STATISTICS OF PRICE GAP IN CHINESE AND AMERICAN STOCK MARKETS

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Abstract - Empirical research is very important for financial research. Some universal laws obtained from statistical analysis have been called touchstones of relevant theoretical models. However, there are stillsome superstitions that have not yet been verified by scholars but spreading among stock traders. For example, there is an axiom about the stock gap, which is "gaps always get filled." Chartists believe that the gaps always exist universally, and the gap should be closed.Research on this issue is still very scarce, both theoretical and empirical. This paper discusses some statistical characteristics of the gap by collecting empirical data and applying statistical analysis. By comparing the results of the Chinese stock market with those of America, this work foundsome similarities and differences of gaps and gap-filling time. Both Chinese and American stock marketsgenerate gaps while the number of gaps in the US. stock market is twice as large as that in China. The gaps are filled in different time lengths, which is very uncertain with a large variance.This study opens a window for research on the sudden changes and collective behaviors in the financial system.

Keywords - Stock market,Price gap, Gap-filling, Length of filling gap,

I. INTRODUCTION

Financial markets can be regarded as model "complex systems". There are many traders and financial products in this system, and there are complex dynamic reactions between them.The criteria of the complex systems, such as feedback, non-stationarity, many interacting agents, adaptation, evolution, open system, are applicable to a financial market [1]. However, because of the importance of the financial system to society and economy, as well as human development, the difficulty of research cannot hinder scholars'enthusiasm for its research.

Research on finance can be roughly divided into two areas: theoretical research and empirical research which are mutually reinforcing.It is worth emphasizing that, empirical work plays an important role in providing factual basis and judgment criteria for theoretical work [2].Empirical research based on statistical analysis has been providing a rich research object for the continuous deepening of financial theory and has also played a great role in promoting the development and exploration of applications.

Statistical analysis of actual data on financial markets has discovered some stylized facts such as the fat-tailed distribution of returns, volatility clustering of returns, and slow decay of autocorrelation in absolute returns,etc. [3,4]. These are popular phenomena that could found in various financial markets and have attracted the attention of a large number of scholars. They explore plenty of mechanisms to reproduce these statistical characteristics, including nonlinear adaptive systems[5], evolutionary percolation model[6], dynamic heterogeneous agent models [7,8],even Ising model, a kind of pure physical processing[9]. Consequently, these stylized factors are recognized as the touchstones for judging a model if it is good enough. The scholar's adherence that the more typical facts that can be reproduced, the more successful the model is[10].

Statistical discoveries continue to bring abundant problems to theoretical research. For example, the power law relation between skewness and kurtosis[11], the universal and stationary price formation mechanism[12], and spurious trend switching[13].

The non-linearity and expectation of the financial system cause some indexes to jump or jump. Price gaps in stock markets are typical performances. But until now, there are only a few academic literatures on the gap which mainly focuses on the similarity and difference of statistics of the trade volume in transactions period such as before, during and after the gap [14,15]. The related discussions are still inadequate.On the contrary, focus on the gap is mainly popular with stock traders in the whole world. In the actual scene, chartists conclude some rules to guide them in their practical activities based on the graphic analysis. They believe if a gap is not closed by the next minor reaction, there is a higher chance that it will be shouted by the very near coming trade day.

This paper focuses on the statistics of the price gap. Besides, trying to reveal how many gaps and how quick the gap can be filled from empirical data, we will compare the empirical statistics reality in different markets. The sections of the article will be arranged as follows. In section 2, a brief introduction to the gap phenomenon and our data sources will be

present. In the next section, statistical results are exhibited and compared. We find some similarities and differences between China and the United States in stock market gaps.

II. BACKGROUND AND DATASOURCE

2.1. Gap and Gap-filling Phenomena

The candlestick-graph is a style of financial chart used to describe price movements. Each ``candlestick" typically shows one day and ``candlesticks" express the whole situation in a continual trading session [16]. As shown as the legend located at the left upper part in Fig. 1, each candlestick is like a combination of line-chart and a bar-chart: each represents all four important pieces of information for that day: the open, the close, the high and the low.

