

# Stock price volume leap principle based on investor sentiment contagion model

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**Abstract.** The rise and fall of the Chinese stock market has been the subject of many studies since its inception. However, the recurring uncertainty of the broad market and individual stocks has overturned many people's perceptions of the financial market. This paper explores the principles of the rise and fall of individual stocks under certain conditions, starting from Samuelson's phenomenon of backward bending of the price supply curve for oil and labour, and proposes a methodology for stock market investment based on this principle. The results of the study show that the rise of stock prices is often characterized by a rapid jump. An important factor related to this is the interest rate of private lending. The rise and fall of private lending rates affect the expected return on stock market investment funds and has an important impact on stock market investment. Therefore, in the absence of a qualitative change in the stock's texture, the medium-term rate of increase is the key to judging the stock price's later trend. The results of this study provide a new direction to think about when judging the short- and medium-term stock price movements.

## 1 Introduction

The capital market is playing an increasingly positive and far-reaching impact on our economic market. The capital market is a barometer of economic development, and a stable financial market is a stable economy. As of the end of 2021, there were 4,674 listed companies in Shanghai and Shenzhen Stock Exchanges, with a total market value of 91.7 trillion, and the total market value accounted for 80.18% of the national GDP, which continued to rise by 1.71% compared with the previous year. Therefore, the importance of the capital market is self-evident at present and in the future [1]. For investors in the capital markets, return on capital is the ultimate theme of investment, and the measure of any investment cannot be separated from the return on capital. Return on capital is a standard line that investors cannot avoid in both the real economy and the financial markets. For investors in the capital market, the expectation of the future price of securities determines the expectation of the return on capital of the investment in the investor's mind, which in turn affects the investor's investment behavior. The sentiment of China's financial markets differs significantly from that of developed countries, and the high proportion of natural person investors in China's investor base may have an important impact on the stability of the stock market, and institutional investors are not necessarily risk stabilizers; emotional factors in investor behavior may be one of the causes of systemic risk escalation in capital markets [2].

Previous studies have shown that irrational natural investors, especially in the Chinese market, are highly susceptible to external information factors, especially gossip, so that the most frequent tragedy in the Chinese stock market is "chasing the upside and killing the downside" due to the fact that investors ignore the real value of the stock as it should be [3]. Investor sentiment is divided into individual investor sentiment and institutional investor sentiment, and different types of investor sentiment can have different effects on the capital market. Investors can buy the company's stock when the capital market investor sentiment is high and gain investment income and can sell the company's stock to avoid more investment losses when the investor sentiment is low.

Hu et al. found that the cumulative effect of investor sentiment has a more significant impact in the market [4]. Initially, this effect may lead to significant positive returns, but as investor sentiment gradually accumulates to a certain level, the market experiences a more substantial price correction. This effect is particularly pronounced for stocks that are not easily arbitrageable [4]. A study by Lu et al. showed that since most investors obtain and frame their information primarily through media coverage, the agenda setting of media coverage can have a change on investor sentiment [5]. Investor sentiment, in turn, directly influences their decision making, which leads to stock price volatility [5]. In particular, the tendency of media coverage tends to have

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an impact on investor sentiment, which in turn triggers stock price volatility [5]. Song et al. found through an empirical study that stocks with larger size, higher volatility, and higher P/N ratio are more susceptible to investor sentiment, while stocks of different ages are not affected by investor sentiment [6]. The work of Luo et al. confirms that investor sentiment in the second interval appears to reverse the direction of its effect on stock index excess returns, while in the third interval, investor sentiment underestimates its increasing effect on the average increase in stock index excess returns [7]. Song et al. found that market sentiment and individual stock sentiment also have a significant effect on IPO premiums [8]. The effect of market sentiment on IPO premium increases as uncertainty about the value of the firm increases. In contrast, the higher the speculative risk of the firm, the smaller the effect of market sentiment on IPO premium. For firms with high IPO premiums, the stock price tends to gradually reverse after the IPO [8].

This paper is motivated by exploring the price changes of stocks in the short and medium term. In the second and third parts, the principle of volume leap and the formation mechanism of capital market are elaborated, the fourth part determines the psychological juncture of long and short flips, the fifth part analyzes investor sentiment based on the SIR contagion model, the sixth part uses existing market data to test the constructed model, and finally proposes a methodology in terms of stock market investment perspective.

