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Culture and stock price clustering: Evidence from The Peoples' Republic of China

by

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Abstract

Price clustering is the tendency of prices to be observed more frequently at some numbers than others. It results from human bias and from haziness or imprecise beliefs about underlying value. To many Chinese, the number "8" is salient because it is considered "lucky", while "4" is "unlucky" and to be avoided.

We conduct a tightly controlled experiment to determine whether a culturally heuristic number preference exists, by studying trading on the Shanghai and Shenzhen stock exchanges, which have been relatively segmented along cultural lines. Our results are extremely clear. For much of our sample period (1994 – 2002), the prices of A-shares (mostly held by Chinese organisations or individuals) traded on the Shanghai stock exchange were more than twice as likely to end in 8 as 4. Similarly, for A-shares traded on the Shenzhen stock exchange a preference for 8 was found. Preference for 8 on both A-share exchanges was initially very strong, but has dissipated somewhat over time. For the Shanghai A-shares the reduction in the preference only occurred in the most recent period whereas for Shenzhen the reduction occurred much earlier. Overall, the cultural preference was widespread for both A-markets and was in fact stronger in opening, high and low relative to closing prices. The preference for 8 was much weaker for B-shares, largely held by foreigners, on both exchanges.

Keywords: Stock price clustering; number preferences; feng shui; Shanghai and Shenzhen stock exchanges.

JEL Classification: G10, G14

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1. Introduction

Price clustering is the tendency of prices to be observed more frequently at some numbers than others. It results from human bias and from "haziness", or imprecision, about underlying value. Some numbers, such as those ending in 0 or 5, are traditionally more salient. Market agents tend to settle on the more salient numbers when submitting an order or quoting a price.

Osborne (1962) initially documented price clustering in equity markets, for a sample of closing prices on the New York Stock Exchange (NYSE). Osborne found high, low and closing prices tended to cluster most at whole numbers, followed by halves, quarters, and odd-eighths. This result was found for both buy and sell limit orders by Niederhoffer (1965) and in daily closing stock prices on the NYSE by Harris (1991). Other more recent studies such as Aitken et al. (1996) for Australia, Hameed and Terry (1998) for Singapore and Grossman et al. (1998) for the London market have demonstrated clustering effects in equity markets that use decimal trading rather than fractions.

It seems that number preference and discreteness, as evidenced by clustering, pervade most if not all financial asset markets. Clustering has been observed in the gold market prices (Ball et al., 1985), foreign exchange rates (Goodhart and Curio, 1991; De Grauwe and Decupere, 1992; Grossman et al., 1997; Mitchell, 1998; Sopranzetti and Datar, 2002.), stock index levels (Donaldson and Kim, 1993; Koedijk and Stork, 1994; Ley and Varian, 1994) as well as index, options and bond futures prices (Gwilym et al., 1998a; 1998b), bank deposit rates (Kahn et al., 1999), initial public offer auction bids (Kandel et al., 2001) and real estate prices (Palmon et al., 2004).

One previous study Brown, Chua and Mitchell (2002) — hereafter, BCM — examined the influence of Chinese culture on price clustering. Their paper was motivated by the observation that particular numbers have special meaning and significance to the Chinese. Under feng shui and Chinese superstition, some numbers are "unlucky" and should be avoided. For instance, the number 4 is particularly inauspicious, because the Cantonese pronunciation of 4 is very similar to the phrase "to die". Thus, it has been observed and is not uncommon for the Chinese to avoid buying houses or apartments with the number 4 in their address (Lip, 1992; Bita, 1997). Correspondingly, the Chinese keenly seek car license plates and residential addresses containing an 8, because the number 8 is regarded as highly auspicious — it sounds like "good luck", "succeed" and "prosper".

BCM studied price clustering in six Asia-Pacific markets, namely Australia, Hong Kong, Indonesia, the Philippines, Singapore and Taiwan, using daily closing stock prices over the period 1994 to 1998. They found some evidence that Chinese culture and superstition influence the number preferences of traders in Hong Kong but for the other five countries, including those with higher proportions of ethnic Chinese, the evidence was weak.

One issue that concerned BCM was the open nature of and potential influence of foreign investors in the equity markets they studied. They attempted to control for this by introducing dummy variables for stocks listed on overseas exchanges and for stocks traded externally in the form of Depository Receipts. BCM also focused their attention on five widely celebrated Chinese festival periods, believing that cultural effects are more likely to be present on these occasions (Stepanchuk and Wong, 1991). Specifically, BCM found that the influence of Chinese culture and superstition was significant in Hong Kong during the auspicious Chinese New Year, Dragon Boat and Mid-Autumn festivals.

We take a different approach. We study the clustering of prices of companies listed on the Shanghai and Shenzhen stock exchanges, differentiating between A- and B-shares. Market segmentation over much of the period we study — the A-shares were held by PRC nationals while the B-shares were held by foreigners — substantially sharpens the experiment. The segmentation of the PRC markets provides a better setting in which we can more easily identify the effect of different investor behaviour and culture on clustering. We are also able to document any change in the cultural effect over time following the reduction in the segmentation of the A- and B- markets.

We find a high level of culture-induced price clustering in the prices of the A-shares, but less so for the B-shares relative to the A-shares on each exchange. For instance, the prices of A-shares traded on the Shanghai stock exchange were more than twice as likely to end in 8 as 4 for much of the sample period. The implications, for market makers and traders operating in the PRC, are obvious. In PRC A-markets if traders value immediacy then in addition to placing orders at whole numbers and fives then 8s would be advantageous as they tend to trade most often.

2. Method

2.1. Why prices cluster

The literature on price clustering is summarized in BCM so there is no need to repeat it in detail here. Various reasons have been suggested. Mitchell (2001) provides a good overview of these reasons. They include human bias (Yule, 1927; Kendall and Smith, 1938), haziness and bounded rationality (von Neumann and Morgenstern, 1953; Ball, Torous and Tschoegl, 1985; MacCrimmon and Smith, 1986; Loomes, 1988; Butler and Loomes, 1988). All of these basic aspects of general behaviour can be amalgamated into two specific hypotheses dealing with number preference in financial markets: Goodhart and Curcio's (1991) "attraction" hypothesis (see Aitken et al., 1996; BCM) and the "informational equilibrium

pricing" or "price resolution/negotiation" hypothesis of Ball et al. (1985) and Harris (1991).

The attraction hypothesis relates primarily to the natural tendency to round or focus on salient numbers. In the decimal system the basic attraction is generally such that numbers are preferred in the following order: 0, 5, 2=8, (3=7, 4=6) and then 1=9. Alternatively, the preference could be as follows: 0, 5, even and then odd numbers.

The price resolution/negotiation hypothesis is concerned primarily about the uncertainty of value and its impact on the price setting process. The hypothesis trades off the competing notions that in the price setting process a coarser grid (more clustering) is a means of reducing the high negotiation and/or information costs but correspondingly the coarser the grid the higher the likely cost from a sub-optimal price and/or associated lost gains from trade. In brief, the higher the value of the asset then the coarser the price grid as market participants are less concerned about fine partitions of value. The degree of price clustering is related to the stock price level or the value of the asset. In particular, for a given tick size there is less clustering at the bottom end of the price range. Naturally the coarseness of the price grid and hence any related clustering is constrained by the minimum tick size available on the exchange. Similarly, as information benefits are lower, price grids are coarser where asset values are known less precisely or when the market is more volatile. Finally, traders choose more salient numbers because they help them to transact more quickly — and they value immediacy. As a result they also use a coarser price grid when a stock is traded more thinly.

2.2. Experimental design

The effect we are observing turns out to be strong in the PRC, so our tests use a straightforward experimental design. We measure the frequencies with which prices ending in each digit 0–9 are observed and compare the results for A and B class shares. We control for the attraction hypothesis by comparing (i) the frequency of 2 with 8 (both are even numbers and equi-distant from 0 and 5), and (ii) 4 with 6. We then compare (iii) the frequency of 4 with 8. The first and second comparisons, 2 with 8 and 4 with 6, allow us to compare the predictions of cultural effects with Benford's Law,[1] while controlling for the attraction hypothesis.[2] The third comparison, 4 with 8, contrasts the prediction of cultural effects (8 is more prevalent than 4) with the joint prediction of both Benford's Law and the attraction hypothesis (4 is more prevalent than 8).

In a second set of tests we attempt to explain the circumstances under which a given price is even more or less likely to end in 4 rather than 8 (i.e., relative to the unconditional expectation.) To do this, we fit four binomial logistic regressions to sub-samples, one for each exchange and share type and where the last sale price

[1] Benford's Law (Benford, 1938) applies to naturally occurring numbers. It predicts larger numbers occur with declining frequency. For an application to securities markets, see Grenci (2001).
[2] Note that 2 and 8 are equi-distant from 0 and also from 5 — as are 4 and 6.

ended in either 4 or 8. The dependent variable reflects whether it ended in 4 (cluster categorical variable =1) or 8 (variable =0). The explanatory variables consist of "culture"-related dummy (categorical) variables (whether the price relates to a trade within one of several festival periods) and control variables that proxy for the precision of beliefs about the share's "intrinsic" value and the expected coarseness of the price grid. The likelihood ratio (LR) statistic is used to test the joint null hypothesis that all of the model's coefficients except the constant are zero. Each model's overall goodness-of-fit is indicated by its McFadden *R*-square. We also report the percentage of clustered and non-clustered cases that are correctly predicted, and the percentage gain in correct predictions made by the logit model relative to a pure chance assignment of cases to the clustered/non-clustered categories (i.e., according to their frequencies of occurrence within the sample).

