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Journal of Banking & Finance 27 (2003) 1859–1878
Journal of BANKING & FINANCE
www.elsevier.com/locate/econbase

Stock exchange governance and market quality

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Abstract

We show that organization structure of a stock exchange matters by utilizing the unique setting prevailing in India. India has two major stock markets, the Bombay Stock Exchange (BSE) and the National Stock Exchange (NSE). These two exchanges adopt similar trading systems, trade essentially identical stocks, and follow the same trading hours. However, these exchanges have different organizational structures: BSE is mutualized whereas NSE is demutualized. Using the Hasbrouck [Review of Financial Studies 6 (1993) 191] measure of market quality we show that NSE provides a better quality market than BSE. This result is consistent with the work of Domowitz and Steil [Brookings–Wharton Papers on Financial Services, 1999], who proposed that demutualized exchanges are superior to mutualized in governance.

JEL classification: G32; G34; G14; G15
Keywords: Stock exchange governance; Demutualization; Market quality

1. Introduction

In sharp contrast to the plethora of studies that examined the impact of corporate governance provisions adopted by manufacturing and service firms, [1] there has

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[1] Gompers et al. (2001), in a recent study, find a striking relationship between corporate governance and stock returns. In their paper, they also conclude that firm value is highly correlated with a "Governance Index" that they develop.

0378-4266/$ - see front matter
doi:10.1016/S0378-4266(03)00105-5

been little research attention devoted to governance of stock exchanges. A notable exception is recent work by Domowitz and Steil (1999), who examine interrelationships between stock exchange automation, governance, and quality of markets. [2] Traditionally, stock exchanges have been organized as non-profit, mutual/membership associations. A recent trend has been conversion of mutualized exchanges into publicly owned corporations, which are themselves listed and traded on a stock exchange. Domowitz and Steil (1999) list several benefits of demutualized as compared to mutualized stock exchanges. The primary driver for such benefits is the favorable governance structure associated with demutualized exchanges. Domowitz and Steil (1999) argue that members of mutualized stock exchanges have incentives to oppose innovations even if they increase the exchange's value. Since traditional stock exchanges are mostly regional monopolies, they could, in the extreme case, even oppose enhancements to quality of services they provide if such improvements are thought to diminish the welfare of the respective exchange members.

One important implication of the Domowitz and Steil (1999) argument is that demutualized stock exchanges should provide a better quality market than mutualized ones. For expositional convenience, we refer to this implication as the "Domowitz and Steil Proposition". Our paper's primary focus is to examine the Domowitz and Steil Proposition using data from two competing stock exchanges in India, which differ in their governance structure – namely, the Bombay Stock Exchange and the National Stock Exchange. Direct comparisons of market quality in the two stock exchanges are facilitated by the simultaneous trading of at least 40 major stocks on both exchanges, with both utilizing similar trading systems. While prior studies have compared the quality of stock markets with different trading systems, reliable comparisons are, in fact, difficult to achieve. [3] There exist two counterexamples to the proposition that *good governance results in market dominance*. Instinet and Tradepoint, despite being organized as for-profit firms, failed to capture significant market share from the floor-based NYSE and London Stock Exchange, respectively. [4] Given evidence suggesting that incumbency places entry barriers to potential entrants, the importance of stock exchange governance is an empirical issue.

Our study makes unique contributions to the literature. First, unlike previous studies to date, using transaction cost as the proxy for market quality, we compare the quality of two stock exchanges, which are similar in most respects except for their governance structure. Second, since our study is conducted in an emerging market

[2] Other recent papers that examine stock exchange governance include DiNoia (1999) and Bradley (2002).

[3] Prior studies have compared quality of different markets by examining measures of liquidity and execution costs of comparable stocks. In such studies, one cannot be certain that firm-specific characteristics are not, in fact, driving the observed results. See, for instance, Affleck-Graves et al. (1994), Huang and Stoll (1996b), and Bessembinder and Kaufman (1997).

[4] We wish to thank our discussant, Jim Angel, for pointing out this counterexample.

setting, it has policy implications for other emerging markets. [5] Third, our paper describes how advances in trading technology have implications for competition in the stock market trading industry. In particular, we show the importance of information technology in breaking down barriers to entry. It is extremely rare for an entrant to upset an incumbent exchange which makes it worthwhile to study the case of Indian stock exchanges. Finally, we draw policy implications for regulators who supervise "natural monopolies" such as stock exchanges.

The paper is organized as follows. Section 2 provides background information on Indian stock markets outlining the principal differences between the two stock markets analysed. Section 3 discusses the methodology used in this paper to compute transaction costs – our proxy for market quality. Section 4 describes the data; empirical results are presented in Section 5. The final section contains our conclusions.

2. Bombay Stock Exchange and the National Stock Exchange

2.1. Genesis of the National Stock Exchange

Until the early 1990s, the Bombay Stock Exchange (BSE) was the premier stock exchange in India. At that time, BSE was plagued with a variety of problems, principal among them, outdated trading and settlement procedures, and poor regard for investor protection. Gupta (1992) prefaces his book on stock exchange reforms with the statement "wide-ranging reforms proposed by official study groups have made no progress because of stiff resistance from powerful lobbies of stock brokers". The recalcitrant attitude of brokers and administration of BSE frustrated efforts of the regulator, namely, the Securities Exchange Board of India (SEBI), in pushing through critical reforms to bring the premier exchange of India on par with the best run exchanges in the world. The complacency of the BSE administration may be attributed to their overestimating the significance of barriers to entry in the provision of stock broking and trading services. BSE also underestimated the determination of the Government of India to reform the stock markets, who took the unprecedented step in creating a new stock exchange with the help of government owned and controlled financial institutions.

