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Call auction transparency and market liquidity: The Shanghai experience

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Keywords

Call, auction, transparency, market, liquidity, Shanghai, experience

Disciplines

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Call auction transparency and market liquidity: The Shanghai experience

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Abstract

On July 1 2006, the Shanghai Stock Exchange (SHSE) changed its pre-market opening auction system from an entirely black box into a more transparent system with indicative auction prices, indicative equilibrium volume and indicative unexecuted volume disseminated in real time throughout the pre-opening period. This paper use the natural experiment offered by SHSE to investigate the impact of opening call transparency on market liquidity. The dynamics of the opening process and its impact on trading activity for the rest of the day is of interest to traders because traders can either cluster their trades during the non-trading period or withhold their orders until the market opens. We find that following the introduction of transparency to the call auction process, there is increased participation during the call auction and reduction in the volume of orders placed in the continuous market. Uncertainty is eased, resulting in lower price volatility and narrower proportional bid-ask spreads. But we find it to be detrimental to the liquidity and spreads of thinly traded stocks.

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1. Introduction

This study examines the impact of a transparency regime change that took place on the Shanghai Stock Exchange and is unique in two ways. Firstly, it examines a system that moved from an opaque ‘black-box’ to a semi-transparent state. Secondly, the alteration in information transparency is during the pre-opening call auction phase. There have been no empirical papers that studied the impact of such change on market liquidity.

According to Huisman and Koedijk (1998), the transparency regime of a trading mechanism is directly reflected in the operational performance of financial markets and in fundamental market variables such as liquidity and price efficiency. These transparencies exist in two dimensions: pre-trade transparency (which concerns the flow of information before a transaction occurs) and post-trade transparency (the dissemination of trade price and volume of completed transactions). The regime change on the SHSE is concerned with the former type.

There is large body of research on the pre-trade information transparency of continuous markets but the academic literature has produced mixed findings. This is possibly due to the differing designs of the exchanges, and due to the varying degrees of transparency between exchanges.

Studies that find a direct relationship between pre-trade information transparency and liquidity improvement have generally explained it as a result of pre-trade transparency reducing search cost for traders, the savings of which are then passed to their posted quotes or orders. Transparency also makes traders more confident about their limit orders, since adverse selection risk is reduced. ([Flood](#), [Huisman](#), [Koedijk](#) and [Mahieu](#) 1998, [Pagano](#) and [Roell](#) 1996, [Biais](#) 1993, [Boehmer](#), [Saar](#) and [Yu](#) 2005)

But there are also studies that have pointed to the contrary; pre-trade transparency can be detrimental to liquidity. [Madhavan et al](#) (2005) found that after the Toronto Stock Exchange publicly disseminated the contents of its limit order book on the traditional floor and automated trading system, the spread widened and volatility increased. Another empirical paper, [Bortoli](#), [Frino](#), [Jarnecic](#), and [Johnstone](#) (2006), examined the impact after Sydney Futures Exchange increased the level of order book disclosure from best bid

and ask prices to depth at the best three prices. They found that whilst there was no significant change to spread, market liquidity diminished as limit order traders began charging market order traders a premium for execution quality by withdrawing depth from the best quotes. It seems that too much pre-trade transparency makes traders reluctant to place limit orders and therefore face the risk of being ‘picked off’. (Bloomfield O’Hara 1999, Flood et al 1999). This is especially acute in illiquid markets (Admati and Pfleiderer 1999, Pagano and Roell 1996, Madhavan 1995, 1996, Baruch 2005, Rindi 2007).

Most studies that examined stock market transparency thus far have adopted either a theoretical or empirical approach. Both approaches have unique flaws according to Huisman and Koedijk (1998). Under a theoretical approach, it is not possible to construct a theoretical model of an exchange where there is a multitude of trader interacting without making behaviour-restricting assumptions about the market. But under an empirical approach, whilst there is no need to make those assumptions, it is very complex to detangle the effects of transparency from other changes occurring in the market at the time.

The comparison of results from varying studies is made additionally difficult by markets having different designs and different existing levels of transparency. The majority of event studies in the area have examined markets with already some level of information transparency. As such, the impact after an additional increase in transparency has tended to be minor. On the SHSE, the change in transparency level of the opening call auction is significant because the market was previously a ‘black box’.

The issue of how changes in market design affect liquidity is important enough to merit further investigation from both an academic and regulatory standpoint, especially when both theoretical predictions and empirical evidence are inconsistent.

In this study, we find that following the introduction of transparency to the call auction process, there is an increased participation during the call auction and a reduction in the volume of orders placed in the continuous market. Uncertainty is eased, resulting in lower price volatility and narrower proportional bid-ask spreads. But we find call auction transparency to be detrimental to the liquidity and spreads of thinly traded stocks.

(The remainder of the paper is organized as follows. Section 2 describes the institutional details of the Shanghai Stock Exchange. Section 3 presents the details on our data and sample. The empirical results are then presented and discussed in Section 4. Finally, our conclusion is discussed in the last section.

2. Institutional Details: Shanghai Stock Exchange

The trading system in the SHSE is based on the electronic Consolidated Open Limit Order Book (COLOB). A 10-minute opening call auction is held at 09:15 and ends at 09:25. This is followed by two continuous auction sessions, the morning session from 09:30 to 11:30 and the afternoon session from 13:00 to 15:00. Continuous trading is conducted through the submission of limit orders. These orders are matched in price then time priority. All orders are purged from the order book overnight.

While no special trading mechanism is used to close the morning session or open the afternoon session, a special mechanism is used at the close of the afternoon session. Closing prices of the stocks of the trading day are generated by taking a weighted average of the trading prices of the final minute of each trading day. The information of the best five offers and bids and their associated volume as well as the price and volume for the latest transaction on the stock exchanges during the continuous trading sessions must be displayed on computer terminals viewable by investors on and off both exchanges. The market is closed on Saturdays and Sundays and other public holidays announced by the exchange.

