A Study of Herd Behavior in Chinese Stock Market Based on a Simulation of Stock Market

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Abstract: Behavioral finance theory as a refutation of the efficient market, complete the study of financial markets. Herd behavior is an important part of behavioral finance theory. This article combines with the characteristics of Chinese stock market to build a simulation of stock market to research the herd effect in stock market. Using this simulation to observe the price changes about stock market to study how the herd behaviors impact on the stock market.

Introduction

Herd behavior reflects the group behavior of animals and is also used to describe the irrational behavior of investors in the financial markets. Banerjee (1992) first formally defined herd behavior of stock market, and he put that there was an imitative behavior for each other. Herd actors tend to give up their private information and follow others, even the information that they grasp have shown the decision is unreasonable. To measure the herd effect, Chang, Cheng and Khorana (2000) used absolute deviation CSAD from the stock market rate of return on the overall cross section, and used this method to test the stock market in United States, Japan and other countries, proved the existence of the herd behavior. This method which is called CKK are universally used to measure herd behavior in different financial markets by scholars all over the world. With the sustainable development of China's stock market, scholars have begun to pay attention to the impact that the herd behavior have had in Chinese stock market. Yijia Fan (2012) thought China's stock market has just emerged, herd behavior impact on the stock market is a universal phenomenon. She analyzes the impact of herd behavior from the perspective of irrational psychology and use CKK model to analysis SSE 180 Index for China. She used deviate acceleration of stocks to show herd behavior. based on CKK model, Chunli Wang (2015) add volume indicators and build a VAR model to analysis China's business section, finding business section's volume can cause investors' herd behavior. From all the evidence above, most scholars just prove the herd behavior's existence in Chinese investment market.

In this paper, the herd behavior is sure to existing in Chinese stock market, Computational Experiment Finance will be used to build a simulation system of stock market to analysis how the herd behavior influence the Chinese stock market.

Construct the simulation market

Computational Experiment Finance believes that the financial markets contain different investment actors and defines them as agents. We suppose that different investment transactions depend on agent's different investment trading strategies, also they have different initial wealth, effect function, risk preferences. Finally, the price of financial markets is determined by these different investment behaviors. According this idea to simulate a stock market and observe how herding affects the stock market by changing the initial parameters of the agent.
Design agents

Stock market investors choose the deal-making behavior often based on the information which they have. Different information makes them choose different deal-making behavior. Therefore, this paper supposes that there are three kinds of agents in stock market.

**Information Owner**

The information owner refers to someone who can get more comprehensive information about the stock, and make decisions based on this information. Information owners estimate the real price of the stock by judging their information. Since the information is not fixed, the real price of the stock will continue to change, so this article assumes that the real stock price obey a random walk rule. Therefore, information owners choose their trading decisions by comparing the real share price and the market price. On the other hand, information owners buy stocks in order to achieve their maximum effect. Therefore, this paper introduce CARA utility function.

\[
U(W'_i, \alpha^i) = E\left[-e^{-\alpha W'_i}\right]
\]  

(1)

\(W'_i\): The sum of the wealth of information owner \(i\) in period \(t\); \(\alpha^i\) the coefficient of risk aversion of the information owner \(i\) (This article assumes that information owners are risk averse, and the risk aversion coefficient is the same).

On the other hand, the sum of the wealth of information owner \(i\) in period \(t\) is depended on the value of the shares he has and the cash he has in period \(t\).

\[
W'_i = S'_i \cdot p_i + C'_i
\]  

(2)

\(S'_i\): The number of shares held in period \(t\); \(p_i\): Stock Price in period \(t\); \(C'_i\): Cash owned in period \(t\);

In order to achieve the maximum effect, we can deduce from the equation the number of shares that the investor should hold in period \(t+\delta\). \(\ddot{p}_i'\sigma\): The real price of the stock that the information owner judged; \(V'_i\): The expected earnings variance).

\[
\pi_{i+\delta}(p_i) = \frac{\ln(\ddot{p}_i'\sigma / p_i)}{\alpha^i \cdot V'_i \cdot p_i}
\]  

(3)

The optimal number of shares that the information owner should hold in period \(t+\delta\) and how many shares should be held in period \(t\) determine the number of shares the information owner should buy or sell.

**Noise Traders**

Noise trader is unable to obtain information or get the noise information. Supposing that its trading strategy is random, which obey the noise distribution transactions? Its prediction about the future stock price is random.

**Herd Actors**

Herd actors are those who follow the overall trend of the market traders and are unable to get information. Even if they can get information they will also give up their information and follow others’ decisions. Therefore, in the simulation of the stock market herd actors determine their own trading strategies by looking at the total supply and demand in the stock market. When it can be seen in the stock market that the stock supply is greater than demand, herd actors have a greater probability to sell their stock. On the contrary, herd actors have a greater probability to buy the stock. This article supposes the degree of the greater probability about buy or sell stock is the same.
Market Pricing and Trading Mechanism

When the market has enough investors, the stock’s price can substantially react by its supply and demand. Various types of agent make demand or supply decisions by their own trading strategies, simulation system then will record the number of the total demands and the total supplies. Total demands and supplies determine the stock market price. When the market demand for shares exceeds supply, it will promote the rise of the stock market price in the next period. When the stock market supply exceeds demand, it will promote the decline of price in the next period. The magnitude of increase or decrease is determined by the proportion of the number of supply and demand. When the number of the total demands and the total supplies are same, the stock market price will be stable in next period. In addition, we will set a price limit of 10% according to price limit in Chinese stock market.

