

Is Penny Trading Optimal for Closed-end Funds in China?

Li Wei
Director
Strategy and Research
New York Stock Exchange
11 Wall Street
New York, NY 10005
U.S.A.
lwei@nyse.com

Donghui Shi
Senior Research Fellow
Research Center
Shanghai Stock Exchange
Shanghai, 200120
China
dhshi@sse.com.cn

January 2002

This draft: January 11, 2002

Early drafts: July 11, 2002, November 11, 2002

JEL Classification: G14 G18 G19

Key words: minimum price variation, tick size, closed-end funds

The research is conducted when the first author was an Assistant Professor of Finance at Iowa State University and a Senior Visiting Financial Economist at the Shanghai Stock Exchange. The first author is grateful to the support and the generous funding from the Shanghai Stock Exchange. In particular, the authors thank Xinghai Fang, Ruyin Hu, Di Liu, Hao Fu, Zhanfeng Chen, Danian Sidu, and Xiaonan Lu for their helpful comments and research support. The comments and point of views expressed in the paper, however, are the authors own, and do not necessarily reflect the opinions of the New York Stock Exchange and the Shanghai Stock Exchange. Therefore, the authors are responsible for all remaining errors.

Abstract

This paper studies the impact of the minimum price variation (tick size) on closed-end fund trading in the Chinese stock market. The current tick size for the closed-end funds is ¥0.01 at the Shanghai and Shenzhen stock exchanges. With the average market prices for the funds around ¥1.00, the penny tick size is relatively large and approximately 1% of the funds' value.

We find the penny tick size is binding and limits the price competition. The bid-ask spread is almost unchanging during a trading day and equal to the tick size. In addition, the large tick size distorts the normal trading pattern for securities. We find that the quotes for the funds are highly inactive and the average quoted depth is surprisingly large. We also find that the limit order fill rate (open rate) for closed-end funds is much lower (higher) than that of stocks. In particular, large orders tend to enter into the book in the early morning and act as “voluntary market makers.”

Finally, we study policy implications. Our evidence supports that the penny tick size is not optimal for trading closed-end funds in China. It makes demanding immediacy expensive, and discourages investors to trade through marketable limit orders, resulting a less liquid market. It also negatively affects the social welfare in the Chinese stock markets: it induces large investors to act as “market makers of a day” and increases trading cost for small investors. We propose using one tenth of a penny as the tick size to trade closed-end funds in the Chinese stock market.

1. Introduction

Is there an optimal minimum price variation in trading securities in the sense of maximizing liquidity? What will happen if the tick size is not optimal? The minimum price variation, also called the tick size, is the minimum unit of price change in trading a security. It determines the prices that are available to investors. The last decade has witnessed the changes of tick size in the US securities market, and financial economists have concluded that the tick size has a significant impact on market liquidity and market quality. In this paper we examine whether a penny tick size is optimal for trading closed-end funds in the Chinese stock market.¹

The tick size varies substantially across markets. Traditionally, stocks, bonds, options, and futures markets have employed prices denominated in fractions, such as the eighth in the US equity market. Until June 4, 1997, the $\$1/8$ tick size has been used as a tick size for more than two hundred years on the New York Stock Exchange (NYSE). Under the $\$1/8$ tick size regime, prices between the fraction grids are usually not available for investors. On June 4, 1997, the tick size changed from $\$1/8$ to $\$1/16$ on the NYSE, and in January 2002, it changed again into a penny.²

The European and the Asian stock markets typically use decimals to quote their prices. For example, in the Japanese stock market as well as the Hong Kong and the French markets, the tick size is a decimal and a function of stock prices. On the Tokyo Stock Exchange, for example, the tick size is ¥10 Japanese Yen for stock priced above ¥1200.00 Yen and above, and ¥1.00 Yen for stocks that priced under ¥1200.00 Yen. On the new Euronext market, the tick size schedule on the Paris Bourse is 0.01 Euro for stocks whose prices are below 50 Euro, 0.05 euro if prices are

¹ Through out the paper, a penny or a cent refers to a penny or a cent in the Chinese local currency Ren Min Bi (RMB). The exchange rate between the US dollar and the Ren Min Bi is $\$1 = ¥8.27$.

² The reduction of tick size in the US equity market began in 1992, when the American Stock Exchange (AMEX) reduces its tick size from $\$1/8$ to $\$1/16$ for all stocks priced below \$5.00, and subsequently for all stocks below \$10 in February 1995. On May 7, 1997, AMEX reduced its tick size from $\$1/8$ to $\$1/16$ for all stocks.

between 50 and 100 Euro, 0.10 euro if prices are between 100 and 500 euro, and 0.50 euro if prices are above 500 euro.³

Although the tick size itself varies significantly across markets, the relative tick size, which is the ratio of the tick size to stock prices, is much more comparable across markets than the tick size itself. In the US equity market, the relative tick size reduces to 3 – 5 basis points (bps) after the decimalization, compared to 20 – 30 bps in the \$1/16 tick regime. In Japan and Hong Kong, it is about 30 – 40 bps for most stocks. Angle (1997) shows that the median relative tick size is 25.9 bps across 2500 large blue chip stocks around the world.

Many studies have shown that tick size has influences on the price formation process and the equilibrium prices. However, there is not an answer for an optimal tick size in the existing financial theories. Copeland and Galai (1983) show that a limit order essentially writes a free option to the market. In order to encourage investors to expose their trading interests and provide liquidity, the market has to protect the limit orders. Harris (1994) points out that a nontrivial tick size is important to enforce the time priority in a limit order book and protect the limit orders. Cordella and Foucault (1998) show that a zero minimum price variation never minimizes the expected trading cost, and the optimal tick size increases with the level of the monitoring cost borne by the dealers. Bessembinder (2001) show that the tick size can affect equilibrium bid-ask spreads in a dealer market, even when the equilibrium spread is larger than the tick size.

However, when the tick size is too large, it usually leads to an uncompetitive spread as shown by many studies, such as Anshuman and Kalay (1994), Bernhardt and Hugeson (1993), Chordia and Subrahmanyam (1995), Kandel and Marx (1997), among others, show that non-trivial tick size can lead to uncompetitive spreads. In practice, the tick size is often equal to a focal currency unit, such as the decimal. It is still an interesting question about the origin of \$1/8 tick size on the NYSE back to 1817, when the earliest documentation of the tick size was recorded.

³ For the old tick size schedule on the Paris Bourse, please refer to Biais, Hillion and Spatt (1995).

Some empirical studies have shown that a smaller tick size improves market quality and benefits to investors. Ronen and Weaver (1998) find that when the American Stock Exchange (AMEX) switches its tick size from \$1/8 to \$1/16, the market volatility decreases, and the market quality improves. Chan and Hwang (1998) find the same for the Hong Kong market. Bacidore (1997), Porter and Weaver (1997), Mackinnon and Nemiroff (1999), and Ahn, Cao, and Coe (1997) find that the general market quality improves on the Toronto Stock Exchange when it lowers its tick size in 1996. The studies, however, document that the quoted depth reduces after the event. Chung and Chuwonganant (2001) report that the tick size reduction on the NYSE in 1997 has increased the quote revision and price competition. Griffiths, Smith, Turnbull, and White (1998) show that the tick size reduction benefits the trading public on the Toronto Stock Exchange.

On the other hand, however, several studies point out that the market depth decreases and institutional investors incur a higher trading cost after the tick size reduction. Harris (1996, 1997) point out that a smaller tick size might not necessarily improve market liquidity. The paper argues that a relatively large tick size encourages investors to submit limit orders and expose their trading interests, while a small tick makes the front-running cheaper in a market that enforces price and time precedence, thus reducing the displayed liquidity in the book.

If the tick size is too large, for example \$1.00 for a stock priced at \$20, then a round trip transaction will cost at least \$1.00, which is 5% of the stock value. In such a case, investors who submit market or marketable limit orders will pay a higher transaction cost and a premium for demanding immediate liquidity, and investors who submit limit orders and trade patiently earn rents by providing liquidity. Therefore, a large tick size encourages submitting limit order and exposing trading interest.

In contrast, when the tick size is small, it enables more price competition among investors and often leads to a tighter spread in the market. As a result, it is usually cheaper for a round trip transaction for small trades, since a smaller increment would lead to a smaller spread and market

orders submitted by small investors typically trade at the best quoted price. However, front-running a limit order, meaning stepping in front of a limit order, also becomes less costly when the tick size is small, which may increase the front-running risk of limit orders. Using the above example, if the tick size reduces to a penny, the round trip transaction cost of the bid-ask spread is decreased to as little as 1 penny or 0.05% of the stock's value. The cost of front-running a limit order also becomes much less: one only needs to improve the limit price by 1 penny to step ahead an existing limit order and gain price priority. As a result, limit orders bear higher risk in a small tick size environment, and this often results in a thin book with a lack of displayed liquidity.

Indeed, several studies find evidence that is consistent with the above argument. They show that a smaller tick size benefits individual investors and exposes a higher transaction cost on institutions. Goldstein and Kavajecz (1998) find that the reduction of tick size on the NYSE has significantly decreased market depth and made small orders better off while large orders worse off. Lau and McInish (1995) document a similar change of the market depth on the Singapore Stock Exchange after the exchange reduces its tick size. Jones and Lipson (2001) also show that trading cost of large institutional investors actually goes up after the tick size reduced to \$1/16 in the US equity market. Bourghelle and Declerck (2002) find a decrease of quoted depth after the tick size reduction on the Paris Bourse, and suggest that a market should not necessarily decrease its tick size.

This paper aims to assess the tick size's impact on closed-end fund trading in the Chinese equity market, and attempts to question the answer: whether a penny tick size is optimal for trading the closed-end funds in China. The study contributes to the current literature by examining the impact of a sub-optimal tick size on trading in a pure limit order book trading. Tick size matters more in markets that honor the time priority rule, which encourages investors to improve price. Tick size affects the price formation process in these markets since the tick size determines the cost of providing a price improvement or obtaining priority through an established price. Unlike the

NYSE or the Nasdaq, the two stock exchanges in China, Shanghai and Shenzhen, are pure limit order book markets without any designated specialists or market makers. Such markets with strict price and time priorities provide a natural experiment to analyze the impact of tick size on trading.

The closed-end funds on the two Chinese stock exchanges have a tick size of ¥0.01, the same as the common stocks, and the market prices of the funds are only one tenth of that of common stocks. With the differences in market prices between the stocks and the closed-end funds, the relative tick size for the closed-end funds is more than 100 bps, 10 times larger than that of the common stocks. Such a large tick size would significantly affect the trading of the closed-end funds in the Chinese stock market.

We study 48 closed-end funds that are traded on the Shanghai Stock Exchange (SHSE) and the Shenzhen Stock Exchange (SZSE) during January 4 – 11, 2002. We find that the current tick size is significantly binding for the closed-end funds. The bid-ask spread is about the size of one tick, ¥0.01, and rarely changes during a trading day. In addition, few quote revisions occur during a trading day for the funds. In our investigation period, quotes on average only change three times during a 4-hour trading day. If quotes ever change, for 90% of the time, they only change by 1 tick.

Consistent with Harris (1994), we find that the large tick size of the closed-end funds provides incentives for investors to submit limit orders and avoid marketable limit orders. The average quoted depth on either side of the best offer or the best bid is about 27 – 42% of a fund's daily trading volume. If considering the best three offers and bids, the average depth on either side of the book, the best three offers or the best three bids, is about 100% of a fund's total daily trading volume. The evidence indicates that investors submit limit orders early and attempt to gain price priority. In addition, market participants are reluctant to trade by marketable limit orders due to the high transaction cost.

The tick size also affects trading strategy. We find that the relative large tick size drives investors to migrate from the continuous trading to the opening call auction. We document that 5 –

10% of the trading volume for the funds are transacted at the opening auction in our sample period, compared to less than 1% for the common stocks. Since the call is a single price auction and it does not have a bid-ask spread, investors can avoid the spread and trade more cheaply in the opening. The migration for the fund investors to the opening call is consistent with the existing literature. (see Madhavan (1992), Brook and Su (1995), Schnitzlein (1996), and Theissen (2000)).

The large tick size additionally has induced a welfare issue: it provides an incentive for market making activities in the market and imposes a higher trading cost for small investors. Our evidence indicates that large orders tend to enter into the limit order book in the early morning and act as “voluntary market makers.” On average, one out of every five orders enters into the book before 9:30AM in a trading day, and one out of every three orders enters into the book before the first 10 minutes in the morning trading session. We also find that the fund order fill rate (open rate) is much lower (higher) than that of stocks.

Furthermore, we show that the penny tick size has distorted the normal trading pattern of the closed-end funds. McNish and Wood (1992), Lee, Muckow, and Read (1993), Chan, Christie, and Schultz (1995), Chung, Van Ness, and Van Ness (1999), among others, find that the intraday pattern for the volume and bid-ask spread follow a “U” shaped pattern for the NYSE and Nasdaq stocks. Unlike the most securities, the intraday volume distribution of the funds does not have a “smile” pattern. Instead, the intraday volume pattern for the funds is almost monotonically decreasing. In addition, there is no any price discovery associated with the funds. The intraday distribution for the bid-ask spread is usually decreasing for most securities under normal trading conditions, but it is flat and remains unchanged for the funds. This is not surprising since the penny tick size is binding.

Finally, we study policy implications, and propose to cut the tick size for the closed-end funds to RMB¥ 0.1 cent to improve the market liquidity for the closed-end fund trading in the Chinese stock market.

2. Institutional Details for Closed-end Fund Trading in China

Closed-end mutual funds are not new financial instruments in the Chinese stock market. In 1991, the first investment fund, “Nanshan Venture Investment Fund,” was founded in Shenzhen China. During the following years, there have been a dozens of such closed-end funds in China and they are traded on the two stock exchanges of China. Many of these closed-end funds have a wider range of investment, such as real estate, stock, bonds, and other ventures, compared to the newly founded mutual funds.

The 48 closed-end funds in our sample are the new type mutual funds in China, which do not exist until November 1997. Comparing to the old mutual funds mentioned above, these new funds are more closely regulated and have specific investment targets. According to the regulations of the China Securities Regulatory Commission (CSRC), these closed-end mutual funds are only allowed to invest in the publicly traded equities and treasury securities. This is the reason that these new funds are also called the Securities Investment Funds. In addition, the new Securities Investment Funds are required to publish their Net Asset Value (NAV) every week and their portfolio holdings every quarter.⁴ These rules do not apply for the old funds.⁵ Like the old funds, these new funds are traded on stock exchanges as the closed-ends.

The Chinese government encourages the development of mutual fund industry. The policy makers hope that the mutual funds can meet the rapidly growing investment demand of individual and institutional investors in China, and the growth of the fund industry helps to develop professional asset management service. Traditionally, the Chinese stock market has been dominated by small individual investors who behave more like day traders. Like many emerging

⁴ For the details of the CSRC regulation about the closed-end funds, please refer to the CSRC regulation “The Interim Regulation on Securities Investment Funds,” November 14, 1997.

⁵ After November 1997, the Chinese government has forced the conversion of the old funds into the new type mutual funds.

markets, the Chinese stock market has a high volatility and a heavy inside information trading, in which many individual investors become victims (see Su and Fleisher (1998, 1999) and Su (2000)). Introducing the new securities investment funds in the Chinese stock market, according to the CSRC, aims to protect small investors, develop institutional investors, and improve market efficiency.

Since November 1998, there have been 20 mutual fund companies in China, and they manage around 50 closed-end funds, which are listed and traded on the two Chinese stock exchanges: Shanghai and Shenzhen. The initial public offer price for one unit of a fund share is set to be ¥1.00 (\$1 = ¥8.27). The stock exchanges employ the lottery mechanism to allocate fund shares if over bidding ever happens. The out-of-pocket cost for investors to purchase a unit fund share after they win the lottery in the initial offering market is ¥1.01, which is the sum of the face value of a unit fund share and a transaction cost, equal to ¥0.01, charged by the fund companies and the stock exchanges.

The trading of the closed-end funds is similar to the trading of stocks in the Chinese stock markets. The trading mechanism of the Shanghai and Shenzhen stock exchanges are basically the same, and we use the Shanghai Stock Exchange to explain the trading procedures of the funds and stocks.⁶ There are three trading sessions at the Shanghai Stock Exchange. The opening call auction starts at 9:15AM and ends at 9:30AM. During the 10 minutes between 9:15AM to 9:25AM, investors can place limit orders and participate in the opening auction. At 9:25AM, the market is cleared at a single price that maximizes the transaction volume. Orders that are not executed in the opening auction are automatically transferred to the continuous trading. The continuous trading in the morning session starts at 9:30AM and ends at 11:30AM, and the afternoon trading session is from 13:00PM to 3:00PM.

