Objective Measurement for Disasters Impact on Companies Stock Prices

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Abstract: We propose a new objective measurement to gauge disasters impacts on companies' stock prices. When a disaster happens, stock prices would drastically drop. In system trading of stock handling, a function to automatically measure the impact of the disaster every moment is required. In addition, the company relation network drawing is needed, so that the traders can see the related companies' changes. Our approach is to use Random Matrix Theory to extract the company relation. Day by day, time to time, extracting principal components by Random Matrix Theory enables the traders see the company network changes. In the paper, we use a case study of Japanese automakers stock price changes owing to President Trump's remarks in 2017 January. As a result, we can see dynamic changes of Toyota's subsidiaries and group companies on the network.

1. Introduction

In January 2017, stock prices of Japanese automakers decreased owing to the President Trump's remark. He said in December the plan of the tariff raise which disrupted the industry around the world. Especially Japanese automakers were severely damaged [1]. During the Japanese automakers, the damage levels were different. We can infer that the more cars the company exports to the United States and the larger the export dependency it has in the company's profit, then the more the stock price drops. It is necessary for us to have objective measurement indicators to measure the impact of such disasters on companies. The disasters are both natural ones such as an earthquake and human ones like this Trump's remark. Our final target is measurement to be used by the system or algorithm trading [2-5]. They would like to measure the impact of such human or natural disasters on company stock prices. Currently, the index of impact is only the expected total damage amount which is estimated in many cases after a long time from the disaster. It lacks immediacy. We would like to develop an on demand measurement. In Section 2, the algorithm of drawing an affected company network is explained. In Section 3, we shall apply the method to the case study of the 2017 Trump's remark disaster and analyze that. Section 4 is conclusions.

2. Drawing Algorithm of Damaged Company Network

In the section, we shall explain our algorithm to automatically draw a damaged company network. The analysis method we adopted is Random Matrix Theory (RMT) that uses SVD (Singular Value Decomposition) [6, 7]. The SVD is used in various kinds of applications; For example, in text mining, LSA (Latent Semantic Analysis) uses the SVD. In RMT, we conduct the SVD on the standardized return values of stock price data [8-12], so that we can obtain eigenvectors called principal components. The principal component means a company group with a similar movement. For example, we can get a bank group, a telephone group, an automaker group, and so forth. A principal component can also show a damage type when the target is damaged companies. For example, the damage type A shows a quick recovery and the damage type B shows a very slow recovery. In the paper, we represent a principal component by "#[number]" such as #7 and the company group of the positive side by "GROUP# [+/-] [number]" such as GROUP#+7 and GROUP#-7.

In a financial analysis, RMT is utilized to find the stable company groups. Using the extracted stable groups, they make an excellent performance portfolio. Our usage of the eigenvalues/eigenvectors is identical to one by their traditional stock price analysis in RMT [9, 13-14]. Our research goal is, however, different from theirs because we would like to find the time series changes of the disaster. We will draw the company group networks and observe the changes of the networks. After a disaster happens, a network of a damaged company GROUP would change day by day. Then, we will change the period of the input stock price data day by day. For example, at first the period is 2017/01/06 to 2017/01/10 and then the period is 2017/01/06 to 2017/01/11. Given the diffusion origin company which mean an epicenter such as Toyota, we will draw its company networks. The network drawing algorithm is as follows: (1) Set the period and execute the SVD, (2) Find GROUPs of the origin company and draw the graph around the origin company, (3) For each GROUP among the above GROUPs, find the representative companies and draw the graph of the GROUP. The representative company is a company having a big element value in the eigenvector. Given a threshold as a parameter which determines the representative companies, a company of which element value is greater than the threshold is selected as a representative company. For example, given the threshold 1.5, in GROUP#+7, a company with 1.6 is selected, and in GROUP#-7, a company with -1.6 is selected. The depth of the graph tree is a parameter which defines the depth of the tree from the origin company.

3. Case Study of Trump and Toyota Analysis

In the section, we shall measure the President Trump's impact on Japanese automakers stock prices. We shall daily draw company networks with the starting date 2017/01/06 to 2017/02/24. As the stock price data, we selected the 38 automaker companies in the first section of Tokyo Stock Exchange (TSE). The data period is from 2017/01/06 to 2017/02/06. The depth of tree is set to be 1 and the origin company is set to be Toyota. The threshold value is 1.2. The principal component with Toyota is just GROUP#-1 for the first 15 days. On the 16th day, however, we can see the change (See Figure 1). GROUP#-1 was separated to GROUP#-1 and GROUP#-2. The shared companies are Toyota, Subaru, Nissan, and Matsuda. We can infer that the dominant continuous damage is still kept as shown in GROUP#-1 but another type damage GROUP#-2 happens. Japanese automobile manufacturing companies are clustered concerning contribution tie-up and technical alliance as follows: (1) Toyota group: Toyota, Suzuki, Matsuda, Isuzu, Subaru and Hino which is a Toyota's subsidiary company, (2) Renault-Nissan-Mitsubishi group, and (3) Honda group. We can guess that a new movement on Toyota, Subaru, and Matsuda happened. On the next day the 17th day, the GROUP#-2 moved to GROUP#+3. This is because another large impact movement happened as the principal component #2 and the previous GROUP#-2 got down to the principal component #3. Table

