The Study on Negative Network Public Opinion Warning for Listed Companies

Qin-Feng XU\textsuperscript{a}, Wen-Ju KONG\textsuperscript{b}

School of Accounting, Tongji Zhejiang College, Jiaxing 314051, China
\textsuperscript{a}290459229@qq.com, \textsuperscript{b}136947381@qq.com

Keywords: BP neural network; Network public opinion; Warning model.

Abstract. The network public opinions of listed companies have grown rapidly, which leads to the company's share price fell, damage the benefit of shareholders and so on. Therefore, building an effective early-warning system of the network public opinion of listed companies is important. This paper analyzes the evolution of the network public opinion event, clarify the definition of the network public opinion of listed company and the theory related to early-warning, then takes the listed company in Public Opinion List of 2017 as research subject to determine the index system. At last, the paper builds a system of negative network public opinion of listed companies based on BP neural network. Because of the establishment of the early-warning model, business managers will be able to take effective measures to avoid or reduce the damage of the crisis.

Introduction

The network public opinions of listed companies refers to all the attitude to the listed company in network space, such as the attitude to the product, service, social responsibility of listed companies and so on. In recent years, with the development of the network, the negative network public opinions of listed companies have occurred, such as the "losses of 2.9 billion yuan" of CITIC Securities, the "disappear" of chairman of the board of directors of Petro China Co Ltd, or the "plasticizer" event in the alcohol industry and so on. All these negative network public opinions have cause different impact to the enterprise.

The reason of the listed company public opinion events is diversiform, this paper tries to use the early warning system for the future public opinion to warn the listed companies early, which can do something to control the negative network public opinions or even prevent the outbreak of the event. This is very important to all the stakeholders of the enterprise.

For the management of listed companies, the system of early-warning of the negative network public opinions reminds them the problems which will produce in the future, and then the management can find the company’s problems in time, then do something to deal with them. For the investors, the early-warning system can help them to analyze the company's data dynamically, and for the government regulators, it can help them to do better supervision.

In this paper, in the process of the construction of the index system, we add the hidden factors, the institutional investors, who have the advantages of information acquisition and processing, which always bring them the utility of the early-warning.

Related Research

Some scholars study confirms that the media can rich the external information environment, can enhance the spread of corporate disclosure effect, can weaken the informed trader's information advantage, and reduce the degree of information asymmetry from a certain extent through the transmission of information as an information intermediary (Frankel&Li, 2004[1]; Bushee, 2010[2]).

When the negative network public opinion of enterprise is happening, the embodiment of the extrinsic value, the share price or the behavior of investors, can reflect the public opinion in some extent. Therefore, this article attempt to establish the early-warning model by some financial
indicators of the enterprise, such as stock price, trading volume and the information content of stock price and so on.

Firstly, in terms of public opinion evolution model, scholars focus more on the personal social network. Sznajd and Vazquez et al., find a model based on the Ising-model [3] [4]. Galam put forward a model based on the theory of the minority obeying the majority [5]. Domestic scholars, Ruobing Li, analyzes the network public opinion supervision [6], and Hengmin Zhu finds an opinion model based on dynamic network [7]. This paper reference the spiral public opinion model put forward by the scholars, to analyze the early-warning system of the negative public opinion events of the listed companies. Secondly, many scholars focus on the significance of corporate governance of media, the main research focus in three parts, government intervention, media supervision, and the corporate governance. In our country, Peigong Li et al., analyze empirically the significance of corporate governance of media by combining with government intervention mechanism [8]. In this paper, with reference to the study of traditional media, the network media communication is faster, more freedom and less regulated, so in the early-warning index system of network public opinion, we choose the media index and search index these two indicators. Finally, BP neural network has profound applications in the field of early warning, but the scholars always consider one aspect on the choice of early-warning indicators. Shue Yang (2005) [9] uses BP neural network model to predict the financial status of listed companies. In this paper, refer to the index, we add the financial indicators into the index system of the network opinion early-warning.

Above all, we try to warn the negative network public opinion for listed companies early by using BP neural network model. Through this model, we combine the governance of listed companies, institutional investors and the network public opinion events together.

The Construction of Samples and Index System

Sample

The samples in our passage are all from public opinion center of listed companies in China, which publish a list of public opinion every week, a total of 115 listed companies of negative network public opinion events, and then find other 115 listed companies which did not have negative network public opinion in the Shanghai stock exchange in 2017. The 230 companies to the research are the samples in this paper, and their financial date is the starting point of the early-warning research. The sample date is all from Shenzhen Taian CSMAR database, wind information database and Securities Times News Network. This paper uses SPSS19.0 software for data analysis and calculation, and Clementine software for the operation of the BP neural network model.

