Research on the Impact of Internet Public Opinion on Asset Prices Based on the Internet Public Opinion Dissemination Model and Event Analysis Method

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Abstract—Starting from the bounded rationality of investors, a feedback trading model of "Internet public opinion-investor-asset price" interaction is constructed to explain the fluctuation of asset prices. The higher the degree of public opinion interaction, the more susceptible investors are to the emotions and opinions of others. The greater the expected divergence of different types of investors, the greater the dislocation of asset prices caused by online public opinion. Finally, this paper constructs a network public opinion communication model, divides three public opinion information transmission paths, and studies the characteristics of investors' state changes after being impacted by the network public opinion information. It is found that the exposure of double-layer social networks and media has attracted more investors' attention and accelerated the interactive dissemination of public opinion information.

Keywords- Internet public opinion; feedback transaction

1. INTRODUCTION

The convenient Internet environment has promoted network media to become one of the main carriers of capital market information release, sharing, and communication. Antweiler & Frank (2004)[1] used natural language processing technology to refine investors' messages about stock information on Yahoo forums, and found that sentiment indicators help predict market fluctuations, denying the assumption that messages in Internet forums are just noise. Public opinion information uses the Internet as a carrier, and investors interact with others around the hot events that cause asset price changes, making online media a platform for the occurrence, fermentation and outbreak of financial public opinion. Investors interact and influence each other on the network platform. Existing related research does not consider the heterogeneity of investors in reality. At the same time, the information effect of online public opinion has also neglected the changes in investors' perceptions.

Aiming at the shortcomings of existing theoretical research, this paper introduces investor cognitive bias and investor heterogeneity, and constructs a feedback transaction model that constructs the interaction of "Internet public opinion-investor-asset price" to explain asset prices Fluctuations. In addition, the SIM and SCIM network public opinion dissemination models are constructed, and the simulation results of the three communication channels are compared, and it is found that the two-layer social network structure has a significant impact on the dissemination of public opinion.

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2. MODEL

2.1 Basic model

Hirshleifer et al. (2006)[2] constructed a stock price model for limited rational investors. The stock price reflects the fundamentals of the company. The blind optimism of investors can affect the overall profitability of the company through feedback effects. The trading of irrational investors As a result, prices deviate from the basic value. When there are positive investment externalities, the impact of such feedback transactions will be magnified and abnormal returns may be obtained. Therefore, from the perspective of the mutual influence of online public opinion and price changes, a basic online public opinion feedback transaction model is constructed.

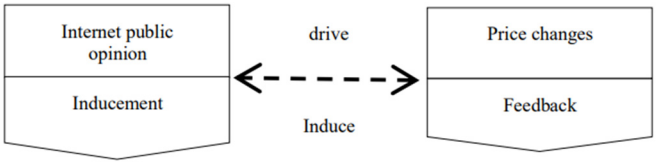

Figure 1. Basic model

2.2 Model evolution

In reality, when a hot event first occurs, a small number of insiders will learn about the information before other investors, and will evaluate the basic value of the asset and the current price and then conduct trading transactions. Andrei & Hasler (2015)[3] constructed a theoretical model to study the impact of increased investor attention on the volatility of the stock market, and found that the variance and risk premium of asset returns increase with the increase in investor attention. Ruan & Zhang (2016)[4] built a model to study whether investor attention affects the market microstructure and found that higher investor attention leads to higher market liquidity, transaction intensity and stock price volatility.

Unsuspecting investors prefer to sell stocks, while investors with limited attention are more likely to buy rather than sell. The volatility of asset prices will again become a hot topic of public opinion among investors, attracting more investors' attention. The rising popularity of online public opinion will induce investors to engage in more active transactions and lead to price changes.