⁶ The trading mechanism of the Shenzhen Stock Exchange is very similar to that of the Shanghai Stock Exchange. For details, see the 2001 Fact Book, Shanghai Stock Exchange, 2002, and the 2001 Fact Book, the

The current continuous trading at the Shanghai Stock Exchange is a pure limit order book with the price and the time as the first and second priorities. Investors can only place simple and good-to-day limit orders. Besides the buy and sell limit orders, no other sophisticated order types, such as trading-at-open, trading-at-close, stop orders, buy-at-minus, sell-at-plus, etc, are supported by the trading system. The tick size for both A share stocks and the closed-end funds are ¥0.01, a penny in the local currency (\$1 = ¥8.27).⁷ During our sample period, January 2002, there are total 1165 A share common stocks and 48 closed-end funds that are listed on the Shanghai and Shenzhen stock exchanges.

The transaction cost schedules are different for funds and A share common stocks in the Chinese stock market. There are two parts in the so-called transaction cost in China: stamp tax and commission and fees.⁸ The State Department regulates the stamp tax rate, and the CSRC makes policies governing the commission and the fee structure. Under the current stamp tax rate, investors pay 0.2% of the total transaction value when they buy or sell A share stocks. The stamp tax is waived for trading closed-end funds. According the most recent CSRC rules on brokerage commission and fees, investors pay a negotiable commission and a fixed securities registration fee when they trade A share common stocks and closed-end funds.⁹

The commission charged by the brokerage houses should not exceed 0.3% of the total transacted value with a minimum of ¥5.00, and the securities registration fee is 0.1% of the total transacted value. With the flexible commission schedule, each brokerage house can set up its own

Shenzhen Stock Exchange, 2002.

⁷ Traditionally, some listed companies issue two groups of shares to investors. Stocks that are issued and are available for local investors is called A share stocks, and stocks that are only available to oversea investors are B share stocks. B shares stocks are traded and settled in the Shanghai Stock Exchange by US dollars and in the Shenzhen Stock Exchange by the Hong Kong dollars. Beginning early 2000, the CSRC issued new regulation and allowed local investors to trade B shares. For more information, please refer to Bergstrom and Tang (2001).

⁸ Note that we use the term “Transaction Cost” to refer the explicitly defined trading cost, which is only a part of the total transaction cost that investors incur in the real economic sense.

⁹ See “Interim Regulation of Trading Commission,” the CSRC, May 4, 2002.

rate. The average commission charged by many brokerage firms is around 0.15%. As a result, a roundtrip transaction cost for the closed-end funds is about $2 \times (0.1\% + 0.15\%) = 0.5\%$ of the total transaction value. However, large institutions usually negotiate their commission charges, and can bring their marginal commission cost down to zero. In such a case, their transaction cost only includes the securities registration fee, which is as low as 0.2% of the total transacted value per roundtrip.

Given the above information, one can easily see a potential profit opportunity in making a market for the closed-end funds in the Chinese stock market. Since most of the funds are priced below ¥1.00, a penny is over 1% of the fund value. The approximate net income of market making is equal to the difference between the gross income and the transaction cost. The gross income for making a market for the funds is approximately equal to the relative bid-ask spread, which is the ratio of the tick size to the fund value, which is about 100 bps. The transaction cost is 50 bps explained previously. Therefore, the profit is $(100 \text{ bps} - 50 \text{ bps}) = 50 \text{ bps}$. In particular, the fund prices are very stable and the price movements are narrow in a trading day, which provides an additionally low risk environment for the market making business. The total daily dollar volume for closed-end funds is about ¥600 million in the two stock markets. If using the 50 bps profit margin as an example, the daily profit of market making can be as high as ¥3 million, which is equivalent to ¥750 million in a yearly basis. It is not surprising that a high profit margin and a low risk induce market participants to act as voluntary market makers.

3. Methodology and Data

3.1. Methodology

We study the market quality for the closed-end fund trading in four aspects: bid-ask spread and quote revision, limit order depth, volume concentration, and order fill rate. To facilitate our

analysis, we employ the following quantitative variables to measure the market liquidity and quality:

- 1.) Bid-Ask Spread: the absolute value of the difference between the best offer price and the best bid price
- 2.) Relative Spread: the ratio of the bid-ask spread to the quote midpoint
- 3.) Best Depth: the time-weighted average buy and sell quantities on the best bid and the best offer

$$\text{Best Depth} = \sum_{i=1}^N \text{weight}_i * 0.5 * (\text{BestOfferAmount} + \text{BestBidAmount})$$

- 4.) Total Depth: the time-weighted average buy and sell quantities on the best three bids and offer

$$\text{Total Depth} = \sum_{i=1}^N \text{weight}_i * 0.5 * \left(\sum_{j=1}^3 \text{OfferAmount}_j + \sum_{j=1}^3 \text{BidAmount}_j \right)$$

In the above equations, N is the total number of observations in the order data, i is the index of each order observation, and j is the index of each best bid and offer.

- 5.) Best Depth Ratio: the ratio of the best depth to the total daily trading (share) volume

$$\text{Best Depth Ratio} = \frac{\text{BestDepth}}{\text{TotalDailyShareVolume}}$$

- 6.) Total Depth Ratio: the ratio of the total depth to the total daily trading (share) volume

$$\text{Total Depth Ratio} = \frac{\text{TotalDepth}}{\text{TotalDailyShareVolume}}$$

- 7.) Quote Duration: the percentage of time that a quote lasts during a trading day

$$\text{Quote Duration} = \frac{\text{QuoteEndTime} - \text{QuoteBeginTime}}{\text{TotalDailyTradingTime}}$$

- 8.) Order Fill Rate: the ratio of the number of orders filled to the total number of orders placed
- 9.) Order Cancel Rate: the ratio of the number of orders cancelled to the total number of orders placed
- 10.) Order Open Rate: the ratio of the number of orders unfilled to the total number of orders

placed

11.) Order Density Ratio: the ratio of the number of orders in an interval to the total number of orders placed

3.2. Data and Sample Selection

Our trade data and order data is directly from the Shanghai Stock Exchange. It includes one-week truncated trade and order data of all listed securities on the Shanghai Stock Exchange and the Shenzhen Stock Exchange. The order data, which are the five-second snapshots of the limit order book, include the best three bids, the best three offers, and the associated quantities on each bid and offer. The trade data, corresponding to the order data, records the trading volume in terms of both share and dollar between each time interval between the snapshots.

Beside the above data, we also have the detailed order trail data for all listed securities on the Shanghai Stock Exchange for 13 days in 2001.¹⁰ In the order trail data, we have the following information for each order entered into the limit order book: the order routing number, order enter time, buy or sell indicator, buy or sell volume, fill indicator, fill quantity, cancel status, and cancel quantity.

We select all the close-end funds that are traded on the Shanghai and the Shenzhen stock exchanges during January 4 – 11, 2002.¹¹ Our sample includes 48 close-end funds. **Table 1** presents the summary statistics of these 48 funds.

We divide our entire fund sample into three sub fund portfolios, large, medium, and small, based on the size of a fund's total outstanding share units. The large group includes 22 funds and each of the funds has at least 300 million outstanding share units; the medium group includes 3 funds whose fund share units are between 100 million and 300 million each; and the small group

¹⁰ This is the only order trail data that is available for the academic research. These 13 days in 2001 are April 23, June 14, June 29, July 27, July 30, July 31, October 22, October 23, October 24, October 25, November 15, December 3, and December 11.

¹¹ When we started our research and required the data from the Shanghai Stock Exchange, the data we

has 23 funds whose outstanding share units are under 100 million each. We also form 10 stock portfolios as benchmarks. We divide our 1165 sample stocks into ten deciles based on their outstanding market capitalization. Stocks in Decile#1 have the largest market capitalization, and stocks in Decile#10 have the least market capitalization. **Table 2** presents the summary statistics of the 3 fund portfolios and the 10 stock portfolios.

The average market price for the closed-end funds is below ¥1.00. This is robust across three fund groups, ¥0.97 for the large and medium funds and ¥0.99 for the small funds. The average market price for stocks, around ¥ 10.00 to ¥12.00 per share, is 10 – 12 times higher than funds. The fund turnover rate is higher than that of stocks. The small funds have the highest average turnover rate, which is 1.15% compared to 0.37% of the most liquid stocks. The daily return statistics show that the market is in a downturn during our sample period. The average daily returns for stocks and funds are about –1.0% during our sample period.

4. Empirical Findings

Our analysis of the closed-end fund trading and the empirical findings cover 4 categories: spread and quote, depth, volume, and order.

First, we look at the daily bid-ask spread for the closed-end funds and compare them to the stocks. The bid-ask spread and its intraday distribution can explain how the tick size affects the price competition and formation process. In this context, we study the time-weighted daily average bid-ask spread and the intraday distribution of the bid-ask spread. We also study the frequency of quote revision and quote time duration for the closed-end funds.

Second, we examine the limit order book depth of the closed-end funds. Through studying the liquidity in the limit order book, we aim to discover how the tick size influences the provision of the

are given is the trade and order data covering January 4 – 11, 2002.

market liquidity and the evolution of the limit order book. We employ the share depth and the relative depth as well as their intraday distributions to examine the issue.

Third, we investigate the intraday volume distribution for the closed-end funds, and its concentration on different transaction prices. The volume distribution reveals the market liquidity and the order interaction in the book. It also indicates the trading strategies employed by the investors under various market environments. We compute the percentage of trading volume on each of the possible prices and the percentage of trading volume in each of the trading intervals to capture the intraday volume variation.

Last, we examine the order submission and cancellation for the closed-end funds. The tick size directly influences the order placement strategy, which in turn affects the market depth, volume distribution, and market liquidity. We look at three ratios for submitted orders: the order fill rate, the order cancel rate, and the order open rate, and use them to examine the limit orders placement strategies.

4.1. Spread and Quote

If a tick size is relatively large compared to the underlying security price, it will be binding in the sense that the bid-ask spread is often equal to the tick size. This implies that the quote prices could not go lower due to the tick size constrain. Is ¥0.01 a binding tick size for the closed-end funds? We examine the time-weighted bid-ask spread and the relative bid-ask spread for each individual fund in our sample, and summarize the results by fund groups. **Table 3** reports the results.

Indeed, consistent with our conjecture, we find that ¥0.01 is a binding tick size for the closed-end funds, but not for stocks. For the 46 out of the total 48 funds, the time-weighted average spreads are almost equal to a penny, the tick size. Only two funds, Fund 184699 and Fund 184708, have a slightly higher average spread. While on the other hand, the bid-ask spreads for stocks are often 3 – 8 times of the tick size. Due to the low market price of the funds, the penny tick size

makes the relative spread much higher for the closed-end funds. The largest relative spread among our sample funds is almost 1.6%, which is huge if compared to the international standards of 20 bps. The huge relative spread not only indicates that the penny tick size is binding but also signals that a less liquid market exists for the closed-end fund investors.

The intraday distribution of the bid-ask spread, reported in **Table 4**, strengthens our findings. In Table 4, we divide the 4-hour continuous trading session into 24 trading intervals with 10 minutes in each interval. The 1st interval starts from 9:30AM and ends at 9:40AM; the 12th interval, the last interval in the morning trading session, is from 11:20AM to 11:30AM; the afternoon trading session opens with the 13th interval, which is from 13:00PM to 13:10PM; the 24th interval, which is from 14:50PM to 15:00PM, closes the market. In later part of the paper, we follow the same convention of the 24 trading intervals to study the intraday distribution of the depth and the volume.

The market microstructure theory shows that the market in the opening usually has a large bid-ask spread due to the information asymmetry, and the bid-ask spread decreases along the trading day proceeds due to the price discovery and the gradual revealing of private information. Indeed we find such a pattern of the intraday bid-ask spread for each of the 10 stock portfolios. The bid-ask spreads are widest in the market opening and gradually decreasing along the trading day. Using stocks in the decile#1 as example, the average bid-ask spread is 5.5 cents in the first trading interval, and reduces to 2.1 cents when the market closes.

In addition, the theory also indicates that the small cap stocks usually have wider spreads because of a higher degree of information asymmetry. Our finding of the small cap stocks confirms the theory. On average the bid-ask spread for the smaller stocks, which are in the lower deciles in our stock sample, have larger spreads than larger stocks. For example, the stocks in the decile#10 have an average 15.9-cent spread in the opening interval and 6.7-cent spread in the market close, both about 3 times larger than the spreads of the deciles#1 stocks.

When we look at the funds, such an intraday pattern of the bid-ask spread does not exist. The median bid-ask spread for the funds is always one tick and unchanging during the entire trading session; the mean spread is also about one tick and remains almost the same across the 24 trading intervals with a tiny difference of less than 0.01 penny across time. The flat pattern of the funds' bid-ask spread reinforces our finding showing that the penny tick size is binding and limits the price competition in the fund trading. The intraday bid-ask spread pattern for the stocks and the funds are confirmed in **Figure 1**.

Furthermore, we show that the price movements for the closed-end funds are surprisingly stable. The maximum and the relative price changes for the funds are only 2 – 3 ticks, equivalent to 2 – 3 pennies, during a whole trading day, compared to 30 – 40 ticks for stocks. Besides the flat spread and stable price, the quotes for the closed-end funds also rarely change during a trading day.

In order to summarize the intraday quote movement, we study the time duration of each quote position. We denote the position of the opening best bid and offer as “0.”¹² If the best bid and offer are one tick above the opening position, we denote the position of the new bid and offer on the “+1” grid; if the best bid and offer are one tick below the opening position, we denote it on the “-1” grid. Grids “+2” and “-2” follow the same logic. For all other quote positions, such as that the quote spreads are equal to or greater than 2 pennies, we categorize them together and denote them on the other grids. **Table 5** reports our findings of the quote time duration.

The quotes for the closed-end funds only change a few times on an average trading day as shown in Table 5. For 90% of the time in our investigation period, the opening quotes only move down one tick in the entire trading day. This is not surprising given that a bear market happened in our investigation period. Using the large fund group as an example, the opening quote accounts for 61% of the entire trading time, and for another 33% of the time, the quote is just one tick below. Therefore, we can see that these two quote positions account for 94% of the total trading time. The quotes for the small fund

¹² In our sample period, the opening spread between the best bid and offer is always one penny. We have

group are slightly more dispersed, but still the opening quote and “-1” quotes account for 80% of the trading time. The evidence shows that the market quotes for the funds are highly inactive, and few price competitions exist.

4.2. Depth

The minimum price increment limits the prices that investors can quote and therefore restricts price competition. This has been confirmed by our findings above of the wide and unchanging bid-ask spread. The bid-ask spread, however, only reveals one dimension of market liquidity, and does not show the quantities that are associated with the spread. In this section, we report our findings of the limit order depth, and study how the penny tick size influences the market depth.

Price and time are the two priority rules in a limit order book. For orders with same prices, the second precedence, the time, ranks and prioritizes the orders. In order to gain time priority, investors have incentives to submit and expose their orders early in a large tick size market, since providing a price improvement is more expensive in such an environment. Harris (1997) shows that a larger tick size encourages investors to expose their limit orders. We employ two depth variables, the Best Depth and the Total Depth, to study how the penny tick size affects the depth in the limit order book. In addition, we compare the two depth variables to the daily trading volume and obtain the Best Depth Ratio and the Total Depth Ratio to conduct a cross-section comparison between the funds and the stocks. **Table 6** reports the results of the depths and the depth ratios for the closed-end funds and the stocks, **Figure 2** shows the intraday pattern graphically.

Consistent with the theory, we find that the book is extremely deep for the closed-end funds during the entire trading day. For the large funds, the average depth on the best bid or offer is about 1.6 million share units, and the average quantity on the best three bids or offers is nearly 10 million units. Relative to the daily total trading volume, the best depth ratio and the total depth ratio are 28% and 75% respectively. The small funds have a much larger depth ratio than the larger funds on

not found any one case that it is larger than one penny. As a result, our “0” position is well identified.

a relative base. The best depth ratio is nearly 40% and the total depth ratio is as high as 150% for the small funds. These numbers are much higher if compared to stocks, whose best depth ratio and total depth ratio are only 1 – 2 % and 3 – 10% respectively.