3. Background

3.1. Share markets in the PRC

History and Institutional Factors in the PRC Share markets

We start with a brief history of PRC markets, to set the scene. The PRC established its first share markets in Shanghai and Shenzhen, which officially commenced trading in December 1990 and July 1991 respectively.[3] PRC companies may currently issue three categories of tradable shares: A-shares, B-shares and H-shares. All three categories are distinct blocks of shares issued by the same company. At the outset, only A-shares were allowed. The A-shares are denominated in RMB/Yuan and can be traded by domestic entities. In 1991 a second category of shares was created, namely B-shares, which are restricted to foreign shareholders. B-shares are traded in foreign currency — USD on the Shanghai and HKD on the Shenzhen exchanges. The third category, H-Shares, represents shares of Chinese companies listed on the Hong Kong stock exchange. They are naturally traded in HKD and are designated as foreign shares. H-shares are similar to B-Shares in that they form an alternative block of foreign-owned shares. Companies with B-shares may not have H-share listings and vice versa. The three classes of shares are otherwise identical, in that they are ordinary shares with the same voting and distribution rights. In addition, some Chinese companies have foreign dual listings of their H-shares in London (L-shares) or New York (N-shares). Alternatively the B-/H-shares can serve as backing for ADRs. They simply represent a portion of the B-/H-share block traded on a different exchange. Table 1 summarises this background.

< insert Table 1 about here >

While A-shares are available to all mainland PRC individuals and legal entities, the amount of free-float or tradability of these shares remains low (see Table 1). This is due to a large portion of the domestic category being designated as state shares or "legal-person shares". These shares are held by the state, state-owned-enterprises (SOEs) or Chinese institutions and may not be traded. Wu et al. (1996) classify

[3] The Shenzhen Stock Exchange commenced trading on an informal basis in December 1990.

SOE shares into three groups: (i) *Guojia Gu* – shares owned by the state; (ii) *Faren Gu* – shares owned by other state owned enterprises; and (iii) *Faqiren Gu* – shares owned by the founding SOEs. The last two groups are part of the non-tradable "legal-person shares" that are effectively owned by domestic legal entities — companies, SOEs and non-bank financial institutions. Finally, some shares are issued as employee shares, again non-tradable for a moratorium period before they become part of the listed A-shares. The high non-tradable portion of the A-shares reduces liquidity for local investors.

B-Shares and H-shares were primarily introduced to provide PRC firms with access to much needed foreign equity capital. However the capitalisation, volume and turnover of B-shares have remained low relative to A-shares (see Table 2). As part of an ongoing plan for deregulation, on 19 February 2001 the CSRC relaxed the restriction on mainland ownership of B-shares to allow domestic investors with legal "hard" foreign currency to purchase them. This is part of the general reform by the CSRC to eventually integrate the domestic and foreign markets. The success of the B-shares has been impeded by the fact that foreign investors prefer H-shares, largely due to their fewer restrictions on trading (see below), the closer regulation and greater liquidity of the Hong Kong market, and the higher quality of research on companies issuing H-shares.

< insert Table 2 about here >

Growth and development of the PRC markets

Originally established in the early 1990's, the growth in PRC share markets has been extremely rapid and persistent. For instance over the period from 1994 to 2002 the total number of companies listed has more than quadrupled from 280 to 1,271. This increase has largely been evident in A-share listings as PRC companies sought to attract domestic capital. B-shares and the "foreign" H-share listings experienced a similar rapid expansion over the same period. However, the B/H-share growth in market value, while impressive in itself pales in comparison with the increase in tradable market value of the Shanghai (1,531%) and Shenzhen A-shares (1,421%) over the same time period (see Table 2). The market capitalization of the total China market at the end of 2002 is USD165.6 billion, the biggest proportion (USD140 billion) of which is associated with the A-share market and USD25.6 billion with the other markets. Figure 1(a) for the A-share and Figure 1(b) for the B-share markets provides a relative comparison of the movement in the A- and B-Index levels and reinforces the A-share market's rapid expansion to 2000, although it declined somewhat during the 2001 recession.

< insert Figure 1 about here >

The rapid development and growth of the PRC share markets can be attributed primarily to three interrelated factors. First, as already mentioned, is the continued demand and the restricted number of shares available to PRC domestic investors, which have resulted in upward pressure on prices. Second, economic output (GDP) has grown strongly in the PRC, which together with a high savings rate and

few viable investment alternatives, has contributed to a vast number of potential new investors and a large amount of wealth ready for investment.[4] Finally, international investors, especially institutions and corporations, have sought to enter the Chinese market, through direct and indirect investment, in an effort to secure access to potentially the biggest consumer market in the world. This has again encouraged the influx of capital, the listing of companies and the expansion of the PRC share markets.

Descriptive statistics for the period 1994 to 2002 in Table 2 illustrate two other important aspects of the PRC markets. First, the A- and B/H-share markets have been largely segmented and unrelated in terms of their investment performance over the recent period. For instance, the performance of the B-share markets (see Figure 1(b)) is mixed, with large gains in the first half of 2001 that then tapered off in the second half. In contrast the A-share market performance in Figure 1(a) and Table 2 is negative for the year 2001. Over the full 1994-2002 sample period risk differences are also apparent. The B-share markets have a lower initial standard deviation of return but higher volatility in later years, which contrasts with the A-share markets, where volatility decreased after 1996. This reduction in volatility may be partly due to the re-introduction of limits to price movements in December 1996. Volatility in B-shares was undoubtedly influenced by the Asian financial crises of 1997, the subsequent recovery and then the recession in 2001. Volatility of B-shares increases substantially from 1999.

Second, the Asian financial crises and subsequent recession had an impact on the B- and H-shares but the A-shares were largely immune. The closed nature of the A-share market and trading restrictions of the A-shares insulated them from the fallout and subsequent economic weakness. This is evident in the Table 2 summary statistics, as the B- and H-shares all have a reduction or a plateau in their market capitalisation, trading volume and turnover over the 1997-1998 period and negative average daily returns in 1998. In contrast, the A-share markets continued to expand and perform relatively well (Figure 1(a)). The recession in 2001 affected both A- and B/H-share markets alike, although to differing extents, most likely due to the global nature of the recession and its impact on the Chinese economy.

A third aspect is that the H-share market has been and remains more liquid than the B-share market. Market capitalisation, volume and turnover of the H-shares were substantially higher relative to the B-shares over the sample period (Table 2). That said, the turnover in the A-share markets is by far the highest across all markets and stands at USD1.4 billion a day relative to the combined B/H-share turnover of USD115.5 million for 2002. Like the red-chip companies listed in the

[4] See the SFC Bulletin, Market Segmentation and the Pricing of Different Categories of Stock in Mainland-Incorporated Companies, Research Department, Hong Kong Securities and Futures Commission, July-September 2000.

Hong Kong market,[5] the H-shares have been the worst performers over the period 2000-2002 (Table 2 and Figure 1(c)). Their poor performance is in contrast to Hong Kong companies generally, as represented by the Hang Seng Index (Figure 1(c)). Hang Seng companies had mixed fortunes, related mainly to the turbulent economic conditions in the Hong Kong market. Hence the H-share performance does not appear to follow the Hong Kong market either and presumably has been driven largely by the actions of foreign investors, who have discounted the H-shares. This discount may be due to concerns about the performance of the SOEs as well as the fact that issuers of H-shares tend to be larger companies than the issuers of B-shares. Further, the issuers of H-shares are generally in the less-risky infrastructure industries, where the share market tends to be more liquid with a greater pool of tradable shares and a less restrictive trading environment.

In brief, the summary statistics clearly illustrate that while there has been substantial growth in the PRC markets, their growth and performance differs across the various share classes and reflects market segmentation. The statistics of the various markets thus further emphasize the structural differences and different trading behaviour for otherwise identical shares. The substantial volatility as well as the emerging nature of the PRC markets suggests that greater clustering should be evident.

Institutional trading rules and tick size

Chinese companies may list on the Shenzhen or Shanghai Exchanges but not both. At select times shares traded on the Shanghai and Shenzhen markets have been subject to daily price limits that restrict price movements in a single day to a maximum of 10% of the previous day's close. Price limits were introduced on 27 July 1990 to counter potential excess volatility but were lifted on 12 May 1992 as a result of thin trading in the markets. As noted above, the PRC markets grew strongly over the 1992-1995 period, with increasing and substantial volatility. In order to curb what was believed to be excess speculation, trading limits were reintroduced on 16 December 1996 (Chen et al., 2002) and they remain until the present time.[6] Hence, for our data set, prior to 16 December 1996 a free trading policy was in effect whereas after this date it was not. Two other restrictions currently apply. First, firms that have reported two years of losses are designated "special treatment firms" and have a price limit movement of 5% per day. Second, companies that have posted losses for three or more years are noted as "particular transfer" firms and are then traded only on Fridays.

The tick size for the A-shares on both the Shanghai and Shenzhen exchanges is RMB0.01. For the B-shares listed in Shanghai the tick size is USD0.001 and for the

[5] Red-chip or China Affiliated Corporations are Hong Kong listed companies that have 35% or more of their shareholding held by PRC mainland entities including SOEs and other governmental or municipal authorities.

[6] As per section 62 of the Shenzhen and Shanghai Stock Exchange Trading Regulations.

Shenzhen Exchange it is HKD0.01.[7] Tick size on the Hong Kong exchange is HKD0.01.

Price differentials

One curious aspect of the China stock markets is the difference in prices of A-shares relative to B-shares issued by the same company. This is generally known as the A-share premium (or B-share discount). Initially documented by Bailey (1994), this effect is persistent (Ma, 1996; Fang, 1997; Chakravarty et al., 1998). The A-share premium is somewhat unique to the markets in China. In other segmented markets where there is a distinction between restricted shares (held by locals only) and unrestricted shares (foreigners and locals) the restricted shares trade at a discount (Bailey et al., 1999), which is the reverse of the China A-share premium.

The persistence of the China A-share premium has been attributed to three interrelated factors: the segmented market itself (Poon et al., 1998; Fung et al., 2000) that effectively creates an excess demand and restricted supply of A-shares for mainland investors; a lack of liquidity in the B-share market driven by the higher trading cost and the low number of tradable shares in the B-market (Chen et al., 2001); and the lack of alternative investment opportunities for mainland investors, whereas foreign investors have alternatives in the form of H-shares and red-chip shares (Sun and Tong, 2000). This third aspect increases the elasticity of demand for the B-shares and is partly related to an information differential and liquidity aspects of dealing in shares listed on Hong Kong rather than the PRC exchanges, as noted previously. Other theories include excess speculation by Chinese investors (Ma, 1996) and equilibrium pricing in terms of risk (Sun and Tong, 2000). A final point is that the difference in prices has not reduced, as arbitrage possibilities have been limited by ownership restrictions and stringent Chinese capital and currency controls.