Recent technological advances in communication and computing technologies aided the efforts of financial institutions that spearheaded the establishment of the new stock exchange. A new stock exchange – the National Stock Exchange (NSE), emerged as a consequence of the government's efforts and initiatives. The ensuing competitive market structure in Indian stock markets, as an outcome of the reform process, is unique and without parallels. NSE dramatically altered the stock market landscape of the country within a short period of its inception, using current

[5] Parisi et al. (2001) compare the Santiago Stock Exchange with the Electronic Stock Exchange to examine which exchange plays a leadership role. They are, however, unable to examine the effect of governance on market quality since observed differences may be attributable either to the variations in trading systems or differences in governance.

best practices in computing and network technology to provide state of the art trading services to Indian investors. In short, NSE dramatically improved the quality of trading services and thereby challenged the dominant position held by BSE.

Indian investors were attracted to the high quality of trading services and systems provided by NSE. In particular, NSE's systems and procedures explicitly incorporated investor protection. [6] Since BSE clearly lagged behind in service quality, it rapidly lost its market share. Fig. 1 clearly depicts the dominance of NSE as measured by trading volume. To stem erosion of its market share, BSE took steps to improve its services. NSE, however, retained its first-mover advantages due to its early lead in adopting leading edge technologies and procedures.

Another significant difference between the two exchanges pertains to governance. BSE follows the mutual form of organization whereby stockbrokers own and operate the exchange. The president of the exchange is elected by broker members and, therefore, represents their interests; investors' interests are consequently relegated to a secondary position. On the other hand, NSE follows the corporate or demutualized form of organization, defined as the separation of ownership of the exchange from membership. According to Domowitz and Steil (1999), incentives of a mutualized exchange differ significantly from a demutualized one. NSE has incentives to adopt actions that increase the quality of its market, while BSE is more likely to resist such changes if they have a deleterious effect on brokerage profits. Thus, we expect the quality of NSE's market to be higher than that of BSE, ceteris paribus. Hence, market quality comparison between NSE and BSE forms the core motivation for our paper.

2.2. Differences between NSE and BSE

We begin by outlining the principal differences between the exchanges. This outline allows us to formulate appropriate expectations regarding quality differences. We use the following dimensions with which to make these comparisons: ownership, governance, trading systems, connectivity, and technology use.

2.2.1. Ownership

NSE has been incorporated as a tax paying company and is owned by a group of large developmental financial institutions. On the other hand, BSE is organized as a brokers' association. Broker members own seats on the exchange and operate BSE.

2.2.2. Governance

NSE is professionally managed by a fulltime Managing Director who reports to a Board of Directors, and is, as such, managed by professionals who do not directly or indirectly trade on the exchange; ownership and management of the exchange are

[6] The Department of Economic Affairs, Government of India, commissioned an expert study in 1991. The terms of reference included measures to boost investor confidence in the major Indian stock exchanges. Gupta (1992) documents prevalent wide-spread disenchantment of small investors with the quality of service provided by major Indian stock exchanges, most notably, the Bombay Stock Exchange.

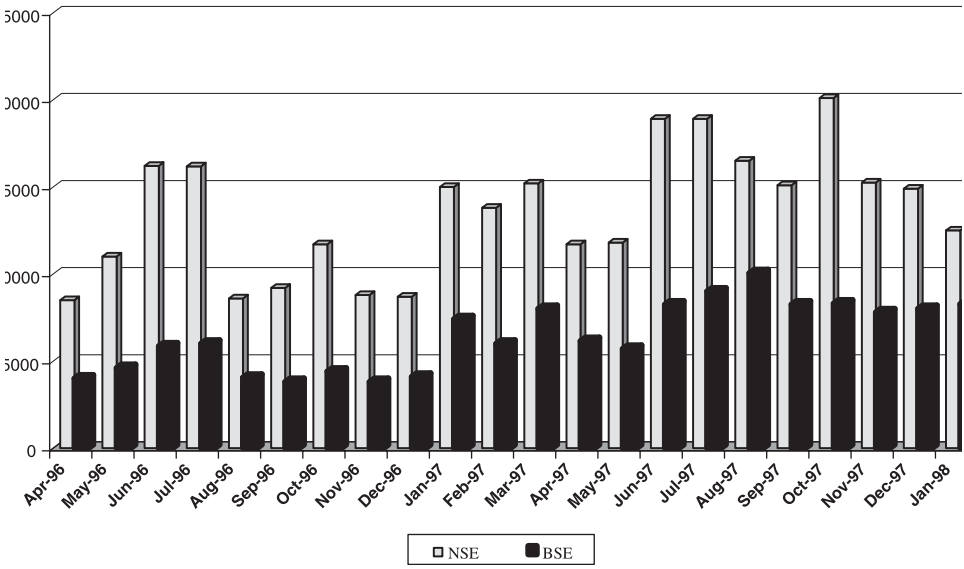

Fig. 1. Trading volume on BSE and NSE.

therefore, completely separated. Until NSE emerged, most stock exchanges in India were owned, controlled and managed by brokers who held seats on the various exchanges. For the BSE, one of the broker members is elected to administer the exchange and is designated as the president of BSE; the president continues to own a seat on the exchange.