The evidence indicates that the limit order book is very deep: at any moment during a trading day, a huge amount of orders, often equal to the total daily trading volume, are queued in the book waiting for execution by the incoming marketable limit orders. The deep book makes a liquid market for the closed-end funds in the sense that large institutional investors can trade large blocks without moving the price. However, the liquidity is at a cost for individual and small investors: they pay a larger premium by demanding the liquidity. For the small investors, they have to pay a high premium, more than 1% of the funds' value, to conduct a round-trip transaction. Besides the cost associated to the bid-ask spread, they have other costs to pay. As a result, if immediacy can be compromised, small and individual investors are better off by submitting limit orders. However, given the intense competition among all the limit orders in the book, a limit order may face a high risk: it may not be executed and will incur an additional opportunity cost.

To further examine the issue, we look at the time varying liquidity in the book and study the best depth ratio and the total depth ratio across a trading day. **Table 7** and **Table 8** report our findings. The evidence reported in Table 7 shows that the best depth and the total depth do vary across time, but the variation is small. For the large and medium funds, the best depth often maintains around 1.6 million share units, and the total depth around 5 million. The best depth and the total depth are little lower for the smaller funds, about 1.1 million share units and 4 million.

More interestingly, the funds' intraday depths have a flat pattern. The large funds have only a 16% variation in the best depth ratio since the ratio ranges from 24% to 28%. The picture is similar for the other funds. In contrast, for each of the all of the 10 stock portfolios, the best depth is increasing along the time, and the deepest book occurs toward the market close. For instance, the best depth ratio for the small cap stocks increases from 1.34% to 4.24% during a trading day, more

than a 300% changes. Even the variations are smaller for other stocks, still the magnitude of the changes are much larger if compared to the funds.

The flat intraday pattern of the fund depth implies that most liquidity enters into the book before the market opening, and the continuous trading has not attracted as much liquidity as it should. The evidence also suggests that the relatively large tick size for the funds makes investors submit orders early to gain time priority, causing a massive amount of orders accumulated in the book. In some sense, the huge liquidity in the book for the funds is almost redundant. For example, the accumulated liquidity on the best three bids or offers is about 150% of a fund daily volume. The redundancy of liquidity creates a paradox: on one hand, a huge amount of limit orders are queued in the book waiting for execution; on the other hand, due to lack of the price competition, it is expensive for investors to consume the liquidity. They prefer submitting limit orders to compromise their demand of immediacy and reduce their trading cost. This preference makes the market liquidity worse.

4.3. Volume

The relatively large spread and few quote revisions also cause a concentration of trading for the funds on prices. For every fund transaction, we benchmark the transaction price to the opening bid price. A “0” price grid transaction refers that the trade price is the same as the opening bid. Similarly, “+1” and “-1” price grid transactions indicate that the prices are one tick above or one tick below the opening bid. Facilitated by this classification, we compute the percentage weight of trade volume on each of the price grids, and report the results in **Table 9**.

Panel A in Table 9 shows that on average 65% of the daily volume concentrates on the “0” price grid. Panel B 9 further demonstrates 90 - 95% of the funds’ trading is concentrated between “+1” and “-1” price grids, which implies that the transaction price ranges are within one tick of the opening bid. The high volume concentration on prices suggests that the trading has a limited price competition, a less degree of price continuity, and a high transaction cost.

In order to minimize the transaction cost, one would expect that investors trade in the opening auction and take advantage of the single price auction, in which bid-ask spread does not exist. If this were the case, we would find that investors migrate from the continuous trading to the opening auction. We examine the intraday volume distribution of the closed-end funds, and the results are presented in **Table 10**.

Indeed, we find evidence showing that investors have learned the transaction cost, and migrate to the opening call. The opening call auction starts from 9:15AM and ends at 9:25AM on the Shanghai and Shenzhen stock exchanges. Since the opening call session also lasts 10 minutes, we denote it as the trading interval “0” in Table 10, making the total number of the trading intervals equal to 25. We compute the relative volume in each trading interval for the funds and compare it to stocks. In Table 10, about 10% of the daily trading volume is done in the opening auction for the large funds, and 4 - 5% for the small funds. The relative volume of the funds in the opening is huge if compared to the stocks, for which only less than 1% of the volume is transacted at the opening.

In addition, like the depth ratio, the intraday volume distribution pattern is significantly different between the funds and the stocks. For the closed-end funds, the volume weights are decreasing along the trading day with heavier volumes happening in the early morning, making the intraday volume gradually decreasing along time. While for stocks, it is just the opposite: the volume in the last trading session right before the market close is several times larger than the volume in the early morning session. With the light trading volume around noon, the intraday volume pattern for the stocks is a typical “U” shaped curve or a “smile” pattern. For instance, the large stocks have less than 1% of the daily volume done in the opening, and only 3% volume in the trading interval #1. The volume weight goes up to over 10% in the last trading interval right before the market close. The volume distribution is even more skewed toward the market close for small stocks. The volume distributions for the funds and the stocks are shown graphically in **Figure 3**.

The different volume distributions between the funds and the stocks are consistent with the

tick size theory and the information asymmetry hypothesis (see Kyle (1985) and Admati and Pfleiderer (1988)). Since the closed-end funds are portfolios of equities and bonds, they have a lower degree of information asymmetry and volatility. In addition, since the spreads are constant and unchanging during a trading day due to the relatively large and binding tick size, fund investors do not gain by trading at market closes. However, it is different for stocks. Stocks have a relatively higher degree of information asymmetry. The price discovery drives the spread narrower and tighter, and the book is deeper and thicker toward the market close, which are exactly the facts that we have found in Table 4 and Table 8. Thus, trading at close can reduce the transaction cost for investors. Therefore, we have observed different volume patterns for the funds and the stocks.

4.4. Order

Based on the current institutional design, the penny tick size for the closed-end funds can generate a positive profit for a market-making style trading: constantly buying and selling the closed-end funds as a market maker do. As shown in Section 2, the profit margin can be as high as 50 bps. Using the average commission schedule, here is how the 50 bps comes from: the total cost for a round trip trade is 0.50% (50 bps) of the total transaction value, including 0.20% as the securities registration fee and 0.30% as the commissions charged by brokers. The relative spread, also can be interpreted as the gross profit, for the closed-end funds is over 1% (100 bps), which implies that the net profit margin as a “market maker” can be as high as 50 bps. The profit margin can be even higher for institutional investors, since they can negotiate an even lower commission.

The positive profit provides incentives for investors to behave like voluntary market makers, buying and selling these funds constantly to take advantage of the artificially wide spread. Furthermore, the infrequent quote updates and stable prices lower the risk of such a voluntary market making trading, which further encourages some investors, especially some institutional investors, to act as “market makers of the day” and capture the profit.

We study the potential market making trading by investigating the order fill rate and the order

placement strategy. **Table 11** and **Table 12** report the detailed order flow information for 650 stocks and 22 funds that are listed on the Shanghai Stock Exchange. Our order trail data provides additional information of order entering time, fill status, and order size beyond the snapshot limit order book data used in the previous section. Our investigation period is 13 trading days in 2001.¹³

Table 11 indicates that the closed-end funds have much higher (lower) order open (fill) rates than the stocks. Specifically, 35% - 45% of all placed limit orders are remained open for the funds in a trading day, compared to the 20% open rate for the stocks. Furthermore, the funds have a lower order fill rate than the stocks: 60% of the limit orders for the stocks that are placed during a trading day are filled, while only 40% of the fund limit orders are filled.

The market microstructure theory suggests that a higher volatility and more frequent price changes are usually associated with a higher limit order cancellation rate and a lower fill rate. Given the low volatility and few price changes for the closed-end funds, we would expect that the closed-end funds have a lower cancellation rate and a higher fill rate. However, the empirical evidence reported in Table 11 shows a surprising picture: the fund cancellation (fill) rate is not lower (higher) than the stocks.

This evidence can be explained by the relatively large tick size and the potential profit in market making. The large tick size limits the prices that investors can quote and therefore restricts price competition among investors. Due to the lack of price competition between limit orders for the closed-end funds, investors have to gain time priority by placing their orders early enough into the book, which causes an unusually thick book as shown in our previous sections. Additionally, trading by the marketable limit orders will incur a higher transaction cost due to the large spreads. This would make some investors migrate to limit order trading, causing a strong competition between the limit orders in the book and a less liquid market. All the above will induce a lower fill

¹³ The 13 - day audit trail order data is given to us by the Shanghai Stock Exchange. We have been told that these 13 days are the only audit trail data that are available for academic research.

rate and a higher cancellation rate.

Given the positive profit opportunity, who would be more encouraged to trade as market makers, small investors or large institutional investors? Table 12 presents evidence to show that large institutional investors have more incentives to act as voluntary market makers in fund trading. This is not surprising since large institutions can negotiate their costs of trading and obtain a more favorable commission schedule. In Table 12, we see that larger orders tend to enter into the book earlier to gain time priority. Nearly one fifth of the orders entered into the book in the opening during 9:15AM to 9:25AM. If considering the first 10 minutes of the morning trading, one out of every three shares that have entered into the limit order book is placed before 9:40AM. The ratio is particularly high if compared to stocks, which is only about 15%.

More strikingly, these “early” orders usually have larger sizes than average daily orders. The average size for the “early” orders that are placed before the opening is 78,000 shares for the large funds, much larger than and nearly doubled the 40,000 shares, the average size for orders placed in the continuous trading. This size pattern is robust across all three fund groups. **Figure 4** shows that the order size is much large in the early morning for the fund groups. In addition, more large orders are placed in the opening session for the funds, while for stocks, both the opening and the closing sessions attract larger orders. Besides the order size pattern, the daily order placing frequency, defined as the order density ratio here, also shows a different pattern for the funds than the stocks.

The intraday order density ratio also shows a “U” shape or a “smile” pattern for the stocks: the ratio is larger at the two ends and lower in the middle of the trading day. This pattern is robust for all 10 stock portfolios. The “smile” pattern makes good economic sense since trading is more concentrated at these time periods. However, the “smile” pattern does not exist for the funds, whose order density ratios are almost monotonically decreasing along a trading day. For example, the last interval right before the market close only captures 2 – 3% of daily orders, well below the 20% in the opening as well as the 5% level for stocks. The evidence again suggests that the large

tick size has distorted the normal trading pattern of the closed-end funds.

5. Summary and Policy Implication

This paper is about the optimal tick size and its impact on trading. We examine the trading of the closed-end funds in the Chinese stock market. The tick size for the closed-end funds is a penny of the local currency. With the low price of these funds, a penny tick size is over 1% of the funds' value. Compared to the international standards, the penny tick size has created a huge relative tick size, which makes it a sub-optimal choice of a tick size.

Choosing an optimal tick size is one of the important issues of designing an efficient, a liquid, and a fair market. A proper tick size should improve market liquidity, encourage price competition, and protect the social welfare for small investors; a proper tick size must also be simple and straightforward. The closed-end fund trading in the Chinese stock market has provided a natural experiment to study how a tick size affects trading and investors' behavior. Our paper is of interest to both academics and regulators. Our findings are consistent with the existing market microstructure theories. The findings in our paper can be viewed as indications showing that how the market responds to a sub-optimal tick size. Furthermore, our study has implications for designing a more efficient and liquid market.

Is the penny tick size optimal for trading closed-end funds in the Chinese stock market? The answer is "NO." First, a penny tick size limits the price competition among investors and it prevents a normal price discovery process. Our evidence shows that the penny tick size has caused an artificially wide bid-ask spread for the funds. Due to the binding tick size, quote prices rarely change during a trading day. Toward the close of the market, the bid-ask spread is much lower and tighter for the stocks, a natural result for a price discovery. However, such a decreasing bid-ask spread does not exist for the funds due to the tick size constrain.

Second, a penny tick size distorts the normal trading pattern of the funds. We have found that the limit order book depth is extremely deep and rarely change for the funds. Most of the time, the deep

book is nearly redundant in the sense that the accumulated depth in the book is even more than the funds' daily trading volume. Given few quote updates and relatively constant book depth, the limit order book is inactive during a trading day for the funds.

Furthermore, unlike the stocks in the Chinese stock market, the funds do not have a trading concentration before the market closing. As a result, the "U" shaped curve or the so-called "smile" pattern does not exist for the funds' intraday trading. The trading volume concentration is a result of price discovery. It facilitates large volume transaction and improves market liquidity. Without the concentration of trading, investors lack an opportunity of a liquid market.

Third, the penny tick size has weakened the function continuous trading and its ability to attract liquidity. Our evidence shows that fund investors migrate to the opening call auction to reduce its trading costs. In addition, for the funds, a significant part of the limit orders, 33%, entered into the book before 9:40AM, and more large orders enter into the book in the opening. The evidence indicates that the continuous trading does not attract as much as liquidity as the opening.

Fourth, the penny tick size increases the transaction cost of small investors and provides incentives for some large institutions to act as "market maker of the day." Under the current trading cost schedule, large institutions have advantages over small investors of obtaining a low commission schedule. We estimate that the profit margin for trading the funds is about 50 bps. Furthermore, the thick book and stable price for the funds further facilitates institutional trading and provide incentives for market making behavior. Our evidence confirms with our expectation and show that large orders tend to enter the book early to gain price priority.

One of the original goals for the Chinese government to introduce the Securities Investment Funds is to provide small investors an opportunity for professional money management and improve their social welfare. Guided by this goal, the fund companies are required to pay out 90% of their profits as cash dividends to all shareholders. Also guided by the goal, the fund companies have been given

priorities and favored policies in obtaining profitable IPOs in the primary market.¹⁴ This goal has also to be considered in designing a financial market. The current penny tick size favors the large institutions and hurts the social welfare for small investors. The thick limit order book has provided benefits for large institutions to trade blocks. However, this benefit is at a cost: small investors have to pay a huge premium for demanding the liquidity in the book and incur a higher transaction cost. In addition, large institutions can also take advantage of the large tick size and exploit profits in market making behavior, further hurting the social welfare of small investors.

Can the market adjust the relative tick size by itself in the Chinese stock market? In the US capital market, firms can keep their relative tick size constant by splitting their shares. For example, Angle (1997) show that the average price of \$40 in the US stock market is related to the \$1/8 tick size. In addition, the author predicts that the average stock price will go down to \$10 with the decimal pricing. Splitting does not work for the closed-end funds in China. Based on the current CSRC regulations, the closed-end funds have to pay out at least 90% of its net profits. The policy prevents profit accumulating and keeps the funds' market prices more constant around its face value. As a result, the funds cannot adjust its prices by utilizing the option of cash dividend or splitting to change its relative tick size.

What is a good and practical tick size for the closed-end funds in the Chinese Stock Market? Our paper has suggested that the current tick size, a penny, is too big and the optimal relative tick size should be smaller. The new tick size must be simple and it can down the relative tick size to the international standards. There are more than one ways to accomplish this goal: either increase the fund face or decrease the tick size. For example, in order to increase a fund face value to ¥10.00, the fund company can have a 1-to-10 reverse split of its fund, meaning that the company can convert 10 fund units into 1 unit to increase the face value of the fund. If the fund value is about ¥10.00, then the relative tick size under the penny trading is about 10 bps, much smaller than the previous level. Besides the reverse split, other way to adjust the relative tick size is to reduce the tick size, such as a half of a penny or a third of a penny.

¹⁴ For details, please see the recent CSRC regulations about the Securities Investment Funds.

We propose using a tenth of a penny, also called “LEA” in the local language! We have three reasons for this. First, a tenth of a penny can bring the relative tick size to an acceptable level. With ¥1.00 face value, a tenth of a penny will reduce the relative tick size to 10 bps, much smaller than the previous level, 100 bps. Second, a tenth of a penny or a “LEA” is simple and practical. A tenth of a penny still maintains the decimal pricing. It is also familiar to Chinese investors. Due to the low price quoted by the US dollars, the B share stocks on the Shanghai Stock Exchange have been quoted and traded under sub penny, “LEA”. Third, the tenth of a penny is easy to implement than the reverse split. The reverse split will change the number of fund shares owned by each investors as well as the per share dividend number. This requires extremely carefulness and intensive explanation when the change happens. However, using “LEA” to quote the closed-end funds will not involve changing mentioned above. The only change is about the trading system.

However, there is one drawback when quoting and trading under the “LEA.” It is the round up. When calculating the final transaction cost, the final number will be a fraction of a penny, the smallest currency unit. As a result, the clearing and settlement needs currency round ups. The round-up needs additional work and further explanation, however, it can be handled effectively. The B shares trading on the Shanghai Stock Exchange has run into similar situations when the final payment value is a fraction of a penny. The accepted convention is using the mathematical round-up rules.

