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Stock Returns and Inflation in China: Evidence From Wavelet Analysis

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Abstract

The relationship between stock market returns and inflation is investigated using signal decomposition techniques based on wavelet analysis. The relationship is negative in the intermediate time scale, while the relationship in the short and long time scales is different. Overall, the Fisher model holds at the most time scales, implying that stocks are a good hedge against inflation.

Key words: Stock return; Inflation; Wavelet Analysis

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INTRODUCTION

The recent surge in inflation around the world has revived interest in understanding the relationship between stock prices and inflation from a better perspective. The link between stock returns and inflation is an issue that has interested researchers for a long time. There are many studies on the relation of stock returns and inflation, but no consensus has been reached.

The fisher model states that the excepted nominal asset returns should move one for one with excepted inflation because they represent claims on real assets, see Geske and Roll (1983). However, empirical evidence in large part shows that stock returns are negatively correlated with inflation, see Adams, G.et al(2004). A negative relationship implies that investors, whose real wealth is diminished by inflation, can expect this effect to be compounded by a lower than average return on the stock market. This negative correlation is surprising for stocks which should compensate for movement in inflation; see J Boudoukh et al (1994).

The Chinese stock markets are new and very important, which can be the representation of the emerging markets. Its birth and development is the inevitable result of the market-oriented and capital market development. The purpose of this paper is to propose a wavelet analysis, for investigating the relationship between the Chinese stock returns and inflation over different time scales.

This paper is organized as follows: Section 2 discusses the wavelet methodology. The data information and the empirical results are presented in Section 3. Section 4 provides some conclusion of the study.

1. WAVELET METHODOLOGY

Wavelet analysis is a relatively new mathematical tool that decomposes a given series according to scale (time components) instead of frequencies, as in the Fourier approach. it is a time and frequency analysis such as it enables us to determine the signal using time and frequency, see Chui, C. K., (1992),. Daubechies (1992), Hernadez, E. (1996), Mallat, S.G (1989).

Early studies in economics that utilize wavelet methods are Ramsey, Usikov and Zaslavsky (1995) and Ramsey and Zhang (1996, 1997), which concentrate on stock markets and foreign exchange rate dynamics. Wavelet transform may be more useful than Fourier analysis in filtering the signal. Firstly Wavelet analysis provides the ability to perform non-parametric estimations of highly complex structures without knowing the underlying functional form. Wavelet analysis employs some basic functions (wavelets instead of sines and cosines) and uses them to decompose the series. Secondly, they have been one of the most important signal processing methods in many fields (including economics). Wavelet analysis does not need any stationary assumption in order to decompose the series as the wavelets method acts locally in time and do not need stationary cyclical components.

Basic wavelets are characterized into father and mother wavelets

$$\phi_{J,K} = 2^{-\frac{J}{2}}\phi(\frac{t-2^J K}{2^J}) \qquad \int \phi(t)dt = 1 \tag{1}$$

And

$$\psi_{j,k} = 2^{-\frac{j}{2}}\psi(\frac{t-2^j k}{2^j}), j = 1,\cdots J \qquad \int \psi(t)dt = 0 \tag{2}$$

$\phi_{J,K}$ is the father wavelet and $\psi_{j,k}$ is the mother wavelet. Father wavelets represent the smooth baseline trend, good at representing the smooth and low-frequency parts of a signal, whereas mother wavelets are used to describe all deviations from trends, good at representing the detailed and high-frequency parts of a signal.

There are several types of wavelet filters available, such as Haar (discrete), symmlets and coiflets (symmetric), daublets (asymmetric), etc., differing by the characteristics of the transfer function of the filter and by filter lengths. Given this family of basis functions, we can define a sequence of coefficients that represent the projections of the observed function onto the proposed basis when the length of the data, n is divisible by 2^j. We define:

$$s_{J,K} = \int f(t)\phi_{J,K}dt \qquad d_{j,k} = \int f(t)\psi_{j,k}dt \tag{3}$$

Where $S_{J,K}$ are the coefficients at the maximal scale for the father wavelet and $d_{j,k}$ are the micro coefficients obtained from the mother wavelet at all scales from 1 to the maximal scale. Given the coefficients the function, function $f(t)$ can be represented by:

$$f(t) = \sum_k s_{J,K}\phi_{J,K}(t) + \sum_k d_{J,K}\psi_{J,K}(t) + \cdots \sum_k d_{j,k}\psi_{j,k}(t) + \cdots \sum_k d_{1,K}\psi_{1,K}(t) \tag{4}$$

