

Superstitions and Price Clustering in the Taiwan Stock Exchange

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ABSTRACT: This paper aims to describe cultural price clustering in the Taiwan Stock Exchange. The Taiwan Stock Exchange is an excellent example of the Chinese culture-exposed market, where one of the basic superstitions is the aversion of unlucky numbers and the preference of lucky numbers. Using bulk historical closing price data in the five years, the authors documented the prevalence of price to cluster in the lucky 8 rather than the unlucky 4. The authors also documented the prevalence of price to cluster at the Chinese lucky number group (3, 6, 8, and 9) rather than the unlucky number group (4 and 7). Finally, the authors conducted a test of proportion difference among two populations to attest to the difference between cultural price clustering at the Chinese New Year event period and the non-Chinese New Year event period. The authors found significance frequencies difference of price ending in 8 during the Chinese New Year event period and the non-Chinese New Year event period.

Keywords: cultural price, Chinese lucky number, Chinese new year

1 INTRODUCTION

Price clustering is the tendency of prices to be observed more frequently at some numbers than others. Osborne (1962) was the first researcher to conduct the test in price clustering, and Osborne found the tendency of price in the New York Stock Exchange to cluster at whole numbers, followed by halves, quarters, and odd eights. While in some Asian countries, some cultures shape different investor behaviors.

Those cultures, superstitions, and beliefs are applied in investors' daily aspects of life and often affect the decision-making process, including important decision making in business and investment. One of the most known superstitions is the lucky and unlucky number. There are some lucky numbers preferred by Chinese people, like 3, 6, 8, and 9, and some unlucky numbers avoided by Chinese people, like 4 and 7. This superstition in numbers affects decisions on the property market. House with numbers ending with lucky number 8 is sold at a premium of 2.5%, while those ending with number 4 sold at a discounted price of 2.2% (Fortin et al., 2013).

These superstitions in numbers also affect price clustering behavior in Asian countries. There is a tendency of some lucky numbers to be observed more frequently, and there is also a tendency of some unlucky numbers to be avoided in quoting price. This tendency is known as cultural price clustering. Brown et al. (2002) tested the influence of Chinese cultural factors on price clustering in several stock markets in the Asia Pacific, and the result is significant in Hong Kong.

The Taiwan Stock Exchange is an excellent example of a Chinese culture-exposed market, with over 93% of the population embraced Buddhism and Taoism beliefs and only less than 7% of foreign investors. Superstition and culture are relevant information on the Taiwan Stock Exchange. Raesita et al. (2017) conducted a test of abnormal return in feng shui index recommended and unrecommended sector's stocks in the year of the fire monkey and found a significant difference in abnormal return of feng shui index recommended and unrecommended sector's stocks in the Taiwan Stock Exchange.

This paper aims to examine cultural price clustering in the Taiwan Stock Exchange, by comparing the lucky 8 and unlucky 4, the unlucky number group and lucky number group and testing the differences between the frequency of lucky number 8 observed during Chinese New Year festival period and non-Chinese New Year period, and finally testing the differences between the frequency of unlucky number 4 observed during Chinese New Year festival period and non-Chinese New Year period.

Price clustering is the tendency of prices to be observed more frequently at some numbers than others. The stock price moves to create a balance between two parties, the bid as the party interested in buying a stock and the ask as the party who is ready to sell a stock. This bargaining process has a minimum amount of price that can move up or down, known as the tick size.

1.1 Chinese Superstitions in Numbers

From the concept of traditional Chinese culture, Chinese people like numbers 8, 3, 6, and 9 as those numbers signify luck and fortune (Bai and Guo, 2010: 50). Meanwhile, in Chinese culture, numbers 4 and 7 are considered as numbers that cause bad luck. Number 8 (八, *bā*) has the same pronunciation as the word *fa* (发), which means great luck and good fortune. Number 3 (三, *sān*) in ancient Chinese have many important meanings; for example, the sun, moon, and stars as three celestial bodies. Heaven, earth, and humans are the three materials. Fathers, children, and grandchildren are three generations, and so on. Number 6 (六, *liù*) is generally considered to be lucky in China because it sounds like *li* (流), which means "flow" in Chinese. Number 9 (九, *jiǔ*) and eternal (久, *jiǔ*) have the same pronunciation; besides, number 9 is the highest. Number 4 (四, *sì*) has the same pronunciation as 死 (*sǐ*), which means dead. Number 7 is also the most avoided because 七 (七, *qī*) and 去 (*qù*) mean to go that have the same pronunciation.

