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# Call auction transparency and market liquidity, evidence from the Shanghai Stock Exchange

Gary G. Tian
*University of Wollongong*, gtian@uow.edu.au

Dionigi Gerace
*University of Wollongong*, dionigi@uow.edu.au

Alex Frino
*University of Sydney*, afrino@uow.edu.au

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## Abstract

This paper examines the impact of pre-trade information transparency in pre-open call auction on market liquidity on the Shanghai Stock Exchange (SHSE). We examine the natural experiment affected by the Shanghai Stock Exchange in July 2006 when it changed its pre-open auction algorithm from an entirely black box into a limited transparent system with a closed order book. We find that the increase in pre-trade information transparency coincides with a statistically significant reduction in spread at the best quotes. The reduction in spread persists even after controlling for known determinants of depth. Furthermore, there is also evidence of a statistically significant reduction in market depths. Finally, the ratio of trading volume to total volume during call auction increases significantly over the first 15 minutes of continuous trading. We conclude that in a more transparent call auction, the change from an entirely black box into a limit transparent limit order book has led to an improvement in market quality in terms of market liquidity and increased participation in the call auction by investors.



## Keywords

Call, auction, transparency, market, liquidity, evidence, from, Shanghai, Stock, Exchange

## Disciplines

Business | Social and Behavioral Sciences

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**Call auction transparency and market liquidity, evidence from the Shanghai stock exchange**

Gary Gang Tian[a1], Dionigi Gerace[b], Alex Frino[c]

a and b – Department of Finance, School of Accounting and Finance, University of Wollongong, NSW 2522 Australia

c – Department of Finance, School of Business, University of Sydney, NSW 2006 Australia

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Abstract

This paper examines the impact of pre-trade information transparency in pre-open call auction on market liquidity on the Shanghai Stock Exchange (SHSE). We examine the natural experiment affected by the Shanghai Stock Exchange in July 2006 when it changed its pre-open auction algorithm from an entirely black box into a limited transparent system with a closed order book. We find that the increase in pre-trade information transparency coincides with a statistically significant reduction in spread at the best quotes. The reduction in spread persists even after controlling for known determinants of depth. Furthermore, there is also evidence of a statistically significant reduction in market depths. Finally, the ratio of trading volume to total volume during call auction increases significantly over the first 15 minutes of continuous trading. We conclude that in a more transparent call auction, the change from an entirely black box into a limit transparent limit order book has led to an improvement in market quality in terms of market liquidity and increased participation in the call auction by investors.

**Call auction transparency and market liquidity, evidence from the Shanghai stock exchange**

## 1 Introduction

This paper examines the impact of pre-trade information transparency in pre-open call auction on market liquidity. Although call auctions are becoming increasingly incorporated into market design at both the opening and closing, the design of the call auction trading mechanism differs between exchanges. Most automated systems allow a high degree of transparency, but it is not clear whether this is desirable for all traders.

For example, the level of pretrade transparency varies. On the Australian Stock Exchange (ASX) and on Euronext, the full order book is disclosed prior to the opening call auction. In contrast, on the Taiwan Stock Exchange (TSEC) and on Deutsche Borse AG (DBAG), the order book is completely closed prior to the opening call auction (Comerton-Forde and Rydge 2006).

The impact of pre-trade information transparency on market quality has attracted the interest of many academics. However, the relation between market efficiency and the optimal level of [pre-trade market transparency] the amount of information about the trading process is still unresolved.

The optimal level of pre-trade market transparency is unclear. Experimental studies by Bloomfield and O'Hara (1999, 2000) and Flood, *et al.* (1999) suggest that higher levels of market transparency might lead to higher or lower levels of information efficiency depending on the specific underlying market structure.

Of particular relevance to the situation faced by the TSE is the study by Bloomfield and O'Hara (2000), which investigates whether transparent markets can survive when faced with direct competition from less transparent markets. The introduction of the *Market-by-Price* system on the TSE in 1990 dramatically increased the level of pre-trade transparency by allowing market participants to view the depth available at the best five bid and ask prices.

Madhavan, *et al.* (2000) found that this increase in pre-trade transparency was detrimental to liquidity and resulted in higher execution costs and increased volatility.

