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Stock Fluctuations Anomaly Detection Based on Wavelet Modulus Maxima

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***Abstract*—Stock fluctuations anomaly increase the uncertainty and investment risk in the stock market, is an important element in financial research. In this paper, wavelet modulus maxima method is used in the detection of abnormal stock analysis. It is obtained based on the irregular sampling in the multi-scale wavelet transform. It overcomes the localized limitation about traditional Fourier analysis in time and frequency domains. Experimental results show that the wavelet modulus maxima method can not only depict the position of the point mutation in the signals but also capture the singular points of the stock unusual fluctuations quickly and accurately.**

Key words—Stock, Abnormal, Wavelet; Modulus Maxima

I. INTRODUCTION

The notion of risk is the core of the modern finance [1]. It will increase the uncertainty of the stock market and investment risk if the stock volatility is too large. With the increasing size of the stock market and numbers of the participants, stock fluctuations have become an important component of the economic life.

An assessment of market stability and contagion depends on measuring the time-varying volatilities and the correlations [2]. Stock market volatility is divided into normal and abnormal fluctuations. The normal fluctuations are running at a reasonable range of the stock index volatility. The rationality of the fluctuation range is mainly embodied in three aspects: (1) running trend of stock index is basically coinciding with the development of the national economy, (2) stock index run interval in the framework of the regional investment, price-earnings ratio of the overall stock market roughly at the same level, people participated in sharing trading should be based on investments, (3) running of stock index is relatively stable, the normal fluctuations in the stock are an important objective of the government regulation. "The stock market stability" usually is mentioned and it refers to the normal fluctuations in the stock market.

Unusual fluctuations have not clearly defined. Generally speaking, the manifestations of abnormal fluctuations have the following existence of the forms: (1) it will lead to an increased risk of the market investment, view from the overall level market risk, (2) it has led to access to information in advance of the investors profit and damage to the market fairness and efficiency because of incomplete disclosure of information, (3) it will cause by signal distortion of market price that seriously affects the market allocation of resources when continuing a substantial deviation from the intrinsic value fluctuations, (4) it will affect the investor about the idea of a rational investment and lead to market speculation when the market fluctuations are deviated from the prediction of investors beyond a certain extent. Generally the word called "stock market volatility" means abnormal fluctuations in the stock market and it requires the intervention of the government regulatory authorities.

A fluctuation of the stock market is an objective phenomena of the economic, but the consequence will be very serious when abnormal fluctuations appears in the stock market. Abnormal fluctuations in the stock market caused by the disastrous consequences which is called as the "stock market crash". The reason of abnormal fluctuations in the stock is that the stock belongs to the virtual capital. Abnormal fluctuations in the stock market are likely to attract substantial capital and talents to participate, and give up the direct creation of wealth for the society. It will result in wastage of resources and might encourage people to do over-speculation and hinder the healthy development of the stock market. Over-speculation will also be caused by the stock market bubble and bring investors huge losses. If not handled properly, it will bring severely affects to the whole financial market and the stock market will lost its normal value, and it is likely to cause economic instability, thus to bring adverse effects to the social stability. Thus, the research of abnormal fluctuations in the stock market is particularly important, and becomes an important element of a financial study.

Anomaly detection refers to the problem of finding patterns in data that do not conform to expected behavior [3][4]. The stock market fluctuations will also increase with the stock market accelerated the pace of development. This requires a good method to detect abnormal fluctuations in stock market, in order to better avoid or diminish the impact of stock market volatility. Traditionally detection of the singular value is based on the Fourier Transform. It can only reveal the overall nature of signal singularity, while does not reflect the local nature of signal singularity. It solves the problem with the emergence of wavelet analysis. Wavelet analysis methods are an extending and supplementary for spectral analysis methods. It can be used for multi-scale analysis in stock market fluctuations and can express the local features of the signals. It is suitable for non-stationary time series analysis and can estimate the long memory

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parameters because it has the features of self-adaptability and zooming [5][6].

II. WAVELET MODULUS MAXIMA METHOD

Waveform chart of the stock price has singular phenomenon, such as immediate steep peak. These dates are taken as a signal for anomaly detection is in fact to find these singular points. Fourier transform is an effective method to detect the singular point. It can determine the overall features of the singular points. But it lacks for sensitivity to the information of partial time-domain and can not determine the local characteristics and occurrence time of the singular points. Wavelet transform is a multi-scale and multi-channel analysis tool. It has very good time-frequency localization and can effectively deal with the non-smoothing information. Wavelet analysis can not only analyze the changing trends, but also accesses to some simple sequences with different frequency bands and observes slight changes of signal. Wavelet analysis has the self-adaptive to signals. It has lower resolving power to the frequency and higher capacity to the time resolved in the high-frequency part. It is just the opposite in the low-frequency part. Wavelet modulus maxima are obtained based on the irregular sampling in the multi-scale wavelet transform. It can depict the point mutation of the signals.

