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How Effective are Stock Market Reforms in Emerging Market Economies?

Evidence from a Panel VAR Model of the Indian Stock Market[*]

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The data that support the findings of this study are available from the corresponding author upon reasonable request.

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Abstract

The paper uses a panel VAR framework to estimate the impact of a series of reforms aimed at reducing transactions cost and information cost in India's secondary market for equity, on trading cost and trading volume. In particular, we focus on the reforms that were introduced after the creation of the National Stock Exchange (NSE) and screen-based trading that have been much discussed in the literature. Our results suggest that only the creation of the clearing corporation that reduced or eliminated counterparty risk had an economically meaningful/significant impact on trading cost and volume. We also find that the impact was much greater for mid-cap firms and, to a lesser extent, for small-cap firms than for large-cap firms. Further, while trading costs and trading volumes Granger cause each other for mid-cap firms, there is only one-way causality for large-cap firms – trading cost Granger causes volume but the reverse is not true, and for small-cap firms there is no causal relationship between the two. The policy implications of these findings are discussed in the paper.

JEL codes: C58, G12, G18, O16

Keywords: Stock market reforms; Trading cost; Trading volume; Panel VAR; Emerging market.

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1. Introduction

A fairly large literature suggests that, by and large, capital market development, in general, and stock market development, in particular, is associated with long-term economic growth (Atje and Jovanovic, 1993; Levine and Zevros, 1996). Levine and Zevros (1996) argue that well developed stock markets facilitate economic activities in a number of ways. In particular, stock markets can (a) reduce the liquidity risk of investors and thereby facilitate long-term investment commitments of these economic agents, (b) encourage investment in potentially risky projects with higher expected returns by facilitating risk diversification, (c) create a market for information about firms that can help overcome the frictions that exist in an environment of imperfect information, and (d) create a market for corporate control that can help reduce agency costs within firms.

This positive view of stock market development in emerging market contexts have been tempered by research that have suggested that the beneficial advantages of stock market development on economic growth may be moderated by country-specific institutions (Arestis and Demeriades, 1997), and that banks may contribute more towards promoting economic growth than stock markets (Arestis et al., 2001). Singh (1997) points out that informational efficiency of stock markets, which underpins some of the benefits of stock market development highlighted above, may not be easy to replicate in emerging market contexts. Similarly, the net benefits of opening up domestic capital markets to international capital flows have been keenly debated (Henry, 2000; Stiglitz, 2000). However, the popular wisdom strongly favors development of stock markets in emerging market contexts.

Unsurprisingly, therefore, there is significant interest in the development of stock markets in emerging markets. Some scholars have attempted to trace the timeline of stock market development in emerging market economies (Bekaert et al., 2003), while others have focused on the institutional and other determinants of stock market development in emerging market contexts (Billmeier and Massa, 2009). A number of scholars have examined the impact of capital market reforms in general (Bekaert and Harvey, 1997; Bekaert et al., 2001), as well as the impact of specific types of reforms such as opening up to international capital flows (Levine and Zevros, 1998; Kim and Singhal, 2000; Henry 2000), creation of

more transparent trading platforms (Corwin and Schultz, 2012), and introduction of trading in financial derivatives (Bhaumik, Karanasos and Kartsaklas, 2016), on observable market characteristics such as bid-ask spreads, volume/liquidity, returns and volatility.[2]

The growing literature on stock market development in emerging market economies, however, does not adequately address two important issues. First, governments and regulators use a number of policy measures to develop the stock market. For example, in the Indian context, there is a long list of reforms that included the creation of the National Stock Exchange (NSE) with order-driven, anonymous screen-based trading, creation of settlement and trade guarantee fund and investor protection fund, gradual introduction of T+N settlement rules, and introduction of derivatives trading on market indices and individual stocks. An important empirical question is whether all these policy measures have a significant impact on stock market development or whether some policy measures are much more important than others.[3]

Second, in order for stock market development to have an economically meaningful impact on the real economy, the benefits of stock market development have to be reaped not just by large blue-chip companies but by a much wider range of companies, especially medium and smaller companies that have a track record of financial viability and those that require growth capital from the stock (and bond) market(s) (Berger and Udell, 1998, 2006). Specifically, the measures should reduce the trading cost and increase the trading volume – with attendant implications for information content – of not just stocks of large firms that anyhow find it relatively easy to access external capital but also those of smaller firms that generally find it more difficult to access external finance. Whether or not policy measures aimed at stock market development in emerging market contexts have this desired impact on stocks of smaller (or non-blue-chip) firms remains an empirical question that has not been adequately examined in the literature.

[2] In addition, there is a fairly large literature on informational efficiency of emerging equity markets (e.g., Kawakatsu and Morey, 1999; Lagoarde-Segot and Lucey, 2008)

[3] A related issue is whether policy measures should be introduced in a specific sequence, with certain policies introduced early to speed up the process of equity market development (Bekaert, Harvey and Lundblad, 2003; Karacadag, Sundararajan and Elliott, 2003). Since the sequence of policy initiatives in a particular context cannot be changed *ex post*, it is difficult to have more than a conjecture about it.

In this paper, we address the aforementioned lacunae in the literature. We model trading cost and trading volumes of a panel of individual stocks as vector auto-regressive (VAR) processes that are influenced by each other and also by policy measures aimed at stock market development. In effect, therefore, we have a panel VAR model, which we estimate using a system GMM approach. We estimate the model in the context of India, an emerging market economy that has adopted a number of measures aimed at stock market development since the early 1990s (Bajpai, 2006; Bhaumik et al., 2016). In particular, we focus on the reforms that were introduced after the creation of the NSE and screen-based trading that have been much discussed in the literature (e.g., Corwin and Schultz, 2012). Our results suggest the following: (a) Secondary markets reforms implemented since the creation of the NSE reduced the trading cost for mid-cap and small-cap firms but did not have a significant impact on the trading cost of large-cap firms. (b) Of these reforms, only the creation of the clearing corporation that reduced or eliminated counterparty risk had an economically meaningful/significant impact on trading cost. (c) There was very little spillover from changes in trading costs to trading volumes, and vice versa, except for mid-cap firms. Indeed, while trading costs and trading volumes Granger cause each other for mid-cap firms, there is only one-way causality for large-cap firms – trading cost Granger causes volume but the reverse is not true, and for small-cap firms there is no causal relationship between the two. (d) The impact of the shocks, whether the reforms themselves or shocks to trading costs and volumes, dissipate within 3-5 periods (months). The implications of these findings are discussed later in the paper.

Our paper makes a number of contributions to the literature. First, while there is a large literature on the impact of capital account liberalization (Henry, 2000b) and factors such as political risk (e.g., Perotti and Van Oijen, 2001) on equity market development in emerging market context, there is very little evidence about the impact of policies and reforms aimed at equity market development on market characteristics such as the trading cost. In this paper, following in the footsteps of Barclays et al. (1999), Weston (2000) and Chelley-Steeley (2008), we contribute to the evidence based on emerging markets. Second, from a conceptual standpoint, we report evidence that suggest that not all policies or reforms have equal impact on equity markets. Specifically, we identify the policy(ies) that have the greatest impact, with

attendant implications for the sequencing of these policies. Finally, we provide evidence about the heterogeneity in the impact of these policies on trading costs and trading volumes of firms, by market capitalization, which highlights both the likely role of these policies on the width of emerging equity markets and the possible limits to the impact of these policies.

The rest of the paper is structured as follows: In Section 2, we describe the context of analysis, namely, the Indian equity market. In Section 3, we discuss our empirical strategy, and the variables used for the analysis. In Section 4, we discuss the data. The empirical results are reported and discussed in Section 5. Section 6 concludes the paper with the policy implications of the findings.

2. Context of analysis

As documented in Shah and Thomas (2000), in the early 1990s, the Indian equity market was dominated by the Bombay Stock Exchange (BSE) which accounted for over 75 percent of the trading volume in the country. Even though the capital market regulator, the Securities and Exchange Board of India (1988), was officially created in 1988, it "acquired legal standing" (pp. 15) only in 1993, such that, until then, the BSE was de facto an unregulated securities market. Shah and Thomas (2000) note that, perhaps as a consequence, the BSE was able to create entry barriers on new members, thereby raising trading costs. The costs were even higher for investors who were located outside Mumbai, where the BSE was located, on account of inadequate telecommunication infrastructure. At the same time, the floor-based trading at the BSE contributed to non-transparency of prices, and market manipulation was arguably common. One of the factors that contributed to non-transparency of prices was the settlement at the BSE which was based on an account period in which "trades made in a single account during each two-week trading period were netted" (Shah and Thomas, 2000: pp. 17).[4] Shah and Thomas (2000) estimate that during that period trades in almost 6,900 of the 7,000 listed shares were settled bilaterally among the BSE members.

[4] This practice, which was known as *badla* trading, is much discussed in the literature and in policy circles. See, for example, Shah (1995) and Berkman and Eleswarapu (1998).