Implications

For our purposes, the important implication of existing and continuing price differences between the A- and B-share markets is clearly that the markets are substantially segmented, with distinctive trading behaviour and market idiosyncrasies. It has been established that there are differences in the way the two markets respond to information (Choi and Kwok, 1998), with the B-shares leading the A-shares. A-shares have greater underpricing and greater performance subsequent to listing compared to B-shares (Mok and Hui, 1999; Chen et al., 2000). Other important differences as noted earlier relate to the market participants, namely their culture and the fact that many A-share traders are largely uninformed and inexperienced individuals, with few information resources compared with the institutional investors that dominate the B-share market (Kim and Shin, 2000). Price clustering is likely to be different across the markets as a result of these institutional and cultural differences.

[7] As per section 57 of the Shenzhen and Shanghai Stock Exchange Trading Regulations.

Ownership restrictions have already been relaxed and further change is likely, along with the relaxation of capital controls. This may cause any culture-related clustering behaviour to dissipate in the future, as the markets become more integrated. Given that the A-shares predominate in terms of market capitalisation and turnover, any clustering behaviour of the A-share prices is likely to be visible in the B-share market, at least in the short-run. We argue this is likely to continue until sufficient foreign investment flows in to offset and alleviate the behavioural tendencies of the local mainland investors.

One final aspect relates to changes over time. An increasing number of PRC individuals may have invested in the foreign B-share market through foreign entities or relatives and offshore accounts. It is partially supported by the evidence of McGuinness (2002), suggesting that the A/B-share premium has been reducing over time. However, Sun and Tong (2000) note that the monthly average A-share premium if anything increased over the 1994-1998 period for shares traded on the Shenzhen and Shanghai exchanges, as did the A/H-share premium for shares traded on the Hong Kong exchange. If a recent shrinking of the A/B-share premium were sufficiently widespread, we would expect to see a trend, over time, in clustering behaviour. More specifically as the market matures and there is more foreign and informed trader influence in the market then one would expect to see less cultural number clustering and a reduction in the relative preference for 8s and avoidance of 4's. Similarly as more information is released to the market traders will be able to partition value more accurately and we should observe a reduction in the clustering in general and in particular on round numbers such as 0.

4. Data

4.1. Share prices

Daily opening, high, low and closing share prices and other market data over the period 19 December 1990 to 31 December 2002 were sourced for the PRC markets from the China Stock Market and Accounting Research Database,[8] and the corresponding H-share and London Stock Exchange (LSE) price data are sourced from Datastream.[9] The final digit of price is our clustering digit. The opening, high, low and closing prices are all individual trade prices.[10] Because of the restricted number of companies, the high growth rate, volatility and speculation in the initial period for the PRC market we only examine and test for clustering effects using the data from 1 January 1994 onwards.

4.2. Explanatory variables

Cultural Variables

The same five festivals studied by BCM are analysed here, so that we can compare our respective results. They are the Chinese New Year, Dragon Boat,

[8] Available from China Accounting and Finance Research Centre, The Hong Kong Polytechnic University.

[9] The cross-sectional logit tests use data only until 31 December 2000.

[10] More recently the closing prices reported on the CSMAR database are volume-weighted average price over the last minute of trading but for our sample period the prices related to a single trade.

Mid-Autumn, Clear Brightness, and Hungry Ghost festivals. A Chinese Lunar Calendar conversion program from the worldwide web was utilised to identify the last two trading days before, and the first two trading days after, the first day of each festival.[11] A dummy variable was then assigned to denote a trade within each festival period.

Control Variables

To maintain consistency with BCM, the precision of beliefs about a share's "intrinsic" value is proxied by the natural logarithm of the firm's market capitalisation and its share price volatility. Market capitalisation was taken to be the aggregate market value of a company's A, B and H shares. Volatility of each stock was calculated as the standard deviation of its daily return for the previous 60 trading days.[12] The expected coarseness of the price grid was proxied by the natural logarithm of the share price. Liquidity was proxied by trading volume.[13]

5. Results

5.1. Frequency counts

In the absence of cultural effects on price clustering in the PRC markets, and assuming Benford's Law applies, we would expect to observe prices ending in 2 more often than 8, 4 more often than 6, and 4 more often than 8. If there are no cultural effects and Benford's Law does not apply but the Attraction Hypothesis does, we would expect to observe 2 as often as 8, 4 as often as 6, but 4 more often than 8. However, if cultural effects are present and sufficiently strong, market segmentation in the ownership of A and B class shares suggests they will be more strongly manifest in the prices of A- than B-shares; and in particular, because under Chinese tradition 4 is to be avoided whereas 8 is to be desired, A-shares are likely to exhibit (i) lower frequencies of 2 relative to 8, (ii) lower frequencies of 4 relative to 6, and (iii) lower frequencies of 4 relative to 8.

Table 3 gives the frequencies with which each clustering digit appeared, for the Shanghai and Shenzhen A- and B-shares, and for the Hong Kong H-shares and the LSE fully paid ordinary shares as comparison groups. The LSE was chosen as the natural benchmark. It used a decimal pricing system over the whole sample period;[14] and among exchanges that trade in decimal price ticks the LSE is the largest, most transparent and liquid international market with substantial participation by informed institutional investors. In particular no Chinese cultural effect is likely to be manifest in LSE prices. There is no official tick size for the LSE

[11] The Chinese Lunar Calendar Conversion program was obtained from http://www.chinesefortunecalendar.com

[12] The returns were censored by filtering out price changes greater than 20% because they are more likely to be due to data errors or major changes in the basis of quotation. We also measured volatility by (i) the spread between that day's high and low price (relative to their average) and (ii) the standard deviation of its daily return for the previous 60 days without censoring larger price changes. The results are robust to these alternatives.

[13] BCM's results were robust to three different measures of liquidity.

[14] The NYSE and the NASDAQ moved to decimal trading on the 29 January 2001.

but convention is to trade to the nearest penny. Companies constituting the FTSE All Share Index as at the end of 2002 were used to represent the LSE market.

Table 3 shows that our cultural hypothesis finds mixed support when we measure the relative frequency with which daily closing prices cluster on each digit. Clearly 8 occurs more frequently than 2 for both the Shanghai and Shenzhen share markets and for both the A- and B-share types; the same can be said for 6 v. 4, and a fortiori 8 v. 4. There is no obvious preference for 8 and only slight avoidance of 4 on the benchmark LSE. However, when we compare across share types for the one exchange, there are fewer 4's relative to 8's for the Shanghai A-shares than for the Shanghai B-shares (ratio of 0.69 and lower than one as predicted), but the same result is not found for the Shenzhen market (ratio of 1.07).[15] The very large sample sizes means that these differences are statistically significant.

< insert Table 3 about here >

One possibility is that the Table 3 results are driven by extreme clustering at the top or bottom of the tradable price range or by shares in price bands where there are few observations. Hence, relative frequencies for Table 3 were recomputed for a "restricted data set". The restricted data set uses only price ranges for which (i) there was a relatively substantial number of observations within narrow price bands (e.g. 10c or equivalent) and/or (ii) the price ranges were not extreme (high/low). The price ranges used were RMB3 – 30 for the Shanghai A and RMB3 – 25 for the Shanghai B-market. Similarly, the price range for the Shanghai B and Shenzhen B market was USD0.1 – $1 and HKD0.51 – 7, respectively. Overall, this captures approximately 95% of the total data for each A-share exchange and 90% for each B-share exchange. The LSE price range was limited to GBP0.51 – 10.00 for the restricted data set covering 90% of the original observations. The price range used for the H-shares was already restricted to HKD0.51 – 2 so no further adjustment is necessary for the HK market. Clustering results using the restricted price data set were almost identical to the Table 3 documented clustering above, illustrating that the results are reflective of the typical trading behaviour and the core price range within each market.

Table 4 sharpens the focus on the frequency of 2, 4, 6 and 8. It weights each share price equally within each day (to calculate a given ratio of clustering frequencies for that day) then in turn weights the ratio for each day equally within the sample period. Because the number of listed shares has been growing over time, the metrics in Table 4 are less influenced by more recent experience than those in Table 3. Nonetheless Table 4 confirms that, when the number of 4's and 8's differed, there were fewer 4's than 8's on 98% of days on which A-shares were traded on the Shanghai exchange. The corresponding figures are 70% for Shanghai B-shares, 82% for Shenzhen A-shares and 65% for Shenzhen B-shares.

[15] For Shanghai the comparative 4 to 8 ratio between the A- and B-markets is (6.6/12.2)/(13.2/16.8) = 0.69 and for Shenzhen it is (8.2/10.7)/(7.6/10.6) = 1.07.

These results are consistent with Table 3. In contrast, the corresponding number for Hong Kong H-shares is 47% and for shares traded on the LSE it is 67%.[16]

< insert Table 4 about here >

Interestingly, when the frequency of 4's to 8's is weighted by days (Table 4) then the comparison of the A-shares to B-shares ratio for Shanghai is 0.57 (0.54/0.94) and for Shenzhen it is 0.89 (0.76/0.85) both lower than the non-daily weighted ratio above. This suggests that fewer 4's relative to 8's in the A-market compared with the B-market for Shenzhen occur predominantly in the earlier years of the sample period and that this has dissipated more in recent years. In addition, for Shenzhen the avoidance of 4's to 8's for the A- relative to B-market is located in a select group of shares. The relative 4 to 8 ratio comparison across the markets using the most likely observation, or median, is much higher at 1.13 (0.75/0.65) relative to the mean of 0.89. Hence there are a few observations that skew the distribution of the ratio downward. This is also apparent in the Shanghai markets (median 4 v. 8 ratio is 0.68) but the difference relative to the mean of 0.57 is not as prominent. This implies a broader cross-section of shares and/or persistence of the difference in the frequency of 4's to 8's in the Shanghai market.