## 2 The quantum leap principle of capital markets

The labor price supply curve has a backward bending phenomenon, where supply increases first as prices rise and then decreases as prices continue to rise, and labor prices do not lead to an increase in labor supply after rising above a certain level [9]. Samuelson argues that this phenomenon exists in other areas as well. The author finds that for capital markets, there is a similar pattern in the surge and fall of prices of some securities. According to the disposition effect proposed by Shefrin and Statman in 1985 [10], when the price of a security rises, profitable investors sell their holdings in the secondary market, bringing about an increase in the supply in the market. Such increased supply itself puts pressure on the upward trend. Therefore, in the author's opinion, until the price supply curve enters a backward bending phase, there will not be a sharp rise in the price of securities. The reason for the surge is that when the price supply curve enters the backward bending phase, the disposition effect is broken and the price increase does not bring about an increase in supply, but at the same time, due to the change in investor psychology, the price increase will bring about an increase in demand, which in turn will stimulate the price increase and a significant price increase, a process called volume jump.

## 3 The formation mechanism of quantum leap phenomenon

The key to the formation of the quantum leap phenomenon is to make the market enter the backward bend of the price supply curve, breaking the disposition effect, the market into an irrational state. For investors, especially institutional investors, the increase in price does not necessarily make investors profitable. If the price of the underlying investment does not rise as much as the cost of capital for investors, investors still psychologically believe that the investment results in a loss. Chinese law is very protective of private lending, and profits and principal are protected for private lending at an annual interest rate of 24% or less. At the same time, China lacks a personal bankruptcy system, which legally reduces the risk of lending, resulting in less risk in private lending than in the stock market. As a result, capital market investors expect a higher return on capital in the capital market than they can get from private lending, otherwise capital would tend to flow to the private lending sector rather than the capital market. Therefore, the disposition effect is broken only when the price of the security rises enough to exceed the investor's expected return on capital, and investors holding positions begin to generally wait to sell rather than close out their positions and cash out. At the same time, other investors in the market expect to buy the security, and the two together stimulate the price to rise, and the price rise further stimulates the market and influences the investment behavior of investors, entering a positive feedback loop that causes the price of the security to rise significantly.

The cost of capital for capital market investors is the bottom line of the expected return on capital for investors, otherwise, even if the price of the underlying investment increases, investors will not be able to make a profit. The capital invested in the capital market bears high risk and expects a high return on capital. Both investors in the capital market and capitalists who provide funds to investors have higher expectations for the return on capital. The author believes that the expectation of return on capital in the capital market is related to the interest rate of private lending. If the capital side for the capital market return on capital is lower than the interest rate of private lending, it is better to invest in investors who manipulate the capital market than to provide private lending to investors who manipulate the capital market. In this case, the private lending rate creates a cost support to the capital market's expected return on capital.

The ideal rise is a rise close to or exceeding the desired return on capital market funds, a sign that market rationality is gradually being lost and the price supply curve is entering a backward bending phase, often signaling a high probability of a back-order volume leap phenomenon. The interest rate for private lending is 2 cents, which is also the legal maximum private lending interest limit, and bank credit loans are often repaid in equal principal and interest, with bridging funds limited to six months. Therefore, the bottom line of the ideal rate of return expected by speculative capital in the capital

market is the actual interest rate of equal principal and interest repayment under the two-cent interest condition, which is calculated by the author as 10.53% per month. This calculation is the psychological barrier to the cost of capital for investors in the capital market. The law does not support the refund of interest paid on usurious loans up to 36% per annum, while the principal amount of usurious loans is protected. Considering the high-risk nature of the securities market, the ideal return on capital for investors should continue to increase in accordance with the 36% annual interest rate compared to the psychological threshold, while the overall return is inversely proportional to the risk of private lending.