Several studies, such as Bourghelle and Declerck (2002), have found evidence that a small tick size will reduce the depth and thus hurt the market quality. This concern is consistent with peoples’ intuition about liquidity spread-out. However, it is not a concern for the closed-fund trading in the Chinese stock market, since we have found out that the depth on the limit order book is huge if compared to the total daily volume. With the small tick size, the depth at each price point will decrease a little if compared to the penny trading level. However, the accumulated depth for each of the 10 “LEA” price levels will be comparable to the pre-reduction level. Nevertheless, this is an interesting empirical issue, and is worth of future study and investigation.

Reference

- Admati, A., and P. Pfleiderer, 1988, "A Theory of Intraday Patterns: Volume and Price Variability," *the Review of Financial Studies* 1, Spring, 3-40.
- Ahn, Hee-Joon, Charles Q. Cao and Hyuk Choe, 1998, "Decimalization And Competition Among Stock Markets: Evidence From The Toronto Stock Exchange Cross-Listed Securities," *the Journal of Financial Markets*, v1 (1, Apr), 51-87.
- Anshuman, V. Ravi and Avner Kalay, 1998, "Marketing Making With Discrete Prices," *the Review of Financial Studies*, v11 (1, Spring), 81-109.
- Bacidore, Jeffrey M, 1997, "The Impact Of Decimilization On Market Quality: An Empirical Investigation Of The Toronto Stock Exchange," *the Journal of Financial Intermediation*, v6 (2, Apr), 92-120.
- Bernhardt, Dan and Eric Hughson, 1996, "Discrete Pricing And The Design Of Dealership Markets," *the Journal of Economic Theory*, v71 (1, Oct), 148-182.
- Bergstrom, Clas and Ellen Tang, 2001, "Price Differentials Between Different Classes Of Stocks: An Empirical Study On Chinese Stock Markets," *the Journal of Multinational Financial Management*, v11 (4-5, Dec), 407-426.
- Bessembinder, H., 2001, "Endogenous Changes in the Minimum Tick: An Analysis of Nasdaq Securities Trading near ten Dollars," working paper, the University of Utah.
- Biais, Bruno, Pierre Hillion, and Chester Spatt, 1995, An Empirical Analysis of the Limit Order Book and the Order Flow in the Paris Bourse, *the Journal of Finance*, Vol. 50, No. 5. (Dec., 1995), pp. 1655-1689.
- Bourghelle, David, and Fany Declerck, 2002, Why Markets Should Not Necessarily Reduce Tick Size, working paper, Universite de Toulouse and University de Lille 1 – General
- Brooks, Raymond M. and Tie Su, 1997, "A Simple Cost Reduction Strategy For Small Liquidity Traders: Trade At The Opening," *the Journal of Financial and Quantitative Analysis*, , v32 (4, Dec), 525-540.
- Chan, K.C., Chuan – Yang Hwang, 1998, "The Impact of Tick Size on Market Quality: An Empirical Investigation of the Stock Exchange of Hong Kong," Working paper, Hong Kong University of Science & Technology
- Chan, K. C., William G. Christie and Paul H. Schultz, 1995, "Market Structure And The Intraday Pattern Of Bid-Ask Spreads For NASDAQ Securities," *the Journal of Business*, v68(1), 35-60.
- Charoenwong, Charlie and Kee H. Chung, 2000, "An Empirical Analysis Of Quoted Depths Of NYSE And Amex Stocks," *the Review of Quantitative Finance and Accounting*, v14 (1, Jan), 85-102.

- Chordia, Tarun and Avanidhar Subrahmanyam, 1995, "Market Making, The Tick Size, And Payment-For-Order Flow: Theory And Evidence," *the Journal of Business*, v68 (4), 543-575.
- Copeland, Thomas E. and Dan Galai, 1983, "Information Effects Of The Bid-Ask Spread," *the Journal of Finance*, v38 (5), 1457-1469.
- Cordella, Tito and Thierry Foucault, 1999, "Minimum Price Variations, Time Priority, And Quote Dynamics," *the Journal of Financial Intermediation*, v8(3,Jul), 141-173.
- Chung, Kee H., Bonnie F. Van Ness and Robert A. Van Ness, 1999, "Limit Orders And The Bid-ask Spread," *the Journal of Financial Economics*, v53 (2,Aug), 255-287.
- Goldstein, Michael A. and Kenneth A. Kavajecz, 2000, "Eighths, Sixteenths, And Market Depth: Changes In Tick Size And Liquidity Provision On The NYSE," *the Journal of Financial Economics*, 2000, v56 (1,Apr), 125-149.
- Griffiths, Mark D., Brian F. Smith, D. Alasdair, S. Turnbull and Robert W. White, 1998, "The Role Of Tick Size In Upstairs Trading And Downstairs Trading," *the Journal of Financial Intermediation*, v7(4,Oct), 393-417.
- Harris, L.E., 1994, "Minimum Price Variations, Discrete Bid--Ask Spreads, and Quotation Sizes," *the Review of Financial Studies*, Vol. 7, No. 1, 149-178.
- Harris, Lawrence, 1994, "Minimum Price Variations, Discrete Bid-Ask Spreads, and Quotation Sizes," *the Review of Financial Studies* 7 (1), 149-178.
- Harris, Lawrence, 1996, "Does A Large Minimum Price Variation Encourage Order Display?" Working Paper, University of Southern California.
- Jones, Charles M., and Marc L. Lipson, 2001, "Sixteenths: direct evidence on institutional execution costs," *the Journal of Financial Economics* Volume 59, Issue 2 February 2001 Pages 253-278
- Kandel, Eugene and Leslie M. Marx, 1997, "Nasdaq Market Structure And Spread Patterns," *Journal of Financial Economics*, v45 (1,Jul), 61-89.
- Kyle, A.S., 1985, "Continuous Auctions and Insider Trading," *Econometrica*, v53, 1315-1336.
- Lau, Sie Ting and Thomas H. McInish, 1995, "Reducing Tick Size On The Stock Exchange Of Singapore," *the Pacific-Basin Finance Journal*, v3 (4,Dec), 485-496.
- Lee, Charles M. C., Belinda Mucklow and Mark J. Ready, 1993, "Spreads, Depths, And The Impact Of Earnings Information: An Intraday Analysis," *the Review of Financial Studies*, v6 (2), 345-374.
- Madhavan, Ananth, 1992, "Trading Mechanisms In Securities Markets," *the Journal of Finance*, v47 (2), 607-642.

- MacKinnon, Greg and Howard Nemiroff, 1999, "Liquidity And Tick Size: Does Decimalization Matter?" *the Journal of Financial Research*, v22(3,Fall), 287-299.
- McInish, Thomas H. and Robert A. Wood, 1992, "An Analysis Of Intraday Patterns In Bid/Ask For NYSE Stocks," *the Journal of Finance*, v47(2), 753-764.
- Porter, David C. and Daniel G. Weaver, 1997, "Tick Size And Market Quality," *Financial Management*, v26(4,Winter), 5-26.
- Schnitzlein, Charles R, 1996, "Call And Continuous Trading Mechanisms Under Asymmetric Information: An Experimental Investigation," *the Journal of Finance*, v51(2,Jun), 613-636.
- Su, Dongwei and Belton M. Fleisher, 1998, "Risk, Return And Regulation In Chinese Stock Markets," *the Journal of Economics and Business*, v50 (3,May/Jun), 239-256.
- Su, Dongwei and Belton M. Fleisher, 1999, "Why Does Return Volatility Differ In Chinese Stock Markets?," *the Pacific-Basin Finance Journal*, v7(5,De), 557-586.
- Su, Dongwei, 2000, "Earnings Announcements And Stock Returns In Emerging Chinese Markets," *the Emerging Markets Quarterly*, v4 (2,Summer), 55-61.
- Theissen, Erik, 2000, "Market Structure, Informational Efficiency And Liquidity: An Experimental Comparison Of Auction And Dealer Markets," *the Journal of Financial Markets*, v3(4,Nov), 333-363.

Table 1
Sample Description

The table reports the statistics of the 48 closed-end funds in our sample. Fund Code is a fund's identification number given by the Shanghai or the Shenzhen Stock Exchange. Size is the outstanding share unit of a fund. Price is the average of daily close price in the sample period. Turnover is defined as the ratio of daily share volume to the total share outstanding. The reported Share Volume, Dollar Volume, and Turnover are all daily averages in the sample period. Maximum Price Change is the difference between the intraday highest price and intraday lowest. Our sample investigation period is January 4 – 11, 2002.

#	Code	Name	Size (Million)	Price (RMB)	Share Volume (10,000)	Dollar Volume (RMB10,000)	Turnover (%)	Daily Return (%)
1	184688	Kai Yun	2000	0.960	361.978	346.591	0.181	-1.029
2	184689	Pu Hui	2000	0.930	962.615	880.887	0.481	-1.279
3	184690	Tong Yi	2000	1.175	2646.752	3103.783	1.323	-0.510
4	184691	Jing Hong	2000	0.815	1657.682	1342.016	0.829	-0.982
5	184692	Yu Long	3000	0.884	1924.253	1683.798	0.641	-1.134
6	184693	Pu Feng	3000	0.913	843.058	767.985	0.281	-0.872
7	184695	Jing Bo	1000	0.941	1150.847	1078.153	1.151	-0.636
8	184696	Yu Hua	500	1.003	300.842	300.465	0.602	-0.998
9	184698	Tian Yuan	3000	0.939	2485.270	2307.733	0.828	-1.062
10	184699	Tong Sheng	3000	1.010	3636.217	3654.145	1.212	-0.790
11	184700	Hong Fei	500	1.055	2998.655	3138.683	5.997	-2.233
12	184701	Jing Fu	3000	0.843	2077.990	1740.074	0.693	-0.947
13	184702	Tong Zhi	500	1.087	160.708	174.323	0.321	-0.729
14	184703	Jing Sheng	500	0.941	237.132	221.219	0.474	-1.062
15	184705	Yu Zhe	500	0.945	284.678	268.123	0.569	-0.840
16	184706	Tian Hua	2500	0.877	1942.958	1686.470	0.777	-1.142
17	184708	Xing Ke	500	0.982	243.168	236.013	0.486	-1.217
18	184709	An Jiu	500	0.984	538.653	526.832	1.077	-1.609
19	184710	Long Yuan	500	0.926	202.187	185.820	0.404	-1.293
20	184711	Pu Hua	500	1.000	585.108	580.277	1.170	-1.406
21	184712	Ke Hui	800	0.997	413.920	413.385	0.517	-0.802
22	184713	Ke Xiang	800	0.984	451.427	443.482	0.564	-1.218
23	184718	Xing An	500	0.942	196.810	183.672	0.394	-1.062
24	184728	Hong Yang	2000	0.977	1269.560	1238.647	0.635	-0.410
25	184738	Tong Bao	500	1.003	609.462	606.683	1.219	-1.396
26	500001	Jin tai	2000	0.963	734.218	698.046	0.367	-0.829
27	500002	Tai He	2000	0.909	716.885	646.508	0.358	-0.659
28	500003	An Xin	2000	1.246	3483.412	4351.181	1.742	-0.317
29	500005	Han Sheng	2000	0.914	955.252	868.933	0.478	-0.655
30	500006	Yu Yang	2000	0.939	855.670	785.437	0.428	-1.483
31	500007	Jing Yang	1000	0.992	899.903	894.590	0.900	-0.200
32	500008	Xing Hua	2000	1.052	1443.102	1503.647	0.722	-0.570
33	500009	An Shun	3000	1.109	3451.398	3820.281	1.151	-0.357

(Table 1 Continued)

34	500010	Jin Yuan	500	0.938	230.912	214.497	0.462	-1.062
35	500011	Jin Xing	3000	1.004	3402.618	3396.228	1.134	-0.790
36	500013	An Rui	500	1.130	623.618	701.580	1.247	-0.710
37	500015	Han Xing	3000	0.872	1312.147	1139.733	0.437	-0.690
38	500016	Yu Yuan	1500	0.975	1204.222	1164.711	0.803	-0.821
39	500017	Jing Ye	500	0.971	1214.113	1173.963	2.428	-1.797
40	500018	Xing He	3000	1.012	3883.152	3904.197	1.294	-0.790
41	500019	Pu Run	500	1.029	1009.297	1023.752	2.019	-1.752
42	500021	Jin Ding	500	0.984	350.837	341.789	0.702	-1.219
43	500025	Han Ding	500	1.061	1135.393	1172.357	2.271	-2.794
44	500028	Xing Ye	500	0.923	460.128	424.092	0.920	-1.085
45	500029	Ke Xun	800	0.998	382.945	378.684	0.479	-1.202
46	500035	Han Po	500	0.994	257.812	253.893	0.516	-1.204
47	500038	Tong Qian	2000	0.974	1349.367	1307.456	0.675	-0.821
48	500039	Tong De	500	1.062	829.120	873.729	1.658	-1.130

Table 2
Fund and Stock Portfolio Statistics

We partition our 48 close-end funds into three sub-groups. Group#1 includes 22 funds whose outstanding shares are at least 200 million units. Group#2 has 3 funds whose outstanding shares are between 100 and 200 million shares. The rest 23 funds are in Group#3, and their numbers of the share outstanding are equal or less than 100 million. We then divided our sample stocks into 10 deciles based of their total market capitalization. Stocks in Decile#1 have the largest market capitalization, and stocks in Decile#10 have the least market cap. We repeat the calculation for stocks. Size is the number of outstanding share of a fund. Price is the average of the daily close price in the sample period. Turnover is defined as the ratio of daily share volume to the total outstanding share. All the reported variables, such as size, price, volume, turnover, and price movement are the simple average of the funds in a group. Panel A reports the three fund groups, and Panel B reports the 10 stock deciles. Our investigation period is January 4 – 11, 2002.

PANEL A: Fund Group							
Fund Portfolio	Sample Size	Outstanding Unit Shares (Million)	Price (RMB)	Share Volume (10,000)	Dollar Volume (10,000 RMB)	Turnover (%)	Daily Return (%)
1	22	2430	.9689	1881.62	1871.54	.7576	-0.824
2	3	1170	.9692	1084.99	1045.8180	.9512	-0.552
3	23	539	.9973	596.39	601.6223	1.1521	-1.296

PANEL B: Stock Group							
Stock Decile	Sample Size	Market Cap (Million RMB)	Price (RMB)	Share Volume (1000)	Dollar Volume (1000 RMB)	Turnover (%)	Daily Return (%)
1	113	4262.670	12.360	1062.245	10794.455	0.374087	-0.933
2	114	1899.149	10.622	578.168	5805.373	0.405706	-1.039
3	112	1458.553	11.511	437.014	4513.164	0.382264	-1.239
4	114	1238.655	11.116	450.754	4343.841	0.459667	-1.236
5	113	1010.820	11.700	302.171	3342.345	0.388747	-1.163
6	114	837.655	10.823	385.777	3883.273	0.500364	-1.233
7	112	758.997	11.218	445.420	4520.821	0.827237	-1.227
8	113	639.617	11.742	476.461	4240.732	0.772848	-1.429
9	112	562.263	11.852	293.456	3046.170	0.588926	-1.397
10	105	368.003	12.086	339.604	2730.164	0.716838	-1.181

Table 3
Daily Bid-Ask Spread for Closed-end Funds and Stocks

We report the bid-ask spread, the relative spread, and the maximum price change for the 48 funds in our sample. The variables that are reported in the table are defined as follows:

$$\begin{aligned} \text{Bid-ask spread} &= (\text{Best Ask} - \text{Best Bid}). \\ \text{Relative spread} &= (\text{Best Ask} - \text{Best Bid}) / [0.5 * (\text{Best Ask} + \text{Best Bid})]. \\ \text{Maximum Price Change} &= \text{Intraday Highest Price} - \text{Intraday Lowest Price} \\ \text{Relative Price Change} &= \text{Maximum Price Change} / \text{Daily Close Price} \end{aligned}$$

We first compute the time-weighted bid-ask spread and the time-weighted relative spread for each fund each day. We then average the daily results to obtain the sample average for each fund during our sample period. In addition, we divided our sample stocks into 10 deciles based of their total market capitalization. Stocks in Decile#1 have the largest market capitalization, and stocks in Decile#10 have the least market cap. We repeat all the above calculation on stocks. Panel A reports the results for single fund, Panel B reports the fund group results, and Panel C reports the results for stocks. Our investigation period is January 4 – 11, 2002.