There are no designated dealers (specialists) to intervene in trading in the market. Investors place their orders with the brokers in the form of either a market order or limit order, and only good-to-day limit orders are accepted by the trading system². At the end of the trading day, all orders are purged from the COLOB. The minimum tick sizes for all stocks are 1 cent (RMB0.01 Yuan). Shares cannot be sold on the same day as they are bought. The minimum trading size for purchase is 100 shares, while there is no minimum requirement for selling shares. Floor trading among member brokers, and short selling are strictly prohibited. During trading sessions on the SHSE, a stock is allowed to trade at a

² Market order was introduced in 17 August 2006 in the SHSE.

price plus or minus 10% from the previous day's closing price in order to avoid sharp price increases caused by 'buy manias' and sharp declines caused by 'sell panics'.

On July 1 2006 a new call auction is introduced to open trading. In the past, SHSE closes its order book over the pre-open period. There was also no information regarding order books available to investors during the auction process, except for the final clearing price generated at the end of the auction. Therefore, the pre-open call auction was entirely devoid of information dissemination. During this 10-minute call auction period, investors could place limit orders and participate in the opening auction, but no orders would be allowed to be withdrawn. Orders that are not executed in the opening auction were automatically transferred to the period of continuous trading. The determined opening price at 09:25 is continued to 09:30.

On July 1 2006, a limit transparent call auction is introduced to open trading. Information of an indicative auction price (IAP), an indicative equilibrium volume indication (IEV), expecting unexecuted volume indication (IUV)³ are disseminated to the market in real time through the pre-open period although the order book is not yet open to the market. It is hoped that by providing pre-trade information during the opening period, the SHSE can increase its efficiency in determining an opening price and will encourage more investors to participate during the pre-opening auction.

There are two relevant time periods in the 10-min pre-open call auction period. During the first period between 09:15-09:20, allowable messages to the system include limit orders and order modifications or cancellations. During the second period between 09:20-09:25, modifications and cancellations are not allowed, but new orders are accepted before the final opening price and quantity was generated in the market. The market then takes five-minute break between the periodic auction at 09:25 and the start of the morning session at 09:30 with continuous trading mechanism. The arrangement of 5-minute cooling-off period is similar to the 2-minute blocking period between 09:58 and 10:00 in the Hong Kong Exchanges and Clearing Limited after 2002 (Asian Etrading 2009). The situation in Shanghai's current pre-opening arrangement is now similar to the

³ The IAP is an indication of the call auction price if the auction was held at that instant. The IEV and IUV indicate the volume of shares that will execute and unexecuted at the IAP.

Deutsche Borse AG, which discloses information about unbalanced amounts but is a closed order book during opening call auction.

3. Data and sample

The data used in this study are obtained from the Reuters database maintained by the Securities Industry Research Centre of Asia-Pacific (SIRCA). The data comprises of trades and the best bid and ask quotes for all stocks in the Shanghai A-share Index. Details of all trades and changes in best bid and ask prices are time stamped to the nearest second.

A period of three months before and after the disclosure of partial order information in the opening call auction of the SSE is used in the study for analysis. This gives us a sufficient window to capture the immediate as well as the permanent effect of the change in opening call auction transparency.

Initially, all stocks in the Shanghai A-share index are sampled. The Shanghai A-share index is of particular interest as it accounts for a substantial proportion of total Shanghai trade volume and market capitalization. The A-shares consists of 891 stocks as at 31 December 2006, and accounts for around 95% of the total market capitalization of listed stocks including both A and B-shares. Seventy stocks are excluded from the sample due to their inactive trading during this period, reducing the sample size to 821 stocks. And then stocks which underwent share splits during the 2006 are also removed from the sample. The final stock sample size is 216.

4. Empirical Results

4.1 Effect on the first hour of trading

Due to the build up of information during the overnight non-trading period, information asymmetry is greatest at the start of each trading day. Thus the impact of the dissemination of indicative opening prices and opening volumes under an efficient market is expected to be most greatly felt during the first hour of trading. It bears influence on traders' decision whether to cluster their trades during the non-trading period or to withhold their orders until the market opens. Call auctions are sometimes desirable

to traders since it can absorb the market impact of liquidity shocks (Barclay et al 2008) and reduce asymmetric information problems by providing all traders with access to the same price (Madhavan 1992).

4.1.1. Descriptive statistics

From the pre-event and post-event data, we compute separately the average values of proportional bid ask spread, average depth (measured by the sum of the best bid and ask volume), and average time within trades, for each stock at every one minute interval between 0930 and 1030. We also compute for each sample stock the average number of transacted trades during the first hour, average price volatility (standard deviation), and the average ratio of transacted call volume to trade volume during the first hour, of the first hour of each trading day. Figures for the pre-event period are subtracted from the values for the post-event period in order to run nonparametric wilcoxon signed rank tests on the difference and assess whether the changes are statistical significant. Table 1 reports the descriptive statistics for the pre-event period, post-event period and the difference in computed values between the two periods.

[insert Table 1 here]

Wilcoxon signed rank p-values report that the difference is significant across all variables. We find that spread is narrowed but there is also a decrease in the level of depth in the market, reduced number of trades in the first hour and there is a longer average wait between trades. The simultaneous decline in spread and liquidity in the market can be explained by an increase in transacted volume during the opening call auction. Traders who otherwise waited to submit their orders when the market opens for continuous trading are now more inclined to place their orders for trade during the pre-opening call auction phase. With an improved information disclosure, there is lower adverse selection risk and less price uncertainty. The market responds to the information transparency by narrowing the spread between proportional bid and ask quotes. Price certainty is also evidenced by lower price volatility.

It is suggested that increased transparency during the opening call auction will influence trading behaviour differently according to stock liquidity. Thinly traded stocks have more information asymmetry so a change in transparency regime will have a greater impact on those securities. (Comerton-Ford and Rydge, 2006). Madhavan et al (2005)

report that illiquid stocks are adversely affected by increased pre-trade transparency for it discourages traders from placing their orders for fear of revealing their information. The absence of orders at the open may impair liquidity and subsequent price discovery.

To see how the impact of transparency varies with stock liquidity, Shanghai A-shares that actively traded during the study period are divided into roughly equal quintiles based on average daily turnover. Quintile one represents the most actively traded stocks, while quintile five represents the least active stocks traded on the Shanghai stock exchange during our sample period. The results from the univariate analysis are presented in table 2.