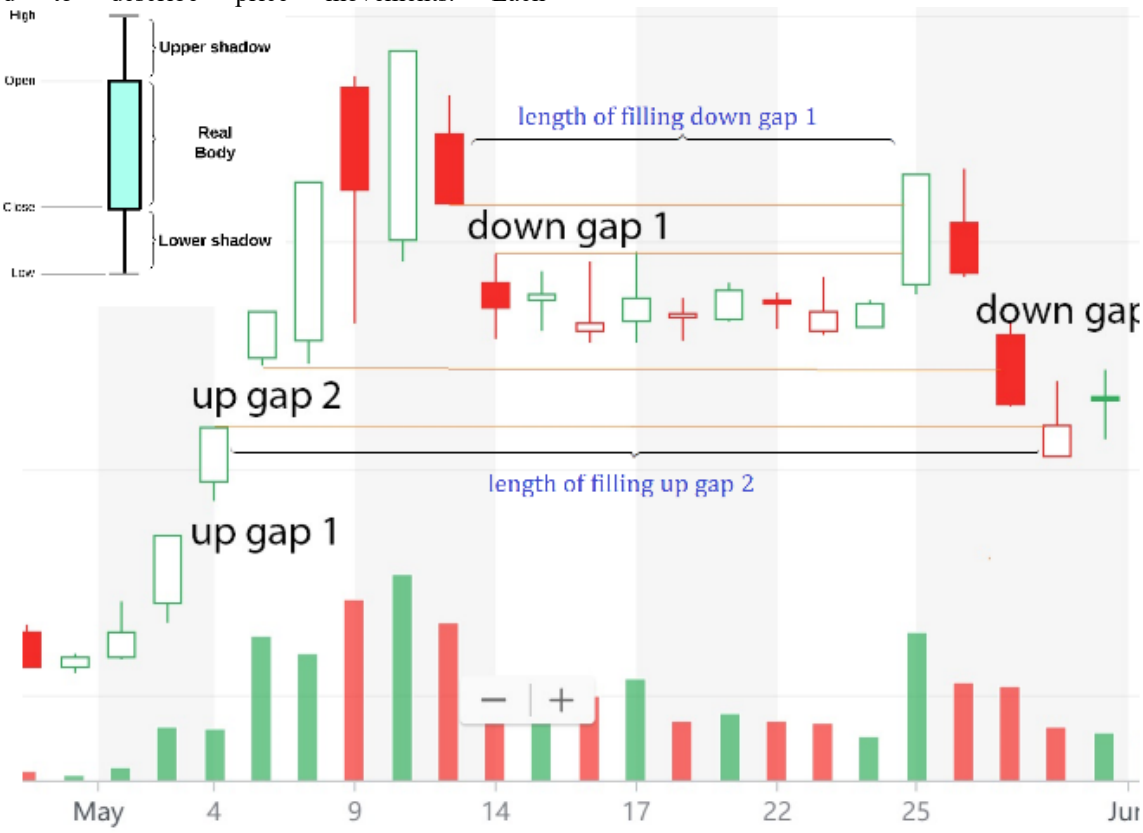


Fig.1. Phenomena of gap and gap-filling.

This plot is got from https://sg.finance.yahoo.com. This candlestick plot is for Shahe Industrial Co., Ltd. (000014.SZ) in the Shenzhen stock exchange (SHSE).

Candlestick graph is one of the most convenient tools to find the trend and the gap of the stock. Figure 1 exhibits the prices of certain trading sessions for Shahe Industrial Co., Ltd. (stock code 000014) that list in Shenzhen stock exchange market in China. In this period, from 25th April to 31stMay 2018, there are 4 gaps occurred on 4th May, 7th May, 14th May and 29th May respectively. On the price chart, it is clear to find 4 spaces appears between the bars that indicating the gap or window. Precisely, gaps happen when the low price is higher than the next day's high price, or high price is lower than the next day's low price that no shares were traded within a particular price range.

