.

11) Statements like “values are both positive and negative need to be clarified.

When I wrote ‘values are both positive and negative’, I meant, mean return estimated from intraday data has been for positive for some companies and negative for some other companies. It also means that, companies did not consistently provide either positive or negative return in a particular year.

12) The sentence “implicit transaction cost estimated as pricing error standard deviation is interpreted as the money spent over fundamental value of a security” also needs clarification.

The transaction cost estimation methodology used in the study divides the time series in to two parts viz. random walk component and residual stationary component. In case of stock prices, random walk is identified as efficient price and residual stationary component as pricing error. So pricing error represents the deviation of transaction price

from random walk. Intuitively I meant, implicit transaction cost is the execs expenditure incurred on a stock which is above the efficient price.

13) Some studies have reported that transaction cost in India is quite high compared to some other markets. Does this finding of the thesis that transaction cost is not very high not point towards a reduction in transaction cost, which is perhaps owed to the changes in the microstructure?

Regarding the implicit transaction cost, I found a study by Krishnamurti *et al.* (2002) who compared the transaction cost difference between BSE and NSE. They found that BSE has higher transaction cost than NSE in almost all stocks of their sample. They also found a mean transaction cost estimate of 0.27 for study period between January 1997 to July 1997. In the present study I compared the transaction cost estimate of my study with Hasbrouck (1993) estimates. But this comparison is only regarding the implicit cost estimates and also keeping in mind the difference in the study period also. Since I did not find studies based on similar methodology for world markets corresponding my study period, I did not extend the comparison of transaction cost with developed or emerging markets. But the study has found a reduction in transaction in transaction cost by comparing the 2005 estimates with 1999.

14) To get an alternative perspective, can the transaction cost not be regressed on market capitalization?

The relationship between transaction cost and market capitalization of the companies is quite well established in the literature. Earlier studies have found large market

capitalization companies with lower transaction cost in comparison with small market capitalization companies. Even in this study also, some evidence is found in support of the relationship between market capitalization and transaction cost.

15) One drawback of the thesis is its focus only on reasonably large stocks. It is necessary to take at least a group of (say 40 stocks) small stocks and compare them along some selected dimensions like say, transaction cost with sample taken in the thesis.

This is an important observation on the sample selected for the study. The primary objective of the study is to look at impact of changes in market structure on market quality over the years. In this context first consideration given for selecting the sample is to have group of companies which are listed and actively traded in the entire study period. If there is a major change in market quality, it would better reflect in companies which are traded actively. But still in the selected sample nearly 20 companies belonged to Nifty and other companies belonged to mostly Nifty Junior which comprises the small market capitalization stocks in comparison with former. Extending the study to further small sized stocks could give interesting results especially regarding the relationship between small and large size capitalization stocks in terms of speed of adjustment, liquidity and transaction cost. Definitely I will extend the present work to further small capitalization stocks while publishing my work.

16) Won't it be interesting to test what has happened to the absolute variance of returns on stocks both in absolute terms as well as with respect to mean returns after the changes in market microstructure?

I have examined the mean and variance of stock return around important events. There events viz. introduction of internet trading, index futures and index options. Six month pre and post estimation window is considered excluding the month in which the event has occurred. In this case also there is no common trend across stocks either in terms of increase or decrease in variance. Some companies have recorded larger variance in the post event window whereas others recorded reduction in variance. Even in the case of mean return also, it does not show a specific pattern.

17) Would it not be interesting to check the characteristics of rims that gained from the changes from the changes in market microstructure and those did not?

Indian securities markets experienced considerable changes in market structure especially since 1995. Research from market microstructure perspective is an emerging field which could bring important insights for regulators and investors. This observation gives direction for my future research work.