[insert Table 2 here]

The results confirm Madhavan et al (2005)'s view that thinly traded stocks are adversely affected by information transparency. Quintile 5 is the only sample group where the average proportional spread increased after the change. Inactive stocks, which already have long time lags between trades, experience the largest increases in time between trades.

There is no discernable pattern in the change to depth measures but quintile 2 and quintile 4 suffer the greatest decline in order book depth. However, whereas one would expect the opening call auction would be less appealing to traders in inactive stocks after the transparency change, the ratio of call auction volume to continuous trade volume grew for thinly traded stocks. This ratio increase is contrary to a priori expectations and may be driven by an even greater decline in the order book volume and depth of illiquid stocks when the market fully opens.

4.1.2. Regression analysis

Although the univariate results indicate a significant reduction in both proportional bid ask spreads and depth in the first hour when the opening call auction moves to a more transparent state, other factors affecting spread and depth could also account for those results. Harris (1994) and McNish and Wood (1992) identified price volatility as a significant factor that influences market depth and bid-ask spreads respectively. It is necessary to control for changes in these variables affecting spread and depth by

estimating the following regressions using pooled data three months before and three months after the regime change:

$$pbas_{it} = \beta_0 + \beta_1 * dollar_depth_{it} + \beta_2 * volatility_{it} + \beta_3 * change_{it} + five_minute_time_interval_dummies + \varepsilon_{it} (1)$$

$$dollar_depth_{it} = \gamma_0 + \gamma_1 * pbas_{it} + \gamma_2 * volatility_{it} + \gamma_3 * change_{it} + five_minute_time_interval_dummies + \varepsilon_{it} (2)$$

where *dollar depth* is the sum of the best bid-ask volume multiplied by its respective market price at that particular point in time. *pbas* is the proportional quoted best bid and ask spread. Since prices follow a random walk, *volatility* is expressed via Parkinson (1980)'s volatility measure⁴. *Change* is a dummy variable that takes a value of one after the change to the opening call system, and a value of zero if otherwise. Also included are 11 five-minute time interval dummies for the first hour of trading, to capture the time varying characteristics of these liquidity measures.

Table 3 presents the OLS coefficient estimates, test statistics and adjusted R-squared values for each equation. The *change* variable in both equations are statistically significant and negative, which rejects the null hypothesis that call auction transparency change have no effect on the spread and depth of the market, at all conventional levels. This result is consistent with the findings from the univariate analysis. In terms of the liquidity of the market during the first hour, call auction transparency alleviates some of the high bid-ask spread at market opening and at the same time reduces order book depth in the market. Coefficient estimates for the rest of the controlling variables are significant and are of the expected signs.

[insert Table 3 here]

4.2 Effect on intraday liquidity

Empirical studies have typically identified either a U-shaped⁵ or L-shaped⁶ pattern in intraday spreads. U-shaped spread patterns feature a gradual fall in spread after the session

⁴ $[\ln S_H - \ln S_L]^2 / 4 \ln 2 \times 100\%$ where S_H is the daily high price and S_L is the daily low price

⁵ McInish and Wood (1992), Chan, Fong, Kho, and Stulz (1996), Lehman and Modest (1994).

⁶ Chan et al. (1995a), Chan et al. (1995b). For China, this pattern was noticed by Tian and Guo (2007).

opening and a gradual rise towards the daily closing. Intraday spread patterns are L-shaped if they open with relatively high spreads but this spread either remains constant or declines over the remainder of the trading day. Stock exchanges that rely on a specialised or designated dealer system for the provision of liquidity typically exhibit U-shaped spread patterns while exchanges that are based on multi-dealer systems generally exhibit L-shaped spread patterns. (Brockman and Chung 1999). In addition to spread, trading volume and volatility have also been found to be U-shaped⁷.

Intraday liquidity flows are of concern to the investment strategy of portfolio managers, traders, and regulators. An understanding of liquidity patterns help market participants to decide on timing of their transactions within the day and better manage trading costs. The morning and closing periods, with its higher than average level of trading activity, is more desirable for traders who regard execution speed as an important criteria in execution quality and less desirable for traders looking to minimise price variation.

China's intraday liquidity pattern may differ from the abovementioned studies because it has a one and a half hour trading break in the middle of the day. Thus the purpose of this section of the paper is two-fold. Firstly, to observe whether the U-shaped liquidity pattern holds for the Shanghai stock exchange; whether the liquidity in the morning and afternoon trading sessions are symmetrical. Secondly, to test for sensitivity of these intraday patterns to a change in the level of information transparency.

To analyse the intraday behaviour of various liquidity and trading activity measures, we partition each trading day into 5 minute intervals and compute the average values for each time interval five trading days before and five trading days after the opening call auction transparency regime change. Twenty-eight stocks that had trading suspended due to abnormal fluctuations during this sample period⁸ were removed. The ten-day time frame captures immediate impact of the change and minimises the possibility of other changes in market conditions that might affect these liquidity measures.

Table 4 and 5 presents the results for the average proportional spread, depth, volatility, volume and proportional volume values for each of the time intervals in the pre and post-event periods respectively.

[insert Table 4 here]

⁷ Cheung et al. (1994), Chang et al. (1993)

⁸ On the SSE, these suspended stocks resume trading the following trading day at 10:30am.

[insert Table 5 here]

Fig 1 graphs the L-shaped intraday pattern of the average proportional spreads. The opening spread is about 1.7 times the proportional spread for the rest of the day. Except for a slight peak at 1pm, proportional spread declines at a monotonically decreasing rate throughout the trading day. Opening proportional spread after the change to the transparency of opening call auction is lower. Proportional spread is overall lower after the event.

[insert Figure 1 here]

Figure 2 depicts the intraday depth pattern in the market. Depth is considerably lower at the start of the day and climbs steadily during the morning session. By the afternoon session, depth plateaus. It drops slightly in the last 20 minutes before market close. The effect of the regime change seems to be less depth in the market during the first 45-minutes of trading.

[insert Figure 2 here]

Figure 3 depicts the intraday volatility pattern in the market. It displays an inverse J-shape pattern. Intraday volatility overall is higher in the post event period but in the first hour of trading, post-event volatility is smoother and generally lower.