The reform of the Indian equity market began in earnest with the creation of the NSE in 1994. The market design at the NSE, which launched screen-based trading from inception and where "trading was based on order matching in an open limit order book market" (Shah and Thomas, 2000: pp. 17), arguably led to price transparency. It has also been argued that the creation of the NSE was a key reason for decline in trading costs in the Indian equity markets (OECD, 2007), with the market impact cost declining from 3.00 percent in 1993 to 0.50 percent in 1997 (Table 5.2, pp. 153). Over the same time period, the brokerage declined from 0.75 percent to 0.15 percent. Between 1994 and 2001, the NSE led the way in introducing several other reforms, such as the creation of a clearing corporation that reduced (or eliminated) counterparty risk associated with transactions "through 'novation' at the clearing corporation" (Shah and Thomas, 2001: pp. 7), dematerialization of shares, and replacement of *badla* trading with separate spot and futures (more generally, derivatives) markets. As discussed in Shah and Thomas (2001), many of these reforms were subsequently adopted by the BSE and other major exchanges.

The end to *badla* trading coincided with gradual introduction of T+N rolling settlement. At its inception, NSE reduced this netting period to one week, from the Wednesday of one week to the Tuesday of the following week. Rolling settlements were introduced gradually but, until June 2001, trading in only shares of only a few small and mid-cap companies had been shifted to Compulsory Rolling Settlement (CRS). However, with effect from July 2, 2001, SEBI mandated CRS in all large cap companies (mostly forming part of BSE- 200 Index and the shares having a facility of deferral of the trading positions) on T+5 basis. Further, with effect from, December 31, 2001, trading and settlement in all listed securities was mandated under CRS on T+5 basis and weekly or account period settlement was discontinued. Finally, with effect from April 1, 2002, trades are settled on T+3 basis.

In the post-2001 period, the two equity market reforms that stand out are the introduction of the Real Time Gross Settlement (RTGS) system and the introduction of pre-open call options. RTGS was first implemented in India in March 2004 as a major technology based electronic funds transfer system across the country. The system facilitated customer, inter-bank payment on a 'real' time and on gross basis. The system also facilitated settlement of Multilateral Net Settlement Batch (MNSB) files emanating from other

ancillary payment systems. The RTGS infrastructure is critical in facilitating the orderly settlement of payment obligations. This policy change is important in our research context as introduction of a critical financial market infrastructure operated by central bank that in turn ensures "safety net" attributes by providing final settlement in central bank money.

Pre-open call auctions, on the other hand, has implications for market transactions cost which can be conjectured as a spillover effect of improved transparency and price discovery. For example, Gerace et al. (2015) find that the dissemination of indicative trade information during the pre-open call auction session in China leads to an overall improvement in stock liquidity in the continuous trading session.[5] Bid-ask spreads narrow in the first trading hour because adverse selection risk fell significantly and there is less price volatility in the continuous market. This effect is greater for actively traded securities than illiquid securities. On the other hand, as the limit order book is opaque during the auction period it may lead to reduction of liquidity especially for small companies which are facing thin market.

The post-NSE set of reforms have also led to decline in transactions cost in the Indian equity market. The counterparty risk associated with trading, for example, was completely eliminated by 2004 (OECD, 2007: Table 5.2). Similarly, between 1993 and 2004, settlement cost declined from 1.25 percent to 0.03 percent. However, estimates suggest that over the same time period, the decline in market impact cost and brokerage accounted for 73 percent of the decline in overall transactions cost. Further, the impact of some of the reforms such as introduction of RTGS have not been estimated at all. A priori, therefore, the impact of all equity market reforms on trading cost and market development is not similar and, at the same time, the Indian context is suitable for empirically examining this proposition.

3. Empirical strategy and variable measurement

3.1 Empirical strategy

[5] In related research, Chelley-Steeley (2008) demonstrates that opening and closing market quality of participating stocks was improved by introduction of closing call auction at the London Stock Exchange. There is, in other words, prima facie evidence to suggest that the beneficial impact of such auctions may be generalizable across countries and across the specific nature of the auctions.

The literature on the economic implications of stock market development suggest that much of the benefits of stock market development results from greater investor participation in the secondary market. Greater investor participation has implications for information flow about the listed companies and, by extension, about the efficiency with which capital is allocated through the stock market. If greater investor participation improves liquidity of stocks in the secondary market, it can also reduce the cost of equity capital for firms (Butler et al., 2005). Arguably, therefore, a test of whether policy measures aimed at stock market development are successful should examine the impact of these policies on trading (or transactions) costs in the secondary market. This forms the basis of our empirical strategy.

Specifically, we use a panel VAR model to examine the implications of such stock market developments on the trading cost in the secondary market. In our VAR framework we also posit that if a change in trading costs has an impact on the trading volume in the secondary market, the resultant change in liquidity may, in turn, affect the trading cost by changing the price impact of trades. We, therefore, consider bivariate panel VAR model using trading costs and trading volumes. We use the panel VAR approach because the interactions between trading volume and transaction cost have not been strongly theoretically grounded, and hence a VAR-based atheoretic set-up would be most applicable. Thus, in our model, we first examine the evolution of trading cost and trading volume following capital market reforms. Next, we explore in VAR framework how the changes in trading cost lead to changes in trading volume, thus affecting market liquidity and, in turn, trading cost.

Our VAR model, therefore, is given by

$$\left|\begin{matrix} y_{1it} \\ y_{2it} \end{matrix}\right| = \left|\begin{matrix} \sum_{j=1}^{l} \gamma_{1j} y_{1it-j} + \sum_{j=1}^{l} \delta_{1j} y_{2it-j} + \sum_{k=1}^{5} \beta_{1k} D_k + (\text{control variables})_t + u_{1i} + \varepsilon_{1it} \\ \sum_{j=1}^{l} \gamma_{2j} y_{1it-j} + \sum_{j=1}^{l} \delta_{2j} y_{2it-j} + \sum_{k=1}^{5} \beta_{2k} D_k + (\text{control variables})_t + u_{2i} + \varepsilon_{2it} \end{matrix}\right| \qquad [1]$$

where y_1 is trading cost, y_2 is trading volume, D_k are dummies for k stock market development policy initiatives, and ε's are iid error terms. Since trading cost is a meaningful characteristic of individual stocks

but not of a market index, we estimate this model using a panel of i firms listed at the NSE,[6] such that u_i are firm-specific fixed effects accounting for heterogeneity at firm level. Further, since our interest does not lie in the market microstructure but in the impact of policy initiatives on trading costs (and trading volume) in the secondary market, we use monthly measures of trading costs and trading volume, such that the time indicator t indicates the number of months in the January 1995-November 2014 sample period.[7] Specifically, for our sample, we have $i = 1, 2, \ldots, 849$, and $t = 1, 2, \ldots, 239$.

The choice of the estimation method for the system characterized by (1) depends on the order of integration of the variables. If the system is a cointegrated CI(d, b) system, for which linear combinations of I(d) variables are I(0), the use of a VECM (vector error correction model) would be appropriate. (e.g., Kurov and Lasser, 2004; Forte and Pena, 2009). However, where the variables are individually I(0), they can be estimated using the basic VAR model (Lutkepohl, 2004). Given that equation (1) also includes strictly exogenous variables, we will, in effect, estimate a VAR-X model (Breitung et al., 2004). As discussed later in the paper, the null hypothesis of (panel) unit root is rejected for our data, and hence we estimate a panel VAR model without any error-correction term required,[8] using the system GMM approach following Holtz-Eakin et al. (1988) and Love and Zicchino (2006).[9] The equations described in (1) are jointly estimated to ensure efficiency gains. We also allow for cross-sectional heterogeneity in the variance of error terms using sandwich variance estimator.

[6] For a rationale for the choice of NSE as the context of analysis, see Bhaumik et al. (2016).

[7] As the policy initiatives were undertaken in the 1990s and early 2000s and the last reform was initiated in 2010, we believe that such that a monthly sample period up till 2014:11 is sufficient to pick up the impact of these policies. Moreover, the reforms during this period were institutionalized in India with a focus on capital market development whereas later reforms were focused on mostly governance issues. In other words, our interest lies less in the VAR process itself and more on the marginal impact of the reforms.

[8] The model structure is, of course, compatible with a VAR as well as a VEC model. As we discuss later in the paper, we use appropriate tests to ascertain that variables are I(0). For details on panel VAR models, see Canova and Ciccarelli (2013).

[9] It is generally argued in the literature that since time-invariant individual-specific intercepts are correlated with the error term in dynamic panels (Nickell, 1981), it is prudent to estimate panel VAR models using GMM (e.g., Goes, 2016; Liu and Zhang, 2016; Ouyang and Li, 2018). While the magnitude of this bias is inversely related to T (Abrigo and Love, 2015), it is unclear as to whether it is sufficiently small to warrant OLS estimation for our sample period, especially because in our unbalanced panel T may not be large for a number of stocks/companied included in our sample.

3.2 Variable measurement

The key measurement issue in the context of our empirical model involves a decision about the proxy for trading costs; trading volume is easily measured (Bhaumik et al., 2016). Based on the discussion in Aiyagari and Gertler (1991) and Keim and Madhavan (1997), we argue that the bid-ask (or buy-sell) spread is perhaps the single most important component of trading costs. This is consistent with the discussion in the literature which suggests that the bid-ask spread is significantly made up of order processing costs and inventory holding costs of the investors (Stoll, 1989; Huang and Stoll, 1997).[10] It is also consistent with the argument that non-trivial bid-ask spreads exist in the presence of (and hence is at least correlated with) transactions cost (Cohen et al., 1981). In other words, while the bid-ask spread may not be the perfect measure of trading (or transactions) cost (Lesmond et al., 1999), it can be a fairly good proxy for trading costs, especially when the analysis is restricted to a single exchange, thereby bypassing the problem of differences in brokerage costs across exchanges.