The formula for determining the ideal rise point is given below. One set the psychological hurdle of investors' cost of capital in the capital market  $P$  where Ideal upside increase is denoted as  $R$  (monthly interest), risk function is represents as  $r$  so that  $R = (P+3\%) * r$ . Taking  $P = 10.53\%$   $r = 1/36\%$  gives  $R = 37.58\%$  where the risk function is chosen: since the maximum interest rate supported by law is 36%. Set when the interest is comparable to the principal, the follow-up can be considered risk-free, therefore, the risk is inversely proportional to the annual interest rate, so  $r = 1/36\%$  is chosen. The ideal rate of increase  $R$  is the investor's ideal rate of return on capital, which is very attractive to investors, but an increase in the price of a security below  $R$  does not mean that the investor loses money. In an uptrend, when the market shows a rise of about  $R/4$  of the weekly increase, the market tends to enter an irrational phase and the price supply curve enters a backward bending phase with a high probability of volume jump.

#### 4 The psychological juncture between the long and short flips

Current research on long-short duels finds that mispricing by investors in a-shares can cause high opening and low moving anomalies [3], presenting a novel perspective on long-short duels. However, the author argues that institutional investors can also misprice stocks. Institutional investors make a long or bearish psychological orientation based on a stock's price movement. Because institutional investors have more capital strength than retail investors, like a non-directional point in the space of binary functions, institutional investors' views on a stock can greatly influence the price movement of a stock, reversing the price supply curve in a very short period of time, making it possible to enter, exit, or even reverse the volume of a stock. The creation and bursting of the stock market bubble was brought about by the actions of institutional investors who increased and decreased their positions from 2007/6 to 2008/12 [11], which shows that institutional investors' bearishness on the stock market at the beginning of the bubble and bearishness at the top of the bull market led to the creation and bursting of the stock market bubble during 2007-2008. The bubble would not have been created if institutional investors had not increased their long positions in the stock market, and it would not have

burst if institutional investors had not reduced their bearish positions at the top of the bubble. The positive feedback behavior of institutional investors to increase their positions when stocks are up or down out of up and decrease their positions when they are down [11] and the return expectations of institutional investors for institutional products make it difficult for institutional investors to maintain a safe position in the stock market. Even if the relevant regulations are met, if institutional investors are worried about the risk of reducing their positions, in front of the floating profits of other institutions, institutional investors will redeem thus bringing huge redemption pressure to the institution, therefore, institutional investors must maintain a large proportion of their positions in pursuit of higher returns.

Closing a position after going long and selling the stock can also be seen as a shorting process. The process of closing a short position after shorting can also be seen as a long process. The long and short positions can be divided into two cases: pocketing profits and psychologically exploding stop loss. Because of the institutional requirements for risk control, as well as the A-share short-selling allows double leverage, institutional investors in the long and short positions have to close the line of risk control requirements. When the stock surges, short-side institutions lose money, when the stock price rises to short-side institutions have to close their positions for short orders, short-side institutions have to do more to close their positions. Besides, the short-side institutions to do long itself brings for the stock to buy further stimulate the stock price rise, making the stock price supply curve further distortion, there is a further rise. When the stock surges, multiple institutions to close positions at a profit, because the short-side institutions have been closed, multiple institutions to close positions short, there is not enough counterparties to take, if the multiparty based on closing profits, the stock price will happen to plummet, the stock price supply curve breaks down the back bend stage, the more the price falls, the more selling, the stock price plummeted. Conversely, if, if a multi-party institution does not close out its position, the multi-party institution in fact becomes a long-term multi-party, the stock price supply curve does not enter the backward curve phase, and the stock price does not plummet. The stock price enters a stabilization phase when a new multi-party institution enters.

#### 5 Empirical analysis

Using the a-share data since 2017, we refer to the points that show a desirable rise, as characteristic points, and the points that show a rise of more than 25% in six months in characteristic points become valid points. The ratio of the number of characteristic points to the number of valid points is counted. The number of characteristic points to valid points is calculated by adding the new year's data to the existing data year by year, starting from 2017, until 2022 when all the data from 2017-2022 are included. By following the years and continuously adding the next year's data to the data of the existing sample starting from