2.2.3. Trading system

NSE uses the latest innovations in computing and network technologies to bring the best available trading system to its customers, and improves the quality of its trading system in its bid to attract and retain its customers. A fully automated screen based trading system, referred to as NEAT and developed by NSE, enables members from all over the country to trade with one another on a real-time basis with ease and efficiency. NEAT is a completely automated system for order matching that is completely order driven and provides complete anonymity to its trading members. NEAT operates on a strict price time priority such that all buy orders received on the system are sorted with the best-priced order getting the first priority for computerized matching with an incoming market sell order. [7] NEAT provides users with several time related orders such as Good-Till-Cancelled, Good-Till-Day, Immediate-or-Cancel. Moreover, traders are able to take advantage of price-related and volume-related orders that may be built into an order.

[7] For instance, within orders that have the same price, time priority is enforced, i.e., orders placed first are executed first. This matching process is computerised, keeping the system transparent, objective and fair. Each order remains in the system until it is matched with an incoming market order or until it is cancelled, whichever occurs earlier.

BSE has, however, been slow to adopt new technology. Floor trading was still the prevalent mode of transacting when NSE commenced operations in November 1994. Since then, a rapid erosion of market share forced BSE to establish its own computerized trading system. This move was a strategic response to a comparatively superior trading system established by NSE. By June 1995, BSE inaugurated its own electronic trading system known as BOLT. BOLT adopted many of the features that were built into NEAT. NSE is the originator of new initiatives. With BSE usually responding after a time lag, it appears as if it is merely trying to protect its market share rather than making a genuine effort to increase customer satisfaction.

2.2.4. Connectivity

NSE established a national network of terminals in over 300 towns and cities including those not served by any stock exchange. Network technology using satellite communications links all member terminals to its main computer located in Bombay. This equal access to traders all over the country sharply contrasts with BSE, which serves only the city of Bombay. BSE was initially operated as a regional monopoly with a charter allowing its trading members exclusive rights and access to its trading floor in Bombay. Shortly after NSE commenced its trading operations, its runaway success seemed to threaten the livelihood of BSE brokers. The cost of a seat on BSE fell from about Rs. 40 million to about Rs. 10 million within a year of NSE's opening. To counter this, BSE quickly set up BOLT, which started operating from 1995, but was still restricted to the city of Bombay. As the first automated exchange in India, NSE had a freer hand in determining its reach. With no physical trading floor limitation, it could logically argue that it is able to cover the entire country. BSE and all the other regional exchanges in India are regional monopolies, and according to their charter, are explicitly prohibited from setting up offices or providing their services in locations outside their respective jurisdictions. This explicit prohibition served to limit the connectivity and reach of BSE. NSE is unaffected by these limitations, has enjoyed much network externalities, at a cost to its most powerful rival, BSE. In this connection, the heavy role of the Indian government in establishing NSE, greatly facilitated its success. [8] Since BSE was not allowed to operate its terminals outside Bombay until late 1997, NSE had an important advantage. It appears that BSE and its members learnt a costly lesson that it does not pay to vehemently oppose the regulatory agencies of the Indian government.

2.2.5. Technology

Technology is another dimension on which the two exchanges had completely divergent attitudes. The expert committee report submitted by Mr. M.J. Pherwani to the government of India in 1991 strongly recommended complete automation in Indian stock exchanges. BSE could have taken the cue and set-up its own electronic exchange. The stance taken by BSE in rejecting a significant role for automation

[8] We thank our discussant for emphasizing this important factor.

in its trading seems absolutely incredible. We conjecture that BSE's brokers perhaps viewed technology as a major threat to their rent seeking activities. [9]

In our opinion, technology served to provide two major advantages to NSE in dealing with he competition from BSE. First, it served to consolidate orders from various cities in the country which were previously fragmented. The second advantage is the network externality that a completely automated nation-wide network creates. NSE managed to accomplish large trading volumes within a short period of its functioning. Scale economies provided by high volume trading activity enabled NSE to reduce brokerage commissions from about 2% to 0.5%. This reduction in explicit transaction cost served to break the monopoly of BSE.

2.3. Automation, governance and quality of markets

Although we identify five major differences between NSE and BSE, ownership structure is considered to be the distinguishing characteristic. We argue that it is the difference in ownership that determines the characteristics of each exchange. Everything that NSE has achieved since inception, BSE potentially could have accomplished in a superior manner. As the premier exchange in India, BSE had access to resources and the clout to maintain its dominant status. Had BSE adopted NSE's approach, it would have pre-empted the creation of NSE. BSE's adherence to its status quo in trading technology most likely stems from vested financial interests of its broker members. The brokers of BSE resisted automation and the attendant improvements in market quality as they perceived that automation would lead to market transparency. In a transparent system, brokers would be precluded from certain rent-seeking activities which are deemed illegal. Unlike the automated system, a manual trading system would not easily detect the illegal activities of these brokers. It is with these considerations that the floor trading system continued in spite of alleged inefficiencies. This culture of pleasing the brokers at the cost of investors is very strong in BSE.

The reputation of BSE has often been sullied in the popular press. The following quote is taken from the editorial column of *The Tribune*, a newspaper published from Chandigarh, India in its March 9, 2001 issue:

> "Price manipulation is an old sin at the BSE. Harshad Mehta did it. ... A shoe exporter jacked up his company's scrip prices. With the active help of the then BSE president J.C. Parekh, ... a few operators entered the trading floor at the dead of night to doctor the computer data to artificially increase the prices of BPL, Videocon and Sterlite. He was sacked. ... There is a structural flaw in the BSE administration. It is run by brokers who are not averse to raking in tainted profit by victimising investors. ... The clear record of NSE is in sharp contrast to the BSE blots".

