Is Stock Price Rounded for Economic Reasons in the Chinese Markets?

Yan He*
Indiana University Southeast

and

Chunchi Wu
Syracuse University

Abstract

This paper investigates whether trading and quoting prices are rounded for both economic and cultural reasons on the Shanghai and Shenzhen stock exchanges in China. We find that close, bid, and ask prices are rounded to the nearest 10s and 5s for economic reasons, while the last decimal point of prices clusters on 8 for cultural reasons. The cross-sectional variation in 10-cent and 5-cent rounding can be well explained by price and inverse of square root of trading volume, whereas the clustering on 8 can hardly be ascribed to economic variables. Both the rounding on 10s and the clustering on number 8 have significant effect on execution costs. Finally, the rounding frequencies on 10s and 5s in the Chinese market are generally lower than those in the NYSE.

JEL classification: G1, G15

Key words: price rounding, price clustering, emerging markets, decimal trading, Chinese markets, bid-ask spreads

*Contact Information: School of Business, Indiana University-Southeast, 4201 Grant Line Road, New Albany, IN 47150. Phone: 812-941-2308. Fax: 812-941-2672. Email: yanhe@ius.edu.

Is Stock Price Rounded for Economic Reasons in the Chinese Stock Markets?

1. Introduction

In stock trading practice, prices are often constrained to a limited set of observations by minimum tick size. Previous studies have documented that prices are frequently rounded to multiples of the minimum tick. Harris (1991) provides evidence on the rounding of quote and transaction prices for NYSE- and Amex-listed equities. Bessembinder (1994) reports evidence on the rounding of foreign exchange quotes. Ball, Torous, and Tschoegl (1985) document pervasive rounding in gold futures prices. As to the behavioral patterns of stocks prices in emerging markets, it is not quite clear whether rounding exists in the same manner as in developed markets and whether it exists for the same reasons. To explore price rounding in emerging markets, on the one hand, we rely on existing theories to design empirical investigations. On the other hand, we take consideration of the unique features in emerging markets and expect certain variations in rounding patterns as well as in the reasons behind the patterns.

According to the market microstructure theory, rounding (or clustering) can be regarded as a byproduct of the price discovery process. Price discovery occurs when traders try to determine an asset's true price. Ball, Torous and Tschoegl (1985) hypothesize that clustering is positively related to the degree of uncertainty concerning the true price, conditioned on the rules and regulations of the trading activity. Harris (1991) and Godek (1996) suggest that the uncertainty about the true price should be modeled using economic fundamentals (e.g., price level, price change volatility, firm size and trading activity) as instrumental variables, and they show that clustering increases with price level and volatility, and decreases with capitalization and transaction frequency.

In addition, rounding (or clustering) can also be viewed as a means to lower negotiation costs. Ball, Torous and Tschoegl (1985) introduce the "degree of price resolution," with the implication that rounded prices involve a lesser degree of resolution than fine prices. Harris (1991) argues that clustering exists because traders use a discrete grid of prices to simplify their information set, hence, to lower negotiation costs. Specifically, a small set of information limits the amount of information that must be exchanged between negotiating traders, reducing the time it takes to strike a bargain. Furthermore, Angel (1997) points out that the above view is consistent with cognitive research such as Miller (1956) and Simon (1974), and indicates that human short-term memory is capable of processing only a few bits of information concurrently.

Because rounding increases the degree of price discreteness, it has an impact on execution costs. Harris (1994) points out that high degree of price discreteness due to regulations creates wide bid-ask spreads. Bessembinder (1997) investigates relations between trade execution costs and price-rounding practices for NYSE- and Nasdaq-listed firms. Execution costs on each exchange vary positively with the proportion of transaction prices and quotations rounded to even-eighths of a dollar. After allowing for variation in market making costs attributable to the private information content of trades, a strong positive relation remains between execution costs and price-rounding frequencies for Nasdaq issues. This asserts that price-rounding conventions effectively increase trade execution costs on Nasdaq. Moreover, Venkataraman (2001) compares the execution costs on the automated exchanges (Paris) and the floor trading (the New York Stock Exchanges), and finds that execution costs are higher in Paris than in NYSE after controlling for differences in adverse selection, relative tick size, and economic attributes across samples. His results suggest that the present form of the automated trading system may not be able to fully replicate the benefits of human intermediation on a trading floor.

Since rounding exists in developed markets for economic reasons, it may also exist for the same or similar reasons in emerging markets such as the Shanghai and Shenzhen stock exchanges in China. However, economic reasons may not be the only factors that trigger rounding. The unique Chinese culture, which favors certain numbers to others, could also cause clustering. For example, 6, 8, and 9 are preferred numbers. In specific, number 6 is often linked to safety or security, number 8 is interpreted as making a fortune or getting rich, and number 9 represents eternity. Especially number 8, it is very much favored by the Chinese business community. Large companies in the service industry such as hotel are willing to spend big money to buy a telephone number with lots of 8 in it. Thus, we suspect that the last decimal point of stocks prices might cluster on number 8 in the Chinese market.

This study is to investigate whether both economic and cultural factors cause rounding in transaction and quote prices of the shares traded on the Shanghai and Shenzhen stock exchanges in China during the late 1990s. In addition, the study is also to provide additional evidence on rounding in relation to decimal price and electronic trading. The two exchanges in China adopt automatic computer matching systems with decimal pricing. The negotiation costs of security transactions may be higher for the auction market. In an auction market, human minds of buyers and sellers determine the pricing process. They negotiate and reach an agreement on prices. Since human minds can only process limited amount of information and since the buy and sell prices have to be matched in order to consummate the transaction, prices are more likely to cluster. In comparison, the electronic market (such as the Chinese markets) is basically a limit order pricing system. A buy order can be offset by several sell orders. It does not take human intervention to process the transaction and buy and sell orders do not have to be matched one on one to consummate the transaction. Therefore, price clustering in the electronic market may not be as pervasive as in the auction market.