[insert Figure 3 here]

Due to a trading break in the middle of the day, intraday volume on the Shanghai exchange shows an asymmetric double-U pattern, as displayed in figure 4 and 5. Except for the spikes at the start and end of the session, absolute and proportional volume is relatively flat during the morning session. By contrast in the afternoon trading session, proportional volume trend in an upward direction. Absolute volume in the post-event period is larger than in pre-event period, but proportional volume is lower in the post-event period across almost all time intervals.

[insert Figure 4 here]

[insert Figure 5 here]

5. Summary and conclusion

The call auction market competes with the continuous market for order flow. Whereas trading activity in call auctions generally improved after the veil was lifted from

SSE's pre-opening process, depth, volume and trading activity during the continuous trading period is diminished, at least during the first hour of the market opening. As well as the movement of order flow from the continuous to the pre-opening period, the dissemination of pre-trade information during that period reduces the impetus for traders to actively place orders to 'test' the market and bring about a faster price discovery in the early moments of trading (Flood 1999). The higher certainty with which traders regard the opening price is evidenced by a lower average price volatility and narrower spread for the whole day. Overall, opening call auction transparency is beneficial to the quality of the Shanghai Stock Exchange.

A direction for future research is to investigate whether the narrowing of spread at the open of trading is consistent with inventory management and asymmetric information explanations. This event study may also be extended to examining possible impact on price efficiency.

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Table 1**Descriptive Statistics for three months before and after July 2006**

This table reports the descriptive statistics of the number of trades, proportional spread (pbas), depth (sum of best bid and ask volume), time within trades (seconds), volatility (standard deviation) and the ratio of transacted call volume to trade volume during the first hour, of the first hour of each trading day, for three months before and three months after July 1 2006. The stocks in the sample are included in Shanghai's A-share index and did not undergo a share split during 2006. The p-value of the wilcoxon signed rank test reports whether the change in those mean values between the pre and post-event period are statistically significant.

	Pre	Post	Difference
<i>Number of stocks</i>	216	216	0
<i>Number of trades in the first hour</i>			
Mean	229.1802	159.3638	-69.8164
Median	211.1411	144.3462	-63.4219
S.D.	107.6138	83.30261	62.12802
P-value wilcoxon signed rank test of the change in the average			<.0001
<i>Pbas (%)</i>			
Mean	0.003611	0.003639	0.00003
Median	0.003201	0.003207	-0.00008
S.D.	0.00184	0.00209	0.00102
P-value wilcoxon signed rank test of the change in the average			<.0001
<i>Depth</i>			
Mean	55110.9	44870.28	-10240.6
Median	34667.24	26573.98	-6524.5
S.D.	80666	69217	31956
P-value wilcoxon signed rank test of the change in the average			<.0001
<i>time within trades (seconds)</i>			
Mean	19.81015	29.22611	9.415964
Median	16.87288	24.55972	7.209027
S.D.	11.53129	17.97397	10.88186
P-value wilcoxon signed rank test of the change in the average			<.0001
<i>Ratio of transacted volume from call auction to trade volume during the first hour</i>			
Mean	0.029752	0.026426	-0.00333
Median	0.01503	0.01752	0.00191
S.D.	0.05989	0.03062	0.06201
P-value wilcoxon signed rank test of the change in the average			<.0001
<i>Volatility (standard deviation)</i>			
Mean	0.048757	0.037641	-0.01112
Median	0.034212	0.028682	-0.00588
S.D.	0.04957	0.02942	0.02821
P-value wilcoxon signed rank test of the change in the average			<.0001

Table 2**Descriptive Statistics for three months before and after July 2006, sorted into quintiles**

This table reports the descriptive statistics of the number of trades, proportional spread (pbas), depth (sum of best bid and ask volume), time within trades (seconds), volatility (standard deviation) and the ratio of transacted call volume to trade volume during the first hour, of the first hour of each trading day, for three months before and three months after July 1 2006. Actively traded A-shares are sorted into quintiles according to their average daily turnover during the study period. The p-value of the wilcoxon signed rank test reports whether the change in those mean values between the pre and post-event period are statistically significant.