[9] A common complaint that was widely mentioned by traders (before NSE was established) was that they almost always paid the highest intra-day price on their purchases and received the lowest intra-day price on their sales. Traders had no way of verifying that the prices that they received (or paid) actually coincided with transaction prices received by their broker on the floor. This rent-seeking activity was largely possible in a floor-traded environment without significant automation.

According to Domowitz and Steil, "trading market automation permits demutualization", meaning that the corporate structure of organization of a stock exchange is feasible when computerized trading replaces floor trading. We illustrate a situation where causality runs in the reverse direction. NSE's corporate organizational structure allowed it to pursue trading automation unhindered by potential conflicts of interest with its broker-members. Using professional managers, NSE's primary objective is value maximization. We conjecture that if NSE adopted the mutual form of organization, it would have failed to incorporate trading automation since the interests of the broker members would have taken precedence to goals of value maximization for the exchange. [10] That NSE did not become the "second exchange" in Bombay is mainly attributable to its governance as compared to BSE. Unhindered by brokers' participation in the management of the exchange, NSE's managers had absolute freedom to determine the appropriate trading technology. History shows that NSE cleverly used technology to exploit the two major weaknesses of BSE: inherent limitation of floor-trading and its poor record of investor protection. NSE's quest for dominance in Indian bourses was greatly advanced by the explicit support of the Indian government.

Having established the superiority of NSE's governance as compared to BSE, we next turn to market quality comparisons in order to substantiate the Domowitz and Steil (1999) proposition.

3. Empirical methods

3.1. Prior literature

A unidimensional quantification of market quality is absent in extant literature. Prior research has focused on liquidity, informational efficiency, and volatility characteristics of markets, as the criteria for market quality comparisons. Another view of market quality is based on transaction costs. In stock markets, transaction costs may be classified either as explicit or implicit (execution costs). Execution cost is the difference between the actual transaction price and the benchmark price that is considered to be in some sense, efficient. Unlike commission costs, which are explicit, execution costs are not directly observed and are not easily measured. Hence, most prior studies have defined different measures of execution costs [11] and compared

[10] We have counterexamples in other countries where automation has occurred in mutual structures. Even if the NSE had pursued trade automation while being governed by a mutual structure, the incompatibility of brokers interests with value maximization of the exchange would have created constraints under which the exchange has to operate.

[11] Measurement of this difference between the actual transaction price and the benchmark price is generally aimed at estimating this figure for both the buyer and seller engaged in a particular transaction. This difference is often calculated as an average transaction cost measure in comparative market analysis, and is used to determine and evaluate market microstructure studies when transaction costs are minimized (Huang and Stoll, 1996b; Bessembinder and Kaufman, 1997). Such a procedure is applied in this paper.

these estimates across markets (e.g., Roll, 1984; Berkowitz et al., 1988; Stoll, 1989; Chan and Lakonishok, 1993; Hasbrouck, 1993).

Several measures of transaction (or execution) cost have been used, principal among them, are quoted bid–ask spreads and effective bid–ask spreads. In a pure dealership market, transactions take place only at the quoted bid or the ask price. Appropriate measures of transaction cost should, therefore, be based on such quoted/posted bid–ask spreads (see for example, Demsetz, 1968; Branch and Freed, 1977; Benston and Hagerman, 1974; Huang and Stoll, 1996a,b; Barclay et al., 1999). In many security markets, however, trades frequently take place inside the spread. [12] When this occurs, quoted spreads will tend to overstate investors' expected trading costs, making the effective spread, which is simply the average difference between the price at which a dealer sells at one point in time and buys at an earlier point in time, a better measure for trading costs (e.g., Roll, 1984; Stoll, 1985).

Using two samples of market orders, one based on orders submitted by retail brokers and another submitted electronically to the NYSE, Petersen and Fialkowski (1994) estimate the spread generated using both orders and report a significant difference between the posted spread and the effective spread paid by investors. Applications of this effective spread method to measure trading costs have been used in numerous studies (e.g., Barclay, 1997, 1999; Bessembinder, 1997; Christie and Huang, 1994; Christie and Schultz, 1994; Huang and Stoll, 1996b).

An alternative approach to measure transaction costs is to calculate the difference between the actual transaction price and the efficient price. Broadly defined, the efficient price, which is considered as the true value of a stock, is an unbiased price estimate that can be achieved in any relevant trading period by any randomly selected trader. Beebower (1989), for example, uses daily high–low midpoint prices and closing prices as efficient prices, and the effective spread to compute transaction costs. This measure may, however, place an excessive weight on trades that are not representative of most trades over a particular trading period and is, therefore, likely to be a biased representation of actual transaction prices. To address this, Berkowitz et al. (1988) propose a measure of transaction costs based on the volume-weighted average price over the trading day. Although their measure yields results that appear less biased as compared to other measures that only use single prices, two main problems may arise: (1) the measure may weight an aberrant trade very heavily, especially when a very thinly traded stock with small market value experiences a relatively large transaction; (2) when gaming takes places, that is, traders adjust their trading behavior to affect the "efficient price" when they become aware that they are being evaluated on this basis. Another approach introduced in Hasbrouck and Schwartz (1988) is an overall measure of average execution costs for all trades of a certain stock, in a particular market, over a certain period of time. This measure relies on the notion that execution costs increase the volatility of short-term price movements

[12] Blume and Goldstein (1992), for example, find that between 12% and 31% of the trades occur inside the spread. Once transactions occur inside the quoted spread, it is often the case that the quoted spread will tend to overstate the investors' expected trading costs and, as such, is not an appropriate measure of transaction costs.

relative to the volatility of long-term price movements. Although the measure is an average value for all trades in a certain market, it is strongly influenced by the preponderance of small trades since it was not designed to measure how execution costs are affected by trading size.