The opening protocols of the Paris Bourse and TSE share several features. Both exchanges operate as continuous electronic limit order markets and have highly transparent pre-opening sessions during which market participants can place, modify, or cancel orders for possible execution at the market opening. Biais, *et al.* (1999) examined the process of price discovery and learning during the Paris Bourse's pre-opening period between 8:30AM and the start of regular trading at 10:00AM. They found that due to the high level of market transparency and the ease with which orders can be cancelled, traders are unwilling to submit the most informative orders until just prior to the market opening. This paper documents a similar order submission pattern during the TSE's pre-opening session.

While there are a number of papers examining the difference between price efficiency in continuous and call markets, there are few published papers that empirically examine the impact of a change in call auction design on price efficiency. Particularly lacking is research on the impact of pre-trade information transparency on market liquidity in a pre-open call auction. Following Fridman (1993), laboratory experimental studies by Oehler and Unser (1998) indicated that the open order-book does not improve informational efficiency and does not result in higher liquidity (lower transaction costs). An increase in information intensity leads to both a higher trading volume and higher volatility in both order-book treatments. The comparison shows that they only differ in price volatility which is higher with an open order-book. The market results mentioned above are confirmed by analyses on the individual level.

Domowitz and Madhavan (2001) discuss the impact of differing levels of transparency on call auction price efficiency. These existing publications were based on experimental studies as there had been no experience of natural experiments of exchanges from black to transparent.

One exception is Comerton-Forde et al. (2006) who examine the impact on price efficiency of the 18 March 2002 changes to the ASX call auction design. Specifically, transparency in the call auction was increased through the dissemination of an indicative auction price (IAP) and a surplus volume (SV) indication. The matching algorithm used to determine the auction price was also altered. Traders were also no longer restricted by the presence of undisclosed orders, and were able to identify any order imbalance present at that price. Their results demonstrate that call auction design has an important influence on price efficiency.

However, this study has its limitations. First, the impact of the change in information transparency was complicated by changes to the other trading algorithm. Secondly, the actual change to transparency was minor, because transparency of the order book during the pre-open and pre-close periods was high before the change, though limited by the presence of undisclosed orders.

The Shanghai stock market provides a unique sample for examining the impact of pre-trading information disclosure on market quality during the pre-open call auction. We found that the introduction of transparent increased liquidity etc.

On 1 July 2006, the Shanghai Stock Exchange (SHSE) changed its pre-open auction algorithm from an entirely black box into a limited transparent system with a closed order book. The implementation of the new algorithm allowed for a change in the level of pre-trade transparency. After 1 July 2006 the SHSE began to disseminate an IAP and SV indication in real time throughout the pre-open period. By providing pre-transaction information of its pre-open auction, the SHSE increased efficiency in determining an opening price and encouraging more investors to participate during the pre-open auction. This post-change situation is now similar to Deutsche Borse AG with extra information regarding unbalanced amounts but with a closed order book during auction.

Therefore Shanghai's change in transparency provides a unique opportunity for research into the impact of changes in transparency on price discovery. This is the first paper examining the impact of pre-trading information transparency on market liquidity by comparing pure black box to limit information disclosure in pre-open call

auctions. Secondly, the microstructure change in Shanghai in July 2006 is a single change, unlike most other natural experiments which have multiple simultaneous changes in both the transparency level and match algorism, which complicates the impact of change on market liquidity such as Sydney's case in 2002. Thirdly, the existing B-shares market in the SHSE provides an excellent control sample to achieve a robust set of results testing the significance of the change because the B-shares were not involved in any changes due to there being no pre-open call auction for the market opening in the B-shares market.

The remainder of this paper is structured as follows: Section 2 provides the institutional details for the SHSE and develops some hypotheses in this paper; Section 3 describes the data set employed in the study, and the research design; Section 4 presents the results; and, Section 5 provides a summary and conclusion.

## 2. Institutional details

The trading system in the SHSE is based on the electronic consolidated open limit order book (COLOB). A 10-minute opening call (consolidated) auction is held at 09:15 and ends at 09:25 and 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 system[2]. 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 can't be sold on the same day once 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 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 was introduced to open trading. In the past, SHSE closed 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 are 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 was introduced to open trading. The 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.