Index

![Index System](image-url)
Network public opinions are break out in the Internet, so we try to analyze the enterprise characteristics at the beginning of the outbreak of the network public opinion, and then build early-warning index system. We try to consider the construction of index system from the following several aspects.

Based on the above analysis, we get 16 related indexes showing in the following Table.

**Table 1. Index.**

<table>
<thead>
<tr>
<th>Code</th>
<th>Index name</th>
<th>Code</th>
<th>Index name</th>
</tr>
</thead>
<tbody>
<tr>
<td>X₁</td>
<td>Mean of search index</td>
<td>X₉</td>
<td>Range of shares</td>
</tr>
<tr>
<td>X₂</td>
<td>Range of search index</td>
<td>X₁₀</td>
<td>Stock price volatility</td>
</tr>
<tr>
<td>X₃</td>
<td>Variance of search index</td>
<td>X₁₁</td>
<td>Range of volume</td>
</tr>
<tr>
<td>X₄</td>
<td>Media index</td>
<td>X₁₂</td>
<td>Volume volatility</td>
</tr>
<tr>
<td>X₅</td>
<td>Industry</td>
<td>X₁₃</td>
<td>Stock yield</td>
</tr>
<tr>
<td>X₆</td>
<td>State-owned enterprise</td>
<td>X₁₄</td>
<td>Times-institutional investor</td>
</tr>
<tr>
<td>X₇</td>
<td>Market type</td>
<td>X₁₅</td>
<td>Volume-institutional investor</td>
</tr>
<tr>
<td>X₈</td>
<td>Market rate of return</td>
<td>X₁₆</td>
<td>Turn volume-institutional investor</td>
</tr>
</tbody>
</table>

**The Selection of Warning Time Point**

**Longitudinal Test-determine the Early-warning Time Point by Event Study.** In traditional capital market, listed companies’ managers have more information than outside investors. In today’s capital markets, the network become a very important way for the investors to get the listed company’s information. Listed companies produce negative public opinion events, which spread rapidly through Internet, and have a negative impact to listed companies, also the impact is reflected in the shares of listed companies first. Jingmei Zhao et al., [10] studied the company’s shares of listed companies, which were impacted by the negative network public opinion. Therefore, we put forward the following assumptions, which is about stock yield. We try to analyze the change of the index at the beginning of the network public opinion events and then determine the early-warning time point by the method of event study.

Suppose H: At the beginning of the network public opinion events, the stock yield of listed companies changes

1. Public opinion model

During the formation and development period of the negative network public opinion, there are very few people tend to find negative Internet public opinion events in addition to people with internal information, however, companies always cope with them after the peak period of public opinion. This kind of behavior can do little for companies, and bring a certain degree of damage to enterprise stakeholders and government regulators. Therefore, we try to analyze the stock yield of listed companies’ changes during this period, which help us to determine the early-warning time point. In this paper, we make sure the research time point according to the spiral network public opinion changes.

![Figure 2. Stage of Event Study Methods.](image)

We find a total of 115 listed companies of negative network public opinion events in Securities Times News Network in 2017, and select only one time for that appeared many times. We regard the day be published by the Securities Times News Network as a public opinion peak point-S, namely, the peak point of the model above. We try to early warn the negative network public opinion before the time-S.

2. The event study

   (1) Define events
At the beginning of the negative network public opinion of the listed company, the influence of events is not obvious, so the specific time point is not sure, therefore, we set the time of estimated window in \([S-130, S-40]\). (Literature shows that the time of the negative network public opinion is due in \([S-40, S]\). During this period, the negative network public opinion hasn't happened yet, and then we assume that the stock yield is "normal" within the time window.

The event day is not sure in our passage, and we regard it as "T0". We set the event window a total of 11 days, which is \([S-15, S-5]\), and we assume that the event day is in it.

\((2)\) The Definition and Estimation of normal and abnormal yield

The normal stock yield is defined as the expected stock yield after the event, and the abnormal stock yield is defined as the difference between the actual stock yield after the event and the normal stock yield.

The market model in this paper: \(R_{it} = \alpha_i + \beta_i R_{mt}\). \(R_{it}\) is the yield of stock \(i\) on \(t\) day, and \(R_{mt}\) is the market yield on \(t\) day, and \(\alpha_i\) and \(\beta_i\) are the regression parameters of the model.

We use the market yield to regress the stock yield in estimation window, and then get the estimated parameters \((\alpha_i', \beta_i')\), then use it to restore the normal stock yield in event window, which is marked as \(R_{it}'\). \(R_{it}' = \alpha_i' + \beta_i'R_{mt}\). We finally get regression coefficients of the 115 companies of negative network public opinion which are shown in the following Table.

Table 2. The Regression Coefficient of 115 Companies.