Similarly, $f(t)$ can be rewritten as:

$$f(t) = S_J + D_J + D_{J-1} + \cdots D_1 \tag{5}$$

where

$$S_J = \sum_k s_{J,K}\phi_{J,K}(t) \qquad D_j = \sum_k d_{j,k}\psi_{j,k}(t) \qquad j = 1,\cdots J \tag{6}$$

The easiest way to visualize the above is to consider a sequence of topographical maps; S_J and each D_j are denominated the smooth and detail signals, respectively. Equation 5 indicates that the complete function will be obtained by the multi-resolution of the signal. The approximation is called a multi-resolution decomposition (MRD).

One can also obtain less detailed representations by examining only:

$$S_j = S_J + D_J + \cdots + D_{j+1} \tag{7}$$

Daubechies (1992) has developed a family of compactly supported wavelet filters of different lengths. As allowing the most accurate alignment in time between wavelet coefficients at various scales and the original time series, It is useful in wavelet analysis of signal series. In most studies, Daubechies wavelet may be used.

2. EMPIRICAL ANALYSIS

There are two stock exchanges in China, the Shanghai Stock Exchange and Shenzhen Stock Exchange. The SSE Composite Index is an index of all stocks (A shares and B shares) that are traded at the Shanghai Stock Exchange. SSE Indices are all calculated using a Paasche weighted composite price index formula. This means that the index is based on a base period on a specific base day for its calculation. The base day for SSE Composite Index is December 19, 1990, and the base period is the total market capitalization of all stocks of that day. The Base Value is 100. The index was launched on July 15, 1991. The SSE index reflects the average of the listed company's stock price in the Shanghai stock market.

We collect the monthly closing prices of the SSE index from the wind Database. The period covers the time from September 29, 2006 to December 30, 2011.

Monthly logarithm return on the SSE index is calculated from the daily closing price.

$$r_t = \ln(p_t / p_{t-1}) \tag{8}$$

Where r_t denotes the monthly return and p_t is the closing price of the SSE index at time t .

The Consumer Price Indexes (CPI) program produces monthly data on changes in the prices paid by urban consumers for a representative basket of goods and services. It is one of several price indices calculated by most national statistical agencies. A CPI can be used to index (i.e., adjust for the effect of inflation) the real value of wages, salaries, pensions, for regulating prices and for deflating monetary magnitudes to show changes in real values. The monthly percentage change in a CPI is used as a measure of inflation. The data of CPI were collected from www.caixin.com. Table 1 reports the several summary statistics for the monthly data of nominal stock returns and inflation. Table 2 describes the correlation matrix of two variables.

Table 1
Basic Statistics

	Nominal stock returns	Inflation
Mean	0.004198	0.003147
Median	0.019649	0.003000
Maximum	0.242526	0.026000
Minimum	-0.282779	-0.008000
Std. Dev	0.106663	0.006062
Skewness	-0.617688	0.808586
Kurtosis	3.406392	4.647999
Jarque-Bera	4.510155	14.21639
Probability	0.104865	0.000818
BDS	0.4068	0.4826

Table 2
Correlation Matrix

	Nominal stock return	Inflation
Nominal stock return	1	0.813
Inflation	0.813	1

The values of kurtosis statistics are more large than those of normal distributions, so the distributions of returns are sharply peaked. The P-value of Jarque-Bera statistic is so small, which indicates the distributions of daily returns are evidently different from normal distribution. Table 1 also gives the BDS statistics values when the embedded dimension at 6. The positive values show all the data is nonlinear.

The Wavelet toolbox in Matlab is used as a standard tool for the process of wavelet decomposition. This step involves several different families of wavelets. In our case, the Daubechies' wavelets of order 4 outperform the other alternatives. A five level wavelet decomposition of the given times series is performed

$$f=s_5+d_1+\cdots d_5 \tag{9}$$

Figure 1 and Figure 2 illustrate the decomposition of original stock returns and CPI.