A. Wavelet

The function $\psi(t) \in L^2(R)$, if

$$\int_{-\infty}^{\infty} \psi(t)dt = 0 \tag{1}$$

$\psi(t)$ is called the wavelet.

Assuming $\theta(t)$ is a smoothing function, and it is satisfied $\int_{-\infty}^{\infty} \theta(t)dt = 1$, $\theta(t) = O(1/(1+t^2))$. The basic wavelet $\psi(t)$ can be selected as the first-order of $\theta(t)$. That is $\psi(t) = d\theta(t)/dt$. Smoothing function $\theta(t)$ introduced the telescopic factor a, there is an expression $\theta_a(t) = 1/a\theta(t/a)$. The wavelet transform of the function $f(t) \in L^2(R)$ can be defined as[7]

$$W_a f(t) = f(t) \times \psi_a(t) = \frac{1}{a}\int_{-\infty}^{\infty} f(t)\psi(\frac{t-b}{a})dt \tag{2}$$

Wavelet transform is defined as the convolution operation, putting $\psi(t)$ and $\theta_a(t)$ into Eq. (2), by the following relationship: [7]

$$W_a f(t) = a\frac{d}{dx}[f(t) \times \theta_a(t)] \tag{3}$$

Wavelet transform does not inverse wavelet transform. For reconstruction $f(t)$ using wavelet transform $W_a f(t)$, requires $\psi(t)$ to meet the admissibility conditions:

$$C_\psi = \int_{-\infty}^{\infty} |\omega|^{-1} |\hat{\psi}(\omega)|^2 < \infty \tag{4}$$

B. Wavelet Modulus Maxima

$W_f(s,x)$ is the convolution-type wavelet transform of the function $f(t)$, in the scale s_0, if $\frac{\partial w_f(s,x)}{\partial x}$ there is one zero at x_0, it is said point (s_0, x_0) is a local extreme point[8]. Any point belonging to x_0 's neighborhood:

$$|W_f(s_0,x)| \leq |W_f(s_0,x_0)| \tag{5}$$

That (s_0, x_0) is called the wavelet transform modulus maxima points.

Wavelet transform reflects the changing circumstances in the different scales changes of the original sequence. Wavelet modulus maxima point is means the wavelet coefficients corresponding points in the value, which is corresponding to changes in the larger scale points in the original sequence, Wavelet Modulus Maxima method applied to the detection of abnormal stock research according to the characteristics of the stock signal singularity.

III. EXPERIMENTS AND ANALYSIS

We selected two stocks Bowin Technology & Industry (stock code: 600883) and Denghai Seed industry (stock code: 002041) as the research object, the time span from the February 13, 2008 to February 13, 2009, exclude the rest days and duration of the suspension, a total of 244 data points for the Bowin Technology & Industry (600,883), a total of 243 data points for the Denghai Seed Industry (002,041). The Day Volume used as input date. Wavelet modulus maxima shares to detect the unusual fluctuations, the algorithm is as follows:

1) getting the time series of stock by reading the stock data;

2) Obtaining the value of multi-scale mold by differentiating of one-dimensional Gaussian function along the time direction which is equivalent to the wavelet function.

3) Convolution operation with deviation of the Gaussian function and the stock data;

4) Calculating the gradient size for each time series point, that is, modulus maxima;

5) Detecting the abnormity and the judgement according to the threshold.

In this paper, we use the day trading volume of the stock for the analysis of data. It is judged to unusual fluctuations when T> 0.75V. T expresses one of the modulus maxima value and V expresses the maximum value.

The experimental results show that Bowin Technology & Industry has a sharp rise and downward trend in time-series points 100 and 196. The two points belong to the unusual fluctuations. As shown in Figure 1. Time series point 100 corresponding to the date of July 8, 2008. Time series point 196 corresponding to the date of November 27, 2008.