	<u>Quintile 1</u>			<u>Quintile 2</u>			<u>Quintile 3</u>			<u>Quintile 4</u>			<u>Quintile 5</u>		
	<i>Pre</i>	<i>Post</i>	<i>Change</i>	<i>Pre</i>	<i>Post</i>	<i>Change</i>	<i>Pre</i>	<i>Post</i>	<i>Change</i>	<i>Pre</i>	<i>Post</i>	<i>Change</i>	<i>Pre</i>	<i>Post</i>	<i>Change</i>
<i>Number of stocks</i>	162	162		161	161		161	161		160	160		162	162	
<i>Number of trades in the first hour</i>															
Mean	396.7847	299.1392	-97.646	287.0489	205.8751	-81.1738	237.5959	173.5623	-64.0335	185.8068	141.1546	-44.6522	136.1883	92.77703	-43.4113
Median	399.0907	293.3944	-107.505	287.3818	203.8281	-96.3675	239.2692	171.3692	-71.0296	187.882	140.6797	-50.3898	136.4104	93.78846	-42.492
S.D.	86.15976	88.06191	86.9468	58.28793	59.71589	75.95109	52.49376	47.26481	66.04519	38.06042	43.59258	58.2468	41.06038	28.41415	38.74253
P-value wilcoxon signed rank test of the change in the average			<.0001			<.0001			<.0001			<.0001			<.0001
<i>Pbas (%)</i>															
Mean	0.002412	0.002218	-0.00019	0.004053	0.002717	-0.00134	0.003289	0.003123	-0.00017	0.005344	0.003425	-0.00192	0.004443	0.00453	0.000087
Median	0.002069	0.001955	-0.00007	0.002554	0.002465	-0.00007	0.002902	0.002841	-0.00005	0.003262	0.00314	-0.00006	0.00391	0.00394	0.000054
S.D.	0.00141	0.000983	0.00104	0.0165	0.00107	0.01639	0.00218	0.00124	0.00202	0.01948	0.0013	0.01949	0.00229	0.00215	0.00162
P-value wilcoxon signed rank test of the change in the average			<.0001			<.0001			<.0001			<.0001			<.0001
<i>Depth</i>															
Mean	153326.3	139273.7	-14052.6	101800	48149.63	-53650.3	57174.4	45934.61	-11239.8	90049.43	34403.35	-55646.1	35751.26	30329.14	-5422.12
Median	43850.6	38512.7	-5273.3	32057.9	28821.72	-4877.4	35222.9	30508.7	-3723.4	27289.3	25149.53	-2442.7	24537.41	19826.31	-3625.11
S.D.	515236	503677	140805	635026	71804	622259	142084	53023	136982	620567	29913	621784	35199	34547	29105
P-value wilcoxon signed rank test of the change in the average			<.0001			<.0001			<.0001			<.0001			<.0001
<i>time within trades (seconds)</i>															
Mean	9.553546	13.19743	3.64388	13.05752	19.12134	6.063815	15.89475	22.66048	6.765731	20.05806	27.61909	7.561028	29.14278	41.38909	12.24631
Median	8.982709	12.22289	3.297392	12.45206	17.51074	5.561334	14.93809	20.74423	5.652711	18.94117	25.13278	6.523473	25.9177	37.23536	12.6218
S.D.	2.64699	4.98165	4.12497	3.09571	7.18933	6.71729	4.10531	9.6516	8.92021	4.68609	10.11651	10.4571	12.31234	15.98834	13.19064
P-value wilcoxon signed rank test of the change in the average			<.0001			<.0001			<.0001			<.0001			<.0001
<i>Ratio of transacted volume from call auction to trade volume during the first hour</i>															
Mean	0.016196	0.014483	-0.00171	0.017412	0.017413	0.000001	0.017618	0.017362	-0.00026	0.022842	0.021054	-0.00179	0.036082	0.03771	0.001629
Median	0.011798	0.012877	0.00161	0.011749	0.014299	0.0015	0.013197	0.015048	0.0011	0.014705	0.016963	0.00232	0.016539	0.022735	0.003547
S.D.	0.01487	0.00618	0.01433	0.01755	0.01845	0.02165	0.01421	0.01146	0.0169	0.02954	0.01856	0.03335	0.06806	0.05551	0.0854
P-value wilcoxon signed rank test of the change in the average			<.0001			<.0001			<.0001			<.0001			<.0001
<i>Volatility (standard deviation)</i>															
Mean	0.079799	0.053257	-0.02654	0.065401	0.048684	-0.01672	0.04812	0.035545	-0.01257	0.04292	0.034536	-0.00838	0.034513	0.028743	-0.00577
Median	0.053785	0.038777	-0.01533	0.047656	0.038616	-0.01091	0.036542	0.027336	-0.00779	0.034406	0.02816	-0.00857	0.029425	0.024632	-0.0041
S.D.	0.0766	0.05124	0.0375	0.06704	0.04219	0.03211	0.03847	0.02455	0.02156	0.02482	0.02468	0.01873	0.01808	0.01462	0.01207
P-value wilcoxon signed rank test of the change in the average			<.0001			<.0001			<.0001			<.0001			<.0001

Table 3**Regression results for spread and depth**

This table presents the regression results for 216 A-share stocks that did not undergo share splits during 2006. Sample period is from 1 April 2006 to 30 September 2006. *Pbas* is the proportional bid-ask spread calculated by dividing the absolute spread by the bid-ask price mid-point. *Dollar depth* is measured by multiplying the sum of the best bid-ask volume by its respective stock price. *Volatility* is a Parkinson's volatility measure. *Change* is a dummy variable that is assigned a value of one if the observation is after 1 July 2006. The remainder variables are dummy five-minute time interval variables to control for the time varying behaviour of *pbas* and dollar depth.

Regression analysis of spread (1)

$$pbas_{it} = \beta_0 + \beta_1 * dollar\ depth_{it} + \beta_2 * volatility_{it} + \beta_3 * change_{it} + \text{time interval dummies} + \varepsilon_{it}$$

<i>Explanatory Variable</i>	<i>Estimate</i>	<i>t-statistic</i>
Intercept	0.00479	486.10
Dollar Depth	-0.00017	-210.91
volatility	0.238164	656.47
Change	-0.00009	-53.21
09:30 to 09:35	0.001292	294.07
09:35 to 09:40	0.000585	137.04
09:40 to 09:45	0.000269	62.75
09:45 to 09:50	0.00012	27.90
09:50 to 09:55	0.000053	12.28
10:00 to 10:05	-0.00003	-7.60
10:05 to 10:10	-0.00007	-15.79
10:10 to 10:15	-0.00008	-18.98
10:15 to 10:20	-0.00009	-21.17
10:20 to 10:25	-0.00011	-24.45
10:25 to 10:30	-0.00012	-26.92
Adjusted R ²	0.1133	

All variables are significant at 1% level

Regression analysis of depth (2)

$$dollar\ depth_{it} = \gamma_0 + \gamma_1 * pbas_{it} + \gamma_2 * volatility_{it} + \gamma_3 * change_{it} + \text{time interval dummies} + \varepsilon_{it}$$

<i>Explanatory Variable</i>	<i>Estimate</i>	<i>t-statistic</i>
Intercept	289128.3	393.22
Proportional Spread	-4825099	-55.90
volatility	1774835	21.59
Change	-26465	-67.71
09:30 to 09:35	-98942.9	-102.32
09:35 to 09:40	-68413.2	-73.09
09:40 to 09:45	-42617.4	-45.36
09:45 to 09:50	-28281.9	-30.05
09:50 to 09:55	-14313.5	-15.19
10:00 to 10:05	6777.454	7.16
10:05 to 10:10	11034.75	11.63
10:10 to 10:15	20235.11	21.23
10:15 to 10:20	26720.69	27.84
10:20 to 10:25	31138.05	32.28
10:25 to 10:30	39980.31	41.38
Adjusted R ²	0.0085	

All variables are significant at 1% level

Table 4**5-minute interval intraday data five day before the regime change**

This table reports the mean values for proportional spread, depth, volatility, volume and proportional volume in each 5-minute time interval, five trading days before the regime change. The sample size is 188 shares. It excludes A-shares that experienced share splits during 2006, stocks that didn't trade during the ten day period, and stocks that resumed trading at 10.30am. *Pbas* is the proportional bid-ask spread calculated by dividing the absolute spread by the bid-ask price mid-point. *Depth* is the sum of the best bid-ask volume. *Volatility* is a Parkinson's volatility measure. *Proportional volume* is the actual volume transacted as a proportion of the daily volume for that stock, on that day.