Figure 2 addresses the issue of possible secular change by plotting the time series of the ratio of 4's to 8's, for the Shanghai and Shenzhen A- and B-shares.[17] The almost-vertical dashed lines connect the ratio on successive days and the solid line is a simple 50-day moving average to dampen the noise. In brief, the graphs are consistent with cultural effects on the incidence of price clustering, especially for the Shanghai A-shares (Figure 2(a)). For the Shanghai A-shares the value of the ratio is steady around the mean of 0.54; i.e., prices end in 8 twice as frequently as 4 up until the end of 2001. However, there is a distinct and upward shift starting at the end of 2001 with the ratio settling at value of 0.8 from late 2001. The Shanghai B-shares fluctuate around the overall mean of 0.95 for the whole sample period (Figure 2(b)). Consequently, the preference for 8 relative to 4 on the Shanghai B-share exchange has remained largely consistent over the sample period. During the first three years of trading (Figure 2(c)), the ratio for Shenzhen A-shares was noisy, but since about April 1997 it also has fluctuated around 0.80 (implying a mean ratio of 4's to 8's of 9:11). Finally, for the Shenzhen B-shares there was an unexplained upward trend until somewhere about 1998/99; after then, the trend in the ratio seems to have dissipated, with a mean ratio very close to 1 (Figure 2(d)). The LSE results display a constant value of approximately 0.95 for the 4 to 8 ratio over the sample period (the LSE figure is not reported).

< insert Figure 2 about here >

[16] The ASX is not a good control as noted in BCM, primarily due to the relative high frequency of 4. BCM comment the low frequency of 4 (and 3) mainly stems from the relatively high concentration and attraction of 0 and 5 on the ASX rather than any cultural influence.

[17] We also compare the ratio of 4 to (4 + 8) as an alternative way of analysing the time series trend. This ratio has the added advantage that it does not need the frequency of trades on 8 to be positive for the comparison. The figures reveal similar results to the 4 to 8 comparison.

5.2. Sub-sample results

There have been structural shifts in the flow of information and the exuberance of the PRC market over the years (Chen et al., 2001). The Company Law took effect in China on 1 July 1994 and required the provision of standard financial disclosures such as financial statements and semi-annual periodic reports which was not previously the case. This Law also imposed penalties for false disclosure. Chen et al., 2001 commented that in late 1994 the market became "less speculative and relatively rational" (p. 144). Whether Chinese investors became more rational after December 1994 is a moot point. It is clear from Table 2 and Figures 1(a) and 1(b) that market sentiment has changed and that market has become less volatile with more depth and liquidity. However, the change took time and occurred mainly after 1996, not 1994. Crucially, in an effort to curb excessive volatility trading restrictions, a daily maximum of 10% daily movement in share price was put in force from 16 December 1996 (Mookerjee and Yu, 1999). Hence there is a price restriction policy after December 1996 but not before, which provided a natural structural break at that time.

Some variation in market behaviour occurs over the remaining time period 1997 – 2002 as well. The period from 1997-1998 was undoubtedly influenced by the Asian financial crisis, which impacted severely on the B-Shares. The A-shares were affected to a lesser degree although there was a decline in volatility and a plateau in market capitalisation, trading volume and turnover of the A-shares over this period. From approximately 2000 onwards a strong interest and increasing demand for B-Shares mainly from overseas investors occurred as evidenced by the increase in liquidity, variance and growth in market capitalisation as well as performance over the period 2000 to 2001 (Table 2 and Figure 1(a) and (b)). It also corresponds with a subsiding of the trading frenzy in the A-shares, as can be seen in the levelling off of the index over the later period (Figure 1) and the reduction in volatility although performance and growth in the A-market has remained steady up to 2001. All PRC A- and B-share markets contracted in 2002 and the performance is negative over the 2002 year for all PRC markets.

The growth in the B-share market has come from two main factors. One is the leakage of PRC domestic investment into the "foreign" market and the other is from foreign investors continued speculation about the opening up of the B-share market, the role of the PRC in the world economy and the eventual merging of the A- and B-share markets. Already, over the recent period some of this has been realised with China's accession into the World Trade Organisation on 12 December 2000, and the opening of the B-stock market to domestic investors with hard currency holdings from 19 February 2001. While the structural shift is difficult to pinpoint exactly, the interest in the B-shares seems closely linked to the steady increase in prices and volatility from about 2000 onwards.

Given the structural changes above for both A- and B-shares, we split the initial sample into three sub-periods (i) before 31 December 1996 (volatile and rapidly expanding A-share market); (ii) from 1 January 1997 to 31 December 1999

(introduction of price limits and then Asian financial crisis – June 1997) and (iii) from 1 January 2000 onwards, which is characterised by a volatile and rapidly expanding B-share market.

< insert Table 5 about here >

The sub-sample results confirm the previous results for the secular change over time but emphasise the shifting number and cultural preferences in relation to predetermined discrete structural points of reference. For instance, not only has there been a distinct change in the preference of 4 v. 8 over time, but also the change is accentuated between the designated sub-sample periods. The ratio of 4 relative to 8 is 0.48 for the Shanghai A-share market for the early sub-period 1994-1996 and has risen to 0.61 for the sub-period 2000-2001 (0.8 for 2002). Hence the cultural effect has diminished over time with the increase in the ratio. The Shenzhen A-market has had an increase in the 4 to 8 ratio from a similar level of 0.56 (1994-1996 sub-period) to 0.80 in the later (2000-2001) sub-period. Hence 4's would only occur half as likely as 8's in the initial period but this has changed so that now they occur about two-thirds as likely as 8's for Shanghai and four-fifths as likely as 8's for Shenzhen. The B-market for Shanghai does not show any particular avoidance of 4's and preference for 8's over any of the sub-periods whereas the Shenzhen B-market has the same relatively rapid dissipating of the cultural effect from 1997 onwards as displayed in the Shenzhen A-market.

The change in the relationship of 4 v. 8 and the individual cultural effect of the avoidance of 4 and preference for 8 can be fleshed out through the comparison of the frequency of observations of the number 4 relative to 6 and 2 relative to 8. Again the comparison of 4 relative to 6 is appropriate as baring a cultural effect we expect the same amount of attraction on both 4 and 6 relative to 5. Similarly, we would expect an equivalent level of attraction on 2 and 8 in reference to 0.

As evident in the 4 v. 6 and 2 v. 8 comparisons in Table 5 the relationship of 4 v. 6 has remained largely static over the sample period. Figures depicting the 4 v. 6 and 2 v. 8 relationships were constructed and allow us to draw similar inferences but are not reported in the interests of space. However, there is a structural shift in the relationship of 2 relative to 8. The ratio of the frequency of 2 relative to 8 increases from 0.61 in the period 1994-1996 to 0.71 in the period 2000-2002 for the Shanghai A-share market. Over the same two sub-periods the 2 to 8 ratio for the Shenzhen A-market increased from 0.73 to 0.83. Hence the increase in the 4 to 8 ratio and the reduction in the cultural preference are mainly located in the initial existence and then reduction in the preference of the number 8 rather than the avoidance of the number 4.

Another conjunct clustering phenomenon in the PRC markets is that of the extent of anchoring on, and then the reduction of the frequency of 0's over time. The congestion on 0 for the PRC markets (range of 17% to 30%) is excessive compared to the 12.5% to 13% of cases observed for the benchmark HK and LSE markets (Table 3). Reduction in this "excessive" 0 digit clustering has occurred

over time for all PRC markets (see Figure 3 and Table 5) and in the Shanghai A-market (Figure 3(a)) in particular there is also a sharp shift downwards around the end of 2001. For the Shenzhen markets the reduction in concentration of 0's is less distinct with the downward drift transpiring more slowly over time (Figures 3(c) and (d)). That said the overall reduction in the frequency of clustering on 0's over time is just as pronounced for the Shenzhen as the Shanghai markets.

< insert Figure 3 about here >

The explanation for the structural shift of lower clustering for Shanghai A-shares at the end of 2001 in Figure 3(a) is perhaps due partly to a reduction in price associated with the deterioration of market value and lower performance of the PRC markets in 2002 (see Table 2). In fact, the average tradable price level on the Shanghai A-market for 2002 was RMB11.62 compared to RMB15.50 for 2001 and RMB15.27 for 2000. A distribution analysis of the frequency of all prices traded comparing year-by-year confirms a higher amount of trading at lower price ranges for 2002 relative to the 2001 and 2002 calendar years. However, this explanation of a reduction in the expected coarseness of the price grid from lower price values only appears to hold for the Shanghai A-market so it is only part of the story. The Shanghai B-market and both the Shenzhen markets exhibit no structural reduction in clustering notwithstanding the same decrease in average price and trading at lower price ranges for 2002.

Another part of the explanation is that the structural shift is related to a more general reduction in clustering due to increase in firm size, liquidity, market depth and informed trading over the period, all of which is evident for all PRC markets. Over 1994 to 2002 the precision with which beliefs are held about share value can logically be seen as to have increased. From Table 2 we have already noted the phenomenal growth in the size of the markets and market capitalisation of the average firm. The increase in the number of listings (Table 1), the increase in the number of participants in the PRC markets as well media coverage and increased focus of overseas investors all contribute to an increase in the level of information and improving market depth over the sample period. Further, reduction in stock return volatility and increase in liquidity both in terms of trading volume evidence an aggregate reduction in uncertainty and greater market liquidity; all supporting the observed reduction in clustering.

5.3. Clustering in opening/high/low prices

We now examine the clustering effect in the available opening/high/low prices. Two main reasons drive this analysis. The documented clustering effect may be restricted to closing prices or it may be different to that contained in the opening, or the low and high prices during the day. Our expectation is that if the Chinese cultural effect is widespread we should see the same avoidance of 4's and preference for 8's as previously documented.

< insert Table 6 about here >

The results of the relative frequencies of the opening/high/low prices are given in Table 6 and are both lucid and striking. First, the same avoidance of 4 relative to 8 observed in the closing prices is apparent for the opening, low and high prices. The effect is even more distinct for the opening, high and low relative to the closing prices. Across all markets, not considering 0 or 5 because of their higher attraction; 8 is observed with the highest frequency relative to the other numbers. Similarly, in all markets 4 is observed with either the lowest or next to lowest relative frequency (in some cases 1 has a lower relative frequency). The evidence is remarkably consistent across all prices, displaying a clear avoidance of prices ending in 4 and a preference for prices ending in 8.