Cumulative Abnormal Returns- Internet Trading

Company	Pre Event	Post Event
ABB	-0.592	0.042
ACC	-0.327	-0.081
APOLLOTYRE	0.490	-0.331
ARVINDMILL	-0.588	-0.496
ASHOKLEY	-0.092	-0.416
ASIANPAINT	0.147	-0.200
BAJAJAUTO	-0.492	0.342
BHARATFORG	0.511	-0.066
BHEL	-0.569	0.083
BPCL	0.220	-0.272
CIPLA	-0.632	-0.177
DRREDDY	0.248	0.010
GLAXO	-0.293	0.130
GRASIM	0.142	0.001
HDFC	0.101	0.437
HDFCBANK	0.863	0.270
HEROHONDA	-0.336	0.281
IDBI	-0.112	-0.105
IFCI	-0.335	-0.326
INFOSYSTCH	0.234	0.119
ITC	-0.539	0.210
LICHSGFIN	-0.448	-0.136
M&M	0.122	-0.790
MOSERBAER	1.170	0.022
NICOLASPIR	0.429	-0.259
NIRMA	0.760	-0.256
PFIZER	0.030	-0.249
PUNJABTRAC	-0.551	-0.963
RANBAXY	-0.172	-0.104
RAYMOND	-0.149	0.473
RELCAPITAL	0.768	-0.670
RELIANCE	0.440	0.251
SAIL	-0.008	-0.453
SATYAMCOMP	0.279	-0.469
SBIN	-0.178	0.029
SIEMENS	0.252	-0.036
SUNPHARMA	1.184	-0.270
TATAPOWER	-0.144	0.131
WIPRO	-0.463	-0.536

Cumulative Abnormal Returns- Index Futures

Company	Pre Event	Post Event
ABB	-0.636	0.392
ACC	-0.518	0.446
APOLLOTYRE	-0.630	0.087
ARVINDMILL	-0.516	0.304
ASHOKLEY	-0.419	-0.162
ASIANPAINT	0.103	-0.227
BAJAJAUTO	-0.074	-0.296
BHARATFORG	-0.456	-0.357
BHEL	-0.675	0.361
BPCL	-0.608	-0.305
CIPLA	-0.740	0.341
DRREDDY	0.211	0.128
GLAXO	-0.814	0.212
GRASIM	-0.505	0.155
HDFC	0.666	0.134
HDFCBANK	0.688	0.028
HEROHONDA	-0.140	0.034
IDBI	0.038	0.317
IFCI	-0.400	0.070
INFOSYSTCH	-0.279	-0.226
ITC	0.039	0.276
LICHSGFIN	-0.247	0.327
M&M	-0.496	-0.204
MOSERBAER	0.166	-0.319
NICOLASPIR	-0.157	0.085
NIRMA	0.108	-0.082
PFIZER	0.078	0.234
PUNJABTRAC	-0.601	-0.090
RANBAXY	-0.586	0.301
RAYMOND	0.034	0.531
RELCAPITAL	0.341	-0.108
RELIANCE	0.444	0.147
SAIL	-0.523	0.145
SATYAMCOMP	0.275	-0.515
SBIN	-0.137	-0.014
SIEMENS	-0.425	0.097
SUNPHARMA	-0.142	0.148
TATAPOWER	-0.266	0.345
WIPRO	0.404	-0.048

Cumulative Abnormal Returns- Index Options

Company	Pre Event	Post Event
ABB	0.145	-0.157
ACC	0.050	0.148
APOLLOTYRE	-0.148	0.335
ARVINDMILL	-0.134	0.214
ASHOKLEY	0.426	0.271
ASIANPAINT	0.083	0.136
BAJAJAUTO	0.123	0.427
BHARATFORG	-0.432	0.476
BHEL	0.464	-0.199
BPCL	-0.021	0.059
CIPLA	0.195	0.037
DRREDDY	0.120	-0.509
GLAXO	-0.073	-0.058
GRASIM	0.397	-0.048
HDFC	0.308	0.009
HDFCBANK	0.121	0.119
HEROHONDA	-0.093	0.582
IDBI	-0.248	-0.435
IFCI	-0.100	-0.291
INFOSYSTCH	-0.562	0.131
ITC	0.056	-0.062
LICHSGFIN	0.292	0.256
M&M	-0.093	0.148
MOSERBAER	0.006	0.004
NICOLASPIR	-0.149	-0.109
NIRMA	-0.567	-0.433
PFIZER	-0.119	0.016
PUNJABTRAC	-0.007	-0.026
RANBAXY	-0.383	0.402
RAYMOND	-0.045	0.129
RELCAPITAL	-0.283	0.104
RELIANCE	0.261	-0.140
SAIL	-0.030	-0.062
SATYAMCOMP	-0.365	0.373
SBIN	0.276	-0.133
SIEMENS	-0.258	-0.019
SUNPHARMA	0.251	0.143
TATAPOWER	0.671	-0.032
WIPRO	-0.350	0.181