1.2 Price Resolution Hypothesis

Ball et al. (1985) used the London gold market data to examine the degree of price clustering. This study concluded that the degree of clustering is not constant but is a function of information availability in the market, price levels, and price variability.

1.3 Negotiation Hypothesis

The price resolution hypothesis can be explained by assuming that traders use discrete price sets to reduce negotiation costs. Discrete set size then the degree of clustering depends on the balance between lower negotiation costs and the lost gain from trading. Negotiation costs will be low if the trader uses a coarse set, but the gain from trading can be lost if the set does not include a price that can be accepted by both parties. Traders use a good set of prices (and a little price clustering will be observed) when the value of the underlying assets is known.

The negotiating hypothesis by Harris (1991) stated that the degree of crowd price should be directly related to the degree of uncertainty in the value of shares. The more shares traded are usually associated with a small degree of uncertainty because trading will reveal value. Therefore, shares that are traded more often should have a smaller crowd of prices. Meanwhile, because greater volatility indicates greater uncertainty, stocks with high volatility should have a larger crowd of prices. Thus, the negotiating hypothesis predicts that clustering increases with price and volatility, and clustering decreases with market value and transaction frequency.

1.4 Collusion Hypothesis

Most NASDAQ shares are rarely quoted with a \$ 0.125 spread, to be exact 70 percent of the NASDAQ sample, including highly actively traded shares such as Apple Computer and Lotus Development. This cannot be explained by the price resolution hypothesis and negotiation hypothesis. The results were astonishing because they emerged from the dealer market, where inside spreads represented the best-consolidated quotes from at least 60 market makers. One possible explanation is collusion. Individual market makers implicitly agree to maintain a spread of at least \$ 0.25 by not posting quotes at \$ 0.125.

1.5 Attraction Hypothesis

According to the attraction hypothesis, people show a preference for integer and tend to round other numbers into integers. Attraction hypothesis is also known as round number syndrome. Goodhart & Curcio (1991) concluded that rounding depends on the linear closeness of the numbers and the basic attraction of each integer. Under the attraction hypothesis and depending on one's assumptions about the basic attractiveness of each number, the ranking of the attractiveness of integers in the decimal system

is 0, followed by 5, [2 = 8], [3 = 7, 4 = 6], and [1 = 9] (Aitken et al., 1996).

1.6 Benford's Law

Benford's law (1938) is the first digit distribution of data from many data sets. Intuitively, the first digit in the data set will be uniformly distributed, so that each number from 1 to 9 has the same possibility to appear. However, Benford's distribution is not uniform. According to Benford's law, smaller digits will be observed with a higher frequency than larger digits.

1.7 Culture Hypothesis

In some Asian countries, there is a tendency of stock prices to cluster around the lucky number 8 and the tendency of stock prices to avoid clustering around the unlucky number 4. According to Lip (1992), number 4 is the most avoided by the Chinese because number 4 has the same pronunciation as a death in Cantonese. Meanwhile, number 8 is considered to bring good luck because the number has the pronunciation "ba", which sounds similar to the word "fa", meaning luck, prosperity, success, and high social status.

Brown et al. (2008) tested the influence of Chinese cultural factors on price clustering in several stock markets in the Asia Pacific (Singapore, Taiwan, and Hong Kong, which represent countries with large ethnic Chinese proportions and Australia, the Philippines, and Indonesia representing countries with small ethnic Chinese proportions). The results showed evidence of cultural price clustering on the Hong Kong stock market, and the effect was stronger in the event window period (auspicious Chinese cultural festivals, namely the lunar new year, mid-autumn festival, and dragon boat festival). Meanwhile, research results were not significant in Singapore and Taiwan.

Anderson et al. (2015) tested price clustering on the Shanghai Stock Exchange and the Shenzhen Stock Exchange using intraday data. The results showed a tendency to ask price to cluster in number 8. There is also a tendency for prices to avoid the number 4 on bid orders. These results are consistent with Chinese beliefs to sell at prices ending with 8 and avoid buying at prices ending with 4.

2 METHODS

2.1 Variables

In this descriptive study, one variable used was the last digit. This last digit was obtained from the last digit of all stock traded at the Taiwan Stock Exchange from 2015 to 2019. As intraday stock price data on the Taiwan Stock Exchange was unavailable, this study used daily closing prices to represent daily stock price variables. The market's minimum tick size rule determines the definition of the clustering digit. This table provides information about the TWSE minimum tick size and clustering digit used in this research.