Further, for each type of price (open, high, and low) and exchange (both Shanghai and Shenzhen) the fewer 4's relative to 8's is less pronounced in the B-markets relative to the A-markets (Table 6). This confirms our prediction that international investors are less susceptible to the Chinese cultural effect and while still evident, it is dissipated by the more informed and foreign influence. Again for the opening, high and low prices when we *directly* compare across share types for one exchange, fewer 4's to 8's for the B- compared with A-Markets exists for both the Shanghai and Shenzhen markets (unlike for the closing prices). The effect of fewer 4's v 8's is still much stronger in the Shanghai A-market and less pronounced in the Shanghai B-market relative to the respective Shenzhen markets.

Finally, the highest relative frequency of 8 occurs for the transaction at the daily high whereas the lowest frequency of 4 occurs for the daily low (Table 6). This is the case for all markets except the Shanghai B-market where the daily low has the second lowest frequency of 4. Accordingly, when the share is at a local high/low then the positive/negative cultural superstition is more dominant and the price is more likely to transact at an auspicious/inauspicious number respectively. This is consistent with and reinforces the cultural explanation. Overall then, the cultural effect identified here is not consistent with the attraction theory or a general tendency to round and is manifest throughout all prices in the PRC markets – it is especially strong and persistent for Shanghai A-share market.

5.4. Why clustering might differ in the Shanghai and Shenzhen markets

The differences in the 4 v. 8 effect between the Shanghai and the Shenzhen stock exchanges may be partially, but perhaps not totally, explained by the idiosyncratic and inherent nature of the two exchanges. The two exchanges are essentially distinct as companies do not cross-list list and trading is separate. There are also several major institutional differences.

First, companies listed on the Shanghai exchange are generally large and state owned. Those listed on the Shenzhen exchange are characterized as small joint ventures, primarily export (Xu, 2000), mainly orientated towards (light) manufacturing and located in the nearby "pearl river" delta.[18] Similarly, for

[18] Some 332 or 60% out of 550 companies listed on the Shenzhen stock exchange are designated as manufacturing per the 2001 fact book.

Shanghai over 33% of companies are located in Shanghai or its two nearby provinces. Again 62% of companies on the Shanghai exchange are classified as industrial but in this case a large majority are heavy infrastructure and manufacturing companies. Essentially, the two exchanges serve different types of company and industry regions.

Another factor to be considered is the degree of institutional investment in the respective markets. The institutional investment percentage is slightly higher for Shenzhen about 0.48%, compared to 0.46% for the Shanghai exchange but still extremely low in absolute terms. As a result, the majority of the investors in China are local individuals (approx 60 million accounts) and there is virtually no institutional trading on either stock exchange. Given the lack of institutional investment institutional investors are unlikely to explain the clustering differences.

The demographics of investors on each exchange are however relevant. The investors in each market tend to have small shareholdings and are typically from the local area. Hence there is limited influence and trade from other regions In China. For example, out of the total trade turnover for 1991 on the Shanghai exchange, 53% come from the two major economic zones, with Shanghai contributing 41.6% and Shenzhen the remaining 11.4%. For the Shenzhen exchange, the concentration of local investors was not quite as pronounced; 31.9% of the trading volume is from the Shenzhen-Guangdong region compared with 24.4% from Shanghai and surrounding provinces. Again this serves to illustrate the dichotomy between the two exchanges: the concentration of investors from the regional local population especially in the case of Shanghai.

There are other aspects that suggest the outside influence in Shenzhen is greater relative to the Shanghai exchange. One is the proximity to Hong Kong. Given this proximity, the ability to receive information on Shenzhen companies is enhanced and disseminated by the well-established Hong Kong media operations in Hong Kong, Shenzhen and Guangdong (the nearby province). Similarly, the Shenzhen SAR by Chinese standards is a multi-faceted society, which was developed as a SAR from the ground up rather than having the infrastructure of a city already in place. As a result of its proximity to Hong Kong, its “grass roots” development and its rise in affluence, Shenzhen has experienced an inflow of a diverse population from all over China. Potentially this information environment, diversity and population has culminated in a more open and informed trading market in Shenzhen relative to Shanghai.

Another factor is that the level of investor education. Unlike most markets the bulk of investors on the Shanghai exchange are not only uninformed, they are comparatively uneducated, with 65% of investors having an education level either at, or below, a technical secondary school level. While figures are not available for Shenzhen, it is unlikely that the education level is as low given its proximity to Hong Kong. This again induces an environment where cultural issues are likely to be reinforced and to be manifest in greater price clustering along the lines that we have found.

5.5. Binary logit results

So far we have considered price clustering averaged across all shares of the same type. We also fit a series of multivariate models estimated as binary regressions in an attempt to explain differences across individual companies that have issued the same share type. The regressions use data up until December 2000 as we have cross-sectional data available up to that point. We capture number preference by employing a dichotomous dependent variable with a value of 1 if the last sale ends 4 and 0 if it ends in 8. The explanatory variables are proxies for the coarseness of the price grid (the log of the stock's price level) and for the precision with which beliefs are held about "true" value (the log of the firm's market capitalisation, stock return volatility and trading volume) and dummy variables to indicate whether a trade occurred during a festival period, where BCM found that cultural influences were more likely to be present. Four separate regressions are fitted, one each for the A- and B-shares in each market.

The results are summarised in Table 7. The McFadden R^2 indicates that the model has very weak explanatory power, regardless of market and share type. The large sample sizes result in the explanatory variables of price, market capitalization and volatility being statistically significant for the Shanghai and Shenzhen A-shares, but collectively they explain little of the cross-sectional variation around the sample mean. None of the dummy variables that designate a price from one of the three auspicious holiday periods is both consistent with our prediction and significant at the 5% level. The dummy variables for the inauspicious Clear Brightness festival are significant although the direction is contrary to the predicted direction (i.e., there is less avoidance of 4 and preference for 8) and this occurs only for the local A-market as one would expect. The Clear Brightness festival is the main inauspicious festival as it is the day on which ancestors are revered and traditionally graves are cleaned. It is the only inauspicious festival recognised as an official holiday in the PRC whereas the Chung Yuan or Hungry Ghost festival is not. None of the dummy variables for the festival periods are consistent with our prediction and significant for the B-share market.

< insert Table 7 about here >

5.6. Summary

In sum, simple frequency counts and time series plots confirm that daily last sale prices are consistent with a ubiquitous avoidance of prices ending in 4 relative to 8. Although the avoidance of 4 relative to 8 is consistent with cultural influences (especially for the Shanghai exchange), the evidence is not unequivocal, for three reasons. First, we argued that as segmentation between the A- and B-share markets breaks down, the difference between the ratios of 4 to 8 for the A- and B-shares should dissipate. While this reduction has occurred to some degree for the Shenzhen market and in an expedient manner over time, clustering on 8 relative to 4 has not completely disappeared for Shenzhen and remained widespread for Shanghai at least up to 2001. We do note that there has been a recent structural shift with the level of clustering substantially reduced in the recent 2002 year for

Shanghai A-Shares; although again even then the ratio of trades of 4's to 8's is now still persistent at around a value of 0.8.

Second, differences between the extent of the clustering observed for the Shanghai and Shenzhen stock exchanges are argued to be driven mainly by the location and development of the Shenzhen market which has encouraged a more diverse, informed and educated investor population. The lack of outside influence in the Shanghai market and the regional and low education base of the local investors hence preserved the cultural influences for a longer period resulting in a persistent preference for trades ending in 8 relative to 4 up until 2001. Third, the metrics we use show no systematic preference for 8 rather than 4 on the LSE, suggesting that the effect is cultural in that it is not observed in traditional established liquid Western markets.[19]

6. Comparison with Previous Literature

Given the evidence of basic concentration of numbers in all the PRC markets, the attraction hypothesis is confirmed, consistent with previous studies. Our overall results indicate a pervasive preference for prices ending in 8 rather than 4, with the preference being strongest in the A-class shares traded on the Shanghai exchange, where last sale prices end about twice as frequently in 8 compared with 4. BCM is the only previous study that has examined the cultural effects on price clustering. In comparison, BCM report (BCM, Table 2) the ratio of 4's to 8's is 0.74 for the ASX, 0.98 for Hong Kong, 0.93 for the Philippines, 0.91 for Singapore and 0.83 for Taiwan. When binary logit models were fitted for each country, BCM (their Table 6) report weak evidence of stronger cultural effects for the Hong Kong market around the auspicious Chinese New Year, Dragon Boat and Mid-Autumn festivals. We do not find similar evidence for either Shanghai or Shenzhen perhaps because the preference for 8's and avoidance of 4's is so ubiquitous for the A-markets that it is not accentuated over the auspicious festival periods.

BCM report the preference for 8 is significantly stronger for higher priced stocks (in all markets) and for smaller stocks (but only in Australia and Hong Kong); we find similar results. Equivalent to BCM who found that clustering on 4 relative to 8 increases with liquidity, the same liquidity effect (measured by volume) is noted for the PRC markets although it is not strong. Finally, BCM report higher volatility is associated with fewer "lucky" prices, which is inconsistent with their predictions; whereas we find that increased volatility does result in a greater number of "lucky" prices ending in 8. The price resolution/negotiation explanation is thus supported for the PRC, especially for the A-markets where the price, market value and volatility variables are all statistically significant. On the whole, though, BCM's models did not fit the data well, with McFadden R^2 ranging between 0.1% and 3.3% for the five countries they studied. Our models likewise explain relatively little

[19] BCM note there is an abnormally low frequency of 4 on the ASX although no overtly strong preference for 8 over and above that expected given the normal attraction theory (2=8). The reduced frequency of 4 (and 3) on the ASX is most likely explained by the excess attraction and concentration on 0's and 5's rather than any particular avoidance, cultural or otherwise, of 4.

of the within-sample variance around the mean. The weak explanatory power of the models suggests that either there are additional, as yet unidentifiable, variables that to some degree it is simply a uniform and ubiquitous cultural phenomenon.

7. Conclusions

The main objective of this paper is to address the question of whether, in a more controlled setting, cultural factors — as reflected in the salience of certain numbers under Chinese culture and "feng shui" superstition — are more strongly manifest in the clustering of equity prices. Two regional markets in The Peoples' Republic of China were examined in detail: Shanghai and Shenzhen. These markets were chosen because there has been a clear delineation between shares that may be held by PRC nationals (A-shares) and foreigners (B- and H-shares).