Market trading mechanism is also based on the number of the total demands and the total supplies. When the number of the demand is greater than 1/2 in the total number of supplies and demands, then all the supply in the market will be met. The demand that can be met is equal to the total number of supply that the market can provided. And the agent's demands are allocated by how much weight their demands have in total demands. On the other hand, do contrary operation. Recalculation of each agent's cash and positions after the allocated and as the next initial parameters.

The cycle of trading period

The article assumes only one stock in the simulation market. After set the relevant parameters the simulation market will calculate each agent's cash and positions in the first period. Various types of the agent according his cash and positions trade in the simulation market, the system will according the trading mechanism to determine the price and recalculate agent's cash and positions in next period. Repeating this trading and update each agent's cash and positions in each period, so we can continuous to get the price of the stock.

Statistical Analysis

In this paper, we can get different price fluctuations in stock price by adjusting the degree of herd actors' reaction and the number of herd actors. We compare different price fluctuations to research the herd behavior's influence on stock price.

First, it assumes that there is no herd actor in the simulation market. Set 80 agents, including 50 information owners and 30 noise traders and set the initial price of the stock that is 35, the information reflected in that the stock's price is 40. Then let the simulative market run 1000 periods to obtain price data (see Figure 1).

![Figure 1. 1000 price series.](image)

It can be seen from the graph, stock prices waved generally around 35-40 price range. Due to changes in the information the real price of stock is different indifferent period. Information owners according to the real price of the stock market to trade that prompted the market price move to the real prices. Due to noise traders, whose trading strategy based on the noise information, it makes the stock market price fluctuate randomly. Overall market price is according to the real price to adjust its price.
The price reflects the useful information about the stock’s value but also affected by noise information. So the simulation market is appropriate to reflect the real stock market system. In this paper, standard deviation of stock returns will be used to reflect the stock price volatility.

To examine herd behavior’s influence on stock market, we add 20 herd actors and adjust the probability about buy or sell stock to obvious the change of price volatility. Set the probability about buy or sell stock as 50%, 60%, 70%, 80% and 90% (50% represent the same probability about buy and sell stock). Run 1000 periods and get the price data, then calculate stock returns' standard deviation, repeat 5 times and average the data of stock returns’ standard deviation (see Table 1).

### Table 1.

<table>
<thead>
<tr>
<th>Number of trials</th>
<th>0</th>
<th>50%</th>
<th>60%</th>
<th>70%</th>
<th>80%</th>
<th>90%</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.01218692</td>
<td>0.00965675</td>
<td>0.01136264</td>
<td>0.0154378</td>
<td>0.02486486</td>
<td>0.03549888</td>
</tr>
<tr>
<td>2</td>
<td>0.01138381</td>
<td>0.00908784</td>
<td>0.01181629</td>
<td>0.0156963</td>
<td>0.02410438</td>
<td>0.03566466</td>
</tr>
<tr>
<td>3</td>
<td>0.01169967</td>
<td>0.00931758</td>
<td>0.01220632</td>
<td>0.01576371</td>
<td>0.02471589</td>
<td>0.03669515</td>
</tr>
<tr>
<td>4</td>
<td>0.01195032</td>
<td>0.00909431</td>
<td>0.01138171</td>
<td>0.01555384</td>
<td>0.02355367</td>
<td>0.03580227</td>
</tr>
<tr>
<td>5</td>
<td>0.01181071</td>
<td>0.00927079</td>
<td>0.01172458</td>
<td>0.01607766</td>
<td>0.02421752</td>
<td>0.03668825</td>
</tr>
<tr>
<td>average value</td>
<td>0.01180628</td>
<td>0.00928545</td>
<td>0.01169831</td>
<td>0.01570586</td>
<td>0.02429126</td>
<td>0.03606984</td>
</tr>
</tbody>
</table>

From the table I, stock market return volatility increased when the degree of the probability increased. The impact on the stock market volatility will continue to increase. Standard deviation increase means that stock price is more discrete. From 50% to 60% and 70% standard deviation increase is relatively flat. However, when it adjusted to 80% and 90%, it increased significantly.

On the other hand, keep the degree of the probability at 60%, 70%, 80% and 90%, change the number of herd actors in the simulation of the stock market. Adjust the proportion of herd actors in the market as 10%, 20%, 30%, 40%, 50%, 60%, 70%, 80%, 90%, also run 1000 periods and get the price data, then calculate stock returns’ standard deviation, repeat 5 times and average the data of stock returns’ standard deviation(see Figure 2).

![Figure II.](image)

As shown in Figure II, the curves from bottom to top represent the degree of 60%, 70%, 80% and 90%. With the increase in the proportion, standard deviation of return is constantly becomes large. In vertical perspective, it also can infer stock market return volatility increased when the degree of the probability increased.

In summary, with the increase of the probability that herd actors to buy or sell the stock and the number of herd actors, stock price volatility increases.
Conclusion

In this paper, the simulation of the stock market is based on the investment policy of stock trader in the real world. It is useful to analyze herd behavior in Chinese stock market by using this simulation. The data which from the operation of the simulation of stock market shows that the existence of herd behavior will have an indeed impact on the volatility of the stock market, and the fluctuations of the rate of return in the stock market is constantly increasing with the increase of herd behavior in the stock market. The reason why the stock market has volatility is that the information that investors have is asymmetric. Without reliable information, Herd actors tend to follow the market. Along with the increase in market demand, they will follow this signal and buy more stocks. As a result, market demand will have a further increase. On the contrary, when the market supply is large, they tend to sell their stocks and market supply will have a further increase. The herd behavior shows that irrational behavior of investors will affect the stock price volatility. The research for this irrational behavior will make the investors more deeply understand the abnormal fluctuations in the stock market, which will help the investors make rational investment.

References