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

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

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.

## 3. Data and hypothesis

### 3.1 Dataset

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 intra-day trades and the best bid and ask prices 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 sample period from 1 January 2006 to 31 December 2006 is selected. This provides a six month window around the event date, 1 July 2006, to study the impact of the introduction of the information transparency in call auction on market liquidity.

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. Sixty-nine stocks were excluded from the sample, reducing the sample size to 822 stocks due to their inactive trading during this period. Sample stocks are divided into quartiles based on a turnover ratio, defined as total value traded over the sample period divided by market capitalization at the start of the sample period. Quartile one represents the most liquid stocks while quartile four represents the least liquid stocks.

Analysis by quartile is used to determine if opening call auction efficiency varies with stock liquidity.

### 3.2 Hypotheses

Intuitively, one would expect increases in pre-trade transparency to allow information to be impounded into prices more quickly, therefore enhancing price discovery and liquidity (e.g., Flood et al., 1999). However, the existing literature on the relationship between pretrade transparency, liquidity and price discovery is far from conclusive. In an experimental markets framework, Flood et al. (1999) found that increased transparency reduces search costs, thereby reducing uncertainty and enhancing liquidity. As a result, dealers use less aggressive price adjustments, slowing price discovery. In contrast, Bloomfield and O'Hara (1999) report that increased transparency heightens informational efficiency, giving rise to more rapid price discovery. Furthermore, in a natural experiment examining a changes in the level of order book disclosure on the Toronto Stock Exchange (TSX), Madhavan et al. (2001) found that increased transparency has a detrimental effect on liquidity. Hence, the following testable hypotheses:

$H_1$: Average market depth at the best available quote at the first 15 minute trading become larger when pre-open call auction become more transparent.

$H_2$: Average market spread at the best available quote at the first 15 minute trading become narrower when pre-open call auction become more transparent.

$H_3$: More investors participate in call auction when pre-open call auction become more transparent.

Hypothesis 1 and 2 are tested by examining the change in depth at the best quotes, as well as bid-ask spreads in the pre and post-event samples. Depth and bid-ask spreads are sampled each minute during the first 15 continuous trading. Depth is defined as the total volume available at the standing best buy and sell quotes in the limit order book at the end of each interval. The standing bid-ask spread in points is also examined. Previous studies examining liquidity in the equities markets analyse spreads across a portfolio of securities and employ a proportional bid-ask spread to control for differences in the minimum tick size across stocks [See McInish and Wood

(1992)]. A parametric *t*-test is used to compare whether the means of the variables in the pre- and post-event periods are significantly different.

Harris (1994) develops a model which identifies a number of variables that explain changes in depth. It is important to control for changes in these variables in order to ensure that any changes in depth observed in this study are attributable to the change in transparency, and not merely to changes in market conditions which influence these variables. The model below is estimated to test the impact of increased pre-trade transparency on market depth, controlling for possible changes in known determinants;

DEPTH = a + b1*PBAS + b2*Time-to-Trade + b3*N-Trade + b4*Volume +b5*Volitlity + b6*D (1)

where the dependent variable $DEPTH_t$ is the logarithm of the daily average limit order volume at the best buy and sell. The log transformation of depth and trading volume is consistent with Harris (1994). The dummy variable *D* is assigned a value of 1 if the observation is drawn from the period where the limit information regarding prices and associated aggregate order volume are disclosed at call auction, or 0 otherwise. $VOLUME_t$ is the logarithm of total daily traded volume. $VOLATILITY_t$ is measured as the standard deviation of the price in the trading day . All *t*-statistics are adjusted for heteroskedasticity and autocorrelation using the procedure developed by Newey and West (1987).