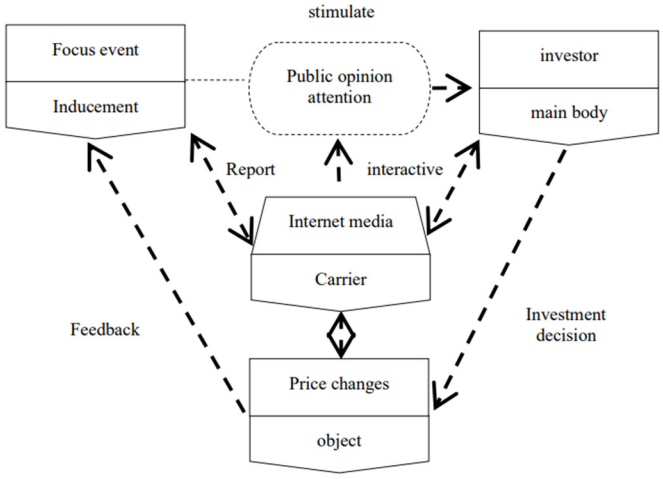

Figure 2. Model evolution

Internet public opinion has the characteristics of fast spreading speed, openness and wide coverage. The information reported by the media has attracted a lot of investors' attention and heated discussions. Investors are not only the receivers of information on the online platform, but also the senders of information. The Internet is a platform for investors to interact, discuss and learn, as well as an important platform for the media to release the latest information. When events that induce public opinion continue to occur, Han et al. (2018)[5] human beings are a manifestation of social animals: people are born with a desire to communicate and interact with other people. The faster the change of public opinion events, and the more likely it is for investors to interact with surrounding investors. The intervention of the Internet media has turned the information that was originally only a small number of insiders exchanged into open and transparent information. Many investors are concerned about the development and changes of the event until they lose interest over time.

3. THE CHANGING CHARACTERISTICS OF INVESTOR STATUS UNDER DIFFERENT PUBLIC OPINION TRANSMISSION PATHS

This chapter constructs the SIM and SCIM network public opinion dissemination models in the market. It is assumed that the dissemination of public opinion information in the capital market can be divided into three situations: 1) Informed traders communicate through word of mouth "offline" and interact in a small range. 2) Traders communicate and learn from each other through the network platform to form an "offline + online" public opinion interaction model. 3) On the basis of situation two, after adding media reports, the explosive spread of online public opinion has formed a public opinion interaction model of "offline + online interaction + media". Different investors will be in four different states, namely the credulous state (The Susceptible, abbreviated as S), the concerned state (The concerned, abbreviated as C), the interactive communication state (The Interactive Communicator, abbreviated as I) and immunity Status (The Immuned, abbreviated as M). According to the relationship between different

communication situations and different types of states, the "offline communication" SIM network communication process is shown in Figure 3:

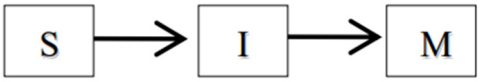

Figure 3. The "offline communication" SIM model

In the second case, on the basis of offline communication, the insider forms a two-layer social network interactive communication mode combining "offline + online" through an online platform. The "offline + online interaction" SCIM network public opinion dissemination process is shown in Figure 4:

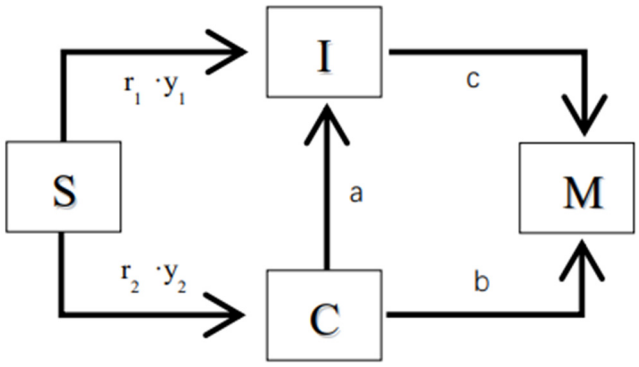

Figure 4. The "offline + online interaction" SCIM model

According to the public opinion transmission path of the SCIM model, the characteristics of its transmission dynamics can be described by formula (1).