PANEL A: Individual Fund					
Index	Fund	Bid-Ask Spread (RMB0.01)	Relative Spread (%)	Maximum Price Change	Relative Price Change
1	184688	1.001	1.042	1.500	1.559
2	184689	1.000	1.074	2.000	2.148
3	184690	1.000	0.852	2.000	1.702
4	184691	1.000	1.229	1.833	2.259
5	184692	1.002	1.133	2.167	2.452
6	184693	1.000	1.093	1.500	1.635
7	184695	1.000	1.063	2.167	2.298
8	184696	1.000	0.996	1.667	1.669
9	184698	1.001	1.066	2.000	2.147
10	184699	1.226	1.558	2.000	1.986
11	184700	1.000	0.948	3.333	3.138
12	184701	1.000	1.185	1.833	2.178
13	184702	1.002	0.923	2.167	1.991
14	184703	1.003	1.066	2.167	2.325
15	184705	1.000	1.057	1.833	1.945
16	184706	1.000	1.143	1.833	2.113
17	184708	1.059	1.129	2.500	2.546
18	184709	1.001	1.017	2.833	2.903
19	184710	1.000	1.080	1.833	1.999
20	184711	1.000	1.000	2.667	2.690
21	184712	1.000	1.002	2.000	2.014
22	184713	1.000	1.015	2.167	2.225
23	184718	1.001	1.061	1.833	1.957
24	184728	1.000	1.024	1.333	1.364
25	184738	1.003	1.000	2.167	2.169
26	500001	1.000	1.040	1.500	1.567
27	500002	1.000	1.102	1.833	2.033
28	500003	1.018	0.832	1.667	1.333

(Table 3 Continued)

29	500005	1.000	1.093	2.000	2.192
30	500006	1.000	1.064	2.000	2.137
31	500007	1.001	1.009	2.000	2.027
32	500008	1.000	0.950	1.667	1.588
33	500009	1.000	0.900	2.000	1.802
34	500010	1.002	1.068	2.000	2.125
35	500011	1.000	0.996	1.833	1.819
36	500013	1.003	0.887	2.167	1.922
37	500015	1.001	1.149	1.833	2.114
38	500016	1.001	1.026	2.000	2.055
39	500017	1.000	1.031	3.500	3.637
40	500018	1.000	0.988	2.167	2.147
41	500019	1.000	0.972	2.833	2.768
42	500021	1.000	1.016	2.167	2.224
43	500025	1.000	0.945	4.000	3.855
44	500028	1.000	1.083	2.167	2.346
45	500029	1.000	1.001	1.667	1.674
46	500035	1.000	1.006	2.000	2.021
47	500038	1.000	1.026	1.667	1.719
48	500039	1.000	0.942	2.667	2.517

PANEL B: Fund Group

Fund Group	Bid-Ask Spread (RMB 0.01)	Relative Spread (%)	Maximum Price Change (RMB 0.01)	Relative Price Change (%)
1	1.011	1.070	1.826	1.909
2	1.001	1.033	2.056	2.127
3	1.003	1.011	2.362	2.376

PANEL C: Stock Group

Stock Group	Bid-Ask Spread (RMB 0.01)	Relative Spread (%)	Maximum Price Change (RMB 0.01)	Relative Price Change (%)
1	2.794	0.224	33.398	2.631
2	4.200	0.460	30.301	2.858
3	3.900	0.307	35.509	2.950
4	3.998	0.336	34.491	3.095
5	4.727	0.382	37.580	3.228
6	3.894	0.349	37.195	3.345
7	4.831	0.411	41.928	3.542
8	8.203	1.038	39.177	3.328
9	6.172	0.510	38.793	3.272
10	8.155	0.764	40.510	3.467

Table 4
Intraday Bid-Ask Spread for Close-ends Funds and Stocks

We report the bid-ask spread in 24 intervals, each with 10 minutes, during a trading day for 3 fund groups and 10 stock groups. There are 12 intervals in each of the morning and afternoon trading sessions. For example, Interval #1 (T1) is from 9:30AM to 9:40AM; Interval #12 (T12) is from 11:20AM to 11:30AM; Interval #13 (T13) is between 1:00PM to 1:10PM; Interval #24 (T24), the last interval, is between 14:50PM to 15:00PM. The trading volume ratio of a fund is defined as the ratio between the interval trading volume to the daily total volume. Panel A reports the results for 3 fund groups, and Panel B reports the results for 10 stock groups.¹⁵ Our investigation period is January 4 – 11, 2002.

PANEL A: Fund Bid-Ask Spread (RMB 0.01)						
Interval	Large Funds		Middle Funds		Small Funds	
	mean	median	mean	median	mean	median
1	1.0014	1.0000	1.0056	1.0000	1.0077	1.0000
2	1.0013	1.0000	1.0000	1.0000	1.0064	1.0000
3	1.0008	1.0000	1.0000	1.0000	1.0000	1.0000
4	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
5	1.0000	1.0000	1.0000	1.0000	1.0050	1.0000
6	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
7	1.0000	1.0000	1.0000	1.0000	1.0006	1.0000
8	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
9	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
10	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
11	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
12	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
13	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
14	1.0000	1.0000	1.0000	1.0000	1.0047	1.0000
15	1.0008	1.0000	1.0000	1.0000	1.0029	1.0000
16	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
17	1.0003	1.0000	1.0000	1.0000	1.0074	1.0000
18	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
19	1.0000	1.0000	1.0062	1.0000	1.0000	1.0000
20	1.0000	1.0000	1.0000	1.0000	1.0016	1.0000
21	1.0000	1.0000	1.0000	1.0000	1.0009	1.0000
22	1.0000	1.0000	1.0000	1.0000	1.0001	1.0000
23	1.0000	1.0000	1.0000	1.0000	1.0000	1.0000
24	1.0000	1.0000	1.0000	1.0000	1.0029	1.0000

¹⁵ Due to the limit of space, we only report the mean bid-ask spread for 10 stock groups. The pattern of the median results, in fact, is similar to that of the mean.

(Table 4 continued)

PANEL B: Stock Mean Bid-Ask Spread (RMB 0.01)										
Interval	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
1	5.486	6.918	8.392	8.887	10.286	8.650	9.612	13.428	12.300	15.866
2	3.588	4.760	6.070	6.039	7.019	6.258	6.923	9.643	9.463	11.182
3	3.017	3.790	4.912	4.899	5.637	4.729	5.304	7.869	7.331	8.765
4	2.667	3.184	4.526	4.129	4.740	4.180	4.688	7.329	6.683	8.130
5	2.500	2.891	3.878	3.891	4.340	3.716	4.303	6.548	5.982	7.503
6	2.436	2.758	4.155	3.608	3.898	3.692	4.257	6.391	5.251	7.211
7	2.442	2.674	3.640	3.179	3.916	3.463	3.894	6.011	5.278	6.515
8	2.408	2.511	3.630	3.127	3.670	3.237	3.638	5.972	4.879	6.288
9	2.405	2.495	3.505	3.149	3.535	3.334	3.982	5.855	4.885	6.454
10	2.490	2.569	3.198	3.167	3.632	3.259	4.111	5.898	4.878	6.136
11	2.617	2.616	4.087	3.230	3.629	3.232	3.831	5.607	4.661	6.022
12	2.391	2.486	3.000	2.820	3.255	2.794	3.420	4.667	4.367	4.980
13	2.610	2.575	3.173	3.345	3.604	3.213	3.700	5.967	4.797	6.465
14	2.287	2.681	3.457	2.956	3.571	3.053	3.345	5.523	4.435	5.775
15	2.407	2.592	3.412	3.006	3.352	3.048	3.590	5.256	4.602	5.729
16	2.346	2.538	3.341	2.990	3.401	3.089	3.868	5.138	4.531	5.647
17	2.406	2.548	2.941	2.951	3.388	3.066	3.528	5.040	4.229	5.532
18	2.460	2.680	3.507	2.773	3.469	2.938	3.688	5.169	4.395	5.918
19	2.449	2.621	3.465	3.053	3.508	2.962	3.769	5.581	4.528	6.358
20	2.355	2.637	3.481	2.912	3.347	3.016	3.566	5.257	4.626	6.372
21	2.348	2.582	3.222	2.837	3.309	2.898	3.411	5.028	4.441	7.059
22	2.341	2.595	3.476	2.974	3.412	2.841	3.843	5.492	4.402	6.608
23	2.335	2.644	3.377	2.995	3.363	2.934	4.126	5.901	4.540	6.482
24	2.199	2.566	3.245	2.803	3.264	2.946	3.963	5.775	4.747	6.710

Table 5
Quote Duration for Closed-end Funds

We report the time duration of the best bid and the best ask on the limit order book for the closed-end funds. We denote the position of the opening best bid and best ask as “0.” If the best bid and best ask move up one tick above the opening position, we denote the new bid and ask position as the grid of “+1.” If the bid and ask move down one tick below the opening position, it is denoted as the grid of “-1,” and so on and so forth. We compute the daily average as the results for a single fund and average them to get the group result. Panel A reports the results for single fund, and Panel B reports the group results. Our investigation period is January 4 – 11, 2002.

PANEL A: Individual Fund							
Index	Fund	Time on Grid “-2”	Time on Grid “-1”	Time on Grid “0”	Time on Grid “+1”	Time on Grid “+2”	Time on All Other Grids
1	184688	0.001	0.466	0.530	0.003	0.000	0.000
2	186989	0.018	0.485	0.497	0.000	0.000	0.000
3	184690	0.000	0.241	0.752	0.007	0.000	0.000
4	184691	0.000	0.351	0.545	0.103	0.000	0.000
5	184692	0.036	0.349	0.603	0.013	0.000	0.000
6	184693	0.000	0.355	0.589	0.056	0.000	0.000
7	184695	0.000	0.401	0.568	0.031	0.000	0.000
8	184696	0.068	0.293	0.635	0.005	0.000	0.000
9	184698	0.016	0.560	0.417	0.007	0.000	0.000
10	184699	0.005	0.373	0.597	0.023	0.000	0.000
11	184700	0.119	0.265	0.296	0.183	0.000	0.137
12	184701	0.001	0.442	0.557	0.000	0.000	0.000
13	184702	0.143	0.290	0.390	0.177	0.000	0.000
14	184703	0.026	0.445	0.502	0.024	0.000	0.003
15	184705	0.007	0.406	0.539	0.048	0.000	0.000
16	184706	0.042	0.514	0.444	0.000	0.000	0.000
17	184708	0.154	0.417	0.401	0.027	0.000	0.001
18	184709	0.172	0.383	0.358	0.017	0.007	0.062
19	184710	0.144	0.364	0.487	0.003	0.000	0.001
20	184711	0.101	0.392	0.388	0.062	0.000	0.026
21	184712	0.132	0.507	0.301	0.060	0.000	0.000
22	184713	0.047	0.479	0.472	0.000	0.000	0.002
23	184718	0.000	0.071	0.318	0.612	0.000	0.000
24	184728	0.000	0.465	0.523	0.012	0.000	0.000
25	184738	0.106	0.544	0.347	0.003	0.000	0.000
26	500001	0.000	0.297	0.703	0.000	0.000	0.000
27	500002	0.000	0.481	0.400	0.116	0.003	0.000
28	500003	0.000	0.042	0.682	0.216	0.060	0.000
29	500005	0.044	0.319	0.582	0.055	0.000	0.000
30	500006	0.025	0.322	0.489	0.034	0.130	0.000
31	500007	0.000	0.211	0.579	0.210	0.000	0.000
32	500008	0.000	0.150	0.723	0.127	0.000	0.000
33	500009	0.003	0.174	0.710	0.112	0.000	0.000
34	500010	0.068	0.496	0.395	0.040	0.000	0.000

(Table 5 continued)

35	500011	0.000	0.051	0.753	0.196	0.000	0.000
36	500013	0.011	0.309	0.567	0.102	0.012	0.000
37	500015	0.000	0.332	0.664	0.003	0.000	0.000
38	500016	0.014	0.271	0.689	0.025	0.000	0.000
39	500017	0.248	0.264	0.217	0.063	0.081	0.127
40	500018	0.000	0.098	0.861	0.040	0.000	0.000
41	500019	0.313	0.288	0.284	0.064	0.000	0.051
42	500021	0.149	0.448	0.378	0.025	0.000	0.000
43	500025	0.026	0.479	0.209	0.008	0.000	0.278
44	500028	0.228	0.204	0.551	0.017	0.000	0.000
45	500029	0.000	0.257	0.743	0.000	0.000	0.000
46	500035	0.000	0.428	0.387	0.168	0.017	0.000
47	500038	0.000	0.316	0.684	0.000	0.000	0.000
48	500039	0.082	0.193	0.545	0.112	0.004	0.064

PANEL B: Fund Group

Fund Group	Time on Grid “-2”	Time on Grid “-1”	Time on Grid “0”	Time on Grid “+1”	Time on Grid “+2”	Time on other Grids
1	0.008684	0.326663	0.604709	0.051094	0.008761	0
2	0.004685	0.294491	0.612065	0.088759	0	0
3	0.105001	0.368211	0.434979	0.052459	0.005255	0.004261

Table 6
Depth Analysis for Closed-end Funds and Stocks

We report the order volume on the limit order book. The best 3 ask prices are denoted as Ask1, Ask2, and Ask3 (Ask1 > Ask2 > Ask3), and the best 3 sell prices are as Sell1, Sell2, and Sell3 (Sell1 < Sell2 < Sell3). The reported variables in the table are defined as follows:

$$\begin{aligned} \text{Best Depth} &= 0.5 * (\text{the total quantities on Ask1} + \text{the total quantities on Sell1}) \\ \text{Total Depth} &= 0.5 * (\text{Depth on Ask 1, 2, and 3} + \text{Depth on Sell1, 2, and 3}) \\ \text{Interval Depth Ratio} &= \text{Best Depth} / \text{Transaction Volume during the Reported Interval} \\ \text{Daily Best Depth Ratio} &= \text{Best Depth} / \text{Total Daily Volume} \\ \text{Daily Total Depth Ratio} &= \text{Total Depth} / \text{Total Daily Volume} \end{aligned}$$

Best Depth, Total Depth, and Interval Depth Ratio are all time-weighted variables. We divide our sample stocks into 10 deciles based of their market capitalization. Stocks in Decile#1 have the largest market capitalization, and stocks in Decile#10 have the least market cap. Panel A reports the results for single fund, Panel B reports the fund group results, and Panel C reports the results for stocks. Our investigation period is January 4 – 11, 2002.