Table 1. Minimum tick size of TWSE and clustering digit

Stock price classification	Min. tick size	Clustering digit
<NT\$10	0.01	last digit
NT\$10<NT\$50	0.05	last digit (0 or 5)
NT\$50<NT\$100	0.10	penultimate digit
NT\$100-NT\$500	0.50	penultimate digit (0 or 5)
NT\$500<NT\$1000	1.00	last digit before decimals
>=NT\$1000	5.00	last digit before decimals (0 or 5)

To answer the first problem (do prices tend to cluster less on unlucky number 4 and more on lucky number 8 in Taiwan Stock Exchange), the following three comparison ratio have been used:

- a. 8 vs. 2
- b. 6 vs. 4
- c. 8 vs. 4

According to attraction hypothesis, digit 2 has the same attractiveness as digit 8 and digit 6 has the same attractiveness as digit 4, so the ratio of frequency 8 to 2 and 6 to 4 should equal to 1. According to Benford's law, digit 2 tends to appear more often than digit 8 and digit 4 tends to appear more often than digit 6. Therefore, if the results show preference of 8 rather than 2, and 6 rather than 4, and in the end 8 rather than 4, it can be explained purely as cultural price clustering and not the cause of Benford's law or attraction hypothesis.

2.2 Population and Sample

The target population in this study was all of the company's shares listed on the Taiwan stock exchange, which (1) actively conducted trading during the study period and (2) in the range of <NT \$ 10, NT \$ 50-NT \$ 100, NT \$ 500- NT \$ 1000. Stocks that have a minimum tick size of 0.05, 0.5, and 5 were excluded from the research sample because this research only focuses on describing cultural price clustering.

The research period was five years (1 June 2015-30 June 2019). Chinese New Year festival period consists of 2 working days before and after the Chinese New Year. Table 2 below describes the event window for hypothesis testing.

Table 2. Event window of CNY festival

Year	Market holiday	T-2	T+2
2015	16/02-23/02	12/02 & 13/02	24/02 & 25/02
2016	04/02-12/02	02/02 & 03/02	15/02 & 16/02
2017	25/01-01/02	23/01 & 24/01	02/02 & 03/02
2018	13/02-20/02	09/02 & 12/02	21/02 & 22/02
2019	31/01-08/02	29/01 & 30/01	11/02 & 12/02

2.3 Data Collecting Procedure

The steps undertaken in this study were as follows:

- Listing all stock symbols;
- Collecting data on daily closing stock prices during the research period;
- Writing stock price data vertically based on a date;
- Inputting the last digit according to the definition in Table 1 in the last digit column;
- Calculating the frequency of each last digit from 0-9;
- Calculating the relative frequency (F_i) of each last digit;

$$F_i = \frac{N_i}{\sum_{i=0}^9 N_i} \quad (1)$$

where $i = 0, 1, 2, \dots, 8, 9$ and N_i is the number of i observed.

- Calculating the ratio of 2 vs. 8, 4 vs. 6, and 4 vs. 8;
- Calculating average relative frequency (%) of lucky number group (3, 6, 8, and 9) and unlucky number group (4 and 7);
- Calculating the ratio of lucky number group vs. unlucky number group;
- Classifying stock prices in the event window period for hypothesis testing. The Z-stat formula is as follows:

$$z = \frac{\hat{p}_1 - \hat{p}_2}{\sqrt{\bar{p}(1-\bar{p})\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} \quad (2)$$

Where: \hat{p}_1 is proportion of x in population 1, \hat{p}_2 is the proportion of x in population 2, n_1 is the population 1 sample size, n_2 is the population 2 sample size, while \bar{p} is the pooled proportion counted as follows:

$$\bar{p} = \frac{x_1 + x_2}{n + n_2} \quad (3)$$

2.4 Hypothesis Testing

H_{a0} : $Last\ digit_{4-CNY} - Last\ digit_{4-nonCNY} = 0$, meaning that there is no difference in the price clustering of the digit ending with 4 in the Chinese New Year event window period and the non-Chinese New Year period.

H_{a1} : $Last\ digit_{4-CNY} - Last\ digit_{4-nonCNY} \neq 0$, meaning that there is a difference in the price clustering of the digit ending with 4 in the Chinese New Year event window period and the non-Chinese New Year period.

H_{b0} : $Last\ digit_{8-CNY} - Last\ digit_{8-nonCNY} = 0$, meaning that there is no difference in the price clustering of the digit ending with 8 in the Chinese New Year event window period and the non-Chinese New Year period.

H_{b1} : $Last\ digit_{8-CNY} - Last\ digit_{8-nonCNY} \neq 0$, meaning that there is a difference in the price clustering of the digit ending with 8 in the Chinese New Year event window period and the non-Chinese New Year period.

3 RESULTS

Descriptive statistics describe the characteristics of each study sample that represents its population.