A newer approach developed by Hasbrouck (1993) measures transaction costs in stock markets based on decomposition of a non-stationary time series into a random-walk component and a residual stationary component. When applied to stock transaction prices, the random-walk component is identified as the efficient price with the stationary component (termed the pricing error) representing the difference between efficient price and actual transaction price. Dispersion of the pricing error that results from this division, measures how closely actual transaction prices follow a random walk and, therefore, constitutes an appropriate measure for transaction costs.

Hasbrouck proposes the standard deviation of the pricing error, σ_s, as a summary measure of market quality that measures how closely the transaction price tracks the efficient price. This measure of market quality can then be applied to different markets to make appropriate inferences about market quality. The role of σ_s as a proxy for market quality depends on the assumption that as transaction costs and other trading barriers are reduced, actual transaction prices should track the efficient prices more closely.

4. Data

The dataset used in this study comprises 40 pairs of common stocks that are simultaneously listed and traded on both BSE and NSE. All selected stocks are Indian index stocks that are observed to have large numbers of observations for each trading day and hence have higher liquidity as compared to other similar stocks. We specifically selected these stocks to minimize stock-specific effects; for example, stocks with larger market capitalization generally have lower trading costs (see Hasbrouck, 1993). [13] In this paper, the 40 pairs of stocks that are traded on both BSE and NSE are identical (see Table 1 for a complete listing of the 40 stocks).

In our paper, we apply the Hasbrouck (1993) method to compute the variance of pricing errors, which is used as the principal metric for market quality comparison. Since we do not have access to the order book, we were not able to obtain data on quoted bid and ask prices, and hence, unable to compute quoted or effective spreads. We also apply the multivariate regression approach of Hasbrouck and Schwartz (1988) to identify the source of the observed differences in market quality between the two exchanges. This approach uses the intuition that firm-specific trading characteristics may have an effect on overall market quality.

[13] Previous studies, such as Huang and Stoll (1996a,b) and Barclay (1997) that attempt to compare the transaction costs between the NYSE and NASDAQ, employ stocks that are only matched in a limited manner, resulting in findings that tend to be strongly affected by stock-specific factors.

Table 1
List of the 40 paired sample stocks traded on both NSE and BSE

Company Name
Asea Brown Boveri Limited
Associated Cement
Andhra Valley Power Supply Co. Limited
Arvind Mills Limited
Ashok Leyland Limited
Asian Paint India Limited
Bharat Heavy Electricals Limited
BSES
Castrol India Limited
Cochin Refineries Limited
Colgate Palmolive India Limited
East India Hotels Limited
Grasim Industries Limited
Gujarat Ambuja CMT
Housing Development Finance Limited
Hindustan Lever Limited
Hindustan Petroleum
Industrial Credit and Investment Corporation of India Limited
Industrial Finance Corporation of India Limited
Indian Hotel Company Limited
Indo Gulf Fertilizers and Chemicals Corp. Limited
Indian Rayon and Industries Limited
ITC
Larsen & Toubro
Mahindra & Mahindra Limited
Mangalore Refinery and Petrochemicals Limited
Mahanagar Tel Nigam Limited
Nestle India Limited
Oriental Bank of Commerce
Ponds India Limited
Ranbaxy Laboratories Limited
Reliance Industries Limited
State Bank of India
Tata Chemicals Limited
Tata Power Co.
Tata Tea
Tata Engr. & Loco.
Thermax Limited
Tata iron & Steel Co.
TVS-Suzuki

High frequency intra-day transaction data are used to compute transaction costs based on Hasbrouck's (1993) approach. All transaction records for the 40 sample stocks covering the period 1 January 1997 to 31 July 1997 are obtained from NSE and BSE. This dataset comprises a total of 144 trading days with the total number of transaction exceeding 15 million. We obtain information on market value, average weekly/daily price, average trading size, and average number of trades per day, for

each pair of stocks traded on both exchanges to determine firm-specific factors relevant in transaction cost measurement.

In constructing the time series of returns and trades, we ignore natural time conventions. Instead, we view the data as an untimed sequence of observations, with the time subscript t incremented each time a new transaction occurs. Overnight returns are not used to avoid the overnight effects on stock prices. Lee and Ready's (1991) approach is used to infer the direction/sign of a trade by comparing its price to the price of the preceding trade(s), and is further based on classifying each trade into four categories: an uptick, a downtick, a zero-uptick, and a zero-downtick. A trade is considered an uptick (downtick) if the price is higher (lower) than the price of the previous trade. When the price is at the same level as the previous trade (that is a zero tick), and when the last price change was an uptick (downtick), then the trade is considered a zero-uptick (zero-downtick). Essentially, if two successive prices are the same, the latter one is assumed to follow the sign of the preceding one. A trade is also classified as a buy (sell) transaction if it occurs on an uptick (downtick) or a zero-uptick (zero-downtick). Such an approach is widely used by many studies and allows us to classify trade directions since quote data are not available. [14]

5. Empirical results

In this section, we present the empirical results of transaction costs comparisons for "multi-trading" stocks that are listed simultaneously on NSE and BSE. We compare both markets on the basis of transaction costs, namely, the standard deviation of the pricing error, using Hasbrouck's (1993) approach. [15]

5.1. Standard deviation of the pricing error using Hasbrouck's (1993) approach

Table 2 lists the computed values of Hasbrouck's (1993) measure for all 40 multi-trading stocks on both markets and the ratio of this measure in NSE relative to its value for BSE. The smallest standard deviation of the pricing error is 0.0152 and 0.0934 for NSE and BSE, respectively; the largest values are 0.8639 and 1.4901 for NSE and BSE, respectively.