<table>
<thead>
<tr>
<th>Stock Code</th>
<th>(\alpha_i')</th>
<th>(\beta_i')</th>
<th>Stock Code</th>
<th>(\alpha_i')</th>
<th>(\beta_i')</th>
<th>Stock Code</th>
<th>(\alpha_i')</th>
<th>(\beta_i')</th>
</tr>
</thead>
<tbody>
<tr>
<td>600031</td>
<td>-0.002</td>
<td>1.176</td>
<td>600808</td>
<td>-0.001</td>
<td>0.563</td>
<td>601318</td>
<td>0.001</td>
<td>1.359</td>
</tr>
<tr>
<td>600066</td>
<td>0.001</td>
<td>0.054</td>
<td>600887</td>
<td>0.002</td>
<td>1</td>
<td>601558</td>
<td>-0.002</td>
<td>1.508</td>
</tr>
</tbody>
</table>

(3) The inspection of abnormal yield

In this paper, according to the abnormal stock yield above, we get the cumulative abnormal yield, then significance test on the abnormal stock yield and the cumulative abnormal yield.

The abnormal stock yield in event time: \(AR_{it} = R_{it} - R_{it}'\)

The cumulative abnormal yield: \(CAR_t = \sum_{i=1}^{N} AR_{it}\)

The average abnormal stock yield: \(ACAR_t = \frac{1}{N} \sum_{i=1}^{N} AR_{it}\), where \(N\) is 115.

To test whether the negative network public opinion events have made an impact on the stock yield, we test the cumulative abnormal yield and average abnormal stock yield by T test, whether \(CAR_t\) and \(ACAR_t\) are significantly different from "0" by the appearing of the negative network public opinion of listed companies which are shown in the following Tables.

Table 3. T Test Results(S-5).

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>S.E.Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>CAR</td>
<td>115</td>
<td>-0.01090425515</td>
<td>.034511256861</td>
<td>.003190566825</td>
</tr>
</tbody>
</table>

Table 4. T Test Results(S+5).

<table>
<thead>
<tr>
<th></th>
<th>t</th>
<th>df</th>
<th>Sig.</th>
<th>Mean difference</th>
<th>Confidence interval-95 percent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Lower limit</td>
</tr>
<tr>
<td>CAR</td>
<td>-3.418</td>
<td>114</td>
<td>.001</td>
<td>-.010904255145</td>
<td>-.01722357476</td>
</tr>
</tbody>
</table>

From the tables above, we can find that Sig. =0.001, which is less than 0.05, so we reject the null hypothesis, which indicates that the average abnormal stock yield is significantly different from "0". The P values of the event window are finally shown in the following Table.

(4) The analysis of the result

From the table above, we can conclude that the market has made a clear response to the negative network public opinion of the listed company. The more closer to the day of \(S\), the average
cumulative abnormal yield is closer to "0" or even less than "0", which indicates that before the Securities Times News Network reports the event, the negative network public opinions has influenced the stock yields of the listed companies. From the analysis above, we find that in [WEEK-3, WEEK-2], the stock yield of listed companies changes obviously, therefore, we regard the week of WEEK-3 as our early-warning period, and try to warn at the time point of S-10, which means the time point is two weeks before the Securities Times News Network reports. The early-warning period in our passage is [S-15, S-10].

**Table 5. The P Values of the Event Window.**

<table>
<thead>
<tr>
<th>Data</th>
<th>P value</th>
<th>The average of CAR</th>
<th>Data</th>
<th>P value</th>
<th>The average of CAR</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-5</td>
<td>0.001</td>
<td>-0.010904255</td>
<td>S-11</td>
<td>0.181</td>
<td>-0.000925552</td>
</tr>
<tr>
<td>S-6</td>
<td>0.04</td>
<td>-0.005460589</td>
<td>S-12</td>
<td>0.442</td>
<td>0.001903861</td>
</tr>
<tr>
<td>S-7</td>
<td>0.042</td>
<td>-0.005266659</td>
<td>S-13</td>
<td>0.209</td>
<td>0.002402773</td>
</tr>
<tr>
<td>S-8</td>
<td>0</td>
<td>-0.011024969</td>
<td>S-14</td>
<td>0.189</td>
<td>-0.002983586</td>
</tr>
<tr>
<td>S-9</td>
<td>0</td>
<td>-0.01478726</td>
<td>S-15</td>
<td>0.713</td>
<td>0.000746779</td>
</tr>
<tr>
<td>S-10</td>
<td>0.085</td>
<td>-0.003380255</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Transverse Test – the Test between two Kinds of Companies.** From the analysis above, we have transverse tested the index of industry, whether state-owned enterprises and institutional investors, then in this part, we try to test the rest indexes. The test method is Mann-Whitney U Test, and the result is shown in the following chart. We can include that all P-values are less than 0.05, so we reject the null hypothesis, which tells us that the entireties of the two independent samples are different and these indexes are significant.