There is a large literature on estimation of bid-ask spreads, which can be traced back to Roll (1984). We estimate the spread using the approach of Corwin and Schultz [CS] (2012). The CS approach assumes that the actual value of a stock price follows a diffusion process, and that the daily high and the daily low prices are buyer-initiated and seller-initiated respectively. Thereafter, the CS approach involves the use of a closed-form solution, rather than the iterative and maximum likelihood estimation approaches that are computationally intensive. Most importantly, for our purposes, the CS estimator "is derived under very general conditions. It is not ad hoc and can be applied to a variety of different market structures" (Corwin and Schutlz, 2012: pp. 720). CS demonstrate that the spread estimated using their approach outperforms those estimated using the popular Roll (1994) and Lesmond et al. (1999) approaches.

The CS approach also enables us to compute bid-ask spreads for time periods such as a month. CS note that "[b]ecause the variance and the spread are nonlinear functions of the high-low price ratio, an

[10] As demonstrated by George et al. (1991), the adverse selection component of the bid-ask spread, while significant, accounts for only 8-13 percent of the quoted spread.

average of spread estimates is not an unbiased estimate of the spread. *However, our simulation results and empirical analysis both suggest that this is not a problem in practice* (pp. 725; emphasis added)." They estimate monthly spreads as the average of all 2-day spread estimates within a calendar month; all negative spreads are set to zero and a minimum of 12 daily price ranges are required to calculate a monthly spread. Additionally, in the seminal paper, the CS estimator has been used to estimate monthly high-low spreads for stocks listed on (NYSE/Amex and) the Bombay Stock Exchange (BSE), i.e., for the Indian context, as a potential application to non-US markets.[11]

Next, we identify the specific policy measures that we include in our empirical model. In the Indian context, starting with the establishment of the National Stock Exchange (NSE) and screen-based order-driven trades, a number of policy measures have been introduced over time to facilitate stock market development (Bajpai, 2006: Appendix IV). To begin with, by way of restricting our sample period to the post-1994 period and considering securities which are listed on NSE, we leave out the creation of NSE and related trading policies from our set of policies, largely because the statistically and economically significant impact of the creation of NSE on bid-ask spread (and transactions cost) are well-documented (e.g., Corwin and Schultz, 2012). Of the others, we choose the following five policies which, in our judgement, constitute the post-NSE policy initiatives that were aimed to reduce transactions cost and information cost in the secondary markets:[12] [*d1*] the creation of National Securities Clearing Corporation Limited (NSCCL) in April 1996, which removed counterparty risk (and its cascading consequences) by guaranteeing each trade; [*d2*] the creation of National Securities Depository Limited (NSDL) in November 1996, which facilitated conversion of stocks from paper/physical to electronic form which, in turn, significantly reduced both trading costs and delays with share transfers; [*d3*] the introduction of derivatives

[11] More recent use of the CS spread can be found in Liu et al. (2016) and Rosati et al. (2017).

[12] In our base model, the dummy variable for each of these policy initiatives has the value 1 for all periods starting from the month during which policy was introduced. However, since investors may have adapted to these policy initiatives in advance, in anticipation of these initiatives, we have examined the robustness of the results by (1- and 2-month) lagged values of these dummy variables as well. The insights provided by our results were not affected by these changes, and the results themselves are available from the authors upon request.

trading and rolling settlement in July 2001;[13] [*d4*] the introduction of real time gross settlement (RTGS) in October 2004; and [*d5*] the (re-)introduction of the call auction for Nifty, NSE's flagship index, in October 2010.[14]

Finally, we control for four exogenous factors that may have affected the Indian stock market. First, we control for the US interest rate which can affect cross-border capital flows. Second, we control for the market risk in developed markets using the VIX index of the Chicago Board Options Exchange (CBOE), which measures the near-term volatility conveyed by S&P 500 stock index option prices. Third, we control for the impact of the financial crisis, using September 2008 as the starting point for the crisis.[15] We also control for industry performance in India, using the (monthly) index of industrial production (IIP), as a proxy for economic performance. Since the series for the US interest rate and the IIP are I(1), we use the first difference of these variables instead of the level variables.

4. Data

Recall that, for the panel VAR framework, we need, to begin with, measures of trading cost and trading volume. We compute these using data from the NSE, which is India's largest stock exchange by market capitalization. It is demutualized and, as mentioned above, has used a screen-based limit order matching system since its inception. It is argued that the NSE, therefore, provides a better-quality market than the BSE (Krishnamurti et al., 2003), and it is also the largest stock exchange in India by market capitalisation.

[13] Even though compulsory rolling settlement (CRS) was introduced in a phased manner, we choose July 2001 as this was the first large scale implementation of CRS, with clear expectations about wider roll out of CRS over the foreseeable future.

[14] Note that the only major change not included in our list of policy initiatives is the ban on *badla* trading. Badla trading was initially banned in December 1994 and this decision was reversed in October 1995. It was banned again, for good, when rolling settlement on all BSE200 stocks and derivatives trading were introduced in July 2001. Given our sample period, and in the interest of model parsimony, we felt that we did not have to separately control for changes in the regulations regarding badla trading.

[15] The exact timing of the start of the financial crisis is not easy to determine; see https://www.stlouisfed.org/financial-crisis/full-timeline. However, based on the movement of the S&P 500 index, we chose to view September 2008 as the start of the financial crisis. This is also consistent with the first substantive government intervention in the form of the decision by the Federal Housing Finance Agency (FHEA) to put Fannie Mae and Freddie Mac under conservatorship, on September 7, significant regulatory intervention by the regulators in Washington Mutual Fund and Wachovia Corporation, and the now infamous decision by Lehman Brothers Holdings to file for Chapter 11 bankruptcy on September 15.

Hence, while the older literature on the Indian stock market used data from the BSE (Berkman and Elewarapu, 1998), more recent literature has used data from the NSE as well (Bhaumik et al., 2016).

To begin with, for each month in our sample period, and for each stock in our sample, we measure volume using the daily average (Indian rupee) turnover of the stocks. Next, we follow the methodology of Corwin and Schultz (2012), discussed earlier in the paper, to calculate monthly spread for each stock, for each month in the sample period. The widely used panel unit root tests of Im, Pesaran and Shin [IPS] (2003) require that there be no gap in the data and given that trading gaps do exist for shares of mid-cap and small-cap companies. Also, for the asymptotic assumption of the IPS test to hold for an unbalanced panel, each stock included in our sample must have data for more than 9 time periods (i.e., months). Hence, we retain in our sample, only those stocks for which at least 12 months, i.e., 1 year of data are available. Overall, our final sample includes data on 849 firms for which continuous trading data is available, and our sample period extends from January 1995[16] to November 2014, such that we have 239 (monthly) data points in our sample. We intentionally refrain from considering years after 2014 to keep our sample "clean" as in 2015 stock markets in India witnessed several anomalies due to flat earnings, rejection of major bills like GST, Land acquisition followed by Demonitisation in 2016. Analysis of reforms that have direct impact on the real sector have more complex transmission to the capital markets and therefore, is beyond the scope of our present study.

INSERT Table 1 about here.

In Table 1, we report the average market capitalization, CS spread, and trading volume for our sample of firms. Unsurprisingly, the large-cap firms in the sample have much higher market capitalization, on average, than the mid-cap and small-cap firms.[17] Average trading volume too drops sharply as we move

[16] The NSE was opened in November 1994, providing Indian investors with an order-driven electronic limit order book, reduced tick sizes, satellite technology with links to sites all over India, and improved settlement and clearing standards (see Shah and Thomas (2000)). By October 1995, NSE had surpassed the BSE, becoming the dominant equities market in India.

[17] Our large-cap sub-sample includes 81 firms that were part of the CNX100 index for the duration of the sample period. Our mid-cap sub-sample includes firms whose average market capitalization over the sample period remained between the 25th and 75th percentiles of the distribution of market capitalization of the 849 firms in the full sample. Finally, our sub-sample of small-cap firms includes 85 firms whose average market capitalization over the sample

from the large-cap sub-sample to the mid-cap and small-cap sub-samples. Importantly, from the point of view of our analysis, the (average) spread too increases monotonically as one moves from the large-cap sub-sample to the small-cap sub-sample. This provides us with prima facie evidence that trading costs are higher for mid-cap and small-cap firms, thereby making it important to understand whether equity market reforms significantly reduce trading cost for these firms.

INSERT Figure 1 about here.

In Figure 1, we report the trends in the two endogenous variables in equation (1), namely, the CS spread and trading volume. The data suggests that over much of the sample period, there was both a difference between spreads of large-cap, mid-cap and small-cap firms, as well as considerable co-movements among these spreads. There was considerable convergence in the spreads of these three types of firms in the immediate aftermath of the financial crisis, but the spread for large-cap firms and others diverged once again from 2010. The volume data confirms that trading volume is much higher for large-cap firms than for mid-cap and small-cap firms. This data also suggests that while trading volume of large-cap firms have increased sharply since 2004, there is a strong persistence in the trading volumes of mid-cap and small-cap firms. This raises the question as to whether any reduction in trading costs (as measured by the spread) on account of equity market reforms has a significant impact on trading volumes, and the efficacy of reforms that aim to increase depth and width of secondary equity markets by reducing the trading cost. We shall examine this issue more rigorously later in this paper.

