Analysis of Financial Fluctuation Based on Wavelet Transform

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Abstract: In recent years, China's economic downward pressure has continued to increase, and GDP growth rates have tended. In order to cope with the increasingly severe economic situation, the state regards the prevention and mitigation of systemic financial risks as one of the three major challenges, reflecting the country's emphasis on financial markets. The Central Economic Work Conference just held put forward a clearer requirement for financial policy, that is, we must adopt a prudent monetary policy and fiscal policy to ensure that financial fluctuations are within a reasonable operating range. The financial market is full of uncertainty, investors' investment philosophy, changes in behavior and capital in financial markets, the rapid flow of information will cause financial asset prices to fluctuate. Especially in recent years, the abnormal fluctuations of financial asset prices are very frequent, the speed of the emergence of financial bubbles has accelerated significantly, and the cycle has been significantly shortened. In this paper, wavelet transform is used as the analysis framework, and several main concepts are reviewed. On this basis, the impact of financial wavelet changes on financial fluctuations is analyzed.

1. Introduction

Finance is the core of the modern economy and the blood of the real economy. Financial fluctuations often have a major impact on the real economy. However, financial volatility is an intrinsic feature of all financial markets, and it plays an important role in asset allocation, financial product pricing, and financial risk management. In practice, the volatility of financial assets cannot be directly observed, and the characteristics of financial assets are mainly derived from the sequence of financial assets. Therefore, studying the financial asset return rate series and financial fluctuation characteristics is very important for a correct and comprehensive understanding of financial markets.

2. The premise of research: several concepts

This paper analyzes the fluctuation law of modern financial markets based on the financial wavelet variation model. Before conducting the analysis, we must first clarify several technical terms: wavelet transform, discrete wavelet transform, financial fluctuation, and wavelet space partition.

Wavelet transform: It is a new transform analysis method. It inherits and develops the idea of localization of short-time fourier transform, and overcomes the shortcomings of window size without frequency variation. It can provide a "time-frequency" that changes with frequency. The window is an ideal tool for signal time-frequency analysis and processing.

Discrete wavelet transform: Discrete wavelet transform discretizes the scale and translation of basic wavelets. In image processing, the dyadic wavelet is often used as the wavelet transform function, that is, the division is performed using the integer power of 2.

Financial volatility: Financial market volatility refers to the statistical indicator that financial markets rise or fall over a period of time. The volatility of financial markets changes over time, which is time-varying.

Wavelet space partitioning: The basic idea of wavelet space partitioning is based on the wavelet transform that transforms the observed data series into corresponding wavelet coefficient sequences. The wavelet coefficient sequence is then partitioned to replace the interval partitioning of the

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original data sequence.

3. Research focus: Wavelet analysis and Financial fluctuations

3.1. Wavelet analysis

Wavelet analysis, also known as wavelet transform, originated from Fourier analysis, which has the characteristics of denoising, de-correlation, etc. It is a mathematical tool that can deal with unsteady signals very well. Wavelet analysis is a method for analyzing time series. It is a mathematical tool widely used in many fields. It is not only profound but also widely used, and has become an analytical tool in many fields. As a scientific method that has developed rapidly in the past ten years, wavelet analysis has received extensive attention and attention in various engineering fields.

The wavelet analysis method is a time-frequency localization analysis method in which the window size is fixed, but the shape can be changed, and the time window and the frequency window can be changed. Wavelet analysis compares the traditional "microscope" function in the time domain and frequency domain with traditional Fourier analysis, which can adopt the gradual fine time domain and frequency domain processing for information components, especially for burst and short-term information analysis. Through the translation and expansion of the wavelet function, it is possible to simultaneously identify the features of the time series in the time domain and the frequency domain. It can also be said that wavelet analysis can not only identify the low frequency features of the time series, but also identify the high frequency features of the time series.

Wavelet analysis is a rapidly developing new field in mathematics. Its application is closely combined with the theoretical research of wavelet analysis. It has the dual meaning of profound theory and application. Now, it has made remarkable achievements in the field of science and technology information industry. First, wavelet analysis of signals and image compression is an important aspect of wavelet analysis applications. It has a high compression ratio and a fast compression speed. It can keep the characteristics of the signal and image unchanged after compression, and can resist interference during transmission. Secondly, the application of wavelet in signal analysis is also very extensive. It can use boundary processing and filtering, time-frequency analysis, signal-to-noise separation and extraction of weak signals, fractal index, signal recognition and diagnosis, and multi-scale edge detection. Finally, wavelet analysis can be applied to engineering and other aspects, including computer vision, computer graphics, curve design, turbulence, remote universe research and biomedical aspects. Therefore, it is necessary to apply wavelet analysis to the analysis of financial fluctuations.

3.2. Financial fluctuations

Financial volatility refers to the fact that in the process of investment and financing, the demanders and suppliers of funds are in an unstable state of change due to environmental changes, information interference, decision-making mistakes or other reasons. However, in the macro sense, financial volatility is a cyclical change in financial system variables such as financial asset prices and asset-liability structures of financial institutions and other economies caused by changes in economic factors. Such fluctuations affect financial systems to varying degrees. The stability of the system function and the smooth operation of the macro economy. Especially in the context of a market economy, financial fluctuations are ubiquitous.