$$\begin{cases} \frac{dS(t)}{dt} = -r_1 \cdot y_1 \cdot I \cdot S / N - r_2 \cdot y_2 \cdot I \cdot S / N \\ \frac{dC(t)}{dt} = r_2 \cdot y_2 \cdot I \cdot S / N - \mathrm{a} \cdot C - \mathrm{b} \cdot C \\ \frac{dI(t)}{dt} = r_1 \cdot y_1 \cdot I \cdot S / N + \mathrm{a} \cdot C - c \cdot I \\ \frac{dM(t)}{dt} = c \cdot I + \mathrm{b} \cdot C \end{cases} \tag{1}$$

First of all, according to the "offline communication" SIM model, assuming that there are a total of N investors (N=1000) participating in the transaction in a stock market, the propagation coefficients of different state stages are r_1=10; y_1=0.02; c=0.07, When using Matlab's modeling operation, if the number of investors in any state is less than 10-5, the number of investors in that state is considered to be zero, and the model will stop running at this time, and Figure 6 is obtained.

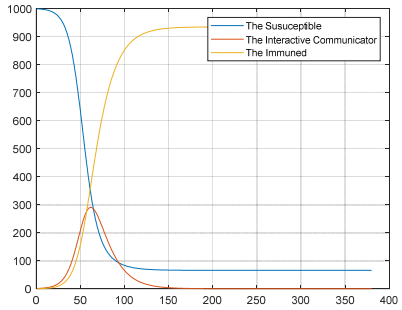

Figure 5. The Simulation results of "offline communication"

From Figure 5, it can be observed that the "offline communication" SIM model stopped running after 370 time steps (I=9.50E-06), and the number of investors in the interactive communication state I (referred to as I curve) Showing a trend of increasing first and then decreasing, the maximum number of interactive communicators was 290.31, which appeared in the 62nd time step.

Then, suppose that 10 days after the triggering event, investors in a state of interactive communication not only communicate offline, but also start online communication through the network platform. Assume that the propagation coefficients of the different state stages in the "offline + online interaction" SCIM model of the two-tier social network are r_1=10; y_1=0.02; r_2=100; y_2=0.02; a=0.2; b=0.2; c=0.07. Get Figure 6. That is to say, the investor in the gullible state S will be affected by the online public opinion and become the online follower C with the probability r_2*y_2. After learning the information, the network follower C changes to the interactive communication state I with probability a to participate in the discussion of this issue, or may not agree with the information and changes to the immune state M with probability b. After spreading for a period of time, the investor in the interactive communication state I will no longer interact with the information with others due to loss of interest, and will change from the interactive communication state I to the immune state M with probability c.

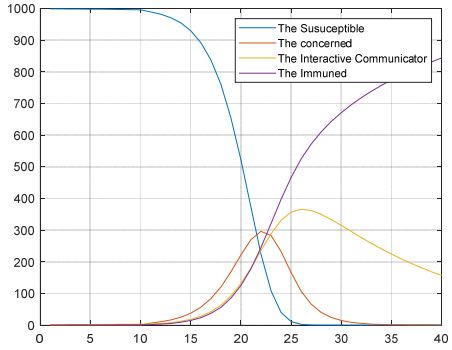

Figure 6. The Simulation results of " offline + online interaction "

In Figure 6, due to the increase in the spread of public opinion information, the running time of the model has been shortened from 370 time steps to 38 time steps (S=7.70E-06 when stopped). The characteristics of the four curves in Figure 7-2 have changed greatly compared with those in Figure 7-1. Considering that investors on online platforms are also more willing to interact and discuss related topics, the maximum value of the I curve is 365.7, which appears at the 26th time step. In Figure 7-2, the curve of investor C (C curve for short) in the state of online attention shows a trend of first increasing and then decreasing. The maximum number of online public opinion followers is 295.91, which appears at the 22nd time step. After the C curve, the I curve shows a trend of first increasing and then decreasing, and has a higher growth rate. The growth rate of the M curve is slightly flatter than that in Figure 5.