INSERT Table 2 about here.

In Table 2, we report the estimates of the panel unit root tests proposed by IPS (2003), and Maddala and Wu (1999) and Choi (2001) [MWC]. The null hypothesis of both the IPS and MWC tests is that all firms in the panel follow a unit root, and the alternative hypothesis is that some (but not all) of the firms have unit roots. The standardized test statistic follows a standard normal distribution. The non-parametric

period was in the bottom decile of the aforementioned distribution. While these classifications are admittedly ad hoc, we feel that they serve the purpose of examining how the impact of the equity market reforms vary across large-cap, mid-cap and small-cap firms.

Fisher-type tests on which MWC is based uses *p*-values from unit root test for each firm, and the test statistic $P = -2\sum_{i=1}^{N} \ln p_i$ asymptotically follows a chi-square distribution with 2*N* degrees of freedom, where *N* denotes number of cross-section units. The *p*-values for the test are obtained using Monte Carlo simulations, and Fisher-type tests are suitable for unbalanced panels. They also allow lag lengths of the (augmented) Dickey-Fuller tests for the individual firms to differ. The test statistics reported in Table 2 and their significance levels suggest that the null hypothesis of unit roots for all sub-sample of firms is rejected by both the IPS and the MWC tests, for both the spread and the trading volume. As mentioned above, we therefore proceed with the estimation of the bivariate VAR model highlighted in equation (1). The results of the VAR model are reported and discussed in the next section.

5. Results of Panel VAR

The estimates of the VAR model (equation (1)) is reported in Table 3. We report the estimates for the large-cap, mid-cap and small-cap sub-samples. The lag lengths for the spread and volume equations were determined using the moment-based BIC criterion developed by Andrews and Lu (2001) for over-identified system. Further, as mentioned earlier in the paper, following Holtz-Eakin et al. (1988), the model has been estimated using system GMM. The Hansen's over identification J statistics (1982) reported in the table suggest that the choice of instruments has been appropriate.

5.1 Policy reforms, trading costs and volume

Recapitulate that the focus of this paper is on the impact of equity market reforms on trading costs, and its implications for depth and width of the equity market. Hence, as the first step of our analysis, we focus on the impact of (the post-1994) equity market reforms on trading cost, our proxy for which is the CS spread. Our results suggest the following: (a) (many of) the five reforms that we have chosen for our model have reduced the spread (i.e., the trading cost), (b) the impact of the reforms on the spread is much greater for

the mid-cap and small-cap sub-samples than for the large-cap sub-sample;[18] and (c) the impact of the introduction of the clearing house that reduces (or eliminate) counterpart risk has had a much greater *economic* impact on the spread than the other reforms (e.g., the coefficient for NSCCL is -0.03 for the mid-cap firms and -0.07 for the small-cap firms while the coefficients of the other reforms are much smaller).[19]

INSERT Table 3 about here.

In other words, the impact of the early reforms, the establishment of the NSE and the subsequent move towards screen-based trading (which has been discussed in the earlier literature), and the establishment of the clearing house (which we discuss in this paper) have contributed to disproportionately greater reduction in the spread (or trading cost) relative to other reforms in the context of India's equity market.

Further, as highlighted by the *dynamic multiplier* graphs in Figure 2, which capture the impact of changes to exogenous variables on spread,[20] the equity market reforms (variables *d1* through *d5* in the graphs) had an immediate impact on the spreads of mid-cap and small-cap firms but incremental impact of these reforms on these spreads was negligible after the third period, where each time period is a month. Hence, it may be important to focus on reforms that reduce information cost and the costs associated with contract enforcement, and to introduce them early to have an early and meaningful impact on equity market development.

INSERT Figure 2 about here.

The policy initiatives captured by *d1-d5* do not have a major impact on the trading volumes of mid-cap and small-cap firms. These reforms had no impact on the trading volumes of small-cap firms and while CRS and call auctions have a positive impact on the trading volumes of mid-cap firms, the economic significance of these impacts is small relative to the average trading volumes for mid-cap firms. Interestingly, the most noticeable impact of these policy initiatives, the creation of NSCCL and NSDL, in

[18] The positive impact of RTGS on the spread for large-cap firms and similar impact of CRS and call auctions on the spread for small-cap firms are counterintuitive. However, the economic significance of these impacts is very small.

[19] This is broadly consistent with the literature in which it has been argued that the centralized clearing being an optimal arrangement for OTC trades especially when liquidity costs are high (e.g., Koeppl, Monnet, C. and Temzelides (2012))

[20] The confidence intervals shown on Figure 2 are constructed using 100 Monte Carlo simulations.

particular, were on the trading volume of the large-cap firms. While NSCCL reduced the trading volumes of large cap firms, NSDL increased these trading volumes. Since the primary focus of the paper is the impact of policy initiatives on trading costs, we do not report the dynamic multiplier graphs for trading volumes. They can be obtained from the authors upon request.

5.2 VAR structure and impulse responses

Next, we examine the VAR structure of the model, i.e., we examine whether changes to the spread had any impact on trading volume and whether the changes to volume (and consequently to the liquidity of the secondary market) had any feedback effect on the spread. As such, if policy initiatives are to reduce trading costs, we should expect an increase in trading volumes and the increased liquidity should, in turn, have a further impact on trading costs. We note that while spread and volume Granger cause each other for mid-cap firms, there is a one-way causality from spread to volume for large-cap firms, and no causality between these endogenous variables for the small-cap firms.

INSERT Figure 3 about here.

Next, we examine the impulse response functions reported in Figure 3, and we are particularly interested in the impact of spread shocks on volume, and vice versa. The impulse response functions indicate the following: (a) For mid-cap firms, there is noticeable but uneven response of shocks to spread and volume on volume and spread, respectively. These impacts persist until around the 5th period. (b) For both large-cap and small-cap firms, a shock on spread has a modest impact on volume.

5.3. Robustness checks

As with any data generating process, there could be non-linearity in the underlying dependent variables. While there is some discussion of nonlinear VAR models in the literature (Rahman and Serletis, 2010; Ajmi, Hammoudeh, Nguyen and Sarafrazi, 2014; Gregoriou, Racicot and Theoret, 2021), we are not aware

of applications of nonlinear VAR models to panel data. We, therefore, attempt to accommodate nonlinearity in our framework using logarithmic transformations of the dependent variables and re-estimate the panel VAR using GMM method. As shown in the table A1, our main results largely remain unchanged. As with the earlier specification, implementation of NSCCL and NSDL significantly reduces the trading costs in the mid and small cap firms. Further, as in the case of the baseline model reported in the paper, in the log transformed model specification, spread Granger causes trading volume in the mid cap firms significantly and small cap firms weakly.

We undertake two sets of tests for the log transformed dependent variables and the associated VAR model. First, following Tsay, (1986), we test for nonlinearity in the average values of individual time series, i.e.. log volume and log spread. The results suggest the presence of nonlinearity for log(spread) but not for log(volume). Specifically, the test statistic for log volume is 0.3569 with p-value 0.55, while test statistic for log spread is 2.54 with p-value 0.002. Next, since the sampling distributions could be sensitive to the conditional heteroscedasticity in the error, we also conduct multivariate extended version test (Lo and Zivot, 2001) of Hansen (1999). The test statistic for the null of linear VAR and the alternative of 1 threshold TVAR is 0.315 with p-value 0.20, while test statistic for the null of linear VAR versus 2 threshold TVAR is 54.82 with p-value of 0.20. In other words, the null of a linear VAR could not be rejected in either case. Overall, therefore, we feel that the log transformation of the dependent variables is sufficient to address any concerns about nonlinearity in the model.

Further, since it is well known that impulse responses are sensitive to the ordering of variables in VAR models, we have experimented with different ordering variables in the estimated VAR models and the magnitude of the impacts have remained qualitatively the same. Specifically, in calculating the orthogonalized impulse response function, we first consider spread and then volume. In order to check for robustness of our conclusion, we also check for the impulse response functions by reversing the order of the variables in the lower triangular matrix.

Finally, we have use robust standard errors across all the specifications.

5.4 Control variables

Regarding control variables, an increase in VIX, a measure of uncertainty, had a very small impact on the spreads of both large-cap and mid-cap firms – positive for the former and negative for the latter – but no impact on the spread of small-cap firms. The spread for all types of firms decreased with the US interest rate and rose after the onset of the financial crisis. The impact of the control variables on trading volume is significant mostly for large-cap firms; volume increased after the onset of the financial crisis and it is inversely related to VIX and changes in the US interest rate. The IIP growth rate, which is the proxy for industry performance in India, had a (positive and) significant impact on only the trading volumes of mid-cap firms.

