# Analysis of Financial Fluctuation Based on Wavelet Transform

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**Abstract:** This paper analyzes the financial fluctuations in China by using wavelet variation as a model, and has implications for predicting and reducing financial risks. The paper adopts the research methods of model analysis and data calculation. Firstly, it introduces the relationship and significance of financial wavelet and financial fluctuations, and then empirically analyzes the stock market risk in China through the form of wavelet model construction.

## 1. Introduction

Fluctuations in financial markets reflect changes in financial market risk, and wavelet transform is an important mathematical tool for analyzing market financial fluctuations. There are many factors that determine financial volatility. The sequence of financial volatility is formed by a combination of factors and effects. It is difficult to effectively analyze the various influencing factors of financial volatility by studying financial volatility as a whole. By constructing a financial wavelet change model, we can quantitatively analyze China's stock market and financial market, and predict changes in financial risks. It can also make up for the shortcomings of modular analysis and effectively avoid financial risks. The structure of the article is as follows: The first part analyzes the meaning of financial wavelet and financial fluctuations; the second part constructs the analysis of financial fluctuation model based on wavelet transform, and the third part takes empirical analysis of Chinese stock market changes as an example.

## 2. The meaning of wavelet changes and financial fluctuations

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. Wavelet analysis, also known as wavelet transform, originated from Fourier analysis and is a mathematical tool for dealing with unsteady signals. It is a method for analyzing time series, including speech processing, signal recognition, multi-scale edge extraction and reconstruction, image processing and other related fields. Wavelet analysis can not only identify low-frequency features of time series, but also identify high-frequency features of time series. Wavelet analysis can simultaneously identify the features of the time series in the time domain and the frequency domain by shifting and scaling the wavelet function.

Theoretical research on financial volatility and wavelet analysis has formed a complete system. Beran proposed a model for both long and short memory and non-stationarity, a stationary and non-stationary fractional difference autoregressive moving average model. Jensen proposed an LMSV model based on MCMC and wavelet transform. Gencay et al. used wavelet-based variance to analyze the scale characteristics of exchange rate fluctuations. The main analysis of wavelet variance and volatility long memory is that Taqqu proposed the aggregation variance method and the aggregate sequence absolute value method, Higuchi proposed the Higuchi method, Peng proposed the regression residual method, Greweke, Porter-Hudak proposed the GPH method. And the Whittle estimator method, Lee, Schmidt proposed the KPSS test.

In the analysis and risk management of financial markets, the relevance of different volatility sequences is often involved. Since the wavelet variance can decompose the variance of the process according to the scale, according to the characteristics of the wavelet variance of the long memory

process, the long memory characteristics of different scale segments of the long memory fluctuation process can be analyzed and estimated. This is another long memory estimation method. What can't be done is also the advantage of the wavy long memory analysis method based on wavelet variance. According to the characteristics of variance of wavelet transform coefficients in long memory process, the method of wave length memory test based on wavelet transform can be established. The method itself and its use to analyze the results of Chinese stock market volatility are still to be studied.
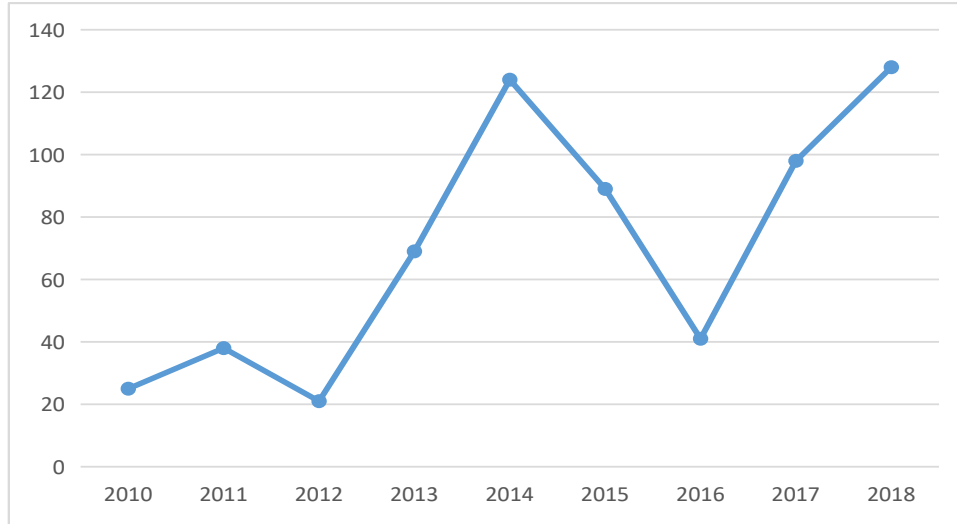


Figure 1 Research on wavelet changes and financial fluctuations

## 3. Analysis of financial fluctuation model based on wavelet transform

Before constructing the financial volatility model, this paper first defines the relevant functions of the financial wavelet transform.

For function $\bigcup(t) = L^2(R)$, $L^2(R)$, $t \in R$ refers to the function space of all square integrable functions of $t \in R$. If $\sum(t)$ meets:

$$\int_{\infty}^{\pm\infty} \in(t)dt = 0$$

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

For wavelet $\sum(t)$, if the tolerance condition is met:

$$\int_{-\infty}^{+\infty} |t| \|\ell(t)\|^2 \, dt < \infty$$

Then we call $\sum(t)$ a basic wavelet function. Do the scaling and translation of $\sum(t)$ to get the wavelet function:

$$\in(t) = |a|^{-1} \varphi\left(\frac{x-b}{a}\right)$$

Assuming a wavelet transform, $W_f(a,b)$ is called a wavelet transform coefficient of $x(t)$. The $W_f(a,b)$ is decomposed into a number of wavelet coefficients $x(t)$, but in order for the wavelet

transform to extract enough information from the original sequence, the wavelet transform is required to reconstruct the original sequence by inverse transform.