Our major findings include: (1) on the Shanghai and Shenzhen stock exchanges in China, close, bid, and ask prices are rounded to the nearest 10s and 5s for economic reasons, while the last decimal point of prices clusters on 8 for cultural reasons; (2) the cross-sectional variation in 10-cent and 5-cent rounding can be attributed to price and inverse of square root of trading volume, whereas the clustering on 8 cannot be well explained by economic variables; (3) the rounding on 10s and the clustering on number 8 have significant effect on execution costs, and the relationship between bid-ask spreads and clustering frequencies remains significant even with control for price, volatility, market capitalization, inverse of square root of trading volume, and transaction amount in RMB; and (4) the rounding frequencies on 10s and 5s in the Chinese market are generally lower than those in the NYSE.

The remainder of the paper is organized as follows. Section 2 discusses the institutional features of the Shanghai and Shenzhen Stock Exchanges in China. Section 3 describes the data and empirical method. Section 4 presents empirical results. Finally, Section 5 summarizes the findings of this paper.

2. Institutional description

The Shanghai and Shenzhen stock exchanges are the major exchanges in China. The Shanghai Stock Exchange was inaugurated in 1990, while the Shenzhen Stock Exchange was established in 1991. At the end of 2000, there were over 1,200 stocks, including both domestic and foreign shares, listed on the Shanghai and Shenzhen stock exchanges. Domestic shares are restricted for purchase and trading by China's domestic investors. Individual domestic investors can only hold up to five percent of the ordinary shares of a listed company. For all the domestic shares, four types of stock ownership exist: state, legal-entity, employee, and public shares. State shares are for state government to hold for assets and capital contribution. These shares are under the control of National Administrative Bureau for State-owned Property (NABSOP) and are rarely traded. Similarly, legal-entity shares are for founding business agencies or enterprises of local governments and are not traded on exchanges. The state and the legal-entity shares account for more than half of the shares issued by publicly listed companies. Employee shares are limited in numbers and are usually issued to employees before a company goes public. Employee shares are prohibited from trading during the first one and half years after a company goes public. Public shares are the only kind of shares that are frequently traded on the exchanges, usually accounting for less than 40 percent of total shares outstanding.

The Shanghai and Shenzhen stock exchanges adopt decimal pricing. On the exchanges, transaction and quote prices are recorded in two decimal points (RMB 0.00), and for most stocks the minimum tick size is one cent (RMB 0.01).[1] As Harris (1997) states, the tick varies substantially by market and location. Stock, bond, and options markets in the U.S. and Canada traditionally used prices denominated in eighths. European and Asian markets typically use decimal prices. All U.S. markets switched to sixteenths in June 1997, and the NYSE switched to decimals in January 2001. Canadian stocks switched to decimal pricing in April 1996.[2]

With fractional or decimal trading, traders often choose to use a larger price increment than the minimum increment due to economic reasons, and prices tend to cluster on certain fractions or decimals.[3] In this study, we first examine 5-, 10-, 25-, 50-, and 100-cent rounding related to economic reasons on the Shanghai and Shenzhen stock exchanges in China. If clustering does not exist, we would observe a uniform distribution with mean of 20% for 5-cent rounding, 10% for 10-cent rounding, 4% for 25-cent rounding, 2% for 50-cent rounding, and 1% for 100-cent rounding. Otherwise, we would observe a higher frequency of rounding than the mean of uniform distribution. In addition, due to the Chinese cultural preference to certain numbers (such as 8), we will

---

[1] RMB is the unit of Chinese currency. 1RMB = 100 cents.

[2] Ahn, Cao, and Choe (1998) report that bid-ask spreads decreased after the decimalization on the Toronto Stock Exchange (TSE). Bacidore (1997) studies the effect that TSE decimalization has on market quality and finds that liquidity is not adversely affected by decimalization.

[3] See Ball, Torous and Tshoegl (1985) for gold, Brown, Laux and Schachter (1991) for silver, Goodhart and Curcio (1992) for foreign exchange, and Aitken, Brown, Buckland, Izan and Walter (1995) for Australian stocks.

also examine the frequencies of prices with the last decimal point on 0 to 9. If clustering does not exist for cultural or economic reasons, we would observe a uniform distribution with mean of 10% for each number ranging from 0 to 9 as the last decimal point of prices. Otherwise, we would observe higher rounding frequencies than the mean for certain numbers.

3. Data and empirical method

We collect daily data for stocks traded on the Shanghai and Shenzhen stock exchanges in China. The sample period covers January 1, 1998 to December 31, 2000. Among the firms issuing domestic shares, stocks are selected if they have trading records throughout the entire sample period and have close prices larger than one unit of RMB. We end up with 771 domestic shares in the sample. For each stock in the sample, daily data are collected, including daily number of shares transacted, daily amount (in RMB) transacted, market capitalization, end-of-day closing price, last bid and ask prices of each trading day, etc.

Based on daily data collected for each stock, we estimate rounding frequency for close, bid, and ask prices. Let F10 and F5 denote the non-path-adjusted frequencies of 10-cent and 5-cent rounding. Due to the time dependence among the decimals, the non-path-adjusted rounding frequency may be biased. Better estimates of the clustering frequencies can be obtained by taking the time dependence among the decimals into account. The problem is more severe for lower-price stocks and less severe for higher-price stocks. This is because higher-price stocks tend to have larger absolute price changes, causing their domain to be more evenly distributed over various decimals. Following Harris (1991), we define the path-adjusted estimators for 10-cent and 5-cent rounding frequencies on the Chinese stock markets as:

$$AF10 = \sum_{j=1}^{10} (G10_j + 0.01 - D10_j), \tag{1}$$

$$AF5 = \sum_{j=1}^{20} (G5_j + 0.01 - D5_j), \tag{2}$$

where AF10 and AF5 denote the path-adjusted frequencies of 10- and 5-cent rounding. $G10_j$ denotes the non-path-adjusted frequencies of rounding to the first tenth when j=1, the second tenth when j=2, …the last tenth when j=10, and $G5_j$ denotes the non-path-adjusted frequencies of rounding to the first twentieth when j=1, the second twentieth when j=2, …the last twentieth when j=20. Thus, the sum of $G10_j$, where j = 1, 2, …10, is actually equal to the 10-cent rounding frequency (F10), and the sum of $G5_j$, where j = 1, 2, …20, is actually equal to the 5-cent rounding frequency (F5). The probability 0.01 denotes the mean of uniform distribution for any decimal. $D10_j$ denotes the frequencies of domain events occurring on the j-th tenth, and $D5_j$ denotes the frequencies of domain events occurring on the j-th twentieth. $D10_j$ is defined by assuming that a domain event over a given tenth whenever prices change so that the price path passes over or arrives on that tenth, and $D5_j$ is defined by assuming that a domain event over a given twentieth whenever prices change so that the price path passes over or arrives on that twentieth.[4] Equations (1) and (2) indicate that if prices do not often visit the region near a given

[4] Please see Harris (1991) for further explanation of the frequency of domain events.

decimal, the frequency for that decimal is adjusted upward; if prices dwell in that region more often than others, the frequency is adjusted downward.

We next test whether the cross-sectional variation in rounding frequency can be explained by some trading variables. Following Harris (1991), we use average price, volatility of price returns, market capitalization, and inverse of square root of volume as independent variables.[5] The following is the regression model of rounding frequency against trading variables:

$$F_i = \lambda_0 + \lambda_1 \log(P_i) + \lambda_2 VOLA_i + \lambda_3 \log(MV_i) + \lambda_4 ISTV + e_i, \quad (3)$$

where F is the rounding frequency, F can be F10, F5, AF10, and AF5, P is the average close price, VOLA is the volatility of daily price returns, MV is the average market capitalization, and ISTV is the inverse of the square root of daily share volume.

We then investigate the impact of rounding on execution costs. In order to control for the effect of market making costs, we regress bid-ask spreads against both rounding and some trading variables. Following Harris (1994), variables such as average price, volatility of price returns, market capitalization, inverse of square root of volume, and transaction amount can be used to proxy market making costs. The following is the regression model of bid-ask spreads against rounding and trading variables:

$$SPR\%_i = \lambda_0 + \lambda_1 \log(P_i) + \lambda_2 VOLA_i + \lambda_3 \log(MV_i) + \lambda_4 ISTV + \lambda_5 \log(AMT) + \lambda_6 F + e_i, \quad (4)$$

where SPR% is the daily average bid-ask spread in percentage, P is the average close price, VOLA is the volatility of daily price returns, MV is the average market

[5] Harris (1991) uses the inverse of square root of trades. Since we do not have any data report regarding daily number of trades for the Chinese stocks, we use the inverse of square root of volume.

capitalization, ISTV is the inverse of square root of daily volume, AMT is the daily dollar amount of volume (in RMB denomination), F is the rounding frequency, which can be F10, F5, AF10, or AF5.

4. Empirical results

4.1. Rounding frequencies of close, bid, and ask prices

Table 1 reports frequencies of rounding on 10s and 5s for 771 domestic shares in the Chinese markets. First, it is noted that for close, bid, and ask prices, the frequencies of 100-cent rounding are larger than 1%, the frequencies of 50-cent rounding are larger than 2%, the frequencies of 25-cent rounding are larger than 4%, the frequencies of 10-cent rounding are larger than 10%, and the frequencies of 5-cent rounding are larger than 20%. Second, the path-adjusted frequencies are very similar to the non-path-adjusted frequencies, and they show similar patterns as the non-path-adjusted frequencies for close, bid, and ask prices. Our finding is largely consistent with previous studies in terms of clustering patterns, but different from previous studies in terms of specific rounding frequencies. For instant, as Harris (1991) reports, about 15% to 30% of trades are performed on round integers for stock prices between 10 and 100 currency units in the NYSE. In contrast, in the Shanghai and Shenzhen stock exchanges, about 3% to 6% of trades are on round integers for stocks prices between 20 and 40 units of Chinese currency. This difference supports the contention by Ball, Torous and Tschoegl (1985) that different rules and regulations between markets may significantly affect the existence of price clustering.

Table 2 reports the clustering of the last decimal point on 0 to 9 in the Chinese markets. First, it is noted that the clustering frequencies on 0, 5, and 8 are respectively larger than 10%, and this is true for close, bid, and ask prices. Second, the frequencies of clustering on 0 and 5 are consistent with the frequencies of rounding on 10s and 5s. For example, the rounding frequency on 10s for close price is 20.46% in Panel A of Table 1, which is the same as the frequency of clustering on 0 for close price in Panel A of Table 2. The rounding frequency on 5s for close price is 33.25% in Panel A of Table 1, which is the equal to the sum of the frequencies of clustering on 0 (20.46%) and 5 (12.8%) for close price in Panel A of Table 2. Thus, the clustering on 0 and 5 is mainly due to economic reasons. Third, the clustering on 8 seems not related to any economic reason, and we suspect that the cultural preference to 8 might play a role here. Finally, the path-adjusted frequencies are very similar to the non-path-adjusted frequencies, and they show similar patterns as the non-path-adjusted frequencies.

Figures 1, 2, 3, 4, 5, and 6 show that prices are rounded to the nearest 10s and 5s and the last decimal point of prices clusters on 8. On the one hand, these figures confirm the presence of clustering; on the other hand, they indicate that the rounding incidence is not uniform. For instance, the rounding frequencies on even 5s are consistently and considerably higher than those on odd 5s. The clustering frequencies of the last decimal point on 0, 5, and 8 are all higher than the uniform mean of 10%. Clustering on 0 and 5 is consistent with the findings in developed markets, but clustering on 8 seems a unique feature of the Chinese markets. In addition, clustering on 9 is higher than clustering on 1, 2, 3, 4, 6, and 7, though the frequency of clustering on 9 does not exceed the uniform mean.