Mean and Variance of daily returns- Internet Trading

Company	Pre Event		Post Event	
	Mean	Variance	Mean	Variance
ABB	-0.0047	0.0011	0.0003	0.0007
ACC	-0.0026	0.0011	-0.0006	0.0012
APOLLOTYRE	0.0039	0.0018	-0.0026	0.0014
ARVINDMILL	-0.0046	0.0007	-0.0039	0.0014
ASHOKLEY	-0.0007	0.0016	-0.0033	0.0012
ASIANPAINT	0.0012	0.0006	-0.0016	0.0032
BAJAJAUTO	-0.0039	0.0005	0.0027	0.0005
BHARATFORG	0.0040	0.0014	-0.0005	0.0015
BHEL	-0.0045	0.0008	0.0007	0.0011
BPCL	0.0017	0.0011	-0.0022	0.0020
CIPLA	-0.0050	0.0099	-0.0014	0.0015
DRREDDY	0.0020	0.0012	0.0001	0.0015
GLAXO	-0.0023	0.0005	0.0010	0.0008
GRASIM	0.0011	0.0013	0.0000	0.0019
HDFC	0.0008	0.0008	0.0035	0.0017
HDFCBANK	0.0068	0.0013	0.0021	0.0013
HEROHONDA	-0.0026	0.0007	0.0022	0.0011
IDBI	-0.0009	0.0007	-0.0008	0.0012
IFCI	-0.0026	0.0006	-0.0026	0.0008
INFOSYSTCH	0.0018	0.0044	0.0009	0.0014
ITC	-0.0042	0.0008	0.0017	0.0009
LICHSGFIN	-0.0035	0.0004	-0.0011	0.0008
M&M	0.0010	0.0013	-0.0063	0.0020
MOSERBAER	0.0092	0.0025	0.0002	0.0017
NICOLASPIR	0.0034	0.0012	-0.0021	0.0007
NIRMA	0.0060	0.0009	-0.0020	0.0013
PFIZER	0.0002	0.0009	-0.0020	0.0046
PUNJABTRAC	-0.0043	0.0005	-0.0076	0.0099
RANBAXY	-0.0014	0.0007	-0.0008	0.0010
RAYMOND	-0.0012	0.0011	0.0038	0.0014
RELCAPITAL	0.0060	0.0018	-0.0053	0.0017
RELIANCE	0.0035	0.0005	0.0020	0.0008
SAIL	-0.0001	0.0037	-0.0036	0.0009
SATYAMCOMP	0.0022	0.0042	-0.0037	0.0021
SBIN	-0.0014	0.0005	0.0002	0.0005
SIEMENS	0.0020	0.0011	-0.0003	0.0007
SUNPHARMA	0.0093	0.0020	-0.0022	0.0022
TATAPOWER	-0.0011	0.0006	0.0010	0.0011
WIPRO	-0.0036	0.0208	-0.0043	0.0025