5.5 Discussion

Emerging market regulators and policy makers pursue a number of different policies and reforms packages aimed at improving the quality of their equity markets, as part of a wider portfolio of reforms aimed at financial development. Indeed, these countries have the option to "liberalize in many ways and many countries have taken different routes" (Bekaert, Harvey and Lundblad, 2003; pp. 275). Not surprisingly perhaps, there is considerable heterogeneity among informational efficiency, transactions cost and other aspects of emerging equity markets (Lagoarde-Segot, 2009). This, in turn, raises the question of whether all policies/reforms have an equal impact on secondary markets – trading costs in particular, which has implications for whether the portfolio of policies and reforms can be streamlined and also for sequencing of these policies. In addition, one has to address the question as to whether policy initiatives are successful at reducing trading costs of all types of listed firms, big and small. In this paper, we abstract from issues of capital account liberalization (Henry, 2000b) and political risk (e.g., Perotti and Van Oijen, 2001) in emerging market economies, and focus on policies aimed at addressing microstructure issues, in the tradition of Barclay et al. (1999), Weston (2000) and Chelley-Steeley (2008). Specifically, we focus on the impact of policy initiatives on trading cost and trading volume in the secondary market.

A key insight provided by our paper is that all policy initiatives do not have an equal impact on the equity market. In the Indian context, the significant impact of the start of NSE and screen-based trading at that exchange on trading costs has been much discussed in the literature (Corwin and Schultz, 2012; OECD, 2007). We focus on the post-NSE policy initiatives and find that the creation of NSCCL, which minimized or eliminated counterparty risk, with attendant implications for transactions cost, had a much greater impact on both trading costs than other policies such as the introduction of T+N rolling settlement and introduction of equity derivatives. Taken together, our results and those reported in the earlier literature suggest that major changes such as transparency in pricing (e.g., via screen-based trading) which reduces information cost and policies that reduce counterparty risk (and transactions cost) are perhaps much more relevant and important for the development of secondary equity markets than other reforms that may improve informational efficiency of the market and reduce volatility (e.g., Bhaumik et al., 2016), but which has limited impact on key market attributes such as trading costs. A plausible conjecture, therefore, is that policymakers should perhaps adopt and implement policies such as introduction of screen-based trading and creating of clearing corporations earlier than policies such as the introduction of *T+N* rolling settlement and introduction of trading in derivative instruments.

A second key insight is that the impact of policy initiatives varies by market capitalization of the firms. These initiatives have little impact on the trading costs of large-cap firms for which information costs and transactions costs are perhaps low to begin with, and whose trading may be dominated by large informed traders who also have greater ability to enforce contracts. The policy initiatives have much greater impact on the trading costs of mid-cap and small-cap firms. Given that the reduction in trading costs may be the first step in the process of creation of a liquid secondary market for shares which, in turn, has positive implications for primary markets; the likelihood of equity issuance by firms varies inversely with liquidity risk in the secondary market (Lin and Wu, 2013). Taken together with the analysis of Berger and Udell (1998, 2006), this suggests that the policy initiatives may have improved the access of medium and relatively small firms to the equity capital. This, of course, comes with the caveat that eventual issue of

equity, as observed by the number of IPOs and SEOs depends on a host of other factors such as the ownership structures of the firms; e.g., family-controlled firms may be reluctant to dilute the control of the families (Bhaumik and Dimova, 2014). However, in the Indian context, at least, the policy initiatives seem to have positively contributed to the likelihood of equity market access by a wider cohort of firms.

Finally, our results suggest that trading cost and volume Granger cause each other only for mid-cap firms. For large-cap firms, trading cost Granger causes volume but not the other way around, and these variables do not Granger cause each other for small-cap firms. In other words, the mid-cap firms may have been the greatest beneficiaries of these policy initiatives. Further, the impact of a shock to either of these variables on the other dissipates within five periods (months).

6. Conclusion

The debate about the exact impact of equity market development on the real sector (and, correspondingly, economic growth) notwithstanding, there is general agreement about the proposition that development of equity markets in emerging market economies, generally as a part of overall financial development, is a worthwhile endeavor. However, with the literature focusing largely on factors such as capital account liberalization and integration of emerging equity markets with global capital markets, there is little evidence about which policies or reforms aimed at equity market development have an economically meaningful impact, and whether these policies have equally beneficial reforms for all firms, irrespective of their market capitalization. In this paper, using a panel VAR structure, and data from 849 listed firms in India, for the January 1995-November 2014 period, we examine these issues. We deliberately leave out the creation of the NSE and the adoption of screen-based trading, whose benefits have been widely discussed, from our sample period. The main insights of our results suggest that only one of the subsequent policy initiatives have had economically meaningful impact on trading costs, and that the observed impact varies by market

capitalization. Specifically, the impact is quite visible for mid-cap firms and less so for small-cap firms but negligible for large-cap firms.

We have already discussed the implications of these findings in the previous section. However, it may be important to consider what the results and their implications mean for the broader issue of financial development, even if we restrict ourselves to the relatively narrow issue facilitating access to external capital for firms, especially small and medium enterprises, which has significant implications for economic growth. The basis for our conjecture is the implications for lower trading costs in the secondary market for secondary market liquidity and, in turn, for new issuances in the primary market. Our empirical analysis suggests that, in emerging market economies, while the likelihood of relatively smaller and medium sized firms may ultimately be influenced by a number of different factors, appropriate policy initiatives (and perhaps also the appropriate sequencing of these policies) can facilitate that process of equity market access by a wide range of firms.

References

Abrigo, M.R.M., Love, I. (2015). Estimation of vector autoregression in Stata: A package of programs, Mimeo, Downloadable from http://paneldataconference2015.ceu.hu/Program/Michael-Abrigo.pdf.

Andrews, D.W.K., Lu, B. (2001). Consistent model and moment selection procedures for GMM estimation with application to dynamic panel data models, *Journal of Econometrics*, 101(1):123-164.

Ajmi, A.N., Hammoudeh, S., Nguyen, D. K., Sarafrazi, S. (2014). How strong are the causal relationships between Islamic stock markets and conventional financial systems? Evidence from linear and nonlinear tests. *Journal of International Financial Markets, Institutions and Money*, *28*, 213-227.

Arestis, P., Demetriades, P. (1997). Financial development and economic growth: Assessing the evidence, *Economic Journal*, 107(442): 783-799.

Arestis, P., Demetriades, P.O, Luintel, K.B. (2001). Financial development and economic growth, *Journal of Money, Credit and Banking*, 33(1): 16-41.

Atje, R., Jovanovic, B. (1993). Stock markets and development, *European Economic Review*, 37(2-3): 632-640.

Ayigari, S.R., Gertler, M. (1991). Asset returns with transactions costs and uninsured individual risk, *Journal of Monetary Economics*, 27(3): 311-331.

Bajpai, G.N. (2006). Development of the securities market in India, In: Aziz, J., Dunaway, S., Prasad, E. (eds.) *China and India: Learning from Each Other – Reforms and Policies for Sustained Growth*, Washington, DC: International Monetary Fund.

Barclay, M.J. et al. (1999). Effects of market reform on the trading costs and depths of Nasdaq stocks, *Journal of Finance*, 54(1): 1-34.

Bekaert, G., Harvey, C.R. (1997). Emerging equity market volatility, *Journal of Financial Economics*, 43(1): 29-77.

Bekaert, G., Harvey, C.R., Lundblad, C.T. (2001) Emerging equity markets and economic development, *Journal of Development Economics*, 66(2): 465-504.

Bekaert, G., Harvey, C.R., Lundblad, C.T. (2003). Equity market liberalization in emerging markets, *Journal of Financial Research*, 26(3): 275-299.

Berger, A.N., Udell, G.F. (1998). The economics of small business finance: The roles of private equity and debt markets in the financial growth cycle, *Journal of Banking and Finance*, 22: 613-673.

Berger, A.N., Udell, G.F. (2006). A more complete conceptual framework for SME finance, *Journal of Banking and Finance*, 30: 2945-2966.

Berkman, H., Eleswarapu, V.R. (1998). Short-term traders and liquidity: A test using Bombay Stock Exchange data, *Journal of Financial Economics*, 47(3): 339-355.

Bhaumik, S.K., Dimova, R. (2014): *How Family Firms Differ: Structure, Strategy, Governance and Performance*, Palgrave.

Bhaumik, S.K., Kartsaklas, A., Karanasos, M. (2016). The informative role of trading volume in an expanding spot and futures market, *Journal of Multinational Financial Management*, 35: 24-40.

Billmeier, S., Massa, I. (2009). What drives stock market development in emerging markets – institutions, remittances, or natural resources? *Emerging Markets Review*, 10(1): 23-35.

Breitung, J., Bruggemann, R., Luktepol, H. (2004). Structure vector autoregressive modeling and impulse responses, In: Lutkepohl, H., Kratzig, M. (eds.) *Applied Time Series Econometrics*, Cambridge: Cambridge University Press.

Butler, A.W., Grullon, G., Weston, J.P. (2005). Stock market liquidity and the cost of issuing equity, *Journal of Financial and Quantitative Analysis*, 40(2): 331-348.

Canova, F., Ciccarelli, M. (2013). Panel vector autoregressive models: A survey, Working paper no. 1507, European Central Bank.

Chelley-Steeley, P.L. (2008). Market quality changes in the London Stock Market, *Journal of Banking and Finance*, 32(10): 2248-2253.

Choi, I. (2001). Unit root tests for panel data, *Journal of International Money and Finance*, 20(2): 249-272.

Cohen, K.J., Maier, S.F., Schwartz, R.A., Whitcomb, D.K. (1981). Transactions costs, order placement strategy, and existence of the bid-ask spread, *Journal of Political Economy*, 89(2): 287-305.