In the following, we will investigate clustering on 10s, 5s, and number 8. Since the pass-adjusted frequencies of clustering are very similar to the non-path-adjusted frequencies, we will only report the test results with the non-path-adjusted frequencies.

4.2. Explanation of rounding frequencies

Table 3 reports summary statistics on sample characteristics. The medians of frequencies on 10s, 5s, and 8 are close to the means, confirming the existence of clustering. The average bid-ask spread in percentage (0.23%) is relatively low in the Chinese market compared to the average spread (0.61%) of the NYSE in this period. In addition, the return volatility (1.45%) for the Chinese market is also low compared to the return volatility (2.05%) on the NYSE in this period. The average price is about 12.5 RMB.

Table 4 provides the GMM test results of rounding frequencies against trading variables. Here we use the frequency of rounding as the dependent variable, and employ the GMM to explain the cross-sectional variation in clustering by price, volatility, market capitalization, and inverse of square root of daily volume. First, the results show that rounding frequencies on 10s and 5s can be attributed to price level and inverse of square root of volume. Price level has a positive effect on rounding because larger price variations (more clustering) is often observed for higher-price stocks. Inverse of square root of volume has a positive effect on rounding because frequent trading tends to reveal stock values quickly by aggregating the information possessed by different traders, leading to low degree of clustering. Our finding supports the price resolution hypothesis of Ball, Torous, and Tschoegl (1985). That is, price clustering depends on how well known is the underlying value of the security. If the value is not well known, prices will cluster.

Second, the adjusted R-square is 29% when the dependent variable is the frequency of 10-cent rounding, and 24% when the dependent variable is the frequency of 5-cent rounding, indicating that rounding on 10s and 5s can be well explained by trading variables. Hence, it is for economic reasons that prices are rounded to the nearest 10s and 5s.

Third, the frequency of clustering on 8 can hardly be ascribed to any trading variable except price level, and the adjusted R-square is only 3%. Hence, it is for non-economic reasons that the last decimal point of prices clusters on 8. As we know, number 8 is pronounced similarly to getting rich or making a fortune in the Chinese language, and is very much favored by the Chinese business community. With a hope of making a fortune, traders in the Chinese market tend to round the cent to 8 more often than to 1, 2, 3, 4, 6, 7, and 9.

4.3. Effect of rounding frequencies on bid-ask spreads

Table 5 provides the GMM test results of bid-ask spread against price rounding frequencies and trading variables. It is observed that the price level, volatility, inverse of square root of volume, and 10-cent rounding frequencies (F10) have significant effects on the percentage bid-ask spreads. The coefficient on F10 is significant with a t-value of 2.29, and the adjusted R-square is 36%. Our results indicate that cross-sectional variation in bid-ask spreads can be ascribed to trading variables including rounding frequencies. In specific, spreads are expected to decrease as the price level increases because the degree of information asymmetry decreases as price level increases; spreads are expected to increase with volatility because dealers are risk averse and because volatility is probably correlated with information asymmetry; spreads are expected to increase with inverse of trading activity because fixed costs of market making are spread over more traders; spreads are expected to increase with price rounding because rounding increases the discreteness of bids and asks. Therefore, more rounding (especially more 10-cent rounding) gives rise to wider bid-ask spreads even when controlling for market making costs. Our finding is in line with Bessembinder (1997). According to Bessembinder (1997), execution costs on the NYSE and Nasdaq vary positively with the proportion of transaction prices and quotations rounded to even-eighths of a dollar. On Nasdaq, after allowing for variation in market-making costs attributable to the private information content of trades, there is a still strong positive relation between execution costs and price-rounding frequencies.

In addition to the 10-cent rounding, we also note that the frequency of the last decimal point clustering on 8 (F8) significantly influences bid-ask spreads. The coefficient on F8 is significant with a t-value of 2.94. The higher the frequency of clustering on 8, the wider the bid-ask spreads. As discussed, the clustering on number 8 is more likely related to the Chinese cultural preference than to economic factors. However, the culture-created clustering does generate economic consequences. When traders round the cent to 8 more often than to other numbers (1, 2, 3, 4, 6, 7, and 9), there seems no economic gain such as lowering negotiation costs, but substantial economic loss such as wider transaction costs.

5. Conclusions

This paper investigates price clustering in emerging stock markets – the Shanghai and Shenzhen Stock Exchanges in China. These exchanges adopt electronic trading with decimal pricing. Overall, we observe consistent clustering in close, bid, and ask prices, given the electronic trading and decimal pricing on the two exchanges. However, by and large, the degree of clustering seems lower on the decimal trading markets than on the fractional trading markets (such as the NYSE).

More importantly, we find that close, bid, and ask prices are rounded for both economic and cultural reasons in the Chinese market. Prices are rounded to the nearest 10s and 5s due to economic factors, while the last decimal point of prices clusters on 8 due to cultural factors. The lack of economic rational for clustering on 8 can be confirmed by the GMM test results. That is, the cross-sectional variation in 10-cent and 5-cent rounding can be well explained by price and inverse of square root of trading volume, with the adjusted R-squire of 29% and 24%, whereas the clustering on 8 can hardly be ascribed to economic variables, with the adjusted R-square of only 3%. In addition, our results show that the higher the frequency of clustering on 8, the bigger the bid-ask spreads. The clustering on 10s also exerts significant effect on execution costs.

The relationship between bid-ask spreads and clustering frequencies remains significant even with control for price, volatility, market capitalization, inverse of square root of trading volume, and transaction amount.

References

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, *Journal of Financial Markets* 1, 51-87.