Mean and Variance of daily returns – Index Futures

Company	Pre Event		Post Event	
	Mean	Variance	Mean	Variance
ABB	-0.0051	0.0011	0.0031	0.0004
ACC	-0.0042	0.0015	0.0035	0.0007
APOLLOTYRE	-0.0051	0.0017	0.0007	0.0007
ARVINDMILL	-0.0042	0.0015	0.0024	0.0014
ASHOKLEY	-0.0034	0.0020	-0.0013	0.0008
ASIANPAINT	0.0008	0.0010	-0.0018	0.0028
BAJAJAUTO	-0.0006	0.0008	-0.0023	0.0006
BHARATFORG	-0.0037	0.0019	-0.0028	0.0008
BHEL	-0.0054	0.0014	0.0029	0.0010
BPCL	-0.0049	0.0024	-0.0024	0.0046
CIPLA	-0.0060	0.0016	0.0027	0.0007
DRREDDY	0.0017	0.0020	0.0010	0.0005
GLAXO	-0.0066	0.0009	0.0017	0.0004
GRASIM	-0.0041	0.0022	0.0012	0.0009
HDFC	0.0054	0.0020	0.0011	0.0007
HDFCBANK	0.0055	0.0018	0.0002	0.0007
HEROHONDA	-0.0011	0.0014	0.0003	0.0007
IDBI	0.0003	0.0016	0.0025	0.0008
IFCI	-0.0032	0.0012	0.0006	0.0009
INFOSYSTCH	-0.0023	0.0054	-0.0018	0.0005
ITC	0.0003	0.0015	0.0022	0.0004
LICHSGFIN	-0.0020	0.0010	0.0026	0.0002
M&M	-0.0040	0.0024	-0.0016	0.0008
MOSERBAER	0.0013	0.0025	-0.0025	0.0009
NICOLASPIR	-0.0013	0.0009	0.0007	0.0004
NIRMA	0.0009	0.0017	-0.0006	0.0005
PFIZER	0.0006	0.0013	0.0019	0.0004
PUNJABTRAC	-0.0048	0.0012	-0.0007	0.0005
RANBAXY	-0.0047	0.0009	0.0024	0.0006
RAYMOND	0.0003	0.0018	0.0042	0.0009
RELCAPITAL	0.0028	0.0023	-0.0009	0.0007
RELIANCE	0.0036	0.0009	0.0012	0.0001
SAIL	-0.0042	0.0021	0.0011	0.0006
SATYAMCOMP	0.0022	0.0021	-0.0041	0.0013
SBIN	-0.0011	0.0008	-0.0001	0.0002
SIEMENS	-0.0034	0.0011	0.0008	0.0004
SUNPHARMA	-0.0011	0.0026	0.0012	0.0007
TATAPOWER	-0.0021	0.0010	0.0027	0.0006
WIPRO	0.0033	0.0035	-0.0004	0.0011

Mean and Variance of daily returns – Index Options

Company	Pre Event		Post Event	
	Mean	Variance	Mean	Variance
ABB	0.0012	0.0006	-0.0013	0.0004
ACC	0.0004	0.0011	0.0012	0.0006
APOLLOTYRE	-0.0012	0.0007	0.0027	0.0014
ARVINDMILL	-0.0011	0.0013	0.0017	0.0008
ASHOKLEY	0.0034	0.0016	0.0022	0.0008
ASIANPAINT	0.0007	0.0004	0.0011	0.0002
BAJAJAUTO	0.0010	0.0009	0.0035	0.0005
BHARATFORG	-0.0035	0.0013	0.0039	0.0013
BHEL	0.0037	0.0013	-0.0016	0.0008
BPCL	-0.0002	0.0056	0.0005	0.0007
CIPLA	0.0016	0.0006	0.0003	0.0005
DRREDDY	0.0010	0.0006	-0.0041	0.0048
GLAXO	-0.0006	0.0006	-0.0005	0.0005
GRASIM	0.0032	0.0007	-0.0004	0.0005
HDFC	0.0025	0.0007	0.0001	0.0006
HDFCBANK	0.0010	0.0004	0.0010	0.0003
HEROHONDA	-0.0008	0.0011	0.0047	0.0008
IDBI	-0.0020	0.0023	-0.0035	0.0005
IFCI	-0.0008	0.0013	-0.0024	0.0014
INFOSYSTCH	-0.0045	0.0013	0.0011	0.0010
ITC	0.0005	0.0005	-0.0005	0.0005
LICHSGFIN	0.0024	0.0004	0.0021	0.0002
M&M	-0.0007	0.0006	0.0012	0.0009
MOSERBAER	0.0000	0.0014	0.0000	0.0012
NICOLASPIR	-0.0012	0.0003	-0.0009	0.0002
NIRMA	-0.0046	0.0007	-0.0035	0.0005
PFIZER	-0.0010	0.0004	0.0001	0.0003
PUNJABTRAC	-0.0001	0.0006	-0.0002	0.0005
RANBAXY	-0.0031	0.0006	0.0033	0.0005
RAYMOND	-0.0004	0.0008	0.0010	0.0005
RELCAPITAL	-0.0023	0.0006	0.0008	0.0004
RELIANCE	0.0021	0.0003	-0.0011	0.0005
SAIL	-0.0002	0.0009	-0.0005	0.0003
SATYAMCOMP	-0.0029	0.0021	0.0030	0.0016
SBIN	0.0022	0.0005	-0.0011	0.0004
SIEMENS	-0.0021	0.0006	-0.0002	0.0004
SUNPHARMA	0.0020	0.0007	0.0012	0.0006
TATAPOWER	0.0054	0.0015	-0.0003	0.0007
WIPRO	-0.0028	0.0020	0.0015	0.0018