Panel A: Funds					
Index	Fund	Best Depth	Total Depth	Daily Best Depth Ratio	Daily Total Depth Ratio
1	184688	1664776	4507683.5	0.513	1.382
2	184689	1756639	6277237.5	0.335	1.17
3	184690	1169980	4694869	0.049	0.195
4	184691	2204863	6718807.5	0.324	0.762
5	184692	2169932	6053531.5	0.442	1.1295
6	184693	2066773	5849590	0.297	0.8975
7	184695	1923008	6128425	0.195	0.6295
8	184696	927337.3	3263110	0.463	1.6685
9	184698	1653595	5186619	0.139	0.4255
10	184699	1337174	3641262	0.047	0.1275
11	184700	1955110	5955318	0.083	0.2575
12	184701	1691100	4187809	0.365	0.6785
13	184702	518951.2	1509970.5	0.338	1.019
14	184703	654174.4	2604420.5	0.391	1.578
15	184705	969068.5	3592540	1.121	3.0815
16	184706	807572.6	3640272.5	0.085	0.3845
17	184708	678276.7	2709442	1.037	3.725
18	184709	2019849	5987299.5	0.533	1.6265
19	184710	775401	1976812	0.533	1.368
20	184711	1073158	3812874.5	0.278	1.0585
21	184712	1388026	5141262.5	0.417	1.65
22	184713	1327286	4464852.5	0.429	1.3685
23	184718	778775.9	2053769.5	0.566	1.5305
24	184728	828151.8	3687403	0.107	0.4635
25	184738	1375163	4820290	0.299	1.0675
26	500001	1958330	5082678	0.65	1.7525

(Table 6 Continued)

27	500002	2810200	6153256	0.606	1.334
28	500003	1529433	4285318	0.089	0.238
29	500005	1670916	5876135.5	0.69	1.698
30	500006	1562100	4310798	0.324	0.9545
31	500007	1254940	4367141.5	0.455	1.5235
32	500008	2202438	5661745	0.475	1.0545
33	500009	1290261	4094078.5	0.046	0.1455
34	500010	752645.1	2354790	0.486	1.788
35	500011	1371324	4243795.5	0.054	0.157
36	500013	1772051	6315104.5	0.384	1.336
37	500015	1615421	5327073	0.289	0.9295
38	500016	1702547	4872672.5	0.156	0.586
39	500017	1497647	5444897	0.147	0.5145
40	500018	1018812	3380109.5	0.031	0.111
41	500019	1542269	4853509.5	0.238	0.734
42	500021	793674.3	2979709.5	0.279	1.124
43	500025	1709114	5091697.5	0.28	0.7995
44	500028	1082317	3788162	0.265	0.9605
45	500029	1400315	5305847	0.476	1.9695
46	500035	682451.9	2268273.5	0.508	1.484
47	500038	1350737	4718829.5	0.138	0.4705
48	500039	1264228	4833310.5	0.18	0.7105

Panel B: Fund Groups

Fund	Best Depth	Total Depth	Daily Best Depth Ratio	Daily Total Depth Ratio
1	1624115	4889950	0.277	0.748
2	1626832	5122746	0.269	0.913
3	1171187	3962055	0.423	1.4095

Panel C: Stock Portfolios

Stock Portfolio	Best Depth	Total Depth	Daily Best Depth Ratio	Daily Total Depth Ratio
1	7328.474	31048.255	0.009	0.037
2	7951.725	19421.405	0.018	0.0555
3	2900.631	10508.215	0.014	0.049
4	3129.701	11741.835	0.015	0.0545
5	2163.436	7853.73	0.016	0.0545
6	2373.694	9029.41	0.013	0.0515
7	2280.29	8761.61	0.014	0.0515
8	5736.663	13625.97	0.019	0.066
9	1942.017	6423.42	0.016	0.0605
10	14591.65	20535.88	0.028	0.078

Table 7
Intraday Depth (Share) for Closed-ends Funds and Stocks

We report the intraday quoted depth in 24 intervals, each with 10 minutes, during a trading day for 3 fund groups. The Best Depth and Total Depth are defined as:

$$\text{Best Depth} = 0.5 * [\text{Depth on Buy1} + \text{Depth on Sell1}]$$

$$\text{Total Depth} = 0.5 * [\text{Depth on Buy1, 2, and 3} + \text{Depth on Sell1, 2, and 3}]$$

Panel A reports the Best and Total Depth for fund group #1, #2, and #3, and Panel B reports only the Best Depth for 10 stock groups.¹⁶ Our investigation period is January 4 – 11, 2002.

PANEL A: Fund Depth (1,000 fund units)						
	<u>Large Funds</u>		<u>Middle Funds</u>		<u>Small Funds</u>	
Interval	Best	Total	Best	Total	Best	Total
1	1660.929	5106.915	1508.293	5222.003	1043.555	3600.797
2	1596.931	4906.86	1418.168	5109.225	1087.685	3779.213
3	1679.551	4885.129	1626.612	5116.026	1133.822	3825.613
4	1775.644	5053.158	1429.298	5059.715	1164.359	3811.732
5	1721.821	4997.72	1381.603	5041.706	1149.517	3855.334
6	1631.214	4901.951	1478.69	5085.448	1219.779	3941.991
7	1611.099	4892.181	1559.653	5348.29	1219.954	3970.34
8	1608.671	4807.11	1503.774	5256.023	1202.051	4017.169
9	1653.776	4855.091	1546.28	5398.58	1159.407	4017.194
10	1619.556	4895.973	1769.925	5627.574	1191.242	4060.569
11	1592.829	4810.836	1696.477	5455.077	1167.574	4089.951
12	1583.591	4798.525	1533.999	5465.851	1151.951	4035.02
13	1461.016	4665.397	1855.663	5353.339	1233.866	4192.134
14	1494.233	4738.075	1689.338	5156.029	1255.863	4179.436
15	1606.568	4850.829	1964.768	5327.319	1240.633	4132.926
16	1608.363	4872.469	1777.425	4809.183	1236.406	4136.437
17	1557.669	4839.249	1779.199	4961.195	1222.197	4131.19
18	1610.314	4872.153	1725.495	4845.518	1215.087	4079.834
19	1621.872	4847.46	1658.186	4847.762	1192.46	4081.519
20	1638.127	4902.809	1736.875	4900.426	1182.476	4065.342
21	1646.442	4971.128	1645.983	4891.232	1186.809	4007.264
22	1680.013	5015.351	1610.367	4794.846	1183.089	3947.898
23	1696.497	5057.956	1493.192	4955.448	1113.44	3756.687
24	1683.611	4986.614	1560.819	4951.302	1016.431	3568.014

¹⁶ Due to the limit of space, we omit the Total Depth for Stocks. The pattern of the intraday total depth is very similar to that of the Best Depth.

(Table 7 continued)

PANEL B: Stock Best Depth (share)

Interval	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
1	3481.546	3165.837	2651.861	1964.769	1915.727	1877.279	2591.487	21265.4	1453.128	5182.669
2	4878.138	3314.665	3200.153	2181.746	1750.167	2105.046	1906.778	9528.895	1617.104	6003.625
3	5542.41	3220.791	3346.551	2385.75	1902.628	2306.796	2016.111	4685.865	1621.58	3227.323
4	6074.915	3823.876	3470.387	2555.682	2097.131	2335.805	2159.339	4968.374	1817.59	7509.489
5	6236.653	3803.455	3636.241	2788.228	2110.656	2500.63	2364.082	5004.336	1903.141	8250.988
6	6798.268	3733.127	3583.489	2940.809	2354.606	2514.581	2329.696	5019.452	2005.058	8371.286
7	6411.909	3989.249	3754.606	3016.276	2298.144	2528.64	2549.357	5125.886	2108.961	9184.459
8	6842.118	4060.569	3627.361	3035.88	2206.641	2595.219	2579.613	5335.967	2052.933	11330.46
9	7431.291	4361.927	3630.529	3087.677	2195.28	2561.035	2540.192	4951.372	2088.973	9704.311
10	7496.699	4052.342	3692.765	2896.467	2187.253	2581.318	2466.722	4967.194	2167.902	9265.977
11	8019.348	3866.361	3761.424	2835.585	2196.624	2569.773	2350.641	5677.849	2108.149	7643.575
12	8095.44	3907.723	3778.734	2774.741	2176.709	2386.211	2320.667	5662.864	2036.466	3773.71
13	7891.484	4215.358	3867.097	3072.945	3976.297	2757.347	2391.575	6630.535	2074.011	10556.37
14	8267.891	4707.592	4068.944	3070.638	2370.164	2854.442	2627.672	6039.258	2397.128	11232.12
15	9495.69	5331.561	4523.77	3174.844	2463.197	2872.232	2841.031	6179.214	2533.398	9904.747
16	10009.44	5502.785	4111.28	3045.718	2486.72	2853.415	2941.041	6032.256	2467.99	8128.31
17	10262.49	5465.529	4569.397	3127.842	2718.469	2966.921	2897.645	6260.744	2501.404	8215.039
18	10296.91	5541.715	4665.906	3342.625	2580.35	3034	3005.425	6118.593	2369.552	5839.567
19	9780.101	5676.117	4423.606	3115.163	2500.786	3191.599	2793.495	5620.405	2330.902	8598.682
20	9482.168	5743.678	4515.914	3170.238	2382.386	2974.832	3040.988	6231.074	2367.847	8975.055
21	9707.993	5518.028	4288.169	3223.605	2606.097	2895.725	3190.648	6232.164	2402.981	10535.97
22	10688.31	6178.059	4795.188	3372.468	2635.643	3280.42	3363.445	6474.028	2367.387	8455.563
23	10438.9	5773.685	4548.798	3731.803	2615.762	3279.113	3739.464	6598.092	2438.851	8472.848
24	10338.61	5728.439	4652.86	3623.026	2717.195	3245.738	3709.864	6838.177	2609.602	9696.652

Table 8
Intraday Relative Depth for Closed-End Funds and Stocks

We report the intraday best depth ratio and the intraday total depth ratio in 24 intervals of a trading day for 3 fund groups and 10 stock portfolios. Panel A reports the Best and Total Depth for fund group #1, #2, and #3, and Panel B reports only the Best Depth for 10 stock groups.¹⁷ Our investigation period is January 4 – 11, 2002.

PANEL A: Depth Ratio for Closed-End Funds (%)						
	<u>Large Funds</u>		<u>Middle Funds</u>		<u>Small Funds</u>	
Interval	Best	Total	Best	Total	Best	Total
1	23.907	66.581	23.804	96.316	35.726	123.087
2	24.522	67.254	25.264	98.108	36.786	128.435
3	25.898	68.048	27.256	95.254	38.752	131.968
4	27.321	72.198	22.208	83.347	41.124	135.753
5	26.606	71.279	25.067	91.825	36.094	123.132
6	27.343	72.529	25.309	92.942	40.239	132.134
7	25.084	70.134	26.971	96.127	41.571	137.732
8	24.737	69.803	24.366	89.493	34.933	120.664
9	26.573	71.683	28.195	104.48	36.607	129.899
10	27.628	72.906	26.372	91.195	37.489	129.731
11	28.000	72.653	29.734	104.194	40.768	140.294
12	27.371	72.524	27.551	96.713	40.995	139.022
13	25.416	70.562	29.008	87.979	42.309	143.306
14	25.311	71.015	25.905	79.418	40.735	137.121
15	26.23	72.132	29.722	85.846	43.163	140.899
16	26.243	72.477	26.867	82.374	42.742	142.38
17	26.092	72.044	26.978	83.551	37.863	130.334
18	26.215	72.375	26.781	82.981	40.868	134.061
19	26.027	70.855	24.441	76.972	45.555	146.325
20	26.964	73.121	26.469	84.166	43.465	142.983
21	26.84	73.501	22.394	74.994	42.597	139.905
22	26.124	74.011	22.115	74.167	42.871	138.746
23	24.924	72.714	24.114	84.283	41.205	135.623
24	25.354	72.188	24.978	84.041	39.5	130.222

¹⁷ Due to the limit of space, we omit the Total Depth for Stocks. The pattern of the intraday total depth is very similar to that of the Best Depth.

(Table 8 continued)

PANEL B: Best Depth Ratio for Stocks (%)

Interval	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
1	0.526	0.785	0.922	0.792	0.895	0.782	0.979	2.632	0.900	1.347
2	0.653	0.927	1.071	0.831	0.884	0.913	0.948	2.458	1.001	1.730
3	0.689	0.845	1.145	0.881	0.963	0.967	0.933	2.547	1.045	1.560
4	0.699	0.924	1.123	0.969	1.009	0.962	1.010	2.582	1.067	1.619
5	0.708	0.916	1.172	0.952	1.009	1.027	1.143	2.603	1.113	1.664
6	0.808	0.944	1.155	1.043	1.106	1.068	1.118	2.650	1.159	1.665
7	0.740	1.010	1.240	1.085	1.104	1.051	1.258	2.603	1.178	1.575
8	0.771	1.033	1.160	1.075	1.059	1.036	1.239	2.855	1.172	4.214
9	0.800	1.033	1.155	1.110	1.055	1.108	1.273	1.598	1.207	1.843
10	0.836	0.962	1.138	1.072	1.045	1.093	1.088	1.455	1.226	1.482
11	0.808	0.904	1.234	1.077	1.162	1.062	1.102	2.687	1.325	1.753
12	0.824	0.967	1.266	1.039	1.128	0.983	1.035	2.620	1.239	1.811
13	0.842	1.045	1.270	1.243	2.288	1.155	1.171	2.556	1.258	3.235
14	0.876	1.166	1.302	1.146	1.198	1.212	1.202	2.636	1.404	3.335
15	0.872	1.197	1.385	1.123	1.193	1.299	1.342	2.573	1.434	4.035
16	0.868	1.232	1.394	1.154	1.259	1.263	1.346	2.612	1.415	4.122
17	0.922	1.226	1.397	1.093	1.375	1.284	1.297	2.830	1.325	4.064
18	0.971	1.234	1.399	1.194	1.306	1.318	1.613	2.712	1.313	2.530
19	0.971	1.286	1.333	1.215	1.275	1.328	1.332	2.079	1.336	4.120
20	1.018	1.339	1.432	1.176	1.205	1.230	1.471	2.703	1.313	4.219
21	0.966	1.296	1.413	1.234	1.329	1.188	1.444	2.662	1.283	4.351
22	1.102	1.358	1.517	1.322	1.347	1.284	1.496	2.757	1.310	3.211
23	1.072	1.309	1.473	1.300	1.301	1.302	1.553	2.264	1.451	3.110
24	1.119	1.377	1.583	1.329	1.402	1.390	1.542	2.290	1.483	4.242

Table 9
Volume Concentration for Closed-end Funds

We break down the fund trade volume on different prices. We denote the opening bid as “0.” If the transaction price is one tick above the opening bid, then we denote it as “+1.” If the price is one tick below the opening bid, we denote it as “-1,” and so on and so forth. We take the daily average to get the result for a individual security, and average them to get the group result. Panel A reports the results for single fund; Panel B reports the fund group results; Panel C reports the distribution of the fund group results. Our investigation period is January 4 – 11, 2002.

PANEL A: Individual Fund							
Index	Fund	Volume on Grid “-2”	Volume on Grid “-1”	Volume on Grid “0”	Volume on Grid “+1”	Volume on Grid “+2”	Volume on Other Grids
1	184688	0.000	0.239	0.657	0.238	0.000	0.000
2	184689	0.000	0.215	0.747	0.038	0.000	0.000
3	184690	0.000	0.008	0.659	0.333	0.008	0.000
4	184691	0.000	0.068	0.625	0.327	0.030	0.000
5	184692	0.000	0.219	0.617	0.245	0.006	0.000
6	184693	0.000	0.408	0.574	0.301	0.017	0.000
7	184695	0.000	0.079	0.749	0.168	0.025	0.000
8	184696	0.009	0.427	0.590	0.236	0.000	0.000
9	184698	0.000	0.195	0.651	0.205	0.002	0.000
10	184699	0.000	0.080	0.696	0.253	0.002	0.000
11	184700	0.135	0.255	0.352	0.322	0.035	0.411
12	184701	0.000	0.223	0.741	0.078	0.000	0.000
13	184702	0.144	0.233	0.427	0.482	0.049	0.000
14	184703	0.338	0.265	0.482	0.233	0.030	0.000
15	184705	0.005	0.279	0.567	0.316	0.009	0.000
16	184706	0.002	0.277	0.670	0.122	0.000	0.000
17	184708	0.049	0.491	0.462	0.242	0.018	0.158
18	184709	0.212	0.438	0.259	0.085	0.254	0.422
19	184710	0.200	0.435	0.427	0.211	0.000	0.000
20	184711	0.263	0.307	0.444	0.182	0.006	0.310
21	184712	0.107	0.365	0.442	0.313	0.000	0.000
22	184713	0.119	0.524	0.418	0.249	0.000	0.001
23	184718	0.209	0.156	0.731	0.109	0.000	0.000
24	184728	0.000	0.221	0.702	0.247	0.000	0.000
25	184738	0.055	0.364	0.536	0.097	0.000	0.000
26	500001	0.000	0.056	0.725	0.244	0.000	0.000
27	500002	0.000	0.346	0.417	0.421	0.096	0.008
28	500003	0.000	0.002	0.310	0.659	0.143	0.046
29	500005	0.012	0.284	0.530	0.353	0.010	0.000
30	500006	0.088	0.185	0.731	0.160	0.341	0.143
31	500007	0.000	0.029	0.544	0.293	0.334	0.000
32	500008	0.000	0.008	0.598	0.387	0.059	0.000
33	500009	0.000	0.135	0.610	0.294	0.029	0.000
34	500010	0.069	0.359	0.509	0.231	0.038	0.000
35	500011	0.000	0.001	0.492	0.497	0.025	0.000
36	500013	0.033	0.177	0.603	0.254	0.161	0.000
37	500015	0.000	0.108	0.646	0.267	0.000	0.000

(Table 9 Continued)

38	500016	0.001	0.211	0.595	0.271	0.010	0.000
39	500017	0.339	0.299	0.283	0.105	0.235	0.475
40	500018	0.000	0.008	0.653	0.340	0.001	0.000
41	500019	0.331	0.250	0.370	0.314	0.011	0.052
42	500021	0.023	0.292	0.682	0.075	0.000	0.000
43	500025	0.053	0.269	0.366	0.062	0.002	0.706
44	500028	0.144	0.312	0.543	0.226	0.000	0.000
45	500029	0.000	0.054	0.814	0.174	0.000	0.000
46	500035	0.000	0.387	0.490	0.294	0.124	0.004
47	500038	0.000	0.078	0.853	0.098	0.000	0.000
48	500039	0.454	0.192	0.460	0.367	0.035	0.058

PANEL B: Fund Group

Fund Group	Volume on Grid “-2”	Volume on Grid “-1”	Volume on Grid “0”	Volume on Grid “+1”	Volume on Grid “+2”	Volume on Other Grids
1	0.005	0.157	0.629	0.277	0.035	0.009
2	0.000	0.102	0.625	0.252	0.098	0.000
3	0.156	0.322	0.472	0.220	0.041	0.116

Table 10
Intraday Volume Distribution for Close-ends Funds and Stocks

We report the trading volume ratio in 24 intervals, each with 10 minutes, during a trading day for 3 fund groups. The trading volume ratio for a fund is defined as the ratio between the interval volume to the daily total volume. Panel A reports the results for fund groups, and Panel B reports the results for 10 stock deciles. Our investigation period is January 4 – 11, 2002.