Price gaps can be divided into two categories that are up gaps and the down ones. To form an up gap, the lowest price after the market closed must higher than the highest price of the previous day, and a down gap is formed oppositely--the high price after the market closed must be lower than the low price of the previous day. There are 2 up gaps and 2 down gaps in figure 1. Up gaps occurred on 4th May and 7th May and down gaps would be found on 14th May and 29th May.

A gap is filled or closed means that the price movement at a later time (few days to a few weeks,even longer) usually retraces at the least to the last day before the gap. For an up gap, the lowest price on the day of filling the gap must lower or equal to the lower boundary of the gap (maximum price on the previous transaction date). For a down gap, the highest price on the day of filling the gap must higher or equal to the upper boundary of the gap (minimum price on the previous transaction date). In that case,

the "up gap 2" was filled in 30th May; the "down gap 1" was filled in 25th May. Until the end of the period, the "up gap 1" has not closed yet.

Gaps are meaningful that can provide clues about the price movement. The breakup from price continuity implies that something important has happened to the fundamentals or the psychology of the crowd that has triggered this market movement. By the inception of technical analysis, these "holes" have always been in the limelight of the chartist.

2.2. Data Source

As shown in table 1, we randomly collected 50 stock data from Shanghai stock exchange (SHSE), the main board of Shenzhen stock exchange (SHSE-1), the second board of Shenzhen stock exchange (SHSE-2), New York stock exchange (NYSE) and NASDAQ stock exchange (NASDAQ) respectively. The first three are from China, and the last two are from the United States. The data of China Shanghai exchange and Shenzhen exchange are from tushare, which is a free, open-source Python financial data interface package. It can collect and store stocks and other financial data. (found more information at http://tushare.org/). The transaction data in the United States come from the Wind Datafeed Service which provides historic reference data and foreign exchanges (see more details on http://www.wind.com.cn/en/). The data that we used in our research are all daily price data, including opening, closing, maximum and minimum prices. We use backward adjusted prices to get rid of the effect of splits and dividends. The data is of the period between January 2, 2008, to December 29, 2017. Due to the late establishment of the second board on the Shenzhen Stock Exchange, the transaction started from December 30, 2009. These stock markets are representative markets. SHSE and NYSE markets are similar, and they list mainly industrial enterprises. SZSE-2 is similar to NASDAQ, and they list mainly high-tech firms.

Table1: Data Source

Stock market	Stocks No.	Period	Average trade days
SHSE	50	2008/1/2-2017/12/29	2314.54
SZSE-1	50	2008/1/2-2017/12/29	2243.88
SZSE-2	50	2009/10/30-2017/12/29	1693.54
NYSE	42	2008/1/2-2017/12/29	2518.00
NASDAQ	36	2008/1/2-2017/12/29	2518.00

III. RESULTS AND DISCUSSION

3.1. Empirical Statistics

It is evident there are gaps and gap-filling phenomena in all 5 stock markets by statistics, but there are some differences between them. Table 2 exhibits some meaningful statistical norms, such that N_{100} the number of gaps in the average 100 trade date per stock; the average and standard deviation of TD_{fill} which presents the number of the trading days required to fill the gap; the average and standard deviation of CD_{fill} which presents the number of the calendardays to fill the gap; and $N_{unfilled}$ the average number of gaps that occurred during this period but were not closed until the end of the period. Besides, thegapsize S_{gap} defined as the gap size or gap width to distinguish how big one is the gap. For an up gap occurred at trade date t, the size is $S_{t,gap} = \frac{X_{t,low} - X_{t-1,high}}{X_{t-1,close}}$ and for a down $S_{t,gap} = \frac{X_{t-1,low} - X_{t,hight}}{X_{t-1,close}}$ respectively. There $X_{t,low}$ and $X_{t,hight}$ are the lowest and highest prices on day t. For $X_{t-1,low}$ and $X_{t-1,high}$ are the extreme prices at last trading date t-1. $X_{t-1,close}$ represents the close price on the last trade date. In addition to some statistics that will be displayed in the next section, there is some clear evidence that we could find from table 2.