Time	Proportional spread	Depth	Parkinson's volatility (%)	Volume	Proportional volume
9:30	0.00426	17935.34437	0.00717	7981.04660	0.00156
9:35	0.00330	22890.72898	0.00313	6071.79327	0.00121
9:40	0.00295	26099.52894	0.00245	5787.31277	0.00122
9:45	0.00278	27736.00897	0.00234	6160.57306	0.00128
9:50	0.00272	31246.45333	0.00192	6222.33316	0.00129
9:55	0.00260	34162.21937	0.00171	6092.81683	0.00130
10:00	0.00267	34139.66824	0.00175	6121.10752	0.00135
10:05	0.00256	33603.63039	0.00144	5833.16769	0.00130
10:10	0.00257	34573.16828	0.00161	6199.02780	0.00131
10:15	0.00261	36000.08634	0.00181	6598.35867	0.00139
10:20	0.00255	37408.80864	0.00178	5784.91555	0.00128
10:25	0.00254	39556.91947	0.00120	5956.46382	0.00130
10:30	0.00257	40105.32367	0.00148	6072.43969	0.00126
10:35	0.00257	42704.36305	0.00109	5988.83961	0.00123
10:40	0.00251	41348.26900	0.00101	6095.77521	0.00127
10:45	0.00251	41728.70223	0.00104	5398.18486	0.00119
10:50	0.00253	40684.75925	0.00098	5460.71614	0.00124
10:55	0.00250	41856.45357	0.00138	5998.36476	0.00124
11:00	0.00253	42697.09712	0.00090	5840.77919	0.00118
11:05	0.00248	43094.36282	0.00090	6277.57253	0.00125
11:10	0.00251	43771.97210	0.00091	6309.44848	0.00126
11:15	0.00252	41670.77095	0.00101	6428.11170	0.00130
11:20	0.00252	44493.59766	0.00089	6576.68326	0.00127
11:25	0.00246	41943.84172	0.00093	5888.51697	0.00118
13:00	0.00251	41656.25912	0.00110	8851.73432	0.00177
13:05	0.00245	44972.46600	0.00080	5840.19055	0.00119
13:10	0.00244	45676.55105	0.00085	5715.32127	0.00125
13:15	0.00244	47248.35884	0.00082	5876.22314	0.00124
13:20	0.00241	48871.31568	0.00093	5829.91866	0.00122
13:25	0.00244	49299.51885	0.00090	5604.82152	0.00123
13:30	0.00245	49155.26894	0.00083	5277.82384	0.00118
13:35	0.00248	51123.39466	0.00089	5404.32223	0.00120
13:40	0.00243	48637.67155	0.00097	5688.86964	0.00123
13:45	0.00241	49213.49016	0.00083	5229.27295	0.00118
13:50	0.00241	48757.43576	0.00085	5282.30683	0.00120
13:55	0.00240	50050.26124	0.00075	5480.64051	0.00124
14:00	0.00235	54660.84122	0.00074	5575.12215	0.00120

14:05	0.00240	54921.63330	0.00101	6061.36763	0.00128
14:10	0.00239	51738.48081	0.00100	6385.24345	0.00130
14:15	0.00241	51156.79226	0.00081	6219.92998	0.00134
14:20	0.00243	53224.01689	0.00084	6034.19056	0.00131
14:25	0.00245	52443.70308	0.00117	5870.42525	0.00134
14:30	0.00242	52481.25625	0.00096	5978.52742	0.00136
14:35	0.00244	56398.86439	0.00098	5853.51208	0.00139
14:40	0.00241	61047.30956	0.00098	6360.52110	0.00138
14:45	0.00240	58506.70981	0.00090	6414.33834	0.00141
14:50	0.00240	53364.63717	0.00101	7165.40700	0.00160
14:55	0.00241	49320.29593	0.00150	7868.88572	0.00176

Table 5**5-minute interval intraday data five day after the regime change**

This table reports the mean values for proportional spread, depth, volatility, volume and proportional volume in each 5-minute time interval, just five trading days after the regime change. The sample size is 188 shares. It excludes A-shares that experienced share splits during 2006, stocks that didn't trade during the ten day period, and stocks that resumed trading at 10.30am. *Pbas* is the proportional bid-ask spread calculated by dividing the absolute spread by the bid-ask price mid-point. *Depth* is the sum of the best bid-ask volume. *Volatility* is a Parkinson's volatility measure. *Proportional volume* is the actual volume transacted as a proportion of the daily volume for that stock, on that day.

Time	Proportional spread	Depth	Parkinson's volatility (%)	Volume	Proportional volume
9:30	0.00398	18571.10019	0.00682	8798.39764	0.00127
9:35	0.00330	23119.20833	0.00455	6958.90976	0.00112
9:40	0.00300	26175.79738	0.00275	6693.82151	0.00110
9:45	0.00274	28734.33939	0.00206	7025.57486	0.00116
9:50	0.00265	32178.45780	0.00180	6934.50092	0.00116
9:55	0.00259	38552.18256	0.00189	7054.75758	0.00117
10:00	0.00256	35140.88494	0.00185	6838.74775	0.00115
10:05	0.00250	34213.92661	0.00170	6387.43299	0.00113
10:10	0.00250	39479.59620	0.00144	6922.82508	0.00113
10:15	0.00245	44127.31671	0.00127	6121.20160	0.00112
10:20	0.00244	56993.82665	0.00120	6557.24273	0.00120
10:25	0.00243	55516.49718	0.00120	6259.09916	0.00114
10:30	0.00241	51728.11554	0.00120	6482.66929	0.00119
10:35	0.00243	53209.87195	0.00120	5934.32326	0.00112
10:40	0.00245	58040.57140	0.00111	5891.74411	0.00112
10:45	0.00244	57943.91112	0.00107	5857.63956	0.00114
10:50	0.00242	51057.92307	0.00130	6898.92503	0.00119
10:55	0.00247	44574.64343	0.00125	6194.25816	0.00119
11:00	0.00242	48528.33215	0.00112	6250.97127	0.00114
11:05	0.00243	45907.31413	0.00116	6610.39843	0.00119
11:10	0.00243	45143.45755	0.00105	6222.69752	0.00120
11:15	0.00241	45566.43168	0.00121	6689.05518	0.00124
11:20	0.00243	45455.03284	0.00105	6343.93834	0.00119
11:25	0.00241	46563.47584	0.00103	5843.26544	0.00114
13:00	0.00249	49879.02377	0.00112	8873.72049	0.00167
13:05	0.00238	48450.52754	0.00097	5923.13222	0.00111
13:10	0.00238	47077.31869	0.00090	5784.99764	0.00109
13:15	0.00239	47423.80390	0.00090	5662.61932	0.00107
13:20	0.00236	50446.36554	0.00085	5819.16501	0.00115
13:25	0.00240	50368.92959	0.00082	6352.15502	0.00122
13:30	0.00237	49476.62078	0.00088	5905.13578	0.00113
13:35	0.00233	55161.11814	0.00083	6098.94173	0.00113
13:40	0.00235	51811.03323	0.00126	7202.13005	0.00136
13:45	0.00239	46655.49772	0.00124	6994.48775	0.00133
13:50	0.00236	44807.38537	0.00129	6724.54380	0.00130