Table 3. Descriptive statistics of last digit variable

mean	median	modus	stdev	min	max	observation
4.088	4	0	3.013	0	9	187.031

This research used 187.031 observations of closing price data. The data were then obtained to determine its last digit using excel =if. The last digit variable is nominal data, which varies from 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9.

Table 4. Frequencies and ranking of most observed the last digit in TWSE 2015-2019

Last digit	Frequency	Frequency (%)	Rank
0	35.653	18.75%	1
1	16.109	8.47%	8
2	16.856	8.86%	4
3	16.417	8.63%	6
4	14.854	7.81%	10
5	23.867	12.55%	2
6	16.417	8.63%	6
7	15.572	8.19%	9
8	18.003	9.47%	3
9	16.421	8.63%	5
Total	190.169	100.00%	

Table 4 describes the frequencies of each last digit. The most observed last digit was 0, followed by 5, and the lucky number 8. Meanwhile, the less ob-

served last digit was the unlucky number 4. This study is consistent with previous studies that there is an aversion of price to cluster at the unlucky number 4 and there is a tendency of price to cluster at the lucky number 8 in some Chinese culture-exposed Asian stock market.

Table 5. The observed ratio of lucky number 8 and unlucky number 4

Ratios of	Expected Ratio	Observed Ratio	Conclusion
6 vs. 4	> 1.00	1.11	Observed ratio meets the expected ratio
8 vs. 2	> 1.00	1.07	Observed ratio meets the expected ratio
8 vs. 4	> 1.00	1.21	Observed ratio meets the expected ratio

Table 5 describes the observed ratio and expected ratio of 6 and unlucky 4, the lucky 8 and 2, lucky 8 and unlucky 4. According to the observed ratio, there is a tendency of price to cluster at the lucky 8, and a tendency of price to avoid cluster at the unlucky 4.

The authors also compared some other lucky numbers with unlucky numbers by counting average frequencies of lucky number group (last digit 3, 6, 8, and 9) with unlucky number group (last digit 4 and 7). The result once again showed a tendency of price to cluster at lucky number group and a tendency of price to avoid cluster at unlucky number group.

Afterward, the authors conducted a test of difference in proportions of two populations. The first population was the Chinese New Year (CNY) period, and the second population was the non-CNY period.

Table 6. Frequencies of each last digit during the CNY period

Last digit	Frequency	Frequency (%)
0	633	20.17%
1	266	8.48%
2	273	8.70%
3	274	8.73%
4	231	7.36%
5	406	12.94%
6	270	8.60%
7	248	7.90%
8	267	8.51%
9	270	8.60%
Total	3.138	100.00%

According to Tables 6 and 7, the authors attest differences in proportions of the CNY period and the non-CNY period. The first test conducted was the unlucky number 4. With a significance level of 1%, 5%, and 10%, the results were insignificant. There is no difference between price clustering at unlucky number 4 during the CNY period and the non-CNY period. Then the second test for lucky number 8 was

conducted, with the results were significant at a significance level of 10%. There is a difference between price clustering at lucky number 8 during the CNY period and the non-CNY period.

Table 7. Frequencies of each last digit during the non-CNY period

Last digit	Frequency	Frequency (%)
0	35.020	18.72%
1	15.843	8.47%
2	16.583	8.87%
3	16.143	8.63%
4	14.623	7.82%
5	23.461	12.54%
6	16.147	8.63%
7	15.324	8.19%
8	17.736	9.48%
9	16.151	8.64%
Total	187.031	100.00%

According to the previous study, the cultural price clustering effect gets strengthened near the cultural festival period. Last digit 4 was definitely avoided in TWSE whether the transactions are conducted in CNY and non-CNY period. This result may also be biased because the distribution of data in the CNY period and the non-CNY period was not balanced.

4 CONCLUSION

There is definitely strong evidence of cultural price clustering in the Taiwan Stock Exchange. According to the observed ratio, there is a tendency of price to cluster at lucky 8 and a tendency of price to avoid cluster at the unlucky 4. The authors also compared some other lucky numbers with unlucky numbers by counting average frequencies of lucky number groups (last digit 3, 6, 8, and 9) with unlucky number groups (last digit 4 and 7). The result once again showed a tendency of price to cluster at a lucky number group and a tendency of price to avoid cluster at unlucky number group.

However, the hypothesis test results showed no difference in price to cluster at the unlucky 4 during the CNY period and the non-CNY period but showed a difference in price to cluster at the lucky 8 during the CNY period and the non-CNY period.

The limitations of this paper are the unbalanced data distribution in the CNY period and the non-CNY period and the use of closing price data instead of intraday price data.

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