Aitken, Michael, Philip Brown, Christine Buckland, HY Izan, and Terry Walter, 1995, Price clustering on the Australian stock exchange, Working paper, University of Western Australia.

Angel, J.J., 1997, Tick size, share prices, and stock splits, *Journal of Finance* 52, 655-681.

Bacidore, J., 1997, The impact of decimalization on market quality: An empirical investigation of the Toronto Stock Exchange, *Journal of Financial Intermediation* 6, 92-120.

Ball, Clifford A., Walter N. Torous and Adrian E. Tshoegl, 1985, The degree of price resolution: The case of the gold market, *Journal of Futures Markets* 5, 29-43.

Bessembinder, Hendrik, 1994, Bid-ask spreads in the interbank foreign exchange market, *Journal of Financial Economics* 35, 317-348.

Bessembinder, Hendrik, 1997, The degree of price resolution and equity trading costs, *Journal of Financial Economics* 45, 9-34.

Brown, Sharon, Paul Laux and Barry Schachter, 1991, On the existence of an optimal tick size, *Review of Futures Markets* 10, 50-72.

Chui, Andy C.W. and Chuck C.Y. Kwok. (1998). Cross-autocorrelation between A Shares and B Shares in the Chinese Stock Market. *Journal of Financial Research*, 21, 333-354.

Crack, Timothy Falcon and Olivier Ledoit, 1996, Robust structure without predictability: The "Compass Rose" pattern of the stock market, *Journal of Finance* 51, 751-762.

Godek, P.E., 1996, Why NASDAQ market makers avoid odd-eighth quotes, *Journal of Business* 65, 509-528.

Goodhart, Charles and Ricardo Curcio, 1992, Asset price discovery and price clustering in the foreign exchange market, Working paper, London School of Business.

Gottlieb, G., and A. Kalay, 1985, Implications of the discreteness of observed stock price, *Journal of Finance* 40, 135-153.

Harris, Lawrence E., 1990, Estimation of stock variances and serial covariances from discrete observations, *Journal of Financial and Quantitative Analysis* 25, 291-306.

Harris, Lawrence E., 1991, Stock price clustering and discreteness, *Review of Financial Studies* 4, 389-415.

Harris, Lawrence E., 1994, Minimum price variations, discrete bid-ask spreads, and quotation sizes, *Review of Financial Studies* 7, 149-178.

Harris, Lawrence E., 1997, Decimalization: A review of the arguments and evidence, working paper, University of Southern California.

Miller, G.A., 1956, The magic number seven, plus or minus two: Some limits on our capacity for processing information, *Psychological Review* 63, 81-97.

Simon, H.A., 1974, How big is a chunk? *Science* 183, 482-488.

Su, Dongwei. (1999). Ownership restrictions and stock prices: Evidence from Chinese markets. *Financial Review* 34, 37-56.

Sun, Qian and Wilson H.S. Tong. (2000). The effect of market segmentation on stock prices: The China syndrome. *Journal of Banking and Finance* 24, 1875-1902.

Venkataraman, Kumar, 2001, Automated versus floor trading: An analysis of execution costs on the Paris and New York Exchanges, working paper.

Table 1 Price frequency on 5s and 10s

This table reports price frequency on 5s and 10s for 771 A-share stocks in the Chinese markets. The sample period is from 1/1/1998 to 12/31/2000. Panel A reports the non-path-adjusted frequency. Panel B reports the path-adjusted frequency.

	Frequency			
Price Range (RMB)	All (1-40)	Low (1-9)	Middle (10-19)	High (20-40)
Average Price (RMB)	12.50	8.00	13.62	25.17
Number of Stocks	711	221	451	39
Panel A. Non-path-adjusted frequency				
Close price				
100s	2.60%	1.83%	2.83%	4.33%
50s	4.66%	3.52%	5.03%	6.88%
25s	7.27%	5.99%	7.72%	9.32%
10s	20.46%	17.01%	21.71%	25.46%
5s	33.25%	29.01%	34.91%	38.17%
Bid price				
100s	1.80%	1.20%	1.97%	3.24%
50s	3.42%	2.39%	3.72%	5.89%
25s	5.99%	4.65%	6.39%	8.94%
10s	16.48%	12.54%	17.69%	24.92%
5s	29.10%	23.38%	30.94%	40.25%
Ask price				
100s	2.75%	1.85%	2.98%	5.09%
50s	4.93%	3.58%	5.29%	8.42%
25s	7.80%	6.08%	8.33%	11.39%
10s	21.94%	17.55%	23.36%	30.44%
5s	35.99%	30.09%	38.01%	45.95%
Panel B. Path-adjusted frequency				
Close price				
100s	2.60%	1.83%	2.82%	4.32%
50s	4.68%	3.55%	5.05%	6.89%
25s	7.29%	6.02%	7.74%	9.34%
10s	20.48%	17.03%	21.74%	25.47%
5s	33.28%	29.04%	34.93%	38.18%
Bid price				
100s	1.80%	1.20%	1.97%	3.24%
50s	3.45%	2.43%	3.74%	5.90%
25s	6.01%	4.68%	6.40%	8.95%
10s	16.52%	12.57%	17.72%	24.94%
5s	29.13%	23.42%	30.97%	40.26%
Ask price				
100s	2.74%	1.85%	2.98%	5.08%
50s	4.95%	3.60%	5.31%	8.43%
25s	7.81%	6.09%	8.34%	11.40%
10s	21.96%	17.57%	23.38%	30.45%
5s	36.00%	30.11%	38.02%	45.95%

Table 2 Price frequency with the last decimal point on 0 to 9

This table reports price frequency with the last decimal point on 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9 respectively for 771 A-share stocks in the Chinese markets. The sample period is from 1/1/1998 to 12/31/2000. Panel A reports the non-path-adjusted frequency of close, bid, and ask prices. Panel B reports the path-adjusted frequency of close, bid, and ask prices.