Therefore, the wavelet transform coefficient $x(t)$ is reconstructed, and its expression is:

$$x(t) = \frac{1}{C} \int \frac{1}{a^2} W_f(a,b) \varphi(\frac{t-b}{a}) da db$$

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 large, the analysis with lower resolution is performed in the frequency domain, and the observation range on the time axis is larger. That is to say, for a given wavelet function, the shape of the wavelet function changes continuously as the value of the scaling factor and the value of the translation factor change, 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.

## 4. Empirical analysis of financial fluctuation targeting the changes of China's stock market

### 4.1 wavelet framework

In order for the wavelet transform to extract sufficient valid information from the original sequence, it is necessary to reconstruct $W_f(m,n)$ the original time series $x(t)$ by inverse discrete wavelet transform. Therefore, there must be a limit to $W_f(m,n)$, and the definition of the wavelet framework needs to be met.

Let H be a space and $(\in)_{je}$ be a sequence of functions in H. If there is $0 < A < B < \theta$ for any $\int \in H$, it makes:

$$A\|f\|^2 < \sum_{m,n} [f, \omega_{m,n}]^2 < B\|f\|^2, \, 0 < A < B < \theta$$

Then $(\in)_{je}$ constitutes a wavelet frame.

### 4.2 Model Analysis

Financial fluctuations usually have long memory, and the long-memory analysis method based on wavelet variance can decompose the process variance.

In financial market analysis and risk management, the analysis of the long memory of China's stock market volatility often involves the correlation between different volatility sequences. According to the wavelet variance, the covariance of the process can be decomposed, and the correlation between the fluctuations of the two markets in China's stock market is analyzed.

The sample used in this section of analysis is the closing price of each of the Shanghai and Shenzhen Stock Exchange Composite Indexes. The sequence studied is still the income fluctuation sequence B. Estimation of wavelet cross-correlation under different scales z of MODWT based on two income fluctuation sequences point. Where the abscissa is m and the scale $\tau_m = 2^{m-1}, m = 1,$ has an ordinate of $\rho_{x,y}(\tau_m)$.
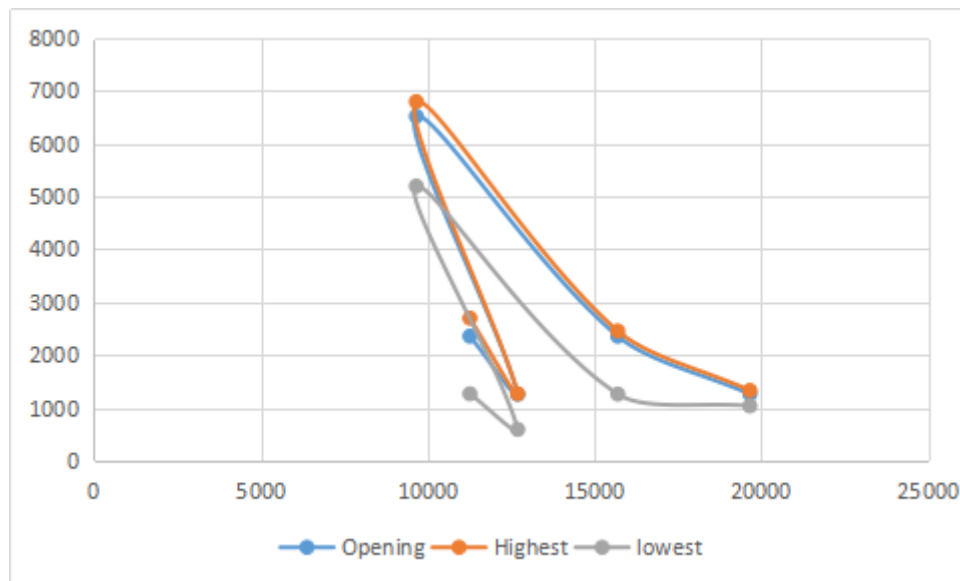
Figure 2 Stock market practice analysis model diagram

The correlation coefficient of the two income fluctuation sequences is 0.86, which indicates the degree of linear correlation of the population of the two income fluctuation sequences. However, the wavelet correlation coefficient is different at different scales. The closer the wavelet correlation coefficient is to 1 at a certain scale, the greater the linear correlation of the sequence at this scale. When m=9, the wavelet correlation coefficient is the largest. When the value exceeds 0.9, the wavelet cross-correlation coefficient exceeds 0.85. At other scales, the wavelet cross-correlation coefficient is between 0.69-0.76.

Overall, the correlation between the two sequences at large scales is stronger than that at small scales. That is to say, although the correlation coefficients of the two volatility sequences reflect their overall correlation, the correlation of the two volatility sequences at different scales is different. This conclusion has very important reference value for portfolio investment managers. The above results generally show that on a small scale basis, the effect of using portfolio investment to spread risk is better than that based on large scale.

## 5. Conclusion

Finance is the core of the modern economy and the blood of the real economy. Excessive financial development and volatility can create systemic risks that have a serious negative impact on economic growth. Building a financial system with anti-risk ability is crucial to achieving healthy economic development. The above empirical analysis conclusions have policy implications for the optimization of China's financial structure, the management of financial volatility and the healthy development of economic growth. First, the marketization of financial structure has a significant inhibitory effect on economic growth. However, increasing the proportion of direct financing and promoting the development of capital markets will help strengthen the economic ability of financial services. Therefore, it is necessary to comprehensively utilize macro-prudential policies, promote financial risk monitoring and evaluation, better maintain the stability of the financial system, and promote stable economic development.

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