Corwin, S.A., Schultz, P. (2012). A simple way to estimate bid-ask spreads from daily high and low prices, *Journal of Finance*, 67(2): 719-760.

Forte, S., Pena, J.I. (2009). Credit spreads: An empirical analysis on the informational content of stocks, bonds, and CDS, *Journal of Banking & Finance*, 33(11): 2013-2025.

Fraser, S., Bhaumik, S.K., Wright, M. (2015). What do we know about entrepreneurial finance and its relationship with growth? *International Small Business Journal*, 33(1): 70-88.

George, T.J., Kaul, G., Nimalendran, M. (1991). Estimation of the bid-ask spread and its components: A new approach, *Review of Financial Studies*, 4(4): 623-656.

Gerace, D., Liu, Q., Tian, G.G., Zheng, W. (2015). Call auction transparency and market liquidity: Evidence from China, *International Review of Finance*, 15(2): 223-255.

Goes, C. (2016). Institutions and growth: A GMM/IV panel VAR approach, *Economics Letters*, 138: 85-91.

Gregoriou, G.N., Racicot, F.É., Théoret, R. (2021). The response of hedge fund tail risk to macroeconomic shocks: A nonlinear VAR approach. *Economic Modelling*, *94*, 843-872.

Hansen, L.P. (1982). Large sample properties of generalized method of moments estimators, *Econometrica*, 50(4): 1029-1054.

Harris, R.D.F. (1997). Stock markets and development: A re-assessment, *European Economic Review*, 41(1): 139-146.

Henry, P.B. (2000a). Do stock market liberalizations cause investment booms? *Journal of Financial Economics*, 58(1-2): 301-334.

Henry, P.B. (2000b). Stock market liberalization, economic reform, and emerging market equity prices, *Journal of Finance*, 55(2): 529-564.

Holtz-Eakin, D., Newey, W., Rosen, H.S. (1988). Estimating vector autoregressions with panel data, *Econometrica*, 56(6): 1371-1395.

Huang, R.D., Stoll, H.R. (1997). The components of the bid-ask spread: A general approach, *Review of Financial Studies*, 10(4): 995-1034.

Im, K.S., Pesaran, M.H., Shin, Y. (2003). Testing for unit roots in heterogeneous panels, *Journal of Econometrics*, 115(1): 53-74.

Karacadag, C., Sundararajan, V., Elliott, J.E. (2003). Managing risks in financial market development: The role of sequencing, Working paper no. WP/03/116, International Monetary Fund, Washington, D.C.

Karmakar, M. (2010). Information transmission between small and large stocks in the National Stock Exchange in India: An empirical study, *Quarterly Review of Economics and Finance*, 50(1): 110-120.

Kawakatsu, H., Morey, M.R. (1999). Financial liberalization and stock market efficiency: An empirical examination of nine emerging market countries, *Journal of Multinational Financial Management*, 9(3-4): 353-371.

Keim, D.B., Madhavan, A. (1997). Transactions cost and investment style: An inter-exchange analysis of institutional equity trades, *Journal of Financial Economics*, 46: 265-292.

Koeppl, T., Monnet, C., Temzelides, T. (2012). Optimal clearing arrangements for financial trades, *Journal of Financial Economics*, 103(1): 189-203

Kim, E.H., Singhal, V. (2000). Stock market openings: Experience of emerging economies, *Journal of Business*, 73(1): 25-66.

Krishnamurti, C., Sequeira, J.M., Fangjian, F. (2003). Stock exchange governance and market quality, *Journal of Banking & Finance*, 27(9): 1859-1878.

Kurov, A., Lasser, D.J. (2004). Price dynamics in the regular and E-Mini futures, *Journal of Financial and Quantitative Analysis*, 39(2): 365-384.

Lagoarde-Segot, T. (2009). Financial reforms and time-varying microstructures in emerging equity markets, *Journal of Banking and Finance*, 33(10): 1755-1769.

Lagoarde-Segot, T., Lucey, B.M. (2008). Efficiency in emerging markets – evidence from the MENA region, *Journal of International Financial Markets, Institutions and Money*, 18(1): 94-105.

Lesmond, D.A., Ogden, J.P., Trzeinka, C.A. (1999). A new estimate of transactions costs, *Review of Financial Studies*, 12(5): 1113-1141.

Levine, R., Zevros, S. (1996). Stock market development and long-run growth, *World Bank Economic Review*, 10(2): 323-339.

Levine, R., Zevros, S. (1998). Capital control liberalization and stock market development, *World Development*, 26(7): 1169-1183.

Lin, J-C., Wu, Y-L. (2013). SEO timing and liquidity risk, *Journal of Corporate Finance*, 19: 95-118.

Liu, W., Luo, D., Zhao, H. (2016). Transactions costs, liquidity risk, and the CCAPM, *Journal of Banking & Finance*, 63: 126-145.

Liu, G., Zhang, C. (2016). The dynamic linkage between insurance activities and banking credit: Some evidence from global countries, *International Review of Economics & Finance*, 44: 40-53.

Lo, M.C., Zivot, E. (2001). Threshold cointegration and nonlinear adjustment to the law of one price. *Macroeconomic Dynamics*, *5*(4), 533-576.

Love, I., Zicchino, L. (2006). Financial development and dynamic investment behavior: Evidence from panel VAR. *Quarterly Review of Economics and Finance*, 46(2): 190-210.

Lutkepohl, H. (2004). Vector autoregressive and vector error correction models, In: Lutkepohl, H., Kratzig, M. (eds.) *Applied Time Series Econometrics*, Cambridge: Cambridge University Press.

Maddala, G.S., Wu, S. (1999). A comparative study of unit root tests with panel data and a new simple test, *Oxford Bulletin of Economics and Statistics*, 61(51): 631-652.

Nickell, S. (1981). Biases in dynamic model with fixed effects, *Econometrica*, 49(6): 1417-1426.

OECD (2007). OECD Economic Surveys: India, Volume 2007/14.

Ouyang, Y., Li, P. (2018). On the nexus of financial development, economic growth, and energy consumption in China: New perspective from a GMM panel VAR approach, *Energy Economics*, 71: 238-252.

Perotti, E.C., Van Oijen, P. (2001). Privatization, political risk and stock market development in emerging economies, *Journal of International Money and Finance*, 20(1): 43-69.

Rahman, S., Serletis, A. (2010). The asymmetric effects of oil price and monetary policy shocks: A nonlinear VAR approach. *Energy Economics*, *32*(6), 1460-1466.

Roll, R. (1984). A simple implicit measure of the effective bid-ask spread in an efficient market, *Journal of Finance*, 39(4): 1127-1139.

Rosati, P. et al. (2017). The effect of data breach announcements beyond the stock price: Empirical evidence on market activity, *International Review of Financial Analysis*, 49: 146-154.

Shah, A. (1995). The impact of speculation upon volatility and market efficiency: The *badla* experience on the BSE, Mimeo, Centre for Monitoring Indian Economy, Mumbai. Downloadable from https://www.researchgate.net/profile/Ajay_Shah6/publication/2349922_The_impact_of_speculation_upon_volatility_and_market_efficiency_The_badla_experience_on_the_BSE/links/54c1bcf80cf2dd3cb958e58d.pdf.

Shah, A., Thomas, S. (2000). David and Goliath: Displacing a primary market, *Global Financial Markets*, Spring: 14-23.

Shah, A., Thomas, S. (2001). The evolution of the securities markets in India in the 1990s, Mimeo, Indira Gandhi Institute of Development Research, Mumbai. Downloadable from https://pdfs.semanticscholar.org/f5e5/1f168f5d641d95e095ce919bca9bdca4dacc.pdf.

Sharma, J.L., Kennedy, R.E. (1977). A comparative analysis of stock price behavior on the Bombay, London, and New York stock exchanges, *Journal of Financial and Quantitative Analysis*, 12(3): 391-413.

Singh, A. (1997). Financial liberalisation, stock markets and economic development, *Economic Journal*, 107(442): 771-782.

Stiglitz, J.E. (2000). Capital market liberalization, economic growth and instability, *World Development*, 28(6): 1075-1086.

Stoll, H.R. (1989) Inferring the components of the bid-ask spread: Theory and empirical tests, *Journal of Finance*, 44(1): 115-134.