Panel A. Non-path-adjusted frequency

	Frequency			
Price Range (RMB)	All (1-40)	Low (1-9)	Middle (10-19)	High (20-40)
Average Price (RMB)	12.50	8.00	13.62	25.17
Number of Stocks	711	221	451	39
Last decimal of close price				
0	20.46%	17.01%	21.71%	25.46%
1	7.44%	8.12%	7.16%	6.88%
2	8.11%	8.98%	7.80%	6.75%
3	7.42%	8.38%	7.08%	5.96%
4	7.26%	8.03%	6.98%	6.19%
5	12.80%	12.00%	13.19%	12.72%
6	8.00%	8.47%	7.84%	7.21%
7	7.08%	7.83%	6.76%	6.53%
8	11.71%	11.31%	11.86%	12.31%
9	9.71%	9.88%	9.61%	9.98%
Last decimal of bid price				
0	16.48%	12.54%	17.69%	24.92%
1	8.38%	8.94%	8.18%	7.56%
2	8.64%	9.16%	8.53%	6.96%
3	7.92%	9.10%	7.55%	5.57%
4	6.58%	7.99%	6.10%	4.17%
5	12.62%	10.84%	13.26%	15.33%
6	9.06%	9.48%	8.95%	7.99%
7	6.91%	8.17%	6.47%	4.90%
8	13.19%	12.56%	13.46%	13.71%
9	10.20%	11.21%	9.81%	8.89%
Last decimal of ask price				
0	21.94%	17.55%	23.36%	30.44%
1	5.84%	7.07%	5.37%	4.21%
2	7.98%	9.31%	7.55%	5.51%
3	7.04%	8.25%	6.62%	4.99%
4	7.50%	8.57%	7.15%	5.43%
5	14.04%	12.54%	14.65%	15.51%
6	7.16%	7.93%	6.91%	5.75%
7	6.53%	7.51%	6.18%	4.95%
8	12.10%	11.39%	12.34%	13.35%
9	9.87%	9.88%	9.86%	9.87%

(Continued)

Table 2 continued.

Panel B. Path-adjusted frequency

	Frequency			
Price Range (RMB)	All (1-40)	Low (1-9)	Middle (10-19)	High (20-40)
Average Price (RMB)	12.50	8.00	13.62	25.17
Number of Stocks	711	221	451	39
Close price				
0	20.48%	17.03%	21.74%	25.47%
1	7.45%	8.13%	7.17%	6.89%
2	8.10%	8.97%	7.80%	6.75%
3	7.41%	8.36%	7.06%	5.96%
4	7.25%	8.02%	6.97%	6.19%
5	12.80%	12.01%	13.19%	12.71%
6	8.00%	8.48%	7.83%	7.20%
7	7.07%	7.82%	6.75%	6.53%
8	11.71%	11.30%	11.86%	12.31%
9	9.72%	9.88%	9.63%	9.99%
Bid price				
0	16.52%	12.57%	17.72%	24.94%
1	8.39%	8.94%	8.18%	7.57%
2	8.63%	9.14%	8.52%	6.96%
3	7.90%	9.08%	7.53%	5.56%
4	6.57%	7.99%	6.09%	4.16%
5	12.61%	10.84%	13.25%	15.32%
6	9.05%	9.46%	8.94%	7.98%
7	6.91%	8.16%	6.47%	4.89%
8	13.20%	12.56%	13.46%	13.71%
9	10.23%	11.24%	9.84%	8.91%
Ask price				
0	21.96%	17.57%	23.38%	30.45%
1	5.85%	7.10%	5.38%	4.22%
2	7.99%	9.32%	7.55%	5.51%
3	7.03%	8.24%	6.62%	4.99%
4	7.49%	8.55%	7.15%	5.43%
5	14.04%	12.54%	14.64%	15.51%
6	7.16%	7.93%	6.90%	5.74%
7	6.52%	7.50%	6.17%	4.94%
8	12.09%	11.37%	12.34%	13.34%
9	9.87%	9.87%	9.87%	9.87%

Table 3
Summary statistics on sample characteristics

This table provides summary statistics on sample characteristics for 771 pairs of A-share stocks in the Chinese markets. The sample period is from 1/1/1998 to 12/31/2000. F8 is the frequency of close price with the last decimal point on 8. F10 is the frequency of close price with 10-cent rounding. F5 is the frequency of close price with 5-cent rounding. SPR is the daily average bid-ask spread in RMB. SPR% is the daily average bid-ask spread in percentage. P is the average close price. VOLA is the volatility of daily price returns. MV is the average market capitalization. V is the daily number of shares transacted. AMT is the daily amount of RMB transacted.

Parameter	Mean	Std. Dev.	Min.	Median	Max.
F10	20.46%	5.68%	11.05%	18.82%	41.47%
F5	33.25%	7.54%	20.96%	31.07%	56.36%
F8	11.71%	1.88%	7.50%	11.57%	18.39%
SPR (RMB)	0.028	0.014	0.011	0.025	0.150
SPR%	0.23%	0.06%	0.09%	0.22%	0.49%
P (RMB)	12.50	4.65	3.18	12.01	39.76
VOLA	1.45%	0.20%	0.89%	1.43%	2.01%
MV (1,000,000 RMB)	3,027	2,966	705	2,196	36,309
V (1,000,000 shares)	1.378	1.006	0.250	1.110	9.962
AMT (1,000,000 RMB)	16.233	11.222	4.044	13.495	148.499

Table 4
Regressions of price rounding frequency on trading variables

This table provides the GMM test results of price rounding frequency on trading variables for 771 A-share stocks in the Chinese markets. The sample period is from 1/1/1998 to 12/31/2000. The testing model is

$$F_i = \lambda_0 + \lambda_1 \log(P_i) + \lambda_2 VOLA_i + \lambda_3 \log(MV_i) + \lambda_4 ISTV + e_i,$$

where F can be F8, F10, and F5, F8 is the frequency of close price with the last decimal point on 8, F10 is the frequency of close price with 10-cent rounding, F5 is the frequency of close price with 5-cent rounding, P is the average close price, VOLA is the volatility of daily price returns, MV is the average market capitalization, and ISTV is the inverse of square root of daily volume.