McInish and Wood (1992) identify trading volume and price volatility as influences upon bid-ask spreads. Specifically, they document that bid-ask spreads are negatively related to volume and positively related to price volatility. The regression model presented below is estimated to control for the possibility that changes in broad market conditions may have an influence upon bid-ask spreads during the sample period;

PBAS = a + b1*DEPTH + b2*Time-to-Trade + b3*N-Trade + b4*Volume +b5*Volitlity + b6*D (2)

where the dependent variable $PBAS_t$ is the logarithm of the daily average bid-ask spread sampled each minute during the 15 minute trading. The explanatory variables are as previously defined for regression model 1. Again, all t-statistics are adjusted for heteroskedasticity and autocorrelation following Newey and West (1987).

Hypothesis 3 predicts that a reduction in execution risk following the increase in transparency of the limit order book is likely to encourage traders to place orders during the call auction. We calculate the executed volume during the call auction relative to the total transaction volume in the first 15 minutes of trading. A t- test of the difference is used to determine whether the ratio changed significantly from the pre to post samples.

## 4. Results

### *4.1 Tests of Hypothesis 1 and 2*

Table 1 provides summary statistics and results from tests of the impact of increased pre-trade transparency in call auction on the two liquidity measures, depth and spreads in six month before and after the event. Consistent with Hypothesis 1, Table 1 documents a rise in average depth with a increase in depth from 39,595 to 42,639. The *t*-tests comparing the means in the pre-event and post-event periods are significant at the 0.01 level. Table 1 also reports descriptive statistics for bid-ask spreads. Average bid-ask spreads decrease by 0.02 from 0.39 to 0.37. Consistent with $H_2$ there appears to be a narrowing of bid-ask spreads following the increase in pre-trade transparency in call auction. The reduction in average proportional bid-ask spreads is statistically significant at the 0.01 level.

Table 1 also provides descriptive statistics for the variables volume ratio, volatility, number of trades and time within trades. Table 1 shows an increase in mean daily number of trades and volatility and reduction in the time within trades in the first 15 continuous trading. Both the increase in number of trades and the reduction in the time within trades are significant at the 0.01 level according to the *t*-statistic. Table 2 further provide the descriptive statistics for the liquidity and the controlling variables in three month before and after the event. The results for Table 2 are almost the same as the Table 1 except for volatility. Table 2 shows a reduction in mean daily volatility in the first 15 continuous trading and significant at the 0.01 level according to the *t*-statistic. These results provide evidence of significant changes in the determinants bid-ask spreads and depth surrounding the change in pre-trade transparency in call auction. The regression analysis presented below reports the effects of an increase in pre-trade transparency after controlling for changes in volume, volatility and other variables.

Table 3 reports the results of regression analysis of depth and bid-ask spreads against the explanatory variables, volume, volatility, a dummy variable for the change in pre-trading transparency in call auction and other variables. Table 3 presents the adjusted $R^2$-statistic and estimates of both the depth and pbas regression parameters.

Coefficients on the log of trading volume ($VOLUME_t$) and price volatility ($VOLATILITY_t$) are in the desired direction and significant at the 0.01 level across the four contracts examined. Consistent with Harris (1994) a positive relationship is documented between $DEPTH_t$ and $VOLUME_t$ and a negative relationship is documented between $DEPTH_t$ and $VOLATILITY_t$. Table 3 also indicates that after controlling for these known determinants of depth the coefficient on the dummy variable ($D$) is postive and significant at the 0.01 level. These results are consistent with $H_1$, that increased pre-trade transparency in call auction results in a rise in depth, even after controlling for changes in possible determinants of depth.

Results of the regression analysis on bid-ask spreads is presented in Table 3. Consistent with McInish and Wood (1992), Table 3 provides evidence of a negative relationship between bid-ask spreads and volume and a positive relationship between bid-ask spreads and price volatility. The coefficient on $VOLUME_t$ is negative and significant and the coefficient on price $VOLATILITY_t$ is positive and significant, both at the 0.01 level, for the four contracts examined. After controlling for the established determinants of bid-ask spreads, the coefficient on the dummy variable ($D$) is negative consistent with $H_2$.

### *4.2 Test of Hypothesis 3*

Table 1 provides results of tests of $H_3$. Consistent with $H_3$, the proportion of trading volume in call auction to total volume in first five-minute continuous trading increases following the change in transparency in call auction. The volume ratio increases from 87.27% to 130.07%. Table 3 documents that the increase in the volume ratio is significant at the 0.01 level based on a t- test. A similar result was found in Table 2 for the situation three month before and after the event.