PANEL A: Fund Group

Interval	Volume Ratio (%)					
	<u>Large Funds</u>		<u>Middle Funds</u>		<u>Small Funds</u>	
	mean	median	mean	median	mean	median
0	9.100	8.297	10.886	9.252	4.640	4.246
1	10.723	10.114	6.220	5.512	7.769	8.167
2	5.656	4.923	5.217	5.378	5.379	5.655
3	5.368	4.573	3.701	3.531	5.789	5.095
4	4.081	4.109	7.145	8.466	4.791	4.400
5	2.787	2.233	3.898	3.826	5.029	5.198
6	3.107	2.474	2.641	2.012	3.578	3.293
7	2.375	1.647	1.734	1.740	3.149	3.119
8	2.360	1.360	1.287	1.315	2.722	2.071
9	2.165	1.536	2.670	1.560	2.268	1.874
10	1.896	1.042	2.192	1.592	2.697	2.164
11	2.130	1.378	3.022	3.376	2.626	2.349
12	2.446	1.287	2.209	1.676	2.178	1.929
13	3.162	2.388	2.447	2.701	3.509	3.261
14	2.111	1.422	7.135	3.936	2.566	2.094
15	2.309	1.654	5.220	2.689	3.304	2.336
16	1.635	1.158	6.619	3.901	1.991	1.884
17	1.740	1.545	2.699	2.616	3.379	2.141
18	3.424	2.869	4.334	5.879	3.536	2.559
19	3.311	3.006	1.133	0.879	3.050	2.712
20	6.909	3.406	3.188	2.632	4.054	2.472
21	4.726	2.547	6.335	6.912	5.027	3.847
22	6.341	5.607	3.602	2.844	5.056	4.753
23	4.828	3.005	3.464	3.566	5.576	4.993
24	5.605	4.571	4.588	5.172	8.290	6.381

(Table 10 continued)

PANEL B: Stock Group

Volume Ratio (%)

Interval	#1	#2	#3	#4	#5	#6	#7	#8	#9	#10
0	0.535	0.920	0.738	0.675	0.842	0.729	0.670	0.937	0.790	0.920
1	3.375	3.434	3.411	3.104	3.391	3.360	3.044	3.839	3.282	3.886
2	3.448	3.651	3.300	3.187	3.264	3.203	3.394	3.302	3.053	3.774
3	3.973	3.815	3.884	3.889	3.953	3.791	4.246	3.876	3.717	3.800
4	4.777	4.579	4.587	4.387	4.209	4.612	4.747	4.385	4.448	4.471
5	4.489	4.483	4.396	4.359	4.428	4.416	4.482	4.287	4.356	4.238
6	4.511	4.415	4.321	4.386	4.648	4.380	4.574	4.424	4.480	4.738
7	3.918	3.709	4.013	3.859	3.756	3.860	4.000	4.001	4.389	4.087
8	3.490	3.259	3.512	3.388	3.336	3.544	3.700	3.487	3.712	3.831
9	3.369	3.381	3.083	3.652	3.495	3.359	3.928	3.470	3.723	3.644
10	3.426	3.302	3.081	3.638	3.180	3.046	3.502	3.455	3.525	3.375
11	3.338	3.226	3.258	3.180	3.162	3.055	3.572	3.595	3.493	3.638
12	2.529	2.304	2.647	2.585	2.340	2.633	2.665	2.779	3.066	2.821
13	3.210	3.257	3.380	3.668	3.276	3.357	3.130	3.631	3.331	4.231
14	3.021	3.223	2.758	3.111	2.865	3.404	3.201	3.152	3.292	3.575
15	3.819	3.541	3.405	3.571	3.429	3.610	3.805	3.612	4.124	4.161
16	3.442	3.202	3.283	3.231	3.133	3.094	3.389	3.450	3.262	3.512
17	3.959	4.306	4.054	4.129	4.142	4.148	3.892	4.403	4.161	4.269
18	4.393	4.414	4.555	4.420	4.674	4.608	4.642	4.584	4.598	4.632
19	3.741	3.845	3.663	3.864	3.759	3.845	3.782	3.762	4.094	4.170
20	3.794	4.176	4.342	4.252	4.327	4.314	4.401	4.471	4.152	4.257
21	4.737	4.644	4.771	4.896	5.411	5.035	4.899	5.058	4.871	5.186
22	6.675	6.890	7.126	7.218	7.149	6.922	7.068	7.260	7.145	7.033
23	6.540	6.632	7.158	6.716	7.061	7.245	6.980	7.041	7.052	6.879
24	9.426	9.607	10.506	10.153	10.467	9.998	11.063	10.418	10.452	18.541

Table 11
Limit Order Fill Rate for Closed-end Funds and Stocks

We report the limit order “Open Rate,” “Withdraw Rate,” and “Match Rate” for 3 fund groups and 10 stock groups that are listed on the Shanghai Stock Exchange. There are total 24 closed-end funds and 640 stocks that are in the sample. An “open” order implies that the order is only partially or not filled; an “withdraw” order is a canceled order; A “match” order is a filled order. The Order Ratio is defined as the ratio between the studied order number and the daily total order number. Panel A reports the results for fund group #1, #2, and #3, and Panel B reports the 10 stock groups. Our sample data includes 13 random picked days in 2001.

PANEL A: Fund Groups						
Fund Group	<u>Open Rate (%)</u>		<u>Withdraw Rate (%)</u>		<u>Match Rate (%)</u>	
	mean	median	mean	median	mean	median
1	45.049	44.337	15.281	15.209	39.669	38.371
2	37.394	37.394	20.641	20.641	41.965	41.965
3	34.184	31.323	22.468	21.303	43.348	44.902

PANEL B: Stock Groups						
Stock Group	<u>Open Rate (%)</u>		<u>Withdraw Rate (%)</u>		<u>Match Rate (%)</u>	
	mean	median	mean	median	mean	median
1	21.523	21.489	16.551	16.825	61.926	61.263
2	21.700	21.524	17.372	17.269	60.928	60.474
3	21.214	21.452	19.107	18.621	59.678	59.556
4	21.107	20.935	19.760	19.517	59.133	59.569
5	20.458	20.603	20.275	19.845	59.266	59.400
6	20.559	20.735	20.884	20.450	58.658	58.876
7	20.074	19.495	20.518	20.646	59.407	59.267
8	20.870	20.405	20.789	21.033	58.341	58.519
9	20.217	19.959	21.641	21.764	58.142	58.483
10	23.118	20.764	21.870	22.753	55.012	56.478

Table 12
Intraday Order Density and Size Analysis

We report the limit order density ratio and average in the 25 intervals, each with 10 minutes, in a trading day for 3 fund groups and 10 stock groups that are listed on the Shanghai Stock Exchange. There are total 24 closed-end funds and 640 stocks that are in the sample. The Order Density Ratio is defined as the interval order number divided by the total order number in a trading day. Panel A reports the results for fund group #1, #2, and #3, and Panel B reports the 10 stock groups. Our sample data includes 13 random selected trading days in 2001.

PANEL A: 3 Fund Groups									
Interval	Large Funds			Middle Funds			Small Funds		
	Order Density Ratio	Mean Order Size (share)	Mean Order Size (¥)	Order Density Ratio	Mean Order Size (share)	Mean Order Size (¥)	Order Density Ratio	Mean Order Size (share)	Mean Order Size (¥)
0	0.206	77897.863	85187.035	0.207	70629.014	76231.736	0.173	29706.996	34394.377
1	0.097	46614.965	51103.193	0.096	55768.773	59889.448	0.123	19089.358	22242.481
2	0.061	46027.393	49519.825	0.049	31511.861	33913.979	0.063	17966.382	20981.704
3	0.050	39343.337	42204.831	0.044	33687.836	36517.519	0.051	16996.169	19764.520
4	0.042	26180.557	28393.091	0.041	30125.274	32655.256	0.043	15753.591	18291.815
5	0.038	34773.825	37012.464	0.036	41700.519	45065.913	0.040	17112.926	19841.367
6	0.036	31907.682	34297.831	0.040	31512.819	34180.000	0.036	22776.026	26482.567
7	0.034	33985.979	37513.235	0.037	41438.954	45388.927	0.035	15835.617	18291.590
8	0.031	27058.388	29082.097	0.032	41020.845	44608.303	0.035	17855.805	20374.206
9	0.029	30103.062	32429.861	0.028	38254.788	41455.434	0.032	17237.778	19747.286
10	0.025	29995.337	31705.431	0.032	22045.316	23720.517	0.034	18216.373	21279.658
11	0.023	30560.528	32296.377	0.030	29379.354	32080.413	0.027	17441.186	20146.354
12	0.018	28589.326	31379.861	0.018	22739.769	25241.302	0.020	13640.256	15921.382
13	0.053	23005.669	25727.106	0.050	46876.899	50685.160	0.040	14047.470	16357.865
14	0.022	29652.247	33154.906	0.027	40466.528	43664.805	0.018	16998.093	20533.761
15	0.023	35175.847	38812.877	0.025	31832.577	34855.535	0.018	16303.748	19047.033
16	0.024	36186.951	39074.770	0.025	70094.954	74699.199	0.019	15050.757	17649.907
17	0.026	47870.946	51879.916	0.023	33774.260	36727.444	0.021	17950.106	20616.510
18	0.024	32904.623	35079.304	0.022	25573.869	27606.874	0.025	17797.462	21206.719
19	0.023	36310.030	37918.916	0.022	50240.978	52956.841	0.024	18304.270	21650.214
20	0.024	40979.189	42795.840	0.022	67079.589	70160.132	0.024	18228.368	21790.981
21	0.022	26593.820	29395.012	0.023	36352.664	39398.960	0.023	15660.093	18343.827
22	0.022	22932.741	25003.433	0.021	28250.324	30352.475	0.024	16683.782	19491.066
23	0.024	43287.923	46064.053	0.025	26724.456	28974.355	0.025	17751.576	21040.700
24	0.022	43183.880	46235.076	0.025	70949.384	73008.376	0.029	23260.876	27565.108

(Table 12 continued)

PANEL B: Stock Groups															
Interval	Order Density Ratio	#1		Order Density Ratio	#3		Order Density Ratio	#5		Order Density Ratio	#7		Order Density Ratio	#9	
		Mean Order Size (share)	Mean Order Size (¥)		Mean Order Size (share)	Mean Order Size (¥)		Mean Order Size (share)	Mean Order Size (¥)		Mean Order Size (share)	Mean Order Size (¥)		Mean Order Size (share)	Mean Order Size (¥)
0	0.067	2223.1	31004.0	0.062	1759.8	23549.1	0.062	1769.9	24949.7	0.064	1715.9	23923.5	0.069	1599.8	23925.3
1	0.087	1877.7	26325.1	0.091	1545.7	20397.4	0.093	1435.9	20306.8	0.092	1420.6	19365.5	0.097	1319.1	19451.1
2	0.059	1605.7	21886.0	0.062	1376.6	18209.9	0.062	1412.7	19873.4	0.061	1330.9	18170.4	0.063	1267.1	18534.7
3	0.050	1623.4	22426.5	0.052	1421.6	18618.7	0.052	1354.6	18919.6	0.053	1299.9	17722.1	0.053	1235.3	17977.0
4	0.045	1705.6	23227.5	0.046	1489.2	19323.5	0.045	1413.7	19742.7	0.047	1379.7	18577.8	0.047	1256.6	18446.6
5	0.046	1628.9	22169.1	0.047	1410.0	18318.5	0.046	1389.0	19673.2	0.046	1294.6	17440.4	0.046	1223.1	17748.0
6	0.043	1670.3	22660.3	0.044	1480.3	19558.9	0.044	1384.6	19514.4	0.044	1351.1	18292.1	0.042	1254.3	18419.2
7	0.042	1736.7	24106.3	0.042	1554.8	20118.2	0.041	1426.5	19765.3	0.042	1324.1	17858.3	0.039	1295.7	19013.5
8	0.040	1725.0	24015.5	0.039	1444.5	18572.6	0.039	1410.4	19643.2	0.039	1402.4	18759.5	0.037	1319.4	18818.5
9	0.033	1789.6	24600.3	0.033	1443.1	18516.3	0.033	1320.0	18343.2	0.033	1359.5	18310.6	0.031	1181.7	17317.7
10	0.031	1845.5	25656.3	0.031	1497.1	19554.6	0.031	1366.1	18817.8	0.030	1353.0	18229.9	0.029	1289.2	18733.3
11	0.029	1877.9	25870.2	0.029	1496.3	19456.1	0.029	1405.1	19469.0	0.029	1381.9	18594.4	0.027	1326.9	19255.2
12	0.025	1853.1	25485.5	0.025	1474.3	19254.4	0.025	1415.5	19738.7	0.024	1412.7	19167.0	0.024	1279.3	18933.1
13	0.047	1518.0	20892.9	0.046	1363.4	17788.0	0.046	1305.7	18416.5	0.047	1310.7	17479.2	0.049	1285.8	18374.5
14	0.026	1771.8	23760.6	0.026	1535.8	20122.2	0.026	1424.7	19498.6	0.026	1342.1	18045.9	0.026	1385.0	20095.6
15	0.027	1735.0	23338.6	0.026	1506.2	19905.9	0.027	1384.4	19116.9	0.027	1397.5	18968.0	0.026	1390.2	20051.5
16	0.029	1733.4	23422.7	0.028	1574.1	20544.9	0.028	1370.4	19055.0	0.028	1384.9	18638.1	0.028	1366.9	19622.7
17	0.029	1717.5	23354.9	0.029	1488.1	19692.0	0.028	1450.3	20115.1	0.028	1329.1	18023.3	0.028	1280.4	18554.3
18	0.030	1813.8	25091.3	0.029	1577.9	20756.4	0.029	1470.7	20161.6	0.028	1397.4	19000.1	0.028	1386.4	20127.5
19	0.030	1782.7	23961.3	0.029	1531.8	19963.6	0.029	1579.1	21899.1	0.028	1367.5	18620.3	0.027	1319.0	19079.2
20	0.031	1735.7	23716.2	0.031	1550.6	20419.4	0.030	1461.9	20586.0	0.030	1400.8	19119.6	0.030	1359.5	19415.7
21	0.033	1943.2	26364.0	0.033	1580.8	20340.3	0.034	1540.9	21715.9	0.034	1384.3	18871.6	0.033	1340.0	19330.7
22	0.037	1956.7	26489.5	0.037	1548.2	19916.6	0.037	1469.9	20316.4	0.038	1432.9	19256.5	0.038	1345.2	19347.8
23	0.042	1869.9	25229.4	0.042	1585.6	20913.9	0.042	1490.0	20381.9	0.043	1481.9	20289.9	0.042	1319.1	19220.7
24	0.052	2259.0	30314.1	0.051	1787.0	23320.1	0.053	1704.2	23589.6	0.051	1644.6	22843.4	0.052	1709.3	24574.2