Through checking the significant events records of Bowin Technology & Industry, floating stock named

35413200 that has restrictions on the sale conditions is listed in circulation by Yunnan Bowin Technology & Industrial Co., Ltd. from July 7,2008 , which leads to the increasing of stock trading volume sharply in July 8, 2008,

According to Bowin Technology & Industry stock unusual fluctuations notice. The closing price of the stock of Yunnan Bowin Technology & Industrial Co., Ltd. deviated from the value of the cumulative increase more than 20%, it belongs to the unusual fluctuations in stock.

Theoretical analysis and empirical research results show that the wavelet modulus maxima method is very effective to stock singular of Bowin Technology & Industry.

At the same time, experimental results show that Denghai Seed Industry in the time series of 81 and 106 has a sharp rise and a downward trend. The two points belong to the unusual fluctuations. As shown in Figure 2. Time series point 81 corresponding to the date of June 8, 2008. Time series point 106 corresponding to the date of July 27, 2008.

According to Denghai Seed Industry stock unusual fluctuations notice. The closing price of the stock of Denghai Seed Industry deviated from the value of the cumulative increases more than 20%, it belong to unusual fluctuations in stock.

Hexun stock release the news, Denghai Seed Industry express steep fall because of great crazy of market speculation and buying stocks very active. So the abnormal fluctuations rose on July 17, 2008.

Theoretical analysis and experimental results show that Wavelet Modulus Maxima method is very effective to analyze the stock singular of Denghai Seed Industry.

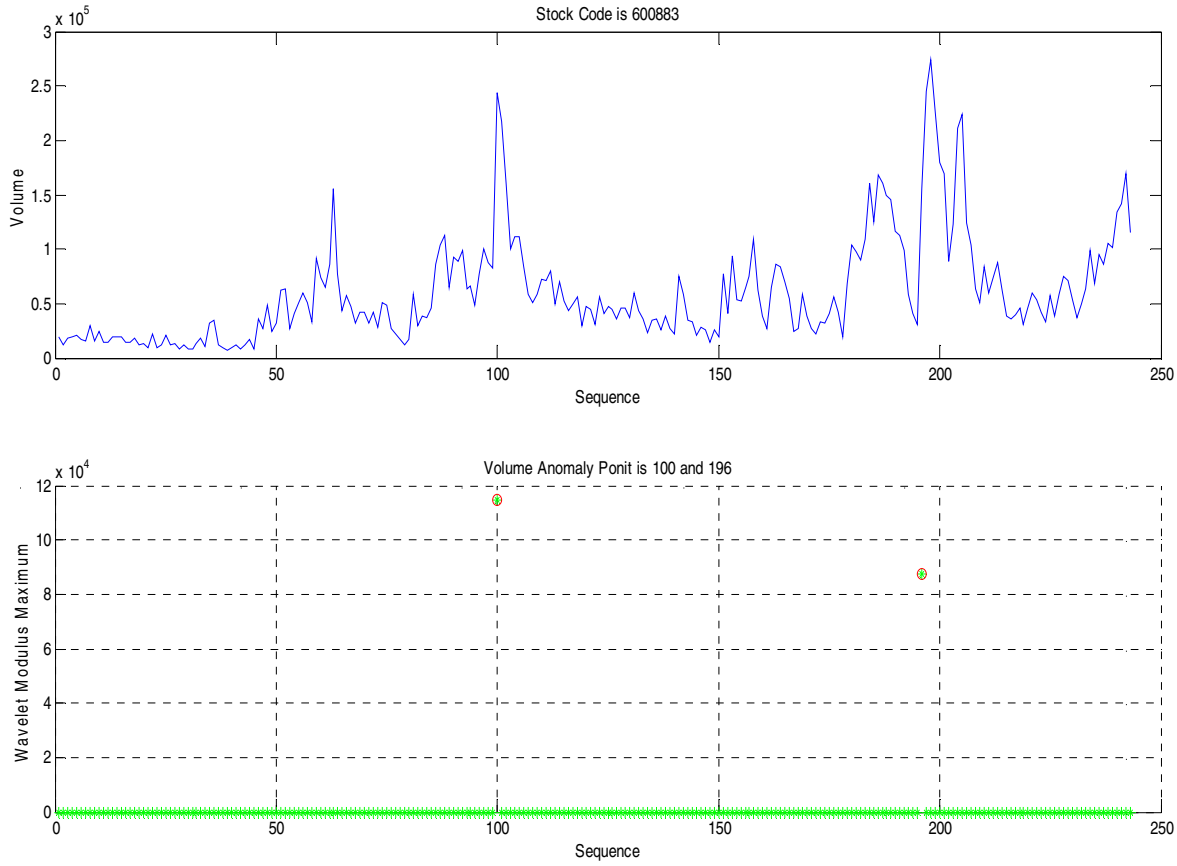

Figure 1. The Bowin Technology & Industry's original signal and the wavelet modulus maxima abnormal test results