These results are consistent with Hypothesis 3, and provide evidence of a change in trading behaviour surrounding the increase in pre-trade transparency in call auction. A

transparent call auction environment provides execution certainty and traders are encouraged to participate the pre-open auction.

### *4.3 Robustness Tests*

Table 4 and 5 provides additional tests to examine the robustness of the evidence presented above which documents a rise in liquidity by way of a increase in depth, and reduction in bid-ask spreads following increased limit pre-trade information transparency in call auction. Sample stocks are divided into quartiles based on a turnover ratio, defined as total value traded over the sample period divided by market capitalization at the start of the sample period. Quartile one represents the most liquid stocks while quartile four represents the least liquid stocks. Table 4 and 5 suggest both quartile 1 and 2. Results in Quartile 3 and 4 are not significant, indicating the transparent call auction does not make any significant impact on the market quality in small and below media stocks. This is consistent to the claim made by Domowitz I, Madhavan A (2001) that "experience also shows that too much transparency may be detrimental. This is especially true for thinly traded assets where information asymmetry may be a severe problem. A very transparent system may discourage 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". The results indicate that these changes significantly enhanced call auction price efficiency, especially in active stocks at the open.

## 5. Conclusion

This paper examines the impact of pre-trade information transparency in pre-open call auction on market liquidity on the SHSE. We found that the increase in pre-trade information transparency coincides with a statistically significant reduction in spread at the best quotes. The reduction in spread persists even after controlling for known determinants of depth. Furthermore, there is also evidence of a statistically significant change in market depths. Finally, the ratio of trading volume to total volume during call auction increases significantly over the first 15 minutes of continuous trading. A robust test further suggests that the impact of the change of the pre-trade information transparency is more effective for media and large stocks. We conclude that in a more transparent call auction, the change from an entirely black box into a limit transparent

limit order book has led to an improvement in market quality in terms of market liquidity and increased participation in the call auction by investors.

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Table 1

Descriptive Statistics - six months before and after

| | *Pre* | | *Post* |
|---|---|---|---|
| No. of Stocks | 822 | | 822 |
| First 15 Minutes Trades | | | |
| *Mean* | 52.16 | | 161.33 |
| *Mean change* | | 109.17** | |
| Proportional spread (%) | | | |
| *Mean* | 0.39 | | 0.37 |
| *Mean change* | | -0.02** | |
| Dollar Depth | | | |
| *Mean* | 39,595 | | 42,639 |
| *Mean change* | | 3044** | |
| Volume Ratio | | | |
| *Mean* | 87.27 | | 130.07 |
| *Mean change* | | 42.8** | |
| Time Within Trades | | | |
| *Mean* | 34.07 | | 23.95 |
| *Mean Change* | | -10.12** | |
| Volatility (%) | | | |
| *Mean* | 2.75 | | 2.96 |
| | | 0.21 | |

** Indicates statistical significance at the 0.01 level

* Indicates statistical significance at the 0.05 level

Table 2

Descriptive Statistics - three months

| | *Pre* | | *Post* |
|---|---|---|---|
| No. of Stocks | 822 | | 822 |
| First 15 Minutes Trades | | | |
| *Mean* | 46.62 | | 58.115 |
| *Mean change* | | 11.495** | |
| Proportional spread (%) | | | |
| *Mean* | 0.45 | | 0.37 |
| *Mean change* | | -0.08** | |
| Dollar Depth | | | |
| *Mean* | 37,698 | | 39,598 |
| *Mean change* | | 1900** | |
| Volume Ratio | | | |
| *Mean* | 79.34 | | 90.35 |
| *Mean change* | | 11.01** | |
| Time Within Trades | | | |
| *Mean* | 34.27 | | 29.54 |
| *Mean Change* | | -4.73** | |
| Volatility (%) | | | |
| *Mean* | 3.79 | | 2.65 |
| | | -1.14** | |