Taken as a whole, our results suggest that cultural factors can influence the salience of numbers and thereby price clustering in segmented markets that are sufficiently insulated from international forces. Although as demonstrated by the evidence on the PRC markets and markets become more developed, information sources and informed investors increase and outside influences impinge and reduce the segmentation then cultural effects will become less prevalent. In markets other than Shanghai and Shenzhen, as BCM observed, the cultural effect is at best weak, especially when compared with a more fundamental human tendency — to round to the nearest whole number.

Finally, the ubiquitous nature of the preference of 8 over 4 in PRC markets conflicts with both the Attraction Hypothesis and Benford's Law, both of which predict the reverse.

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Table 1: Market segmentation, ownership structure and share listing in China stockmarkets; 1994 – 2002.

Panel A: Market segmentation and ownership structure in China stockmarkets.

	Investor Participants	Categories of Shares	Markets
Local:-	Government and government entities	State owned shares	Non-tradable[1]
	Legal persons/SOEs	Legal person shares	
	Employees	Employee shares	
	Others	Other shares	
Local:-	Individual mainland investors	A-shares	SHSE or SZSE[3]
Foreign:-	Individual and institutional investors including residents of Macau, Hong Kong and/or Taiwan	B-shares	SHSE or SZSE
		H-shares	HKEX, or other overseas market

Panel B: Number of PRC Companies with share listings on China stockmarkets.[2]

Companies Listed	1994	1995	1996	1997	1998	1999	2000	2001	2002
A-Market only	227	242	431	627	727	822	955	1,023	1,085
B-Market only	4	12	16	25	26	26	28	24	24
H-Market only	12	6	9	25	25	27	33	35	40
Both A and B Market	34	58	69	76	80	82	86	88	87
Both A and H Market	3	11	14	17	18	19	19	26	29
Total	**280**	**329**	**539**	**770**	**876**	**976**	**1,121**	**1,196**	**1,271**

Notes to table: [1] Legal person shares for some companies are traded on over-the-counter markets but are illiquid.
[2] Source – China Securities Regulatory Commission – Introduction to China's Security Markets and Stock Exchange of Hong Kong Fact Book.
[3] SHSE – Shanghai Stock Exchange; SZSE – Shenzhen Stock Exchange; HKEX – Hong Kong Stock Exchange.

Table 2: Summary statistics for PRC company shares traded on China stockmarkets; 1994 – 2002.

	Exchange[1]	1994	1995	1996	1997	1998	1999	2000	2001	2002
Market value[3] (Mill USD)	SHSE A-share	5,457	5,903	14,624	27,989	34,138	49,324	94,535	92,181	83,579
	SHSE B-share	1,315	1,105	1,854	2,247	1,214	1,688	4,030	7,969	5,275
	SZSE A-share	3,970	3,536	14,287	29,699	31,948	45,223	88,295	67,836	56,453
	SZSE B-share	418	626	2,237	1,948	1,079	1,623	2,718	5,439	3,775
	HKEX H-share[2]	2,582	2,129	4,077	6,277	4,329	5,390	10,917	12,801	16,574
Trading volume (daily) (Mill shares)	SHSE A-share	251.7	197.0	434.8	479.8	441.2	622.0	967.0	596.6	714.7
	SHSE B-share	8.9	7.7	11.2	20.4	17.3	30.2	53.0	168.0	37.0
	SZSE A-share	142.2	76.4	563.1	537.2	408.9	550.9	940.7	431.6	492.3
	SZSE B-share	1.2	2.1	16.9	16.6	8.0	21.8	31.9	128.0	29.3
	HKEX H-share[2]	50.1	39.2	61.3	456.9	262.1	310.2	477.4	718.6	348.0
Turnover (daily) (Mill USD)	SHSE A-share	257.8	145.7	438.3	672.5	604.0	850.5	1,566.4	1,001.3	838.3
	SHSE B-share	43.0	24.1	38.3	87.6	33.3	58.4	17.4	151.7	26.4
	SZSE A-share	110.2	45.0	584.8	890.9	545.1	712.9	1,478.8	673.5	545.7
	SZSE B-share	0.9	0.9	8.9	10.9	2.3	6.8	10.7	115.4	16.9
	HKEX H-share[2]	17.2	8.8	12.9	156.9	38.4	53.6	85.3	129.4	72.5
Average return[4] (% daily)	SHSE A-share	0.02	-0.01	0.24	0.14	-0.01	0.09	0.18	-0.09	-0.07
	SHSE B-share	-0.18	-0.10	0.16	-0.05	-0.24	0.16	0.39	0.32	-0.16
	SZSE A-share	-0.12	-0.04	0.48	0.11	-0.03	0.08	0.20	-0.12	-0.07
	SZSE B-share	-0.20	-0.16	0.43	-0.14	-0.23	0.25	0.24	0.35	-0.13
	HKEX H-share	-0.21	-0.13	0.12	-0.05	-0.16	0.09	-0.04	0.06	0.06
Standard deviation of return[4] (% daily)	SHSE A-share	4.96	3.21	2.76	2.22	1.33	1.77	1.38	1.38	1.55
	SHSE B-share	1.57	1.04	2.23	2.38	2.26	3.13	2.61	3.11	1.88
	SZSE A-share	4.57	2.93	3.12	2.52	1.46	1.85	1.44	1.41	1.71
	SZSE B-share	0.91	0.95	3.37	2.45	2.25	3.29	2.37	3.37	2.08
	HKEX H-share	2.56	1.72	1.82	3.77	3.98	2.87	2.73	2.25	1.27

Notes to table:
[1] SHSE – Shanghai Stock Exchange; SZSE – Shenzhen Stock Exchange; HKEX – Hong Kong Stock Exchange.
[2] Source – Hong Kong Stock Exchange: Fact Book.
[3] Market value is measured as the market capitalisation of the tradable portion of shares.
[4] Average return and standard deviation of return are computed using the comprehensive indices of the respective markets.

Table 3: Relative frequency (%) with which daily closing prices clustered on each digit; 1994-2002 for PRC markets, Hong Kong H-shares and LSE; 1994-1998 for Hong Kong BCM sample (BCM, Table 2).

Digit	Shanghai		Shenzhen		Hong Kong		LSE
	A-shares	B-shares	A-shares	B-shares	H-shares	BCM sample	All shares
0	22.9	29.8	16.7	20.9	12.6	13.7	12.9
1	6.7	2.1	8.5	7.1	9.1	8.4	9.0
2	7.9	14.1	8.7	8.1	9.7	10.4	10.6
3	7.0	2.2	8.2	8.0	10.0	9.8	8.9
4	6.6	13.2	8.2	7.6	9.6	9.6	8.5
5	14.1	3.0	11.6	13.4	10.6	11.5	12.7
6	7.6	14.5	8.7	8.0	9.8	9.5	9.3
7	6.4	2.0	8.2	7.4	9.4	8.7	10.6
8	12.2	16.8	10.7	10.6	9.9	9.8	9.2
9	8.5	2.4	10.4	8.8	9.3	8.6	8.5
0-9	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Notes to Table:

Shanghai A-Shares 1994 - 2002; all prices; clustering on 2nd d.p.

Shangahi B-shares 1994 - 2002; all prices; clustering on 3rd d.p.

Shenzhen A-Shares 27/4/1994 - 2002; all prices; clustering on 2nd d.p.

Shenzhen B-shares 27/4/1994 - 2002; all prices; clustering on 2nd d.p.

H-shares 1994 - 2002; price range 0.51 - 2.00; clustering on 2nd d.p.

LSE FTSE All share Index constituents 1994 - 2002; price at least 1p; clustering on integer value of price.

Table 4: Summary statistics for the distribution of the daily ratios.

Exchange/share type	Cluster Comparison		
	2 v. 8	**4 v. 6**	**4 v. 8**
Predicted ratio (#1/#2)	<1	<1	<1
Shanghai: A-shares			
Average daily ratio	0.65	0.91	0.54
Median daily ratio	0.63	0.85	0.51
Proportion of daily ratios <1	0.95	0.70	0.98
Number of days	2,194	2,194	2,194
Days when ratio < 1	2,060	1,467	2,130
Days when ratio > 1	108	614	54
Shanghai: B-shares			
Average daily ratio	1.01	1.13	0.95
Median daily ratio	0.80	0.92	0.75
Proportion of daily ratios <1	0.64	0.57	0.70
Number of days	2,182	2,158	2,182
Days when ratio < 1	1,237	1,087	1,340
Days when ratio > 1	696	809	583
Shenzhen: A-shares			
Average daily ratio	0.83	0.96	0.76
Median daily ratio	0.81	0.93	0.75
Proportion of daily ratios <1	0.77	0.56	0.82
Number of days	2,107	2,107	2,107
Days when ratio < 1	1,617	1,185	1,726
Days when ratio > 1	406	808	306
Shenzhen: B-shares			
Average daily ratio	0.89	1.14	0.85
Median daily ratio	0.71	1.00	0.67
Proportion of daily ratios <1	0.61	0.49	0.65
Number of days	1,825	1,709	1,825
Days when ratio < 1	1,120	841	1,193
Days when ratio > 1	468	609	432
Hong Kong: H-shares			
Average daily ratio	1.15	1.14	1.15
Median daily ratio	1.00	1.00	1.00
Proportion of daily ratios <1	0.47	0.48	0.47
Number of days	1,668	1,666	1,668
Days when ratio < 1	776	800	792
Days when ratio > 1	564	541	546
London Stock Exchange			
Average daily ratio	1.17	0.94	0.94
Median daily ratio	1.16	0.90	0.92
Proportion of daily ratios <1	0.30	0.68	0.67
Number of days	2,347	2,347	2,347
Days when ratio < 1	685	1,546	1,515
Days when ratio > 1	1,623	725	751

Table 5: Relative frequency (%) with which daily closing prices clustered on each digit; 1994-2002 for PRC markets, partioned across subperiods 1994-1996, 1997-1999, 2000-2002.