Table2: Gap Statistics of Empirical Data From Some Stock Exchanges

Gap type	Index	SHSE	SZSE-1	SZSE-2	NYSE	NASDAQ
up gap	N_{100}	1.5588	1.73	1.7951	3.716	3.2113
	TD_{fill}	31.847 (108.248)	26.653 (83.340)	24.779 (69.675)	27.924 (89.949)	31.773 (121.065)
	CD_{fill}	50.371 (171.161)	41.969 (131.306)	38.316 (108.184)	40.477 (130.503)	46.049 (175.589)
	S_{gap}	0.01367 (0.01618)	0.01420 (0.01589)	0.01422 (0.01708)	0.006011 (0.009601)	0.01514 (0.03964)

	$N_{unfilled}$	2.14	2.2	1.7	10.429	7.4167
downgap	N_{100}	1.9658	2.0491	2.056	3.0203	2.791
	TD_{fill}	64.844 (220.770)	48.379 (155.295)	37.001 (118.015)	24.518 (87.697)	34.114 (122.846)
	CD_{fill}	100.883 (339.160)	76.369 (242.267)	58.053 (184.038)	35.540 (127.203)	49.480 (178.273)
	S_{gap}	0.01049 (0.01245)	0.01112 (0.01347)	0.01153 (0.01501)	0.00723 (0.01451)	0.01459 (0.03114)
	$N_{unfilled}$	1.5	1.6	1.9	0.9048	0.8889
total	N_{100}	3.5246	3.7792	3.8511	6.7363	6.0023
	TD_{fill}	50.475 (181.324)	38.556 (128.323)	31.308 (98.671)	26.307 (88.897)	32.911 (121.927)
	CD_{fill}	78.887 (279.832)	60.816 (200.592)	48.860 (153.739)	38.134 (128.961)	47.716 (176.889)
	S_{gap}	0.01189 (0.01431)	0.01253 (0.01470)	0.012783 (0.01606)	0.006558 (0.012068)	0.01489 (0.03594)
	$N_{unfilled}$	3.64	3.8	3.6	11.3333	8.3056

3.2. The Compare

Either up gaps or down gaps in the US stock exchange markets have a larger amount than Chinese markets do, and during the same period, the former creates double quantities of gaps than the later. The less occurrence of the gaps in Chinese markets perhaps due to the T+1 trading rules and 10% restrictions imposed by the Chinese markets.

The fill gap effect is more intense in U.S. markets because the gap-filling process in the US market often takes less trading days and less natural days than the Chinese market. Relative to the others China's markets, SZSE-2 has a shorter time to make up the gap, and its up-shortening gap is the shortest among all five markets.

The down gaps in the US stock exchange markets are closed significantly faster than the Chinese market. The up and down gaps in the United States are approximately the same, but the filling time for China’s down gap is almost twice that of the upper gap. The above indicates that the development of the Chinese stock market is relatively weak, and it requires more time to recover once it is reduced by the unexpected environment impacts.

Comparing to China, there is a big number of unfilled up gaps and less unrecovered decline gap in the US market. The proportion of up gaps in the US market is far greater than down gaps and almost 10 times than later. The unclosed up gaps are slightly more in Shanghai main board and Shenzhen main boards than Shenzhen second boards, but it is slightly less for down gaps.

Whether there are up gaps or down gaps, the NYSE has the smallest gap size, and the NASDAQ has the largest gap size. The order is the same, NASDAQ>SZSE-2>SZSE-1>SHSE>NYSE

CONCLUSIONS

In this paper, we discuss the gap in stock price. Specifically, we focused on the statistic characteristics of the gap and naturally gap-filling phenomenon. From the statistics,we can see there are gapsin all the 5 markets in China and the US. Meanwhilewe find similar gap-filling phenomenon in both two countries. The fill gap effect is more intense in U.S. markets because the gap-filling process in the US market often takes less time than the Chinese market.Apart from that, different markets were slightly different in some statistic characteristics, such as the number of gaps, the unfilled gaps, the size of the gap and so on, but generally, they are similar. We may recognize that gaps appear in both two countries and the gap-filling phenomenon is widespread in these countries. As for future work, we can focus on how this gap-filling phenomenon appears or whether the gap-filling time follows some specific distribution. We believe that this study would open a new window for research on catastrophe and collective behavior in the financial system.

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