Dependent Variable		CONST λ_0	log (P) λ_1	VOLA λ_2	log (MV) λ_3	ISTV λ_4	Adj. R^2
F10	Coefficient	-0.0414	0.0602	0.2485	0.0057	0.0508	29%
	t-value	*-0.99*	*8.79**	*0.24*	*1.53*	*5.26**	
F5	Coefficient	0.0330	0.0681	0.8437	0.0069	0.0676	24%
	t-value	*0.55*	*7.10**	*0.57*	*1.32*	*5.25**	
F8	Coefficient	0.0895	0.0076	-0.2565	0.0011	0.0044	3%
	t-value	*5.11**	*3.06**	*-0.64*	*0.66*	*1.16*	

*: A significance level of five percent or better for a two-tailed test.

Table 5
Regressions of bid-ask spreads against trading variables and rounding frequencies

This table provides the GMM test results of bid-ask spreads on trading variables and rounding frequencies for 771 A-share stocks in the Chinese markets. The sample period is from 1/1/1998 to 12/31/2000. The testing model is

$$SPR\%_i = \lambda_0 + \lambda_1 \log(P_i) + \lambda_2 VOLA_i + \lambda_3 \log(MV_i) + \lambda_4 ISTV + \lambda_5 \log(AMT) + \lambda_6 F + e_i,$$

where SPR% is the daily average bid-ask spread in percentage, P is the average close price, VOLA is the volatility of daily price returns, MV is the average market capitalization, ISTV is the inverse of square root of daily volume, AMT is the daily amount of RMB transacted, F can be F8, F10, and F5, F8 is the frequency of close with the last decimal point on 8, F10 is the frequency of close price with 10-cent rounding, and F5 is the frequency of close price with 5-cent rounding.

F		CONST λ_0	log (P) λ_1	VOLA λ_2	log(MV) λ_3	ISTV λ_4	log(AMT) λ_5	F λ_6	Adj. R^2
F = F10	Coeff.	0.0011	-0.0007	0.0505	-0.0001	0.0016	0.0003	0.0011	36%
	t-value	*2.22**	*-2.86**	*5.43**	*-1.51*	*3.81**	*1.33*	*2.29**	
F = F5	Coeff.	0.0010	-0.0007	0.0502	-0.0001	0.0017	0.0003	0.0006	35%
	t-value	*2.02**	*-2.82**	*5.35**	*-1.50*	*3.89**	*1.42*	*1.77*	
F = F8	Coeff.	0.0007	-0.0007	0.0514	-0.0001	0.0018	0.0003	0.0030	36%
	t-value	*1.42*	*-2.98**	*5.52**	*-1.62*	*4.15**	*1.64*	*2.94**	

*: A significance level of five percent or better for a two-tailed test.

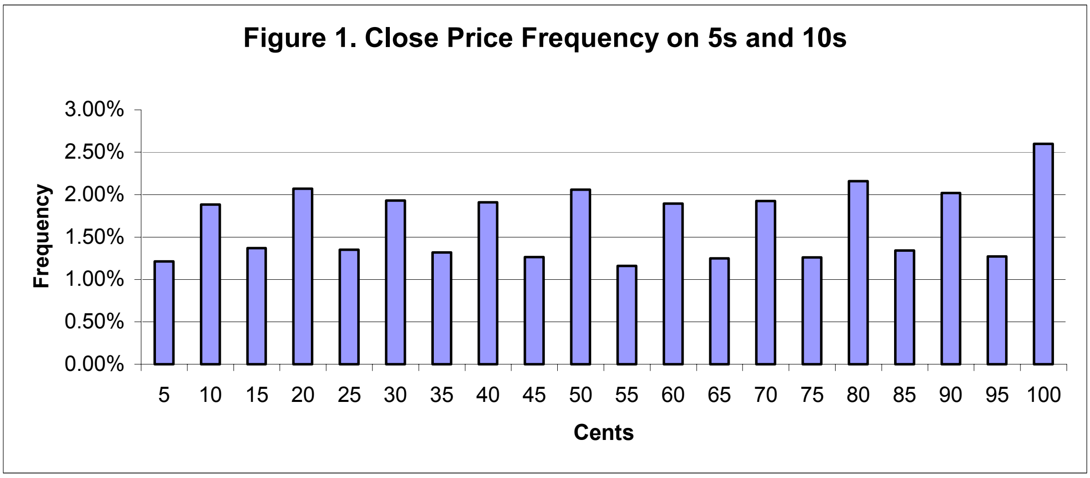
Figure 1. Close Price Frequency on 5s and 10s
Frequency
3.00%
2.50%
2.00%
1.50%
1.00%
0.50%
0.00%
5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
Cents