The standard deviation of pricing error represents the percent value of transaction costs for a particular stock. Clearly, both minimum and maximum values of Hasbrouck's measure are greater on BSE. Moreover, the mean standard deviation of the pricing error is 0.27% and 0.64% of stock prices on NSE and BSE, respectively. The mean ratio (NSE/BSE) of 0.4034 confirms that the average transaction cost of these multi-trading stocks on NSE is lower than BSE. Hasbrouck's (1993) results

[14] Holthausen et al. (1987) also use a tick rule in their study.

[15] In an earlier version of the paper, we also included estimated spreads using the approach of Roll (1984). Since the estimates obtained with daily data were extremely noisy, we have discarded these results for the sake of brevity. These results also show conclusively that NSE has lower transaction costs as compared to BSE.

Table 2
Hasbrouck's (1993) measure for paired sample stocks in NSE and BSE

Stocks	BSE (%)	NSE (%)	Ratio (NSE/BSE)
Andhra Valley Pwr.	0.4370	0.1716	0.3927
Arvind Mills	0.5458	0.1248	0.2287
Asea Brown Boveri	1.3727	0.5550	0.4043
Ashok Leyland	0.9676	0.1819	0.1880
Asian Paints	0.9762	0.3578	0.3665
Associated Cement	0.8645	0.4310	0.4986
Bharat Heavy Els.	0.3483	0.2159	0.6199
BSES	0.3980	0.0972	0.2442
Castrol India	0.6287	0.2379	0.3784
Cochin Refineries	0.2894	0.1852	0.6399
Colgate-Palmolive	0.5111	0.1529	0.2992
EIH	1.4901	0.6690	0.4490
Grasim Inds.	1.3783	0.3778	0.2741
Gujarat Ambuja CMT	0.4223	0.1429	0.3384
Hdfc Bank	0.8448	0.8639	1.0226
Hindustan Lever	0.9546	0.4183	0.4382
Hindustan Ptl. Corp.	0.4831	0.3289	0.6808
ICICI	0.3896	0.0750	0.1925
IFCI Ltd.	0.0934	0.0152	0.1627
Indian Hotels Co.	1.1899	0.7472	0.6280
Indian Rayon & Inds.	1.0697	0.3229	0.3019
Indogulf Fert.	0.1174	0.0771	0.6567
ITC	0.4136	0.1086	0.2628
Larsen & Toubro	0.3786	0.0904	0.2388
Mahanagar Tel Nigam	0.2705	0.1101	0.4070
Mahindra & Mahindra	1.0382	0.3837	0.3699
MRPL	0.0955	0.0350	0.3665
Nestle India	0.8387	0.2679	0.3194
Oriental Bk. of Com.	0.1226	0.0513	0.4184
Ponds	0.7593	0.8611	1.1341
Ranbaxy Labs.	1.1797	0.4189	0.3551
Tata Chemicals	0.6699	0.1664	0.2484
Tata Engr. & Loco.	0.4220	0.1184	0.2806
Tata Iron & Steel	0.4020	0.0625	0.1555
Tata Power Co.	0.2988	0.0792	0.2651
Tata Tea Co.	0.5675	0.1666	0.2936
Thermax	0.5792	0.3842	0.6633
TVS-Suzuki	0.9522	0.6084	0.6389
Reliance Inds.	0.4919	0.0751	0.1527
State Bank of Ida.	0.3804	0.0617	0.1622
Mean	0.6400	0.2700	0.4034

of 0.33% of stock prices on the NYSE are closer to NSE's average figure of 0.27% while BSE reports average values of 0.64%.

A Wilcoxon signed ranks test is used to compare the mean standard deviation of the pricing error for these multi-trading stocks to determine whether there is significant difference in Hasbrouck's (1993) measure between the two markets. The test

statistic is highly significant at the 1% level with a value of −5.417, strongly supporting our hypothesis that the average standard deviation for the pricing error for multi-trading stocks on NSE is significantly lower for identical set of stocks traded on BSE. Since the standard deviation of the pricing errors is used as a measure for transaction costs, results suggest average trading costs on NSE are significantly lower than BSE.

We have shown that NSE is a better quality market than BSE, a finding consistent with the Domowitz and Steil (1999) proposition. Can we attribute observed differences in the quality of market to the difference in governance in structure? Outlined below are possible structural explanations of findings.

5.2. Why is the quality of market better on NSE?

Although transaction costs on NSE are lower than BSE, market structure differences may account for these results.

Table 3 summarizes the main structural differences between the two exchanges which enable NSE to operate with lower transaction costs, and led to NSE's domination of BSE. The factors shown in italics are related to ownership/governance. Following Domowitz and Steil (1999), we argue that a demutualized ownership structure has enabled NSE to score higher on these governance variables: use of technology, internal control systems, transparency, regulation and investor protection. Small and medium investors would be attracted to NSE due to the perceived better quality of governance and protection. In addition, the geographical reach, which is not a governance factor, is likely to augment trading activity on NSE, and therefore have a beneficial effect on execution costs.