Panel A	Shanghai A			Shenzhen A		
Digit	**1994-1996**	**1997-1999**	**2000-2002**	**1994-1996**	**1997-1999**	**2000-2002**
0	27.4	24.5	20.2	21.5	16.7	15.6
1	6.0	5.9	7.5	6.3	8.7	8.9
2	7.4	7.6	8.3	8.6	8.5	8.8
3	6.0	6.6	7.6	7.8	8.2	8.4
4	5.8	6.2	7.2	6.6	8.4	8.5
5	16.3	15.0	12.9	15.5	11.1	11.0
6	6.8	7.3	8.1	8.0	8.7	8.9
7	5.4	5.8	7.1	6.4	8.4	8.5
8	12.1	13.0	11.7	11.7	10.6	10.6
9	6.9	8.0	9.4	7.6	10.8	10.8
0-9	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Panel B	Shanghai B			Shenzhen B		
Digit	**1994-1996**	**1997-1999**	**2000-2002**	**1994-1996**	**1997-1999**	**2000-2002**
0	44.2	31.0	20.4	38.5	20.9	15.1
1			5.2	4.7	7.1	8.0
2	13.4	16.7	12.0	5.4	8.0	9.1
3			5.5	4.7	8.0	9.2
4	12.5	15.6	11.3	4.2	7.5	8.7
5			7.5	18.4	13.4	11.7
6	13.4	17.4	12.6	5.4	8.0	8.9
7			4.9	3.9	7.2	8.8
8	16.5	19.3	14.6	8.8	10.6	11.2
9			5.9	5.9	9.3	9.5
0-9	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Notes to Table:

Shanghai A-Shares 1994 - 2002; all prices; clustering on 2nd d.p.

Shangahi B-shares 1994 - 2002; all prices; clustering on 3rd d.p.

Shenzhen A-Shares 27/4/1994 - 2002; all prices; clustering on 2nd d.p.

Shenzhen B-shares 27/4/1994 - 2002; all prices; clustering on 2nd d.p.

H-shares 1994 - 2002; price range 0.51 - 2.00; clustering on 2nd d.p.

LSE FTSE All share Index constituents 1994 - 2002; price at least 1p; clustering on integer value of price.

Table 6: Relative Frequencies of Clustering Digit, for Daily Opening, High, Low and Closing Prices of A and B Class Shares Traded on Shanghai and Shenzhen Exchanges; 1994-2000.

Panel A	Price at Market Opening				Price at Day's High			
	Shanghai		Shenzhen		Shanghai		Shenzhen	
Digit	A-shares	B-shares	A-shares	B-shares	A-shares	B-shares	A-shares	B-shares
0	40.0	47.3	40.5	30.1	32.5	43.8	34.8	26.8
1	6.2		6.0	6.5	3.4		3.2	5.5
2	5.7	13.4	5.3	7.1	5.1	13.5	5.0	7.1
3	3.8		4.2	6.6	4.0		4.4	6.7
4	2.9	11.4	3.1	5.1	4.8	12.5	4.3	6.7
5	16.4		16.9	16.4	17.2		18.3	16.0
6	4.7	12.9	5.0	6.7	5.3	13.8	5.2	6.6
7	3.1		3.2	5.0	5.1		4.3	5.8
8	12.4	15.0	10.7	10.1	14.7	16.3	12.9	10.7
9	4.8		5.1	6.5	7.8		7.6	8.2
0-9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Panel B	Price at Day's Low				Price at Market Close			
	Shanghai		Shenzhen		Shanghai		Shenzhen	
Digit	A-shares	B-shares	A-shares	B-shares	A-shares	B-shares	A-shares	B-shares
0	34.8	46.4	37.9	30.0	26.4	44.4	19.3	25.0
1	9.9		8.4	7.4	5.9		8.0	6.5
2	7.3	13.6	6.1	7.3	7.4	13.5	8.2	7.4
3	4.7		4.6	6.6	6.3		7.8	7.3
4	2.9	11.8	2.8	4.9	5.9	12.5	7.7	6.9
5	15.6		16.8	16.1	15.2		12.9	14.7
6	6.2	13.2	6.0	7.3	7.0	13.9	8.2	7.3
7	3.0		2.9	5.1	5.6		7.7	6.6
8	11.8	15.0	10.7	9.6	12.4	15.8	10.3	9.9
9	3.9		3.8	5.7	7.8		10.0	8.3
0-9	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Notes to table:

Data for table is up until the end of 2000 as Opening, High and Low prices are available up until that point in time.

Across the four share types, the greatest relative frequency of 8 is observed at the day's high whereas the lowest frequency of 4 is at the day's low, see the shaded numbers in the table (shb is the exception to this).

The frequencies are based on the second decimal of price for sha, sza and szb shares, and on the third decimal for shb shares.

Table 7: Binomial logit model estimates of the determinants of clustering in daily closing prices at 4 relative to 8; Shanghai and Shenzhen stock exchanges, A- and B-shares, 1994-2000.

Variable	Pred.	Shanghai A-shares			Shanghai B-shares			Shenzhen A-shares			Shenzhen B-shares		
	Sign	Coeff.	*Z*-stat.	prob.	Coeff.	*Z*-stat.	prob.	Coeff.	*Z*-stat.	prob.	Coeff.	*Z*-stat.	prob.
Constant	-	-0.80	-4.35	<0.001	-1.08	-2.24	0.025	-1.66	-7.71	<0.001	-1.32	-1.86	0.062
Ln(Price)	-	-0.53	-33.45	<0.001	-0.21	-6.05	<0.001	-0.05	-3.48	<0.001	-0.27	-5.48	<0.001
Ln(MVE)	+	0.07	7.90	<0.001	0.03	1.38	0.167	0.08	7.30	<0.001	0.06	1.71	0.087
Volatility	-	-7.22	-12.42	<0.001	-1.85	-1.56	0.119	-4.73	-7.78	<0.001	-3.00	-2.20	0.028
Volume (billions)	+	0.30	1.50	0.134	1.62	0.95	0.344	0.01	0.05	0.959	6.97	3.09	0.002
CNY	-	0.01	0.04	0.972	0.60	1.87	0.061	-0.40	-1.51	0.131	-1.18	-1.09	0.274
CBF	-	0.09	2.64	0.008	0.00	0.03	0.976	0.07	1.88	0.060	0.11	1.09	0.277
DBF	-	0.01	0.19	0.853	0.24	2.60	0.009	0.14	2.81	<0.001	0.18	1.13	0.257
HGF	-	-0.04	-0.84	0.403	0.08	0.74	0.458	-0.06	-1.29	0.197	0.08	0.59	0.556
MAF	-	0.04	0.75	0.453	-0.07	-0.66	0.509	0.03	0.68	0.496	0.03	0.20	0.845
Class. accuracy													
--% correct			56.59			50.77			51.11			51.90	
--% gain			1.27			0.33			0.20			0.56	
LR statistic			1269.95			63.19			170.97			56.35	
Prob.(LR stat.)			<0.001			<0.001			<0.001			<0.001	
McFadden-RSQ			0.010			0.002			0.001			0.004	
Sample size			99,466			19,217			85,214			10,027	

Notes to Table:

Z-statistics are calculated using asymptotic standard errors.

All standard errors are computed using the quasi-maximum likelihood (Huber/White) method.

Classification is determined using a prediction cut-off *p*-value of 0.5 in all cases.

Overall percentage gain is the increase in classification accuracy relative to a model based on chance. The chance model is where the *N* cases are assigned to the clustered/non-clustered groups based on the proportion of observed cases.

CNY, CBF, DBF, HGF and MAF are dummy variables denoting days in close proximity to the Chinese New Year, and the Clear Brightness, Dragon Boat, Hungry Ghost and Mid-Autumn festivals.

Figure 1(a): Shanghai and Shenzhen Stock Exchange A-Share Indices; 1994 – 2002

Figure 1(b): Shanghai and Shenzhen Stock Exchange B-Share Indices; 1994 – 2002

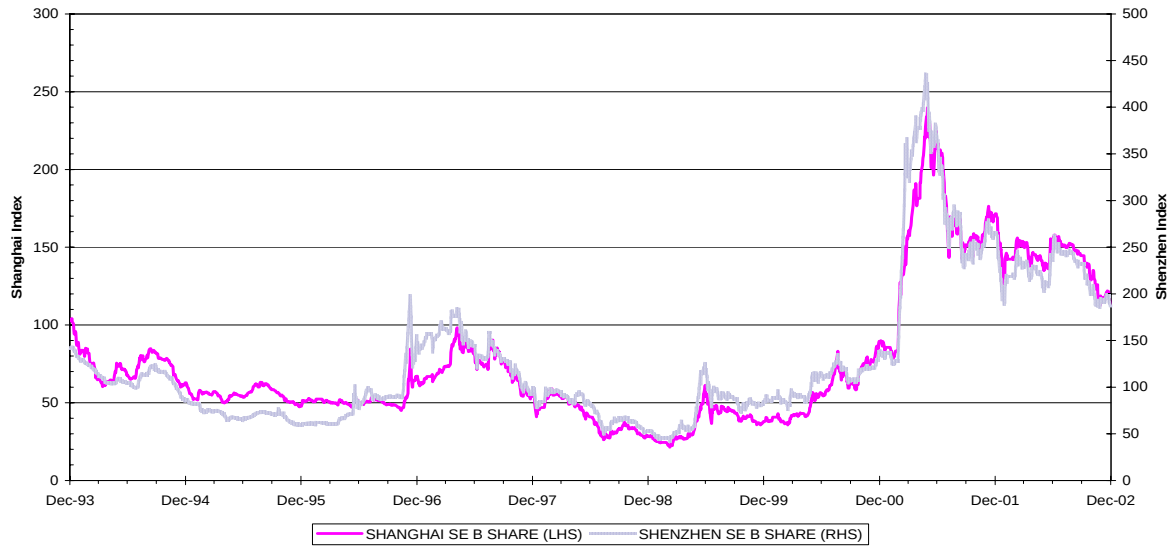

Figure 1(c): China Enterprises (H-shares), China Affiliated Corporations (Red-Chips) and Hong Kong Hang Seng Indices; 1994 – 2002