TABLE 1. THE CHANGING CHARACTERISTICS OF INVESTOR STATUS UNDER DIFFERENT PUBLIC OPINION TRANSMISSION PATHS

Public Opinion Spread Path	When the model stops					Model running			
	operation hours	Quantity S	C	I	M	Maximum C	Appearance time	Maximum I	Appearance time
"Offline Communication" SIM	370	65.69	0	9.50E-06	934.31	-	-	290.31	62
"Offline + Online Interaction" SICM	38	7.70E-06	0.24	180.81	818.95	295.91	22	365.70	26

Combined with the data in Table 1, the peak value of the I curve (I=365.7) in Figure 6. When the model stops, the value of the M curve in Figure 6 drops slightly, and the value of the I curve increases from 9.50E-06 to 180 compared to Figure 6. The main reason is that the influence of media reports will cause the gullible investor S to become the concerned investor C with a higher probability in the short term. Investor C who is concerned about the state will participate in the discussion of public opinion interaction and become interactive communi-cation table 1.

In summary, considering that the dissemination of public opinion has the characteristics of multiple channels of offline and online dissemination, based on the virus transmission model and communication dynamics, the SIM and SCIM network public opinion dissemination models are constructed. Comparing the simulation results of the two communication channels, it is found that the two-tier social network has a significant impact on the dissemination of public opinion, accelerating the transformation of investors into network followers and interactive communicators. The addition of online investor interaction and media reports is conducive to the spread of public opinion, and more investors receive the influence of public opinion information in a short period of time, which in turn changes the behavior of investors and causes changes in asset prices.

4. EMPIRICAL TEST OF THE RELATIONSHIP BETWEEN PUBLIC OPINION DISSEMINATION AND STOCK RETURNS

In the fourth part, the data comes from the China stock sentiment in public forum database, which screens the data posted by investors in China's largest stock forum from January 2017 to July 2021. Through the processing of artificial intelligence algorithms, the attitude tendency and the number of posts of each post sample are automatically identified. We subdivide the study sample into events triggered by abnormal bullish or bearish levels expressed on day t, and the event research method is used to empirically test the relationship between the spread of public opinion and the changes in stock returns.

We define a hot public opinion event as t days (at least 400 bullish/bearish news) when the volume of news posts is abnormal, and determine the event window from t-5 to t + 5. A total of 1886 bullish samples and 6795 bearish samples are screened out. It can be seen from Figure 7 and Figure 8 that investors' opinions on stock prices have a different relationship with excess stock returns, depending on the attitudes expressed by public opinion information.

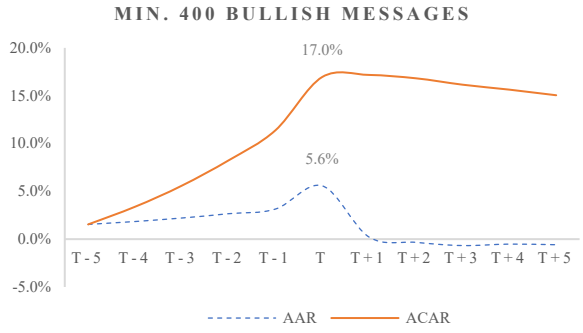

Figure 7. Abnormal Bullish Messages and Abnormal Returns

Observing Figure 7 finds that on day t, the stock's daily Average Abnormal Return (AAR) reached 5.6%, while the stock's Average Cumulative Abnormal Return (ACAR) reached the highest value of 17.0% on that day. After t+1 day, positive information no longer brings abnormal return, and the stock price returns to its basic price. In the next 5 days, the AAR and ACAR are stabilized, and the final ACAR is 15%, which proves that the bullish public opinion information is positively correlated with excess stock returns.

TABLE 2. THE AVERAGE AND MEDIAN CUMULATIVE ABNORMAL RETURNS FOR VARYING EVENT WINDOWS

Min. of 400 Bullish Messages (n = 1886)	ACAR (%)	Median CAR (%)	t-test
[-1, 0]	8.7%	8.5%	40.31***
[0, 0]	5.6%	6.5%	42.32***
[0, 1]	5.8%	4.8%	27.44***
[-5, -1]	11.3%	7.5%	27.30***
[1, 5]	-1.9%	-2.4%	-5.21***