**The Establishment of Early-warning Model**

**The BP Neural Network**

The BP neural network is presented by Rumelhart, McCelland and other scientists in 1986, which is one of the most widely used neural network model currently. The BP neural network is consist of an input layer, one or more hidden layers and an output layer, and each layer is consist of a number of neurons, and each output value of the node is determined by The input value, the role function and the threshold value. BP neural network has an ability of remarkable self-learning, recognition, judgment, memory, data processing and logical reasoning.

Because the advantage of BP neural network model, this paper chose the neural network model to build negative network early-warning model of listed companies to warning the negative network public opinion early.

**The Building of the Early-warning Model**

The process of the model used by us is shown in the diagram below. We choose a total of 200 companies to take them as our learning samples, in which the number of each kind of company is 100, then after the learning of the sample, we get the parameter includes the weight and the threshold value, then use them to test the rest sample. From the test, we can evaluate the accuracy of the model.

![Figure 3. The Model.](image-url)
Learning Process. In this process, we use the original data to learning and training. First of all, we use the 100 companies which had happened negative network public opinion in 2017 and the other 100 companies which had not happened negative network public opinion in 2017, and the 16 indexes are input nodes of the model, and the output node is “0” or “1”. Our model determines the number of hidden layer and nodes on each floor by the method of testing and training.

From the above simulation dynamic curve, we can conclude that the learning sample fits well in the learning process, and also is highly accurate in prediction. Eventually, we get all the parameter of the model which is in high accuracy and use it to the next stage.

Testing Process. By the research model, we found that in the media, institutional investors trade number, and so on are occupying very important position in the negative network early-warning system of listed companies, the importance in the process of the early-warning model is close to 9%, and accuracy of the model can up to 76.67%, which achieved good prediction effect. By using the early-warning model, we can warn the managers and investors the possible event ten days, namely two weeks in advance, which shows that the model’s warning effect and efficiency is good.

Table 6. Statistics of Early-warning Results.

<table>
<thead>
<tr>
<th>Time</th>
<th>Type</th>
<th>Test sample</th>
<th>Actual number</th>
<th>True judgment</th>
</tr>
</thead>
<tbody>
<tr>
<td>S-10</td>
<td>Occurring</td>
<td>Actual number</td>
<td>15</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Not occurring</td>
<td>Actual number</td>
<td>15</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Accuracy rate</td>
<td></td>
<td>76.67%</td>
<td></td>
</tr>
</tbody>
</table>

Summary – The Conclusion of the Model

We select 15 listed companies which had happened negative network public opinion and 15 companies which had not happened negative network public opinion to predict the model. The accuracy of the model is high than 75% comprehensively, and companies with negative network public opinion are more accurate than companies without negative network public opinion. From the establishment and analysis of the model, we get the following conclusion.

Firstly, in the construction of the index system of the early-warning system of listed companies, this paper carries out the horizontal and vertical analysis process of the indicators. This paper also verifies the assumption that the company's stock yield will change during the formation of network public opinion through the event study.

Secondly, the importance of each variable is different but significant in the early warning model.

Last but not least, from the perspective of the effect of early-warning, early warning of the negative network public opinion model of listed companies is feasible. In this paper, after learning the indexes of 100 companies which had happened negative network public opinion and 100 companies which had not happened negative network public opinion, we use this learning result to make an early warning for other 30 companies, and the accuracy of results reaches 76.67%.

Conclusion

Through continuous observations on the network public opinion of listed companies, it can be found that the stock prices and trading volume of listed companies with negative public opinion tend to fluctuate greatly in this cycle. Although the changes in stock prices and trading volume are not obvious in the early stage of the public opinion, this paper has observed the hidden factor of institutional investors and then added it to the index system of the early-warning model. From the operation of the model, the index of institutional investors is very important.

Early warning of network public opinion is a problem requiring urgent attention for the managers, investors, creditor, and other stakeholders of listed companies in China. Therefore, the paper intends to build an early-warning model of network public opinion based on BP neural network. This paper studies 115 companies and their paired companies that have had negative network public opinion in 2017, and then regression analysis and significance tests of data by event study method and SPSS Clementine. In this paper, the neural network model is studied and trained based on the
significant early warning indexes, such as media, institutions and industries, etc. The prediction accuracy of the model is over 75 percent, which is a good effect.
By establishing an early-warning model of listed companies, the paper can improve the internal control system of listed companies and provide a powerful tool for implementing effective internal control. The model can send out signals in the early stage of public opinion in time, and then the managers of companies can be alert and act.

Reference


[8] Li Peigong, Shen Yifeng, The role of Media in Corporate Governance: Evidence from China [J].