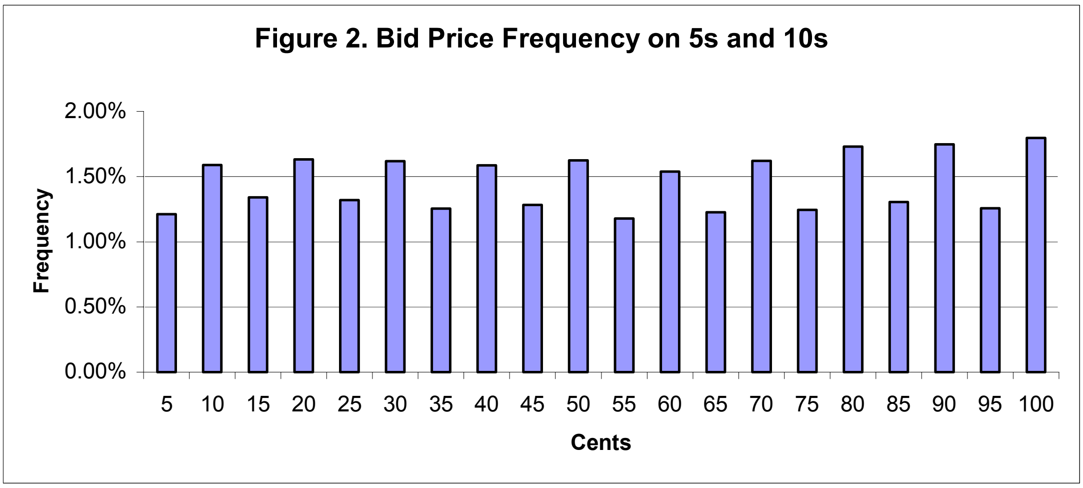
Figure 2. Bid Price Frequency on 5s and 10s
Frequency
2.00%
1.50%
1.00%
0.50%
0.00%
5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
Cents

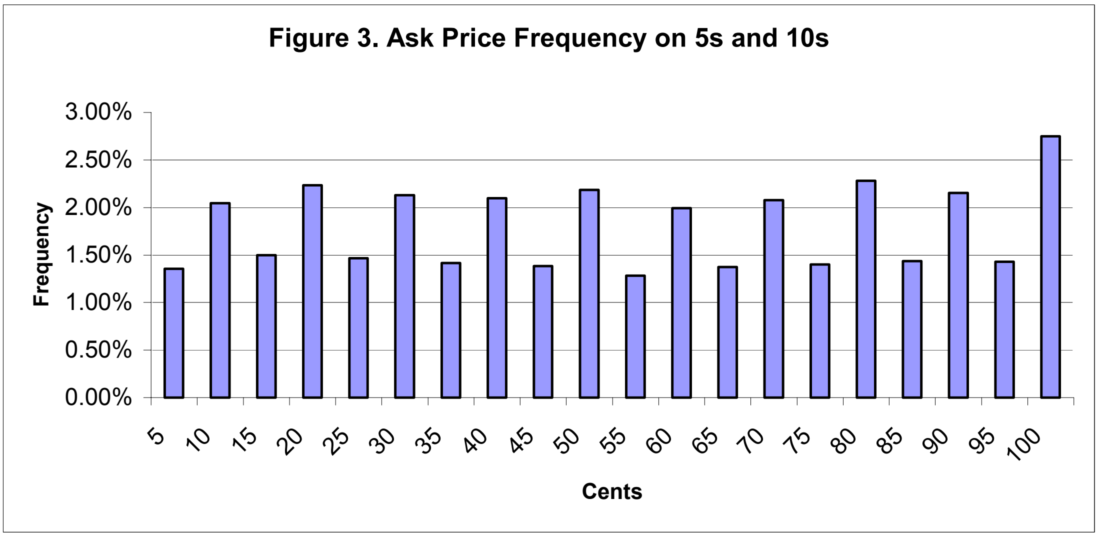
Figure 3. Ask Price Frequency on 5s and 10s
Frequency
3.00%
2.50%
2.00%
1.50%
1.00%
0.50%
0.00%
5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100
Cents

Figure 4. Close Price Frequency on the Last Decimal Point

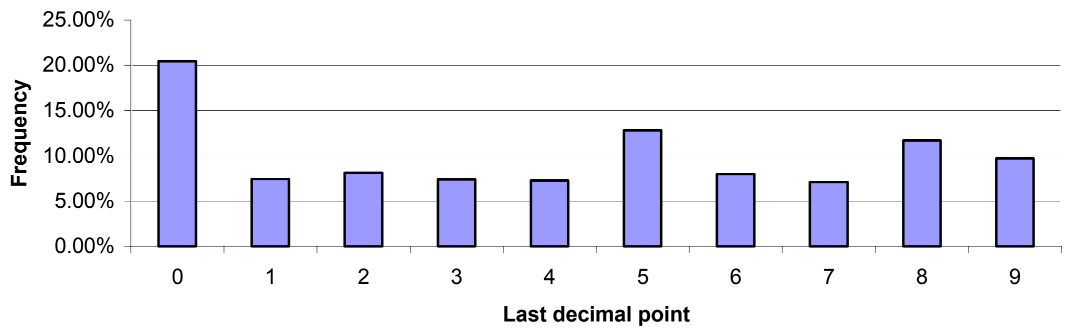

Figure 5. Bid Price Frequency on the Last Decimal Point

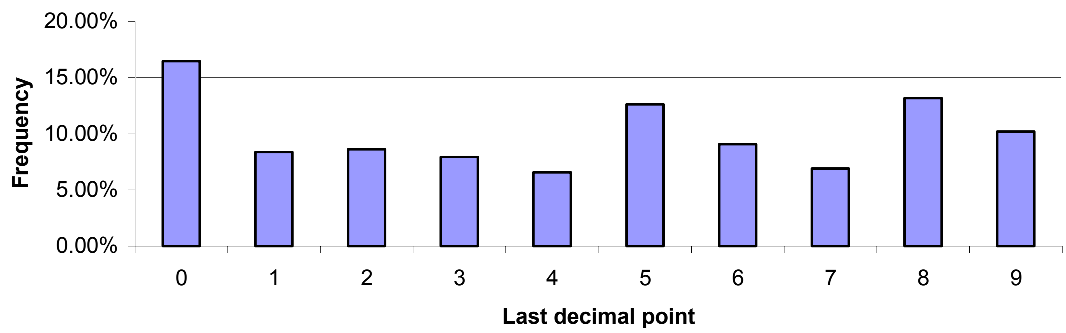

Figure 6. Ask Price Frequency on the Last Decimal Point