While factors such as technology use and investor protection serve to enhance market quality by attracting liquidity traders, it is not obvious that a more transparent market with better internal control systems, transparency and regulation will enhance the quality of market as measured by execution costs (transaction costs). A market with fewer regulations and weak internal control systems would be attractive to traders who seek to exploit inside information. Such a market would be attractive to institutional traders if the exchange were negligent in enforcing regulations. In fact

Table 3
A comparison of the Bombay Stock Exchange and the National Stock Exchange

Factors	BSE	NSE
Geographic reach	Mainly limited to Bombay city	Across the whole of India
Ownership structure	Brokers' association	Organized as a company
Use of technology	Laggard and follower	Pioneer in computerized trading
Internal system control	Insider trading and market manipulation are rampant	Stickler for market integrity
Transparency	Relatively secretive	Follows an open policy
Regulation	Resists regulatory change	Self-regulated; better risk management systems
Investor protection	Low standards	High standards

BSE would be more attractive to insiders and institutional traders on account of the perceived laxity of that exchange. Such a market can theoretically provide lower execution costs if some traders place limit orders of large sizes.

Based on a comparison of the two exchanges, we expect NSE to have a higher degree of trading activity (number of trades) and BSE to have a larger trade size. Both these factors are expected to result in an improvement in market quality via a reduction in execution costs. Some governance factors for which we have no proxies, technology use and investor protection, may have an influence on market quality. To disaggregate the source of market quality differences a multivariate study is conducted.

5.3. Multivariate analysis using Hasbrouck and Schwartz's (1988) method

Hasbrouck and Schwartz (1988) compare execution costs across different markets by using a multivariate approach. We use a variation of their model to examine the effect of governance and other factors on trading costs. The multivariate regression model is used to control for firm-specific factors that have a bearing on execution costs. Explanatory variables include average price (AP), average size per trade (AST), average number of trades per day (ATD), and market value (MV) for a particular stock over the sample period. AST is used to account for the occurrence of block trades of a particular stock while ATD is a proxy for the liquidity of the stock on a particular exchange. We expect that ATD would be higher on NSE as compared to BSE while the AST of BSE is expected to be larger. Price and market capitalization are used as control variables following the work of Hasbrouck and Schwartz (1988).

Transaction costs are regressed against a set of variables, which include the stocks' price, liquidity, market value, according to the following equation:

$$C_i = a_0 + a_1 \mathrm{AP}_i + a_2 \mathrm{AST}_i + a_3 \mathrm{ATD}_i + a_4 \mathrm{MV}_i + a_5 D_i + e_i, \tag{1}$$

where C_i represents the transaction costs for stock i, defined as the standard deviation of the pricing errors; other variables are defined above except for D_i, which is a dummy variable to distinguish between the two markets and set equal to one for NSE stocks and zero for BSE stocks. The dummy variable is included to capture potential governance factors.

Table 4 provides descriptive statistics pertaining to AP, AST and ATD on both exchanges. The average stock price of 546.46 rupees is higher on BSE as compared to 467.11 rupees on NSE. Stocks traded on NSE have a smaller mean AST, suggesting larger trades on BSE as compared to NSE primarily due to frequent insider trading and institutional block trading on BSE. Wilcoxon and t-test statistics for the difference in AST between these two markets are significant at the 1% level.

The mean value of 2299 daily trades on NSE is larger than the 1196 recorded for BSE and the difference is statistically significant using both the Wilcoxon and the standard t-test. As the average trade per day is often used as a proxy for the liquidity of stocks, this result is indicative of higher liquidity of NSE as compared to BSE. The

Table 4
Descriptive statistics of independent variables in multivariate regressions

	BSE	NSE
Number of sample stocks	40	40
Average price (AP)[a]		
Minimum[b]	20.09	23.46
Maximum[c]	4357.03	3705.17
Mean	546.46	467.11
Average size per trade (AST)[d]		
Minimum	29	22
Maximum	903	545
Mean	363	259
Wilcoxon test[e]	−4.396* (0.000)	
t-test	−4.215* (0.000)	
Average number of daily trades (ATD)[f]		
Minimum	12	46
Maximum	7802	19451
Mean	1196	2299
Wilcoxon test[g]	4.241* (0.000)	
t-test	2.143* (0.038)	

Notes:
[a] AP is the average price over the sample period.
[b] The stock "HDFC Bank" has the highest average price over the sample period on both the NSE and BSE.
[c] The stock "MRPL" has the lowest average price over the sample period on both NSE and BSE.
[d] AST is the average size per trade over the sample period.
[e] From the Wilcoxon ranks test for AST, we obtain 7 positive ranks, 1 tie and 32 negative ranks; *t*-statistics are based on positive ranks.
[f] ATD is the average number of trades per day computed as the total number of trades/total number of days over the sample period.
[g] From the Wilcoxon signed ranks test for ATD, we obtain 36 positive ranks and 4 negative ranks; *t*-statistics value are based on positive ranks.
* Significance at the 5% level (*p*-values in parenthesis).

increased trading activity is possibly a consequence of the nation-wide network established by NSE as compared to a city-wide network employed by BSE.

A total of fifteen regressions are estimated based on all possible combinations of the independent variables in our study. [16] Selected results of these regressions are presented in the Table 5. Values of the adjusted R^2 range from 0.278 to 0.403. The dummy variable, D_i, is negative and statistically significant in all regressions, suggesting that transaction costs on NSE are lower than BSE even after controlling for trading activity, trade size and the control variables.

Estimates of the average price are positively related to transaction costs in all regressions and significant in regressions 4 and 5. The statistical significance wanes as

[16] This procedure is valid when the number of regressors is small since the total number of regressions is a function of $[2\exp(k) - 1]$, where k represents the number of regressors (see Maddala, 1977).