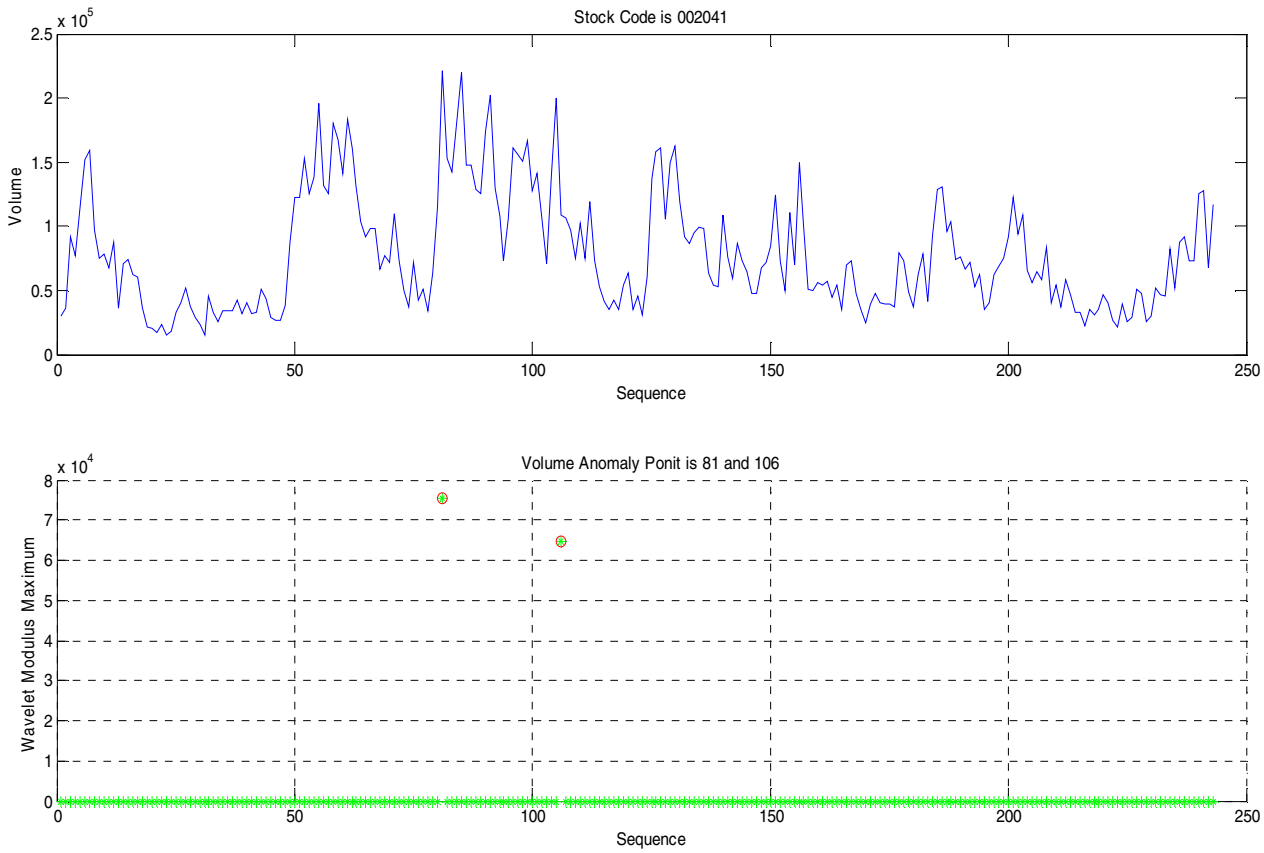

Figure 2. The Denghai Seed Industry's original signal and wavelet modulus maxima abnormal test results

IV. CONCLUSIONS

Anomaly detection is an important component of the share prediction. In this paper, wavelet modulus maxima method is used in the detection of abnormal stock analysis. The wavelet modulus maxima signal singularity detection method overcomes the localized limitation of Fourier analysis in time and frequency domains. It can quickly and accurately capture the extreme points through the partial modulus maxima of wavelet transform to detect signal singularity. The experimental results show that the method is effective, practical and predictable. The wavelet modulus maxima theoretical methods will be further developed and applied in the stock market research.

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