Proportionate Spread Variance

Company	1999	2000	2001	2002	2003	2004	2005
ABB	0.00012	0.00013	0.00020	0.00010	0.00024	0.00015	0.00017
ACC	0.00010	0.00012	0.00006	0.00022	0.00006	0.00058	0.00007
ARVINDMILL	0.00007	0.00017	0.00021	0.00027	0.00008	0.00021	0.00009
APOLLOTYRE	0.00065	0.00086	0.00034	0.00041	0.00010	0.00029	0.00032
ASHOKLEY	0.00016	0.00009	0.00025	0.00017	0.00010	0.00041	0.00043
ASIANPAINT	0.00009	0.00008	0.00006	0.00015	0.00037	0.00014	0.00010
BAJAJAUTO	0.00010	0.00007	0.00016	0.00020	0.00004	0.00014	0.00007
BHARATFORG	0.11343	0.00022	0.00028	0.00064	0.00010	0.00016	0.00017
BHEL	0.00009	0.00013	0.00009	0.00030	0.00013	0.00015	0.00014
BPCL	0.00020	0.00015	0.00025	0.00033	0.00011	0.00013	0.00011
CIPLA	0.00011	0.10938	0.00012	0.00005	0.00004	0.00009	0.00015
DRREDDY	0.00011	0.00022	0.00003	0.00013	0.00005	0.00007	0.00009
GLAXO	0.00004	0.00018	0.00016	0.00005	0.00005	0.00027	0.00013
GRASIM	0.00448	0.00037	0.00011	0.00007	0.00004	0.00007	0.00006
HDFC	0.00116	0.00019	0.00014	0.00006	0.00006	0.00009	0.00008
HDFCBANK	0.00010	0.00010	0.00008	0.00014	0.00009	0.00014	0.00008
HEROHONDA	0.00015	0.00013	0.00027	0.00018	0.00003	0.00021	0.00010
IDBI	0.00007	0.00017	0.00063	0.00056	0.00017	0.00020	0.00045
IFCI	0.00021	0.00154	0.00251	0.00200	0.10864	0.00095	0.00046
INFOSYSTCH	0.00023	0.00010	0.00014	0.00009	0.00004	0.00008	0.00008
ITC	0.00009	0.00006	0.00011	0.00008	0.00004	0.00008	0.00005
LICHSGFIN	0.00015	0.00012	0.00014	0.00074	0.00007	0.00014	0.00014
M&M	0.00048	0.00039	0.00023	0.00014	0.00011	0.00021	0.00009
MOSERBAER	0.00082	0.00019	0.00027	0.00028	0.00008	0.00029	0.00012
NICOLASPIR	0.00048	0.00011	0.00005	0.00038	0.00009	0.00024	0.00012
NIRMA	0.10794	0.00016	0.00023	0.00004	0.00018	0.00021	0.00020
PFIZER	0.00010	0.00015	0.00005	0.00015	0.00017	0.00018	0.00010
PUNJABTRAC	0.00018	0.00020	0.00013	0.00022	0.00003	0.00032	0.00008
RANBAXY	0.00017	0.00009	0.00004	0.00006	0.00003	0.00007	0.00007
RAYMOND	0.00013	0.00012	0.00012	0.00015	0.00011	0.00023	0.00020
RELCAPITAL	0.10964	0.00025	0.00021	0.00019	0.00008	0.00017	0.00014
RELIANCE	0.00014	0.00003	0.00061	0.00007	0.00005	0.00006	0.00003
SAIL	0.12174	0.00069	0.00473	0.00118	0.00021	0.00014	0.00021
SATYAMCOMP	0.00007	0.00011	0.00015	0.00010	0.00004	0.00010	0.00010
SBIN	0.03863	0.00008	0.00017	0.00020	0.00005	0.00008	0.00012
SIEMENS	0.00033	0.00013	0.00003	0.00044	0.00010	0.00013	0.00008
SUNPHARMA	0.00015	0.00019	0.00008	0.00008	0.00112	0.00006	0.00013
TATAPOWER	0.00010	0.00020	0.00012	0.00010	0.00005	0.00012	0.00035
UNITECH	0.00055	0.00034	0.00034	0.00154	0.00012	0.00102	0.00132
WIPRO	0.00075	0.00019	0.00012	0.00008	0.00005	0.00007	0.00035