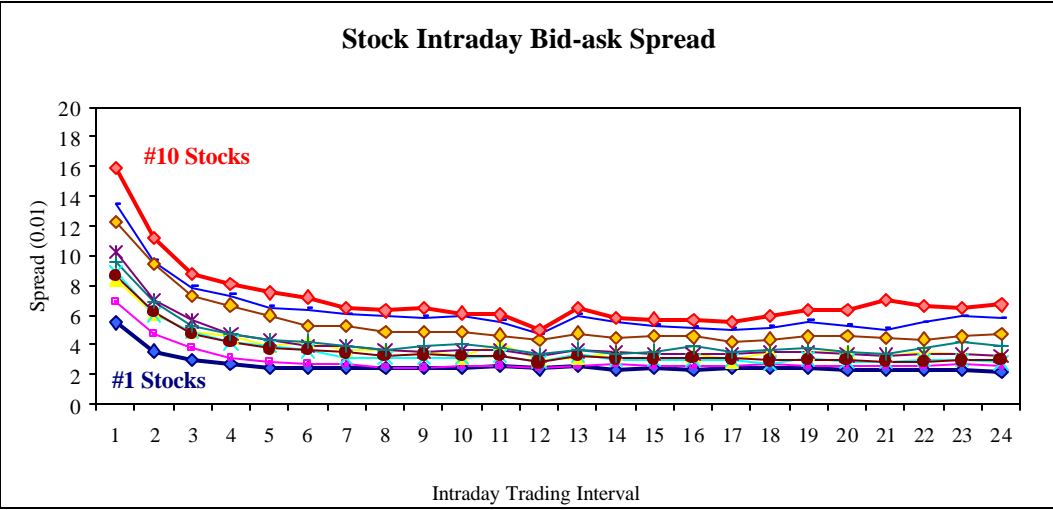


Figure 1 – A

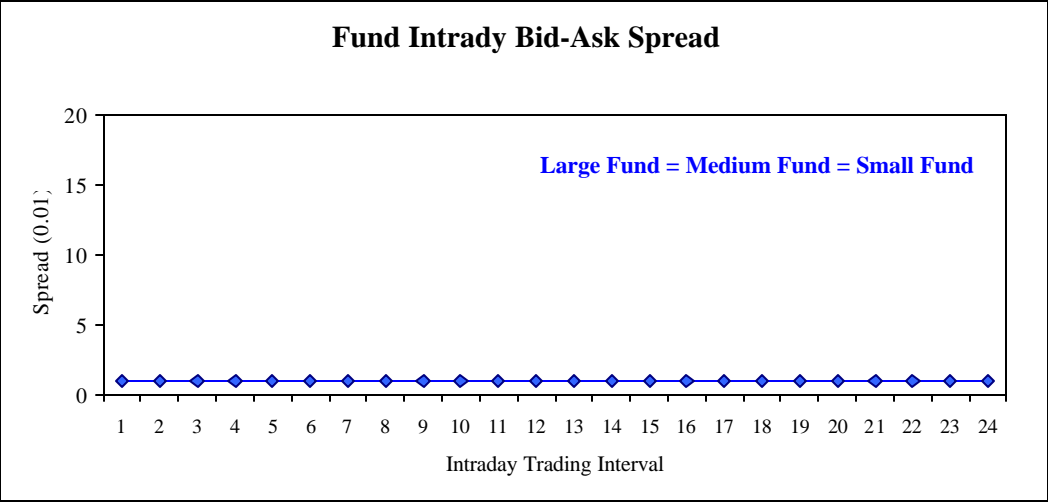


Figure 1 – B

Figure 1: A and B show the intraday bid-ask spread for 10 stock portfolios and 3 fund groups. In Figure 1 – A, a color represents stocks in a decile. For example, in the chart, we only indicate the large stocks (dark blue), stocks in decile #1, and small stocks (red), stocks in decile#10. Due to the limit of space, we ignore the index of other groups. We divide the whole trading day (4 hours or 240 minutes) into 24 trading interval, with 10 minutes in each interval.

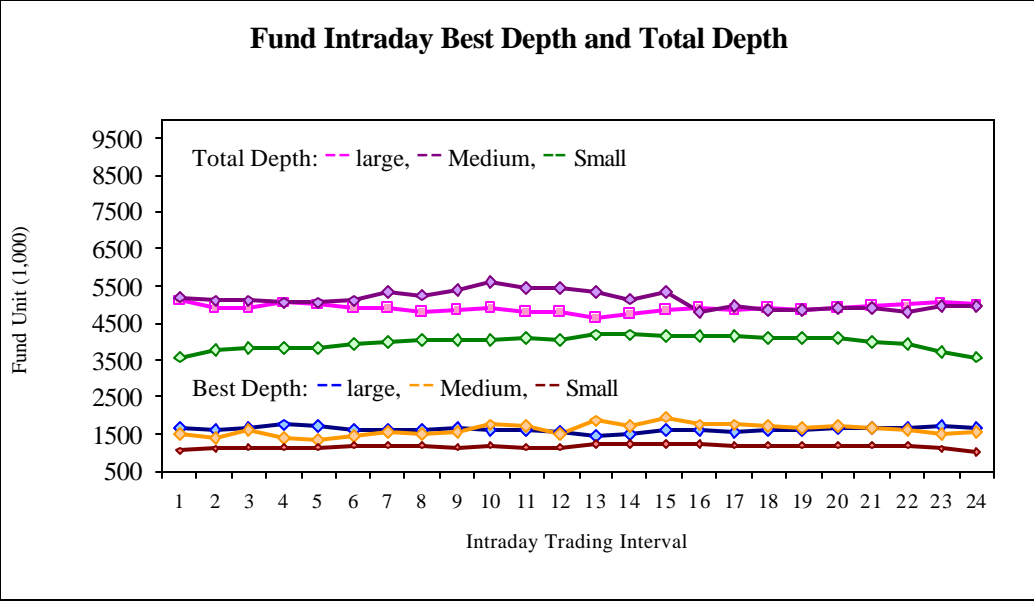


Figure 2 – A

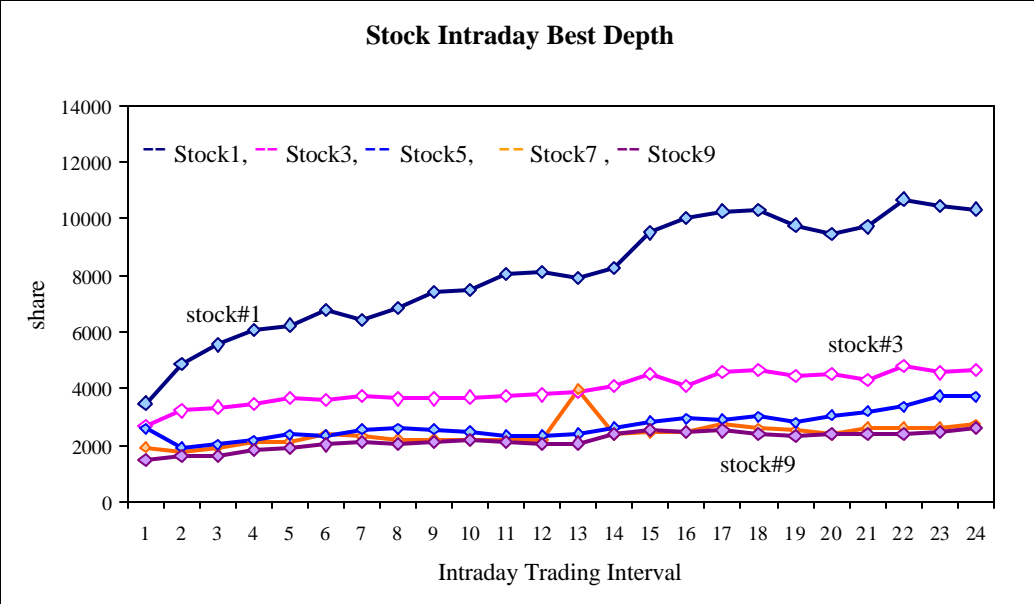


Figure 2 – B

Figure 2: A presents the intraday best depth and total depth for the 3 fund groups. B presents the intraday best depth for the stocks in decile 1, 3, 5, 7, and 9. “Stock1” refers to the stocks in decile #1, and the same logic follows for “Stock3,” “Stock5,” “Stock7,” and “Stock9.” We divide the whole trading day (4 hours or 240 minutes) into 24 trading interval, with 10 minutes in each interval.

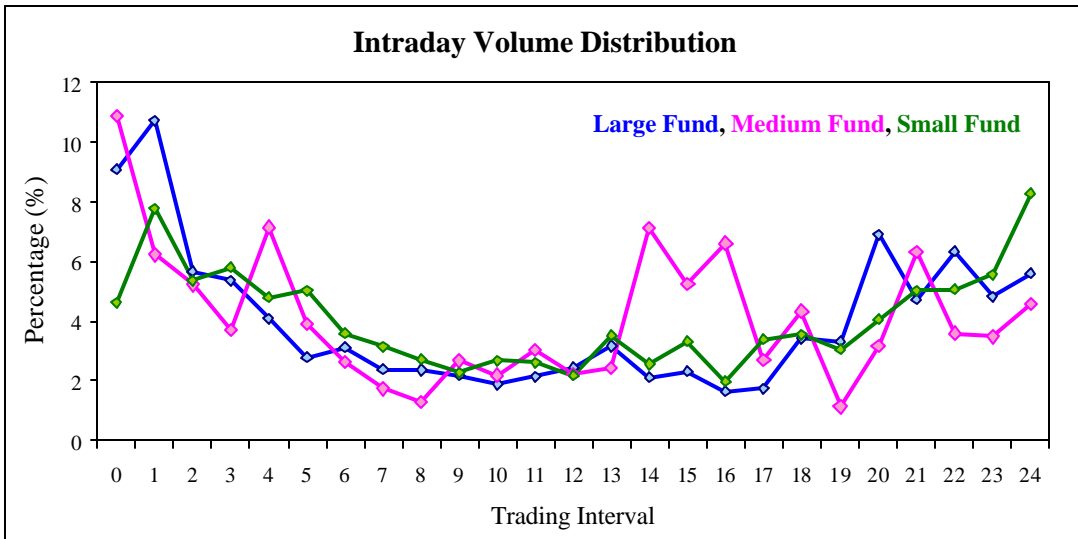


Figure 3 – A

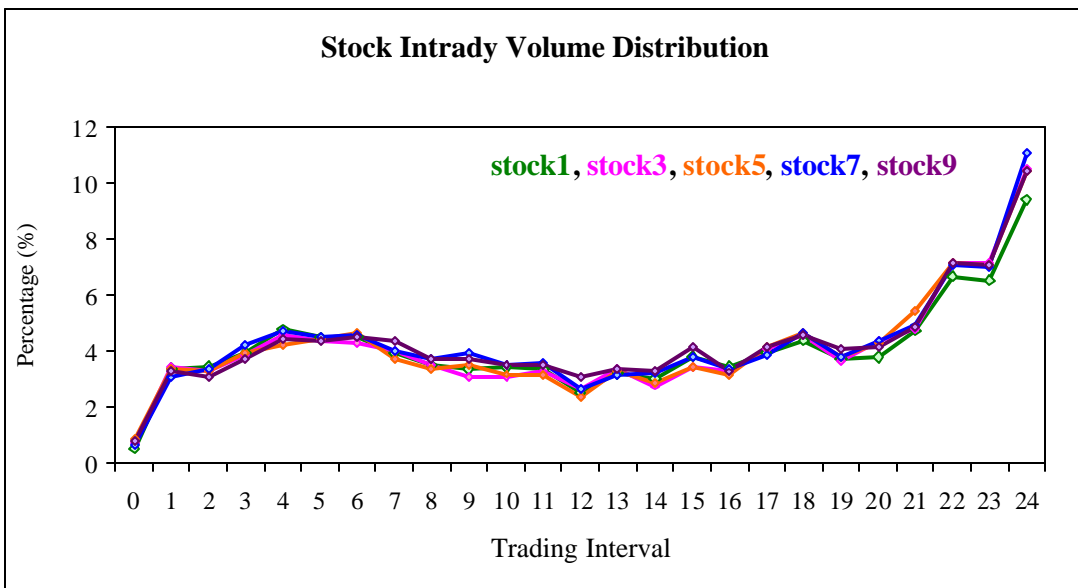


Figure 3 – B

Figure 3: A shows the intraday volume distribution across the 25 trading intervals, including the opening call for the 3 fund groups. B shows the intraday volume distribution for the stocks in Decile 1, 3, 5, 7, and 9. “Stock1” refers to the stocks in decile #1, and the same logic follows for “Stock3,” “Stock5,” “Stock7,” and “Stock9.”

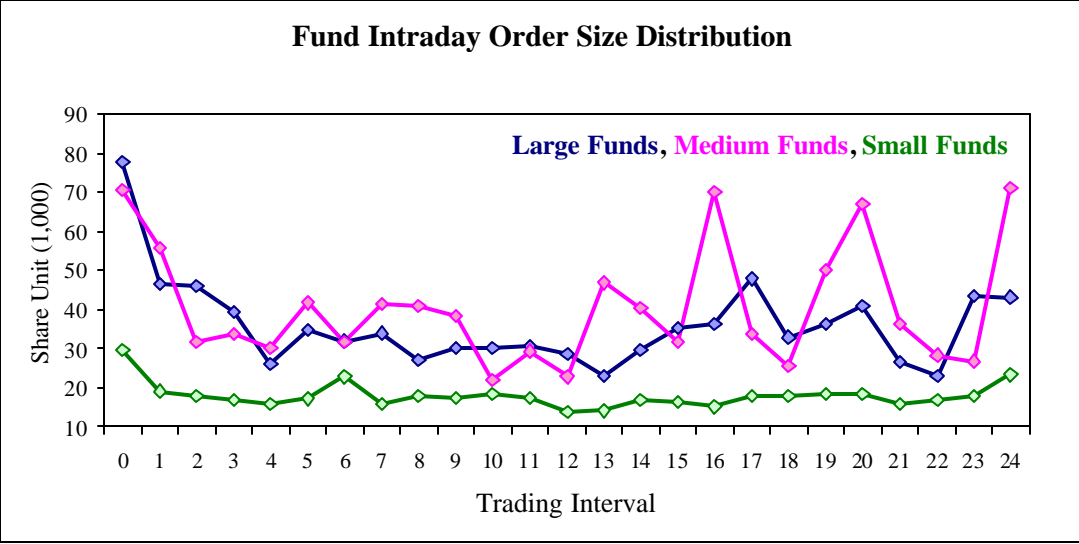


Figure 4 – A

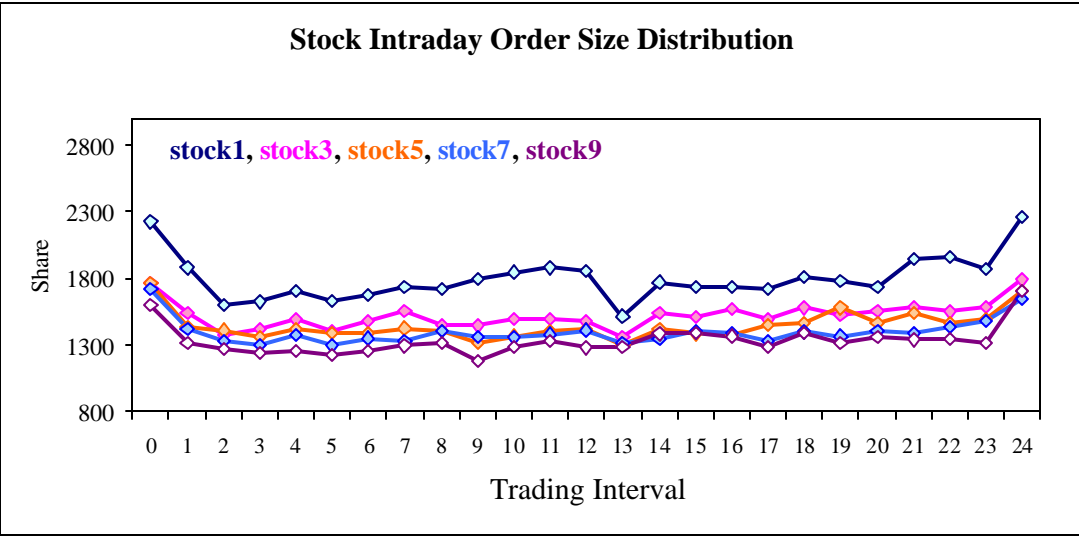


Figure 4 - B

Figure 4: A shows the intraday order size distribution for 3 fund groups. B shows the intraday order size distribution for stocks in decile 1, 3, 5, 7, and 9. “Stock1” refers to the stocks in decile #1, and the same logic follows for “Stock3,” “Stock5,” “Stock7,” and “Stock9.” There are total 25 trading intervals including the opening call.