13:55	0.00241	46709.57268	0.00110	6266.12819	0.00123
14:00	0.00237	45338.57645	0.00112	6158.53271	0.00120
14:05	0.00234	48866.31282	0.00104	6397.73679	0.00120
14:10	0.00236	50306.11521	0.00109	6578.98590	0.00129
14:15	0.00235	49218.37156	0.00118	6522.72319	0.00132
14:20	0.00236	48154.37670	0.00097	6425.59847	0.00125
14:25	0.00232	49781.90712	0.00110	6355.50056	0.00122
14:30	0.00233	48889.03478	0.00084	5938.38163	0.00123
14:35	0.00232	49182.32405	0.00114	6420.05795	0.00130
14:40	0.00234	52211.32906	0.00104	6562.70771	0.00135
14:45	0.00233	52725.18395	0.00105	6615.84396	0.00137
14:50	0.00231	51227.93939	0.00118	6889.37722	0.00143
14:55	0.00237	51501.00072	0.00162	7663.12559	0.00155

Figure 1

This figure depicts the average proportional bid-ask spread across each five-minute time interval for 216 A-share stocks during five trading days before and five trading days after 1 July 2006.

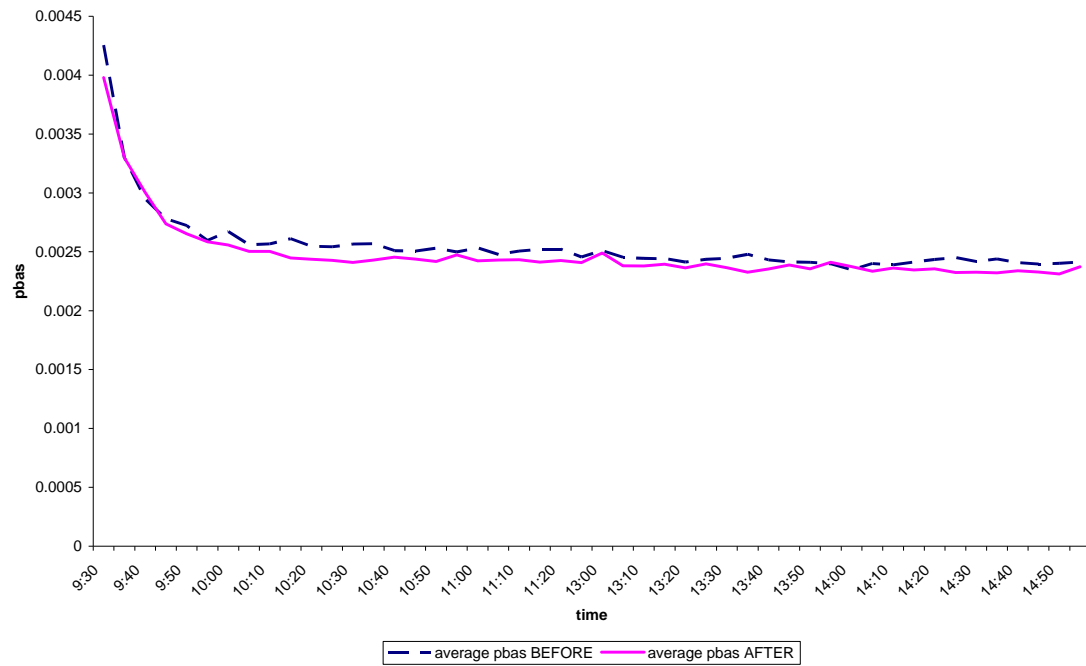


Figure 2

This figure depicts the average depth across each five-minute time interval for 216 A-share stocks during five trading days before and five trading days after 1 July 2006. Depth is sum of the volume at the best bid and ask quotes.