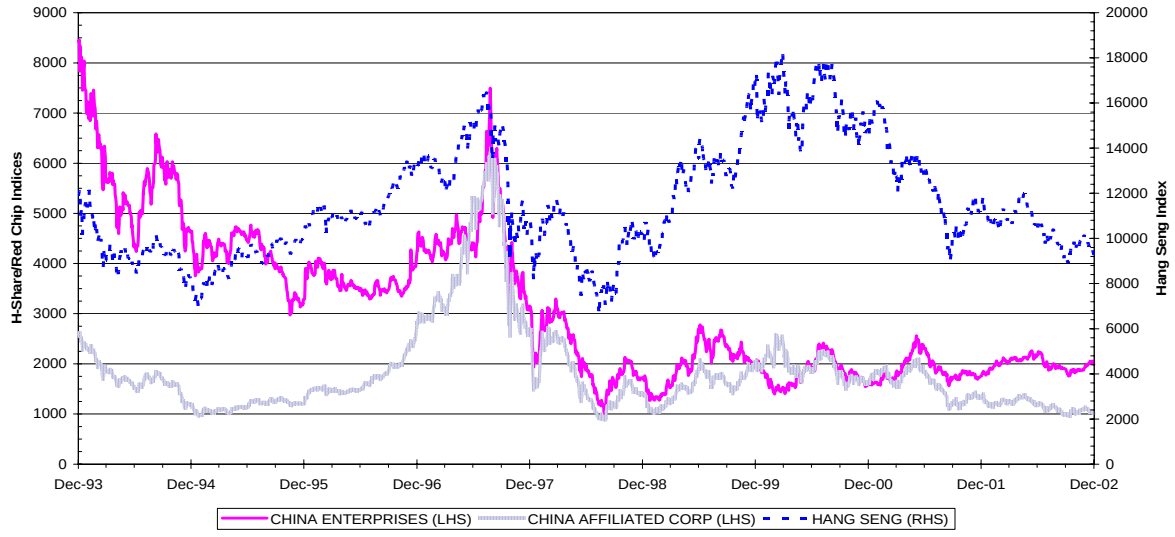

Figure 2(a): Shanghai A Shares: Time Series of the Ratio of the Number of Daily Closing Prices Clustering on 4 v. 8

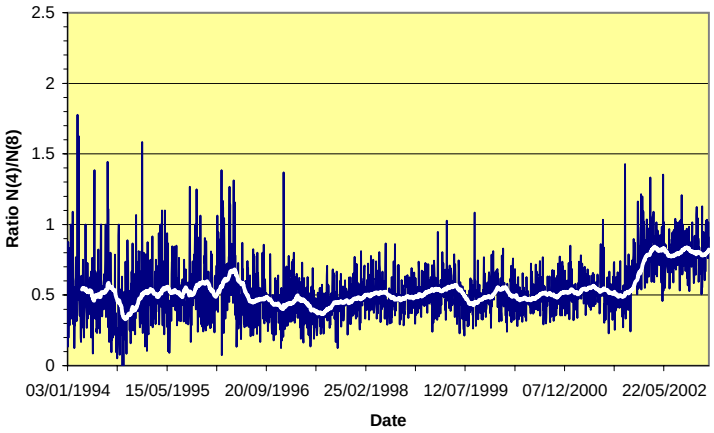

Figure 2(b): Shenzhen A Shares: Time Series of the Ratio of the Number of Daily Closing Prices Clustering on 4 v. 8

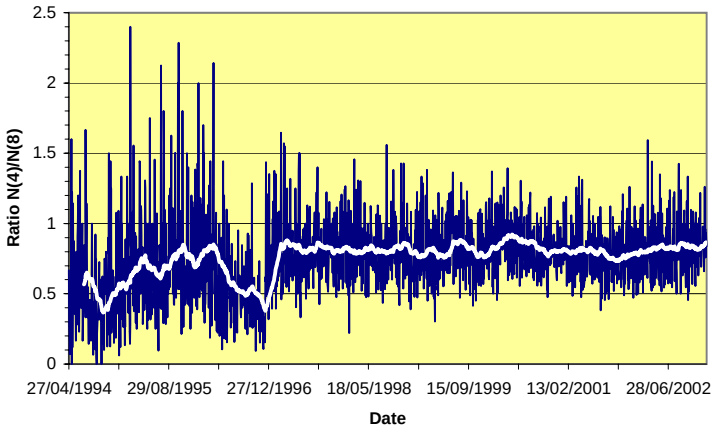

Figure 2(c): Shanghai B Shares: Time Series of the Ratio of the Number of Daily Closing Prices Clustering on 4 v. 8

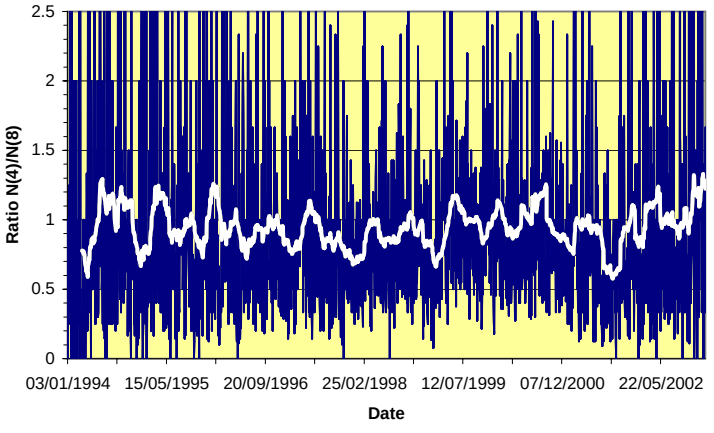

Figure 2(d): Shenzhen B Shares: Time Series of the Ratio of the Number of Daily Closing Prices Clustering on 4 v. 8

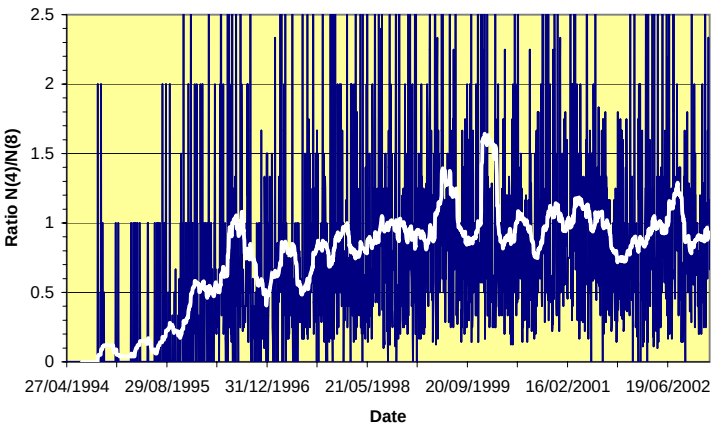

Figure 3(a): Shanghai A Shares: Time Series of the Proportion of the Daily Closing Prices Clustering on 0

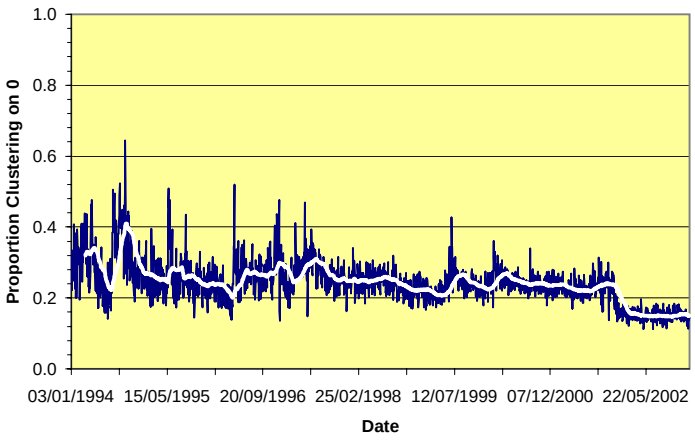

Figure 3(b): Shenzhen A Shares: Time Series of the Proportion of the Daily Closing Prices Clustering on 0

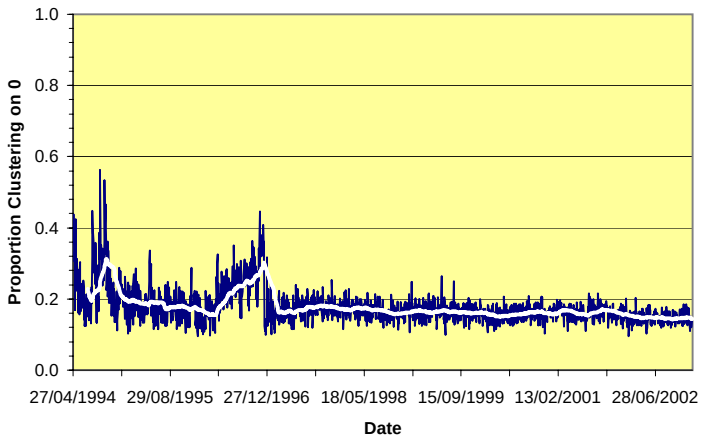

Figure 3(c): Shanghai B Shares: Time Series of the Proportion of the Daily Closing Prices Clustering on 0

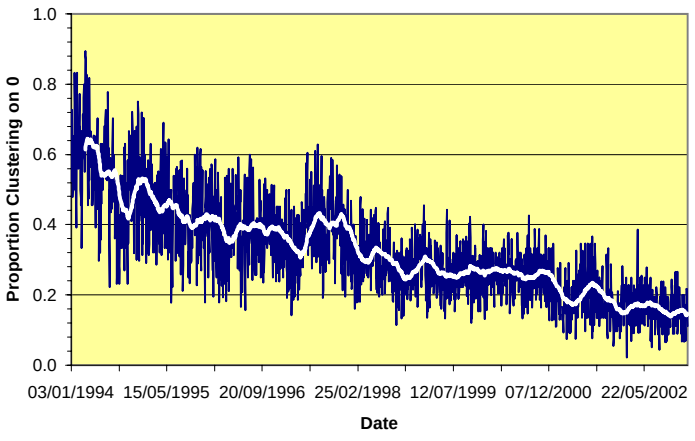

Figure 3(d): Shenzhen B Shares: Time Series of the Proportion of the Daily Closing Prices Clustering on 0