** Indicates statistical significance at the 0.01 level

* Indicates statistical significance at the 0.05 level

Table 3
Regressions - six months

| Dependent Variable | Intercept | Dollar_Depth | Pbas | Time_trade | N_trade | Volume | Volatility | Change | R-Square |
|---|---|---|---|---|---|---|---|---|---|
| Pbas | 0.002 | | | | | | | -0.00051 | 0.014 |
| Dollar Depth | 40,342 | | | | | | | 3,119.42 | 0.03 |
| Pbas | 0.0015 | 0.0004 | | 0.00012 | -0.00001 | -0.0011 | 0.0043 | -0.00064 | 0.0093 |
| Dollar Depth | -378,231 | | -323,073 | -277.49 | 83.29 | 50,505 | 55,893 | 6057.23 | 0.145 |

** Indicates statistical significance at the 0.01 level
* Indicates statistical significance at the 0.05 level

Table 4
Regressions - three months

| Dependent Variable | Intercept | Dollar_Depth | Pbas | Time_trade | N_trade | Volume | Volatility | Change | R-Square |
|---|---|---|---|---|---|---|---|---|---|
| Pbas | 0.0045 | | | | | | | -0.0008 | 0.23 |
| Dollar Depth | 38134 | | | | | | | 3,078 | 0.11 |
| Pbas | 0.0065 | -0.0001 | | 0.00001 | -0.02 | -0.00001 | 0.01 | -0.0012 | 0.3 |
| Dollar Depth | -256678 | | -1,465,508 | -275.12 | 472.85.25 | 31,470 | -23,194.00 | 16,967.00 | 0.07 |

** Indicates statistical significance at the 0.01 level
* Indicates statistical significance at the 0.05 level
all significant at 1%

| Table 5 (six month) Descriptive Statistics - medium cap | Quartile 2 | | Quartile 1 | |
|---|---|---|---|---|
| | *Pre* | *Post* | *Pre* | *Post* |
| No. of Stocks | 465 | 465 | 357 | 357 |
| First 15 Minutes Trades | | | | |
| *Mean* | 53.135 | 164.03 | 58.43 | 176.32 |
| *Mean change* | 110.895 | | 117.89 | |
| Proportional spread (%) | | | | |
| *Mean* | 0.37 | 0.35 | 0.35 | 0.31 |
| *Mean change* | -0.02 | | -0.04 | |
| Dollar Depth | | | | |
| *Mean* | 39,525 | 42,645 | 47,340 | 49,439 |
| *Mean change* | 3120 | | 2099 | |
| Volume Ratio | | | | |
| *Mean* | 87.32 | 130.21 | 90.45 | 131.46 |
| *Mean change* | 42.89 | | 41.01 | |
| Time Within Trades | | | | |
| *Mean* | 30.93 | 22.34 | 25.72 | 21.42 |
| *Mean Change* | -8.59 | | -4.3 | |
| Volatility (%) | | | | |
| *Mean* | 2.71 | 2.85 | 3.14 | 2.94 |
| *Mean change* | 0.14 | | -0.2 | |

** Indicates statistical significance at the 0.01 level (all at 1%)

* Indicates statistical significance at the 0.05 level

Table 6
Regressions - six months

| Dependent Variable | Intercept | Dollar_Depth | Pbas | Time_trade | N_trade | Volume | Volatility | Change | R-Square |
|---|---|---|---|---|---|---|---|---|---|
| Quartile 2 | | | | | | | | | |
| Pbas | 0.0086 | -0.0005 | | 0.00004 | -0.0001 | -0.0003 | 0.004 | -0.0007 | 0.009 |
| Dollar Depth | -80101.6 | | -677486 | -142.59 | 94.35 | 14680 | -88628 | 6,222.31 | 0.057 |
| Quartile 1 | | | | | | | | | |
| Pbas | 0.0073 | -0.0004 | | 0.0001 | -0.00001 | -0.0009 | 0.0032 | -0.0008 | 0.006 |
| Dollar Depth | -346352 | | -734516 | -239.43 | 91.19 | 41602 | -180269 | 4448.1 | 0.09 |

** Indicates statistical significance at the 0.01 level (all at 1%?)

* Indicates statistical significance at the 0.05 level

all stationary after disk fuller tests for volume, depth and volatltiy afer and before; did not for price