Table 5
Regressions with transaction cost as dependent variable

Equation	Constant	AP	AST	ATD	MV	Dummy	R^2
1	0.800	6.548E−5	−4.573E−4	−1.373E−5	−1.376E−7	−0.404	0.402
		(1.650)	(−1.947)	(−1.149)	(−0.218)	(−5.493*)	
2	0.773	6.995E−5	−4.303E−4	−1.190E−5		−0.397	0.403
		(1.810)	(−1.917)	(−1.220)		(−5.592*)	
3	0.871		−6.055E−4	−8.965E−6		−0.424	0.377
			(−2.946*)	(−0.919)		(−6.021*)	
4	0.608	1.019E−4		−1.934E−5		−0.341	0.373
		(2.873*)		(−2.125*)		(−5.178*)	
5	0.585	1.024E−4				−0.363	0.336
		(2.823*)				(−5.443*)	
6	0.886		−6.748E−4			−0.441	0.370
			(−3.533*)			(−6.501*)	
7	0.664			−1.951E−5		−0.349	0.305
		(−2.049*)	(−5.069*)				
8	0.686				−6.742E−7	−0.374	0.278
					(−1.085)	(−5.188*)	

Notes: The dummy variable is assigned a value of 1 for all NSE stocks and 0 for BSE stocks; *t*-statistics are given in parentheses.
* Denotes significance at the 5% level.

other trading activity and market value variables are included. [17] A negative relation is observed between the average size per trade and transaction costs, implying that larger trade size lowers transaction costs. This negative relation is significant in regressions 3 and 6. The number of trades per day is significant and negatively related to transaction costs in regressions 4 and 7. The significance drops when the AST variable is included (correlation between ATD and AST is 0.23). As expected, stocks that trade actively tend to be associated with lower transaction costs. Also, since ATD is a proxy for liquidity, higher liquidity results in lower transaction costs. The market capitalization (MV) of stocks is negatively related to transaction costs indicating that stocks with larger market value generally exhibit lower transaction costs, a result consistent with that obtained in Roll (1984) and Hasbrouck (1993). In all cases, the dummy variable is negative and statistically significant. We cautiously interpret this finding to indicate that the residual impact of superior governance in the NSE results in a lower transaction cost as compared to BSE.

These results are consistent with Krishnamurti and Lim (1999), who find that NSE, with lower execution costs, lower price volatility, and higher liquidity, is a better-quality market than BSE. It is, therefore, not surprising to observe that NSE has taken over much of the transaction volume from BSE since its inception. This dominance is clearly demonstrated in Fig. 1 over the period April 1996 until January 1998, which shows NSE with a consistently higher trading volume as compared to BSE since its inception.

[17] The correlation between AP and MV is 0.39, while AP has a negative correlation of −0.28 with the AST variable.

6. Conclusion

The primary role of a stock exchange is to provide trading services to its ultimate clients. Prior studies have concentrated on comparing the quality of markets with different trading systems. Little attention has been paid to the critical issue of the quality of markets and stock exchange governance. A recent trend has been in the demutualization of stock exchanges, ostensibly, to better deal with emerging competition from electronic trading networks. In a recent paper, Domowitz and Steil (1999) provide convincing arguments in favor of demutualized exchanges. They reason that members of a mutualized exchange have incentives to oppose innovation that increase the quality of its services, and hence the value of the exchange, while stakeholders of a demutualized exchange, are likely to favor any measure that enhances the value of the firm.

We examine the Domowitz and Steil proposition using data from a large emerging market, namely, India, which has two major exchanges with distinguishably different organizational structures. The National Stock Exchange uses a demutualized form of organization unlike the Bombay Stock Exchange, which continues to pursue the mutual structure. Consistent with the Domowitz and Steil proposition, we find that National Stock Exchange has a better quality market as compared to Bombay Stock Exchange based on the market quality measure derived by Hasbrouck (1993). Multivariate regression results indicate that superior governance of NSE is at least partially responsible for its better market quality. Better governance, incorporation of the latest technology, and governmental support, are major factors that jointly contributed to NSE's superior market quality as compared to BSE.

This study has implications for emerging markets where regulators do not have sufficient experience or influence in dealing with recalcitrant monopolists. Competition has been shown to be more effective than regulatory dictates in transforming behaviour of members on the Bombay Stock Exchange. Economic incentives are likely to be more potent in transforming rent seeking behavior than directives from policy regulators.

The role played by technology in transforming Indian stock markets is particularly evident. Applying the latest technology, the National Stock Exchange was able to penetrate barriers to entry in the stock-broking industry, which had the consequent benefit of reducing the cost of providing these services. Being able to pass on lower trading costs to investors, the National Stock Exchange posed a serious threat to the existence of the oldest exchange in India, namely the Bombay Stock Exchange. That technology is responsible for breaking barriers to entry and for dramatically improving quality of markets in Indian stock exchanges is unequivocal.

Acknowledgements

We would like to thank participants at the "Future of Stock Exchanges in a Globalizing World" Conference organized by the Journal of Banking and Finance and the Capital Markets Institute of the University of Toronto for helpful comments. In

particular we express special thanks to Jim Angel, Robert Jennings, and Paul Halpern. We also acknowledge comments from Shanta Hegde (University of Connecticut), Lim Guan Hua (National University of Singapore) and participants of the Pacific Basin Finance Conference, Tokyo for useful comments on an earlier version of the paper.

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