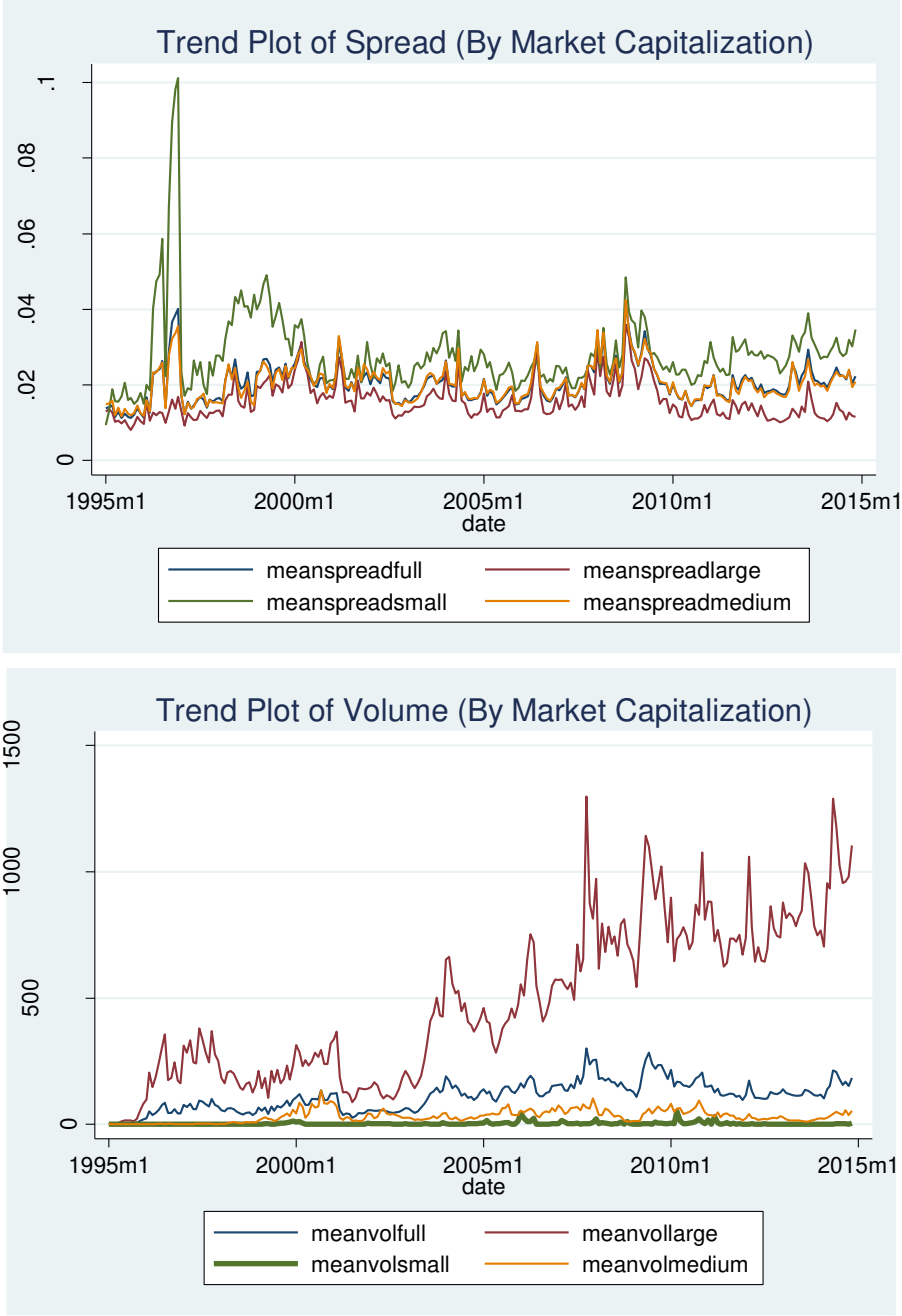
Weston, J.P. (2000). Competition on the Nasdaq and the impact of recent market reforms, *Journal of Finance*, 55(6): 2565-2598.

Table 1. Descriptive statistics

	No. of firms/stocks (No. of firm-months)	Market capitalization	CS Spread	Volume
Large-cap firms	81 (14,694)	270,942.80 (486,127.80)	0.016 (0.008)	544.19 (1,008.28)
Mid-cap firms	425 (49,126)	7,987.52 (10,063.50)	0.021 (0.013)	36.03 (149.90)
Small-cap firms	85 (7,005)	529.39 (472.70)	0.028 (0.023)	3.69 (35.74)

Note: Our final data involves a sample of 849 firms listed at the National Stock Exchange of India (NSE), for a period of 239 months. In the course of the analysis, we distinguish between large-cap firms, those that were consistently part of the CNX100 market index for the sample period, mid-cap firms that lay between the 25^{th} and 75^{th} percentiles of the distribution of market capitalization for the sample period, and small-cap firms that were consistently in the bottom decile of the distribution over the sample period. The figures reported in Table 1 suggest that there was a steep decline in both the market capitalization and trading volume of the average firm as one move from the large-cap sub-sample to the small-cap sub-sample. Correspondingly, there is a noticeable increase in the CS spread, which is our proxy for trading costs. (The values within parentheses are standard deviations.)

Figure 1. Trends in CS spread and volume over the sample period



Note: The plots reported in Figure 1 suggest that while there is a clear difference in the spread for *large*-, *medium*- and *small*-cap firms, these trends tend to move together. By contrast, there is a clear divergence between the trading volumes of *large*- and *medium*- and *small*-cap firms since 2005. While the trading volume of *large*-cap firms has risen sharply, trading volumes of the *medium*- and *small*-cap firms remain steady at much lower levels.

Table 2. Panel unit root

Sample	Im, Pesaran and Shin		Maddala and Wu/Choi	
	Spread	**Volume**	**Spread**	**Volume**
Large-cap firms (n = 81 & nT = 14,694)	- 35.05*** (0.00)	- 16.49*** (0.00)	1377.50*** (0.00)	469.24*** (0.00)
Mid-cap firms (n = 425 & nT = 49,126)	- 69.87*** (0.00)	-100.00*** (0.00)	5640.22*** (0.00)	5267.36*** (0.00)
Small-cap firms (n = 85 & nT = 7,005)	- 29.52*** (0.00)	-290.00*** (0.00)	818.86*** (0.00)	1187.35*** (0.00)

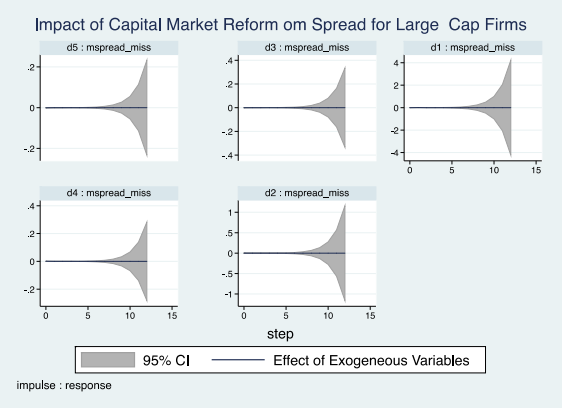
Note: The results reported in the table use the panel unit root tests proposed by Im, Pesaran and Shin (2003), and Maddala and Wu (1999) and Choi (2001). The null hypotheses for both these tests are that all panels have unit roots. The reported test statistics were generated using ADF test; the lag length was chosen on the basis of AIC. The values within parentheses are p-values and *** indicate significance at the 1 percent level. The Choi Test Statistic is Chi-Square and IPS test follows asymptotically normal distribution.

Table 3. VAR estimates

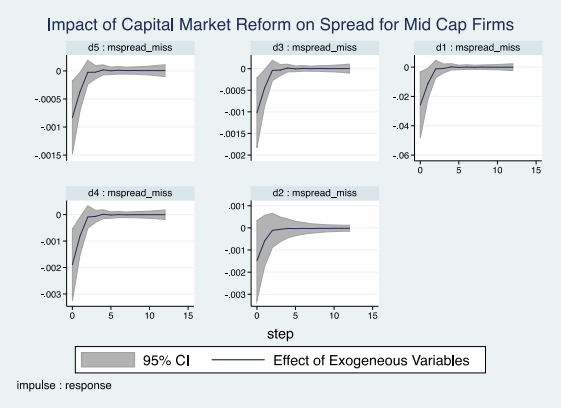
	Large-cap firms		Mid-cap firms		Small-cap firms	
	Spread Eq.	**Volume Eq.**	**Spread Eq.**	**Volume Eq.**	**Spread Eq.**	**Volume Eq.**
Autoregressive elements						
Spread (L1)	0.49*** (0.00)	- 36021.73 (0.12)	0.40* (0.08)	7280.20*** (0.01)	0.71 *** (0.00)	803.95 (0.38)
Spread (L2)	0.22 ** (0.04)	10083.66 (0.50)	- 0.05 (0.54)	- 1867.66 (0.23)		
Volume (L1)	- 2.15E-06 (0.14)	0.24 (0.45)	- 3.58E-06 (0.44)	0.29 (0.17)	- 0.000004 (0.87)	0.37 *** (0.00)
Volume (L2)	1.85E-06 (0.14)	0.62** (0.02)	6.37E-06 (0.11)	0.57*** (0.00)		
Equity market reforms						
NSCCL(d1)	0.001 (0.74)	- 534.75 * (0.07)	- 0.03 ** (0.04)	211.78 (0.19)	- 0.07 ** (0.05)	72.64 (0.58)
NSDL(d2)	0.0004 (0.49)	167.33 ** (0.02)	- 0.001 (0.14)	0.47 (0.97)	- 0.01 ** (0.02)	2.94 (0.50)
CRS (d3)	- 0.001 *** (0.01)	- 21.12 (0.30)	- 0.001 ** (0.03)	10.48 * (0.07)	0.002* (0.10)	- 2.07 (0.64)
RTGS (d4)	0.001 *** (0.01)	4.91 (0.83)	- 0.002 *** (0.01)	15.19 (0.12)	- 0.003 ** (0.04)	3.43 (0.54)
Call auction (d5)	- 0.001 *** (0.01)	- 22.68 (0.56)	- 0.001 ** (0.02)	10.67 ** (0.04)	0.001* (0.09)	- 3.01 (0.32)
Control variables						
VIX	0.00004 * (0.07)	- 8.87 ** (0.05)	- 0.0003 ** (0.02)	1.63 (0.26)	- 0.001 * (0.07)	0.71 (0.52)
Change in US interest rate	- 0.003 *** (0.00)	- 168.55 ** (0.05)	- 0.01 *** (0.00)	76.34 *** (0.01)	- 0.01 ** (0.05)	11.76 (0.34)
Financial crisis dummy	0.002 ** (0.02)	550.01 *** (0.01)	0.01 *** (0.00)	- 73.95 (0.16)	0.02 * (0.09)	- 25.23 (0.47)
Industrial growth	5.17e-06 (0.70)	- 0.47 (0.83)	4.65e-06 (0.90)	0.79** (0.03)	- 0.00004 (0.54)	0.20 (0.21)
Granger test Spread –> Vol Vol –> Spread		9.57 *** 2.22		6.46 ** 8.52 **		0.03 0.77
Hansen J statistic with p-value		6.97 (0.54)		4.27 (0.83)		5.67 (0.69)
No. of obs. (No. of firms)		14,451 (81)		47,843 (424)		6,835 (85)