Financial assets have the characteristics of volatility clustering, volatility continuously changing with time and changing within a fixed range, volatility with positive price changes and negative price changes. In the classical efficient market theory, financial volatility is described as an irregular random volatility, but in the actual financial market volatility problem, there are many factors affecting financial market volatility.

After further analysis, it is found that the time-varying of wavelet fluctuations is continuous, that is, the current fluctuations will continue to act in the process of future fluctuations. In the past, the research on the volatility spillover effect was slow. Until the 1980s, the research methods on the volatility spillover effect continued to innovate and the results increased. It is also one of the hot issues in the financial field. It can be seen that people's understanding of the causes and characteristics of financial market volatility is deepening with the advancement of time. Summarizing the results of previous studies, the characteristics of financial market volatility are as follows: First, there are spikes and thick tails in the yield series. Second, the fluctuations are concentrated. Third, the volatility is asymmetric, that is, the occurrence of negative news leads to increased volatility. Conversely, the volatility decreases with the appearance of positive news.

The volatility spillover effect, also known as financial contagion, means that the market is not only affected by its own past volatility, but also that there may be mutual influences between fluctuations in different markets, and volatility will pass from one market to another. When there is a large financial market volatility in a subsystem of the financial system, whether the correlation of financial markets has become closer. However, due to the different models and methods selected, many scholars at home and abroad have not yet reached a consensus theoretical result. Some scholars believe that during the non-financial crisis, there is a strong correlation between international capital markets, and the phenomenon of volatility spillovers is only the result of continuous and overlapping of strong correlation fluctuations during the crisis period.

However, the more consistent view is that when a country's financial markets have experienced large fluctuations, the correlation with other financial markets will be significantly enhanced. There are still many disputes about the existence of volatility spillovers in financial markets. Previous research conclusions are based on linear correlation coefficients. However, it is not enough to use linear research methods to study problems.

4. Analysis framework based on the meaning of financial wavelets

For the function $\varphi(t)\epsilon L^2(R)$, $L^2(R)$ refers to the function space composed of all square integrable functions of $t\in R$,

If $\varphi(t)$ satisfies:

$$\int_{-\infty}^{+\infty} \varphi t dt = 0,$$

It is called a wavelet. It can be seen that φ(t) is a function that integrates zero and square integrable over the entire real set R. When t tends to positive and negative infinity, φ(t) gradually approaches zero. From the geometrical point of integration, the area of the upper and lower halves formed by the image of φ(t) and the x-axis of the real axis are equal, and it can be seen that φ(t) varies with the variable t on the x-axis. Fluctuating up and down, that is, having positive and negative alternating volatility.

For wavelet φ(t), if the tolerance condition is met:

$$\int_{-\infty}^{+\infty} \lfloor t \rfloor\, (\varphi(t))dt < \infty$$

Then φ(t) is a basic wavelet or wavelet master function, and φ(t) is stretched and translated to obtain a wavelet function.

$$\varphi a_{b(t)=(a)b1^{-2}} \varphi \frac{(x-b)}{a}$$

The parameters a and b are the expansion factor and the displacement factor, respectively, and a and b are continuously changed. For any time series $b(t) = (a)b1^{-2}$, define the following formula:

$$W_{f(a,b)} = (a)\int_{-\infty}^{+\infty} x(t)\varphi^{*}\left(\frac{t-b}{a}\right)dt$$

For the time series x(t), the continuous wavelet transform for the base wavelet is referred to as a function. $W_{f(a,b)}$ is called a wavelet transform coefficient of x(t). However, in order to make the wavelet transform extract enough information from the original sequence, the wavelet transform is needed to reconstruct the original sequence through the inverse transform. Therefore, the wavelet transform coefficient reconstructs x(t), and its expression is:

$$x(t) = \frac{1}{C_w} \int_{-\infty}^{+\infty} \int_{-\infty}^{+\infty} \frac{1}{a^2} W_f(a, b) \varphi\left(\frac{t - b}{a}\right) dadb$$

Where C is the permissive condition and is a constant dependent on the wavelet.

It can be seen from the definition of the above wavelet and the definition of continuous wavelet transform that wavelet analysis is a kind of time-frequency analysis, which has good localization properties in both frequency domain and time domain. When the value of the scaling factor is small, the analysis with higher resolution is performed in the frequency domain, while the observation range on the time axis is smaller. When the value of the scaling factor is larger, the resolution is lower in the frequency domain. Analysis, while the observation range on the time axis is larger. That is to say, for a given wavelet function, as the value of the scaling factor and the value of the translation factor change, the shape of the wavelet function changes continuously, and the local analysis method that changes the frequency domain window and the time window for the entire original sequence makes time The local features of the sequence are more pronounced.

5. Conclusion

In the continuous wavelet transform, the obtained information is redundant in most cases, increasing the amount of calculation. Moreover, most time series, especially financial data series, generally exist in discrete forms, so discrete wavelet transform is more widely used in practical applications. The expansion factor and the translation factor of the wavelet function in the continuous wavelet transform are taken as discrete forms, and the obtained discrete wavelet transform is obtained. When the original time series is reconstructed by inverse discrete wavelet transform using discrete wavelet transform coefficients, the wavelet function is required to satisfy the definition of wavelet frame.

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