Chow- Denning Variance Ratio- Daytime Returns

Company	1995-99	2000-03	2004-08
ABB	2.26	0.56	2.68
ACC	1.94	0.83	1.76
APOLLOTYRE	3.95	1.01	0.49
ARVINDMILL	2.60	1.24	2.89
ASHOKLEY	0.66	2.84	1.03
ASIANPAINT	2.21	1.15	3.88
BAJAJAUTO	2.76	1.31	1.22
BHARATFORG	3.41	2.32	1.54
BHEL	0.91	0.52	3.04
BPCL	2.65	2.02	1.15
CIPLA	3.86	3.02	1.07
DRREDDY	2.38	0.91	0.85
GLAXO	0.59	1.11	3.34
GRASIM	4.08	2.23	3.61
HDFC	1.05	0.68	1.69
HDFCBANK	1.07	2.28	2.15
HEROHONDA	3.09	2.36	1.55
IDBI	1.20	1.63	0.66
IFCI	1.17	0.78	1.42
INFOSYSTCH	1.74	1.68	0.54
ITC	0.63	1.73	1.19
LICHSGFIN	5.74	1.35	2.69
M&M	1.89	1.56	3.59
MOSERBAER	1.26	1.41	0.41
NICOLASPIR	0.61	2.39	2.20
NIRMA	4.38	3.28	2.02
PFIZER	1.80	2.69	3.90
PUNJABTRAC	3.04	4.06	1.69
RANBAXY	4.39	1.26	0.92
RAYMOND	4.08	1.54	2.87
RELCAPITAL	1.98	0.93	1.22
RELIANCE	0.47	1.33	1.25
SAIL	1.40	1.95	1.04
SATYAMCOMP	2.50	2.21	1.34
SBIN	1.47	1.58	1.24
SIEMENS	1.11	3.15	3.27
SUNPHARMA	2.06	0.55	1.07
TATAPOWER	1.65	0.93	2.99
UNITECH	1.68	3.50	2.01
WIPRO	1.27	1.09	2.27

Chow- Denning Variance Ratio Variance Ratio- Overnight Returns

Company	1995-99	2000-03	2004-08
ABB	4.39	1.77	0.27
ACC	0.14	3.63	1.92
APOLLOTYRE	6.59	1.34	1.11
ARVINDMILL	4.87	2.26	1.49
ASHOKLEY	2.95	5.44	0.12
ASIANPAINT	1.13	1.63	4.21
BAJAJAUTO	2.13	1.41	0.47
BHARATFORG	4.93	4.94	0.26
BHEL	2.80	3.26	0.56
BPCL	4.85	2.52	2.82
CIPLA	1.90	1.68	0.47
DRREDDY	5.74	1.51	1.57
GLAXO	2.98	2.60	4.18
GRASIM	9.51	2.75	1.55
HDFC	5.94	0.68	1.54
HDFCBANK	6.14	5.36	1.84
HEROHONDA	0.78	1.62	5.79
IDBI	2.65	5.93	2.01
IFCI	2.19	4.39	3.15
INFOSYSTCH	0.87	2.57	0.69
ITC	4.20	3.18	0.21
LICHSGFIN	7.91	3.57	0.76
M&M	3.35	1.93	0.62
MOSERBAER	8.08	1.33	2.26
NICOLASPIR	1.63	3.35	0.26
NIRMA	5.74	4.95	0.67
PFIZER	2.76	2.53	2.50
PUNJABTRAC	2.52	2.04	1.96
RANBAXY	2.78	2.24	1.71
RAYMOND	6.48	0.78	0.52
RELCAPITAL	0.99	1.23	0.45
RELIANCE	7.63	8.52	2.36
SAIL	5.00	4.00	2.32
SATYAMCOMP	5.01	0.65	1.46
SBIN	2.47	1.50	0.72
SIEMENS	7.23	1.55	0.26
SUNPHARMA	4.55	1.29	1.54
TATAPOWER	0.87	8.73	1.17
UNITECH	3.00	3.77	0.58
WIPRO	6.06	7.50	0.41