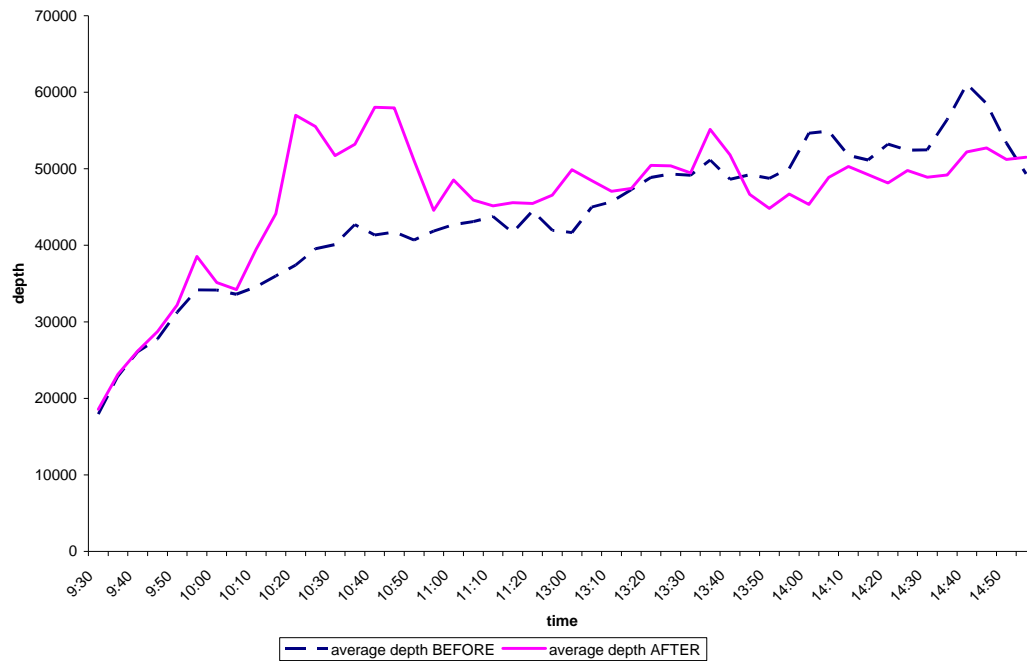


Figure 3

This figure depicts the average volatility across each five-minute time interval for 216 A-share stocks during five trading days before and five trading days after 1 July 2006. *Volatility* is a Parkinson's volatility measure.

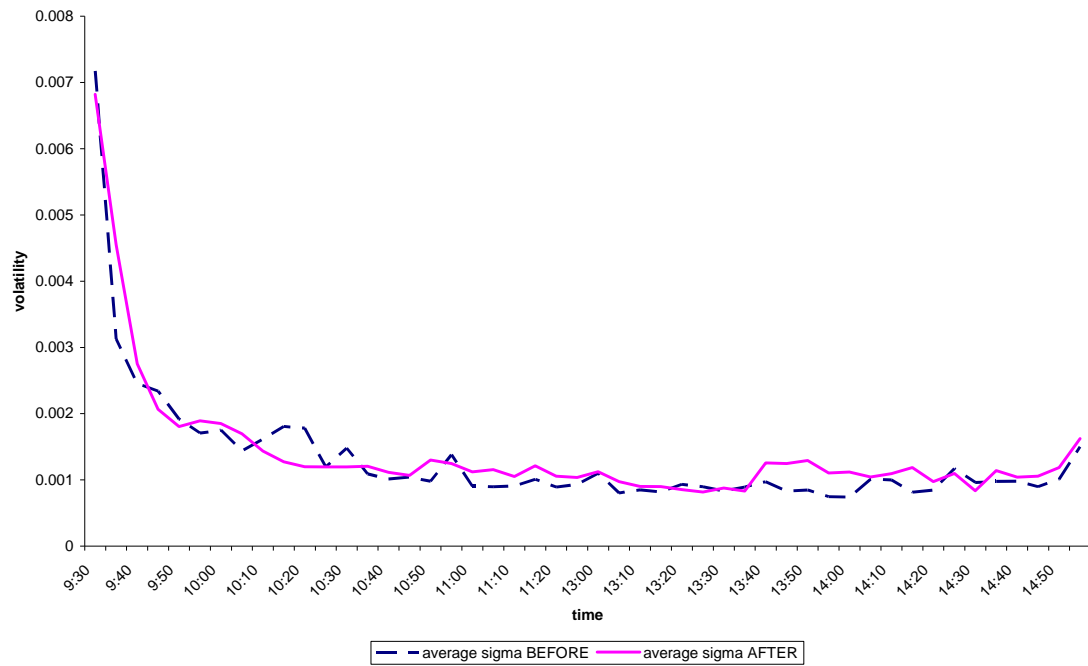


Figure 4

This figure depicts the average volume across each five-minute time interval for 216 A-share stocks during five trading days before and five trading days after 1 July 2006.

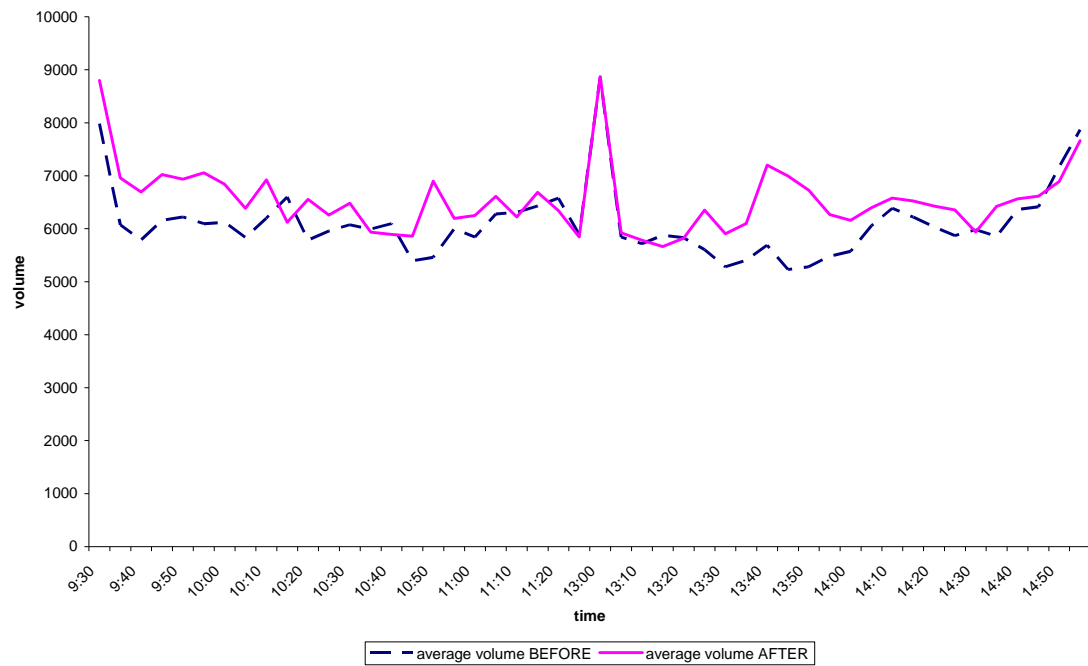


Figure 5

This figure depicts the average proportional volume across each five-minute time interval for 216 A-share stocks during five trading days before and five trading days after 1 July 2006. Proportional volume is the ratio of individual transacted volume divided by daily volume.