2017, the ratio under the larger sample is obtained and the line graph is plotted. (i.e., 2017 is only the result obtained based on data from 2017, 2018 is the result obtained based on data from 2017 and 2018, and 2019 is the result obtained based on data from 2017-2019.... Both were removed due to the extreme data obtained for 2017 and the data for 2023 due to the unavailability of full-year data. Using the data obtained for 2018-2022, the line graph is obtained by plotting. The results are shown in the Fig. 1. In the data processing, the year 2017 exhibits an extremely low ratio of characteristic points/valid points

and the data is unreliable, thus the author removes the data with only the data of 2017 as the sample. Also, the data for 2023 were removed because the data were unreliable as the year-end was not reached in 2023. Except for 2018, when the effective point ratio was lower at 0.68, with the expansion of the sample, the effective point ratio increased, and all over 70%, it can be asserted that the ideal rising point has a strong judgment role for the a-share market in recent years, and has a high reference value for the rising prediction of individual a-share stocks.

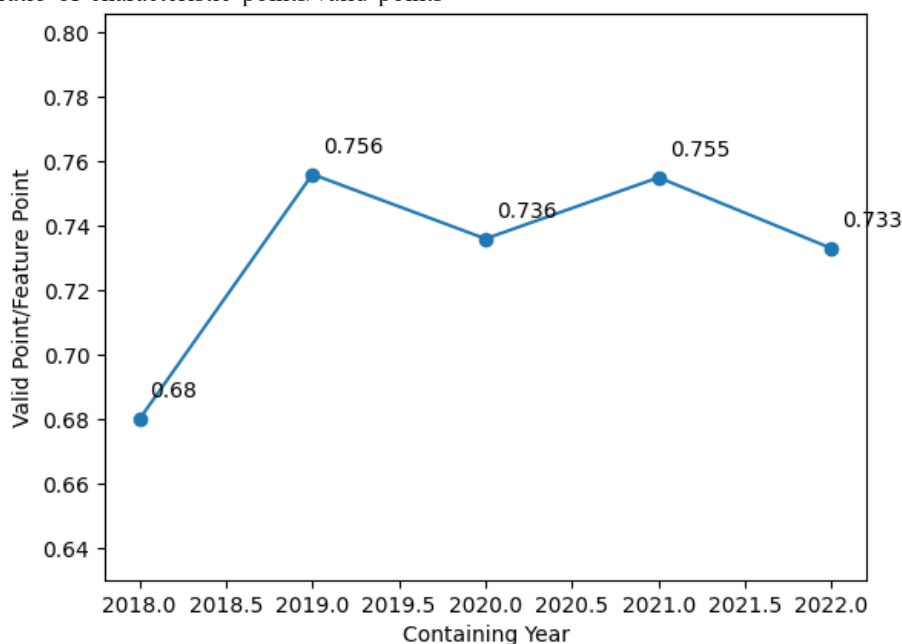


Fig. 1 Feature point/effective point ratio plot (Photo/Picture credit: Original).

## 6 Limitations and prospects

The essence of academic research is to better serve the economy and society, and to identify the shortcomings for academic summary and research outlook, which is beneficial to both local scientific research in China and relevant academic discussions abroad. This section is divided into "research shortcomings of this paper" - "research shortcomings of existing literature" - "academic outlook". This section will be explained in accordance with the following principles. As for the research of this paper, the research data selected in this paper only selects A shares in the national scale and only focuses on the Chinese market; in the time length of only 5 years, the sample size selected can be expanded, so that the generalizability of the model can still rise. In addition, the current selection of indicators is relatively single, and the results of the joint action with other indicators are not studied. We plan to use the sir model for a combined study of investor sentiment contagion.

Investor sentiment brings about a volume leap process. Various factors need to be considered to determine whether the stock price is entering the volume leap phase. Referring to the SIR contagion model, investors are

classified into neutral, bearish, and bearish categories to establish a model of investor sentiment contagion.