Note: The table reports the estimates of the VAR model highlighted in equation (1). The lag lengths were chosen on the basis of the moment-based AIC criterion developed by Andrews and Lu (2001). Following Holtz-Eakin et al. (1988), the model is estimated using GMM. The non-significance of the Hansen J statistic suggests that the choice of instruments is appropriate. The figures within parentheses are p-values and ***, ** and * indicate significance at the 1 percent, 5 percent and 10 percent levels, respectively. The number of observations indicate *nT* after adjusting for lag-lengths used in the VAR models.

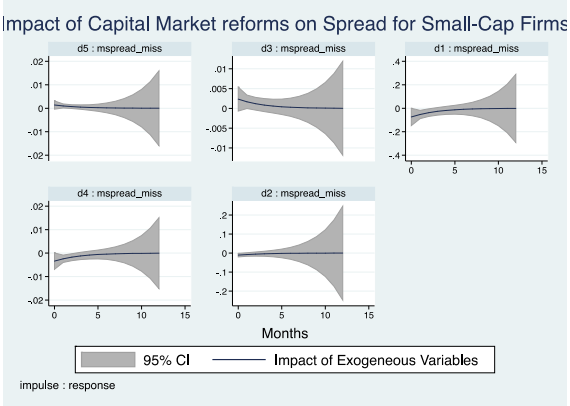
Figure 2. Impact of equity market reforms on spread



Large-cap firms



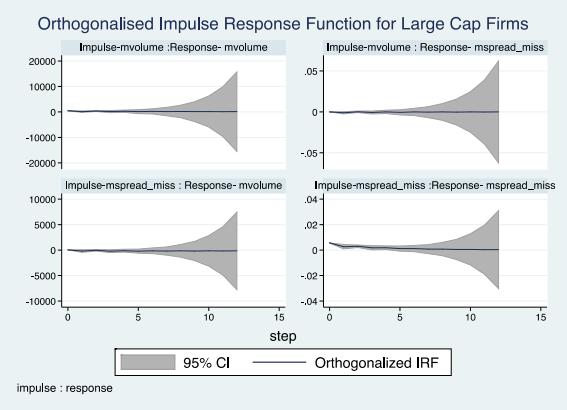
Mid-cap firms



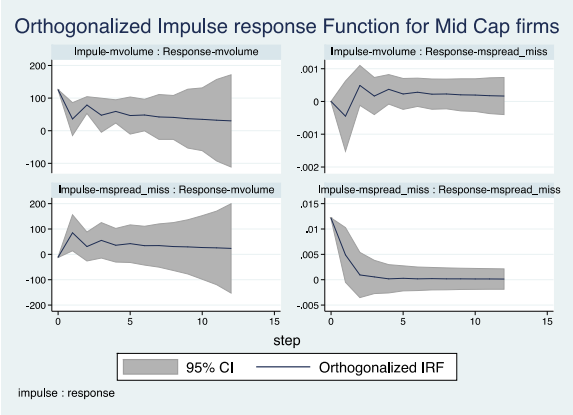
Small-cap firms

Note: In this figure we report the impact of changes to the exogenous variables on spread and volume, for the full sample as well as for the large-cap, mid-cap and small-cap sub-samples. The graphs suggest that the five equity market policies/reforms (*d1* through *d5*) used in our model reduced the spread (*mspread_miss*) for the mid-cap and small-cap firms immediately after their introduction but there was no incremental impact on the spread beyond the 3rd period (month, in our case). The impact of these reforms on the spread for the large-cap firms was insignificant from an economic viewpoint.

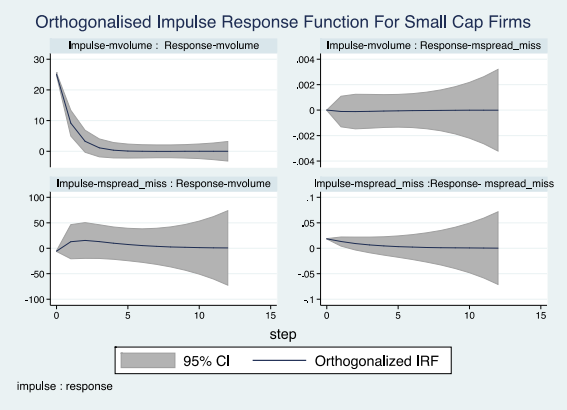
Figure 3. Impulse response functions (spread and volume)



Large-cap firms



Mid-cap firms



Small-cap firms

Note: For mid-cap firms, there is noticeable but uneven response of shocks to spread (*mspread_miss*) and volume (*mvolume*) on volume and spread, respectively. These impacts persist until around the 5th period. For both large-cap and small-cap firms, a shock on spread has a modest impact on volume.

Appendix

Table A1. VAR estimates with log transformation of dependent variables

	Large-cap firms		Mid-cap firms		Small-cap firms	
	Spread Eq.	**Volume Eq.**	**Spread Eq.**	**Volume Eq.**	**Spread Eq.**	**Volume Eq.**
Autoregressive elements						
Spread (L1)	0.905** (0.020)	-0.6089 (0.222)	0.613* (0.087)	-.252 (0.859)	0.420 (0.330)	1.487 (0.141)
Spread (L2)	-0.050 (0.891)	-0.153 (0.753)	0.327 (0.304)	1.018 (0.423)	0.651 (0.109)	-0.803 (0.402)
Volume (L1)	0.473* (0.071)	0.827*** (0.012)	0.137 (0.306)	2.105*** (0.000)	-0.239* (0.093)	0.367 (0.210)
Volume (L2)	-0.461* (0.082)	0.183 (0.582)	-0.131 (0.312)	-1.078** (0.047)	0.239* (0.073)	0.516* (0.060)
Equity market reforms						
NSCCL	0.142* (0.071)	0.179 (0.204)	0.113 (0.150)	-0.378 (0.223)	-0.916*** (0.012)	-1.707** (0.030)
NSDL	-0.025 (0.770)	0.204* (0.068)	-0.145*** (0.000)	-.204 (0.174)	-0.200** (0.044)	0.370* (0.060)
CRS	-0.046 (0.139)	-0.032 (0.426)	-0.014 (0.364)	.031 (0.603)	0.044 (0.344)	-.0779 (0.458)
RTGS	0.023 (0.347)	-0.067** (0.038)	0.008 (0.588)	-.049 (0.409)	-0.058 (0.165)	-0.306*** (0.002)
Call auction	-0.043 (0.548)	-0.179** (0.048)	0.014* (0.081)	.095*** (0.007)	0.020 (0.520)	-0.259*** (0.001)
Control variables						
VIX	0.0039** (0.024)	-0.002 (0.303)	0.003 (0.225)	.003 (0.723)	-0.0047 (0.159)	-0.027*** (0.000)
Change in US interest rate	-.106** (0.057)	-0.117* (0.095)	-0.120 (0.057)**	.186 (0.456)	-0.065 (0.405)	0.675*** (0.000)
Financial crisis dummy	-0.025 (0.826)	0.448*** (0.001)	-0.005 (0.922)	-.259 (0.257)	0.108 (0.219)	0.305* (0.089)
Industrial growth	0.0062** (0.019)	0.004 (0.235)	0.001 (0.177)	.017*** (0.000)	-0.0017 (0.350)	0.0037 (0.358)
Granger test Spread –> Vol Vol –> Spread	4.784* 5.102*		19.041*** 1.273		5.931* 4.587	
Hansen J statistic with p-value	9.17 (0.328)		13.78 (0.088)		12.69 (0.123)	
No. of obs. (No. of firms)	14451 (81)		47843 (424)		6750 (85)	

Note: The table reports the estimates of the VAR model after taking the log transformation of dependent variables highlighted in equation (1). The lag lengths were chosen on the basis BIC criterion developed by Andrews and Lu (2001). Following Holtz-Eakin et al. (1988), the model is estimated using GMM. The non-significance of the Hansen J statistic suggests that the choice of instruments is appropriate. The figures within parentheses are p-values and ***, ** and * indicate significance at the 1 percent, 5 percent and 10 percent levels, respectively. The number of observations indicate nT after adjusting for lag-lengths used in the VAR models.