[-5, 5]	14.9%	11.1%	24.82***
Min. of 400 Bearish Messages (n =6795)	ACAR (%)	Median CAR (%)	t-test
[-1, 0]	-2.3%	-2.5%	-20.18***
[0, 0]	-2.5%	-2.5%	-32.60***
[0, 1]	-3.8%	-3.4%	-35.28***
[-5, -1]	3.2%	0.4%	14.38***
[1, 5]	-4.3%	-3.7%	-28.45***
[-5, 5]	-3.5%	-4.4%	-12.07***

Observation Table 2 finds that the bullish sample size is 1886, which is far smaller than the bearish sample size (6795), but the impact of bullish public opinion has a greater impact on excess returns. We found that the AAR reached 5.8% on day t when the bullish shock occurred, and the ACAR reached 11.3% on day t-5 to t-1. In the subsequent days from t+1 to t+5, the stock price returned to its basic value, accompanied by a low return of -1.9% due to excessive market volatility. The AAR of the bearish public opinion shock on day t is -2.5%, and the ACAR from day t+1 to t+5 is -4.3%. It proves that the impact of the bullish public opinion shock is more lasting and will continue to affect the weakening of stock prices.

Observing Figure 8, we find that on the t day when bearish public opinion information is spreading, the AAR of the stock is -2.5%, and the ACAR of the stock has dropped sharply from close to 3.3% to 0.8%. After t+1 day, although AAR reversed, stock returns continued to be affected by bearish information. In the next 5 days, AAR continued to be negative, ACAR continued to fall, and the final ACAR was -3.6%, proving that bearish public opinion information is negatively correlated with excess stock returns.

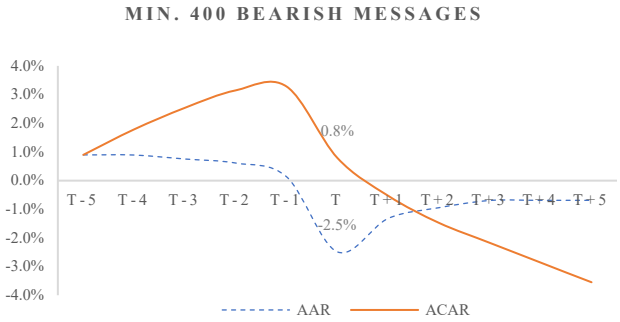

Figure 8. Abnormal Bearish Messages and Abnormal Returns

Comparing Figure 7 and Figure 8, it is found that Internet public opinion information with different attitudes has different degrees of impact on stock returns. Bullish information will bring higher excess returns, and bearish information will have a more lasting impact on stock prices. Investor opinions conveyed by online public opinion contain value, which has a predictive effect on stock yields.

5. Conclusion and Outlook

On the basis of the existing belief model, starting from the bounded rationality of investors, an interactive feedback trading model of "Internet public opinion-asset prices" is constructed to explain the changes in stock returns. This model takes into account that investors' bounded rationality will be affected by online public opinion, which is more in line with the characteristics of the real market and is more universal. At the same time, establish a dynamic behavior model for the spread of online public opinion, and study the changing characteristics of investor identities under different public opinion transmission paths. Construct an online public opinion dissemination model to study the status change characteristics of investors affected by the online public opinion information and the path of public opinion information dissemination. Public opinion information is disseminated through social networks and online media to attract more investors' attention and participate in public opinion interactive discussions. The dissemination of public opinion information has become more rapid, and the cycle from triggering an event to hot discussion on the Internet to the end of public opinion has been greatly shortened. Finally, an empirical study on the derivation of the above theoretical model found that Internet public opinion contains value, which has a predictive effect on stock returns. Among them, bullish information will bring higher excess returns, and bearish information will have a more lasting impact on stock prices.

The research in this article can be further developed. The general online public opinion impact linear feedback transaction model is reasonable. However, in reality, there are some inducing factors that have special effects on asset prices, and the linear feedback model may not be able to explain the abnormally large fluctuations well. Therefore, we can try to construct a nonlinear feedback loop, that is, use chaos theory to explain the complexity of capital market behavior, which is an important direction for the follow-up research of this article.

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