Introduction of the sir contagion model to simulate the process of investor sentiment change. As shown in Fig. 1, at any moment there are:

$$S(t) + I(t) + R(t) = K \quad (1)$$

Here,  $S(t)$  is the number of neutral investors vulnerable to emotions at moment  $t$ ;  $I(t)$  is the number of investors who have been infected by sentiment and made a bearish move at moment  $t$ ;  $R(t)$  is the number of investors whose sentiment is repaired and make a bearish move at moment  $t$ ;  $\alpha$  correspondons to the increase of the first characteristic point to the highest price and  $\beta$  is feature points. They can be described as :

$$\gamma = \frac{1}{1 + \left| \frac{\text{Price at time } t - \text{lowest price in three months at time } t}{\text{lowest price in three months at time } t} \right|} \quad (2)$$

The  $\mu$  is inverse of the number of feature points ; and  $\delta$  can be calculated as :

$$\delta = \frac{\text{max price in three months at time } t - \text{Price at time } t}{\text{max price in three months at time } t} \quad (3)$$



K is +1 increase from the beginning of the year to moment t. The mechanism of emotional contagion is schematically illustrated as follows:

$$\begin{cases} \frac{dS(t)}{dt} = -\beta S(t)I(t) - \alpha S(t) + \delta R(t) + \mu I(t) \\ \frac{dI(t)}{dt} = \beta S(t)I(t) - \gamma I(t) - \mu I(t) \\ \frac{dR(t)}{dt} = \alpha S(t) + \gamma I(t) - \delta R(t) \end{cases} \quad (4)$$

Let the entire financial market investors have only the state of healing and no state that is infected by emotions or can be infected, i.e., the derivative of t. At this point, two equilibrium points of the system of equations are solved:

$$E_0 \begin{cases} S_0 = \frac{\delta K}{\alpha + \delta} \\ I_0 = 0 \end{cases} \quad (5)$$

$$E_1 \begin{cases} S_0 = \frac{\gamma + \mu}{\beta} \\ I_0 = \frac{\beta \delta K - (\alpha + \delta)(\gamma + \mu)}{\beta(\delta + \mu)} \end{cases} \quad (6)$$

Re-introduce the concept of the basic regeneration number  $R_0$ , i.e., the number of new infections transmitted by infected individuals in an average infection cycle, and in this paper, i.e., the number of new investors affected by investor sentiment in an average influence cycle. Let the basic regeneration number:

$$R_0 = \frac{S_0}{S_1} = \frac{\beta \delta K}{(\alpha + \delta)(\gamma + \mu)} \quad (7)$$

When  $R_0 < 1$ , investor sentiment is not contagious and has an effect, bearish. When  $R_0 > 1$ , investor sentiment creates a contagion effect and is bearish. When  $R_0 < 1$ ,  $I_1 < 0$  is not in the range of values, at this time there is a unique equilibrium point  $E_0$ , that is, the market sentiment without contagion equilibrium point. When  $R_0 > 1$ , there are two equilibrium points  $E_0$  and  $E_1$  in the system of equations, where  $E_0$  remains the contagion-free equilibrium point of financial market sentiment, while  $E_1$  reflects the tendency of risk to be contagious by sentiment across investors. The existing literature on the fundamentals of key models refers to earlier studies, and the correctness and sustainability of the studies need to be further updated, in addition to focusing on the Chinese literature and less on the foreign literature. In terms of academic outlook, the authors' team hopes to expand the data volume from 5 years of A-share data to 15 years of data from major global stock markets. In addition, they hope to combine with mainstream forecasting models to become a price factor with greater impact.

## 7 Conclusion

In summary, the concept of stock price volume leap is proposed based on the existing research results, and the signs of stock price occurrence of volume leap: the iso-velocity rising point is proposed. The characteristics of the anisotropic rising point are derived from the upper limit of the national legal private lending rate, and the a-share stock price data from 2017-2023 are collected

through the tushare library to collect the points consistent with the anisotropic rising point under the smooth trend and observe the subsequent rise. In the experiments, the anisotropic rising points are called characteristic points - the points with a weekly increase of more than 9% under a smooth, rising trend, and the characteristic points with a subsequent increase of more than 25% in six months (considered to have a subsequent desirable increase) are called valid points. The ratio of the valid points to the characteristic points is calculated to verify the effectiveness of the out-of-phase upside points in predicting stock price increases. The data proves that the ratio of valid points to characteristic points is above 60%, then the characteristic points obtained by using the anisotropic rise as the benchmark are more effective in predicting the rise of stock prices. This paper, through the proposed concept of quantum leap and the concept of isochronous rise, provides a better investment judgment standard for the a-share investors this year, allowing more people to participate in high-risk and high-return stock investment activities.

## Author contribution

All the authors contributed equally and their names were listed in alphabetical order.

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