Chow- Denning Variance Ratio Variance Ratio- Opening Returns

Company	1995-99	2000-03	2004-08
ABB	1.19	8.24	4.26
ACC	0.89	2.98	8.92
APOLLOTYRE	2.10	3.69	3.40
ARVINDMILL	2.33	4.45	4.60
ASHOKLEY	3.70	2.83	1.82
ASIANPAINT	2.93	8.11	12.39
BAJAJAUTO	1.58	8.45	6.20
BHARATFORG	4.05	5.56	3.36
BHEL	1.60	3.03	2.78
BPCL	2.44	0.54	7.95
CIPLA	1.90	4.14	1.86
DRREDDY	1.03	4.82	6.10
GLAXO	4.54	6.30	9.38
GRASIM	1.74	3.57	6.79
HDFC	3.16	4.55	4.41
HDFCBANK	2.65	7.37	9.53
HEROHONDA	3.29	1.06	9.30
IDBI	1.75	2.69	3.30
IFCI	5.23	10.03	3.77
INFOSYSTCH	2.24	2.85	1.90
ITC	1.71	5.52	1.14
LICHSGFIN	2.48	5.78	3.42
M&M	2.90	2.57	2.23
MOSERBAER	0.93	5.52	4.79
NICOLASPIR	2.59	8.03	3.09
NIRMA	5.47	7.55	8.87
PFIZER	2.50	5.11	9.27
PUNJABTRAC	3.98	2.08	7.26
RANBAXY	1.35	4.15	3.44
RAYMOND	1.58	6.64	9.83
RELCAPITAL	1.44	5.85	7.13
RELIANCE	2.08	0.96	3.13
SAIL	3.23	4.16	5.37
SATYAMCOMP	1.21	1.63	4.94
SBIN	1.51	3.09	6.24
SIEMENS	2.26	7.18	2.56
SUNPHARMA	2.14	1.64	9.21
TATAPOWER	0.72	3.46	5.46
UNITECH	5.83	8.50	1.60
WIPRO	6.33	1.22	4.00

Chow- Denning Variance Ratio Variance Ratio- Closing Returns

Company	1995-99	2000-03	2004-08
ABB	4.82	1.43	0.29
ACC	0.54	0.59	2.18
APOLLOTYRE	4.02	1.39	1.17
ARVINDMILL	3.29	2.68	3.12
ASHOKLEY	2.46	1.67	0.90
ASIANPAINT	1.12	1.69	3.07
BAJAJAUTO	1.43	1.65	1.06
BHARATFORG	1.97	1.30	1.12
BHEL	1.10	0.44	2.09
BPCL	1.28	2.03	1.48
CIPLA	3.59	4.28	1.76
DRREDDY	3.25	2.11	0.60
GLAXO	0.30	1.71	1.17
GRASIM	5.07	4.45	2.61
HDFC	1.45	2.26	2.88
HDFCBANK	1.73	1.97	3.09
HEROHONDA	1.42	0.92	2.98
IDBI	1.33	2.78	4.31
IFCI	1.02	0.45	2.86
INFOSYSTCH	0.55	2.76	0.85
ITC	1.15	1.24	0.38
LICHSGFIN	1.55	2.49	4.56
M&M	2.38	4.75	3.68
MOSERBAER	5.66	1.06	1.88
NICOLASPIR	2.40	1.85	1.57
NIRMA	0.74	6.27	1.28
PFIZER	1.49	1.03	3.96
PUNJABTRAC	0.27	2.61	3.80
RANBAXY	3.69	1.77	1.54
RAYMOND	4.90	1.64	1.69
RELCAPITAL	1.65	3.00	1.50
RELIANCE	3.49	5.93	2.92
SAIL	0.95	2.82	1.56
SATYAMCOMP	3.95	0.82	2.21
SBIN	3.47	2.00	2.74
SIEMENS	3.66	2.18	1.79
SUNPHARMA	4.60	2.13	1.81
TATAPOWER	0.70	3.67	2.10
UNITECH	1.98	2.27	0.77
WIPRO	5.78	4.66	1.70