3 shows element values of the both principal components, which clarifies these two are the same movement. In the principal component #3, the Toyota's damage is positive +1.4 and Subaru and Matsuda also have the positive number +1.6. Therefore, we can think that Subaru and Matsuda have the similar movement to Toyota. After the 17th day, this second group of Toyota disappeared and there is only GROUP#-1 until the 21st day. On the 22nd day, GROUP#+4 with Toyota and Subaru appeared again. Then, we can guess that Toyota and Subaru then had a similar pattern of damage or recovery. The impact amplitude of the change can be measured by the eigenvalue and by the element values in the eigenvector. We need an objective measurement for disasters impact. Then the eigenvalue which shows the impact of the principal component and the individual company's element value which shows the amplitude of the company in the principal component are helpful as objective measurement.

Table 1. Element values on 16th and 17th days.

	16th day GROUP#-2	17th day GROUP#+3
Toyota	-1.5	1.4
Subaru	-1.8	1.6
Nissan	-1.6	1.6
Matsuda	-1.4	1.6

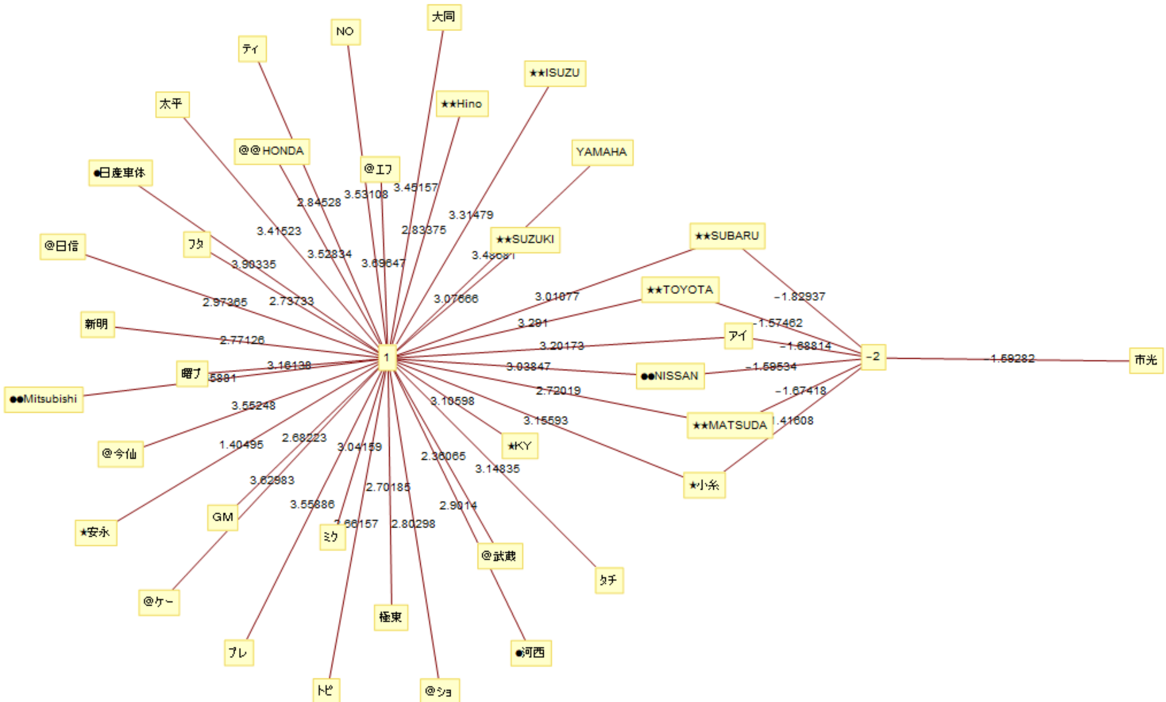

Figure 1. On the 16th day GROUP#-1 was separated to GROUP#-1 and GROUP#-2.

4. Conclusions

In the paper, we proposed the new objective measurement to gauge a disaster impact on stock prices. The point is a company relation network changes every moment which can be calculated using Random Matrix Theory (RMT) on the stock price data. The eigenvalues of RMT show the impact factor of the damage or movement. The first principal component has the largest impact. Using the proposed method, we measured the damage impact factors of Japanese automakers owing to President Trump's remarks in 2017 January. We traced the Toyota's relation networks from the sixth January to 24^{th} February in 2017. First, Toyota's damage group was only one which was the first principal component. However since 16^{th} day another damage type group appeared continually which included Subaru, Matsuda and Nissan. We can guess from that a tight relationship between Toyota and Subaru. As functions for system trading, impact factor changes on the company relation networks are needed. We shall conduct the research continuously on the theme.

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