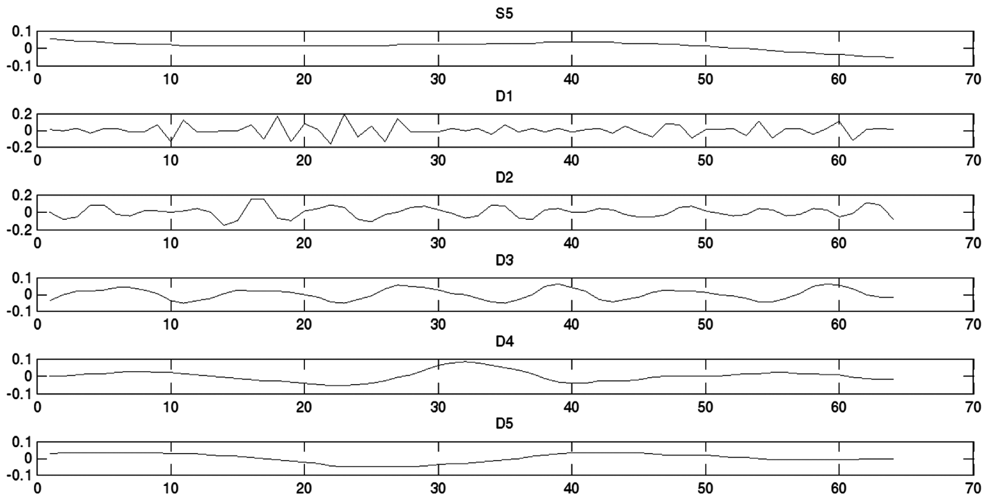

Figure 1
Five Level Decomposition of the Nominal Stock Return

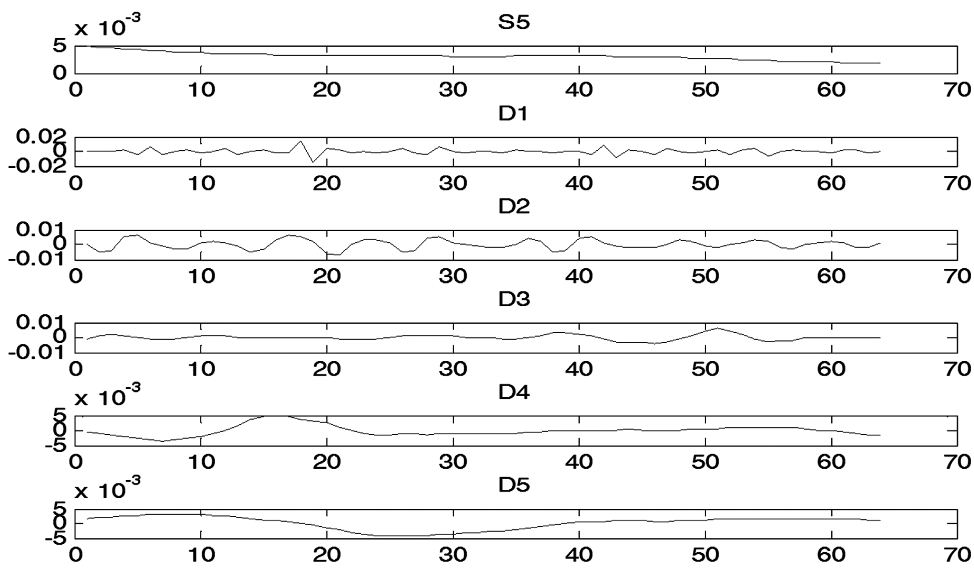

Figure 2
Five Level Decomposition of the CPI

Obviously, the smooth part of f is stored in s_5, and details on different levels are captured by $d_1,\cdots,d_5$. Consequently a decomposition of the time series in five different scales is obtained.

Here the first level of details d_1 provides the short term variation within a month, while the next levels of details represent the variations within 2^j months' horizon. We use OLS regressionsto get the relationship of stock returns and inflation in wavelet domain. As can be seen in Table 3, the estimated coefficients of b_0, $b_1$and R^2 are reported.

Table 3
Regressions in Wavelet Domain

	d1	d2	d3	d4	d5	s5
b_0	0.0001	0.0015	0.014	0.00018	-0.0015	-0.046
b_1	6.29**	2.69*	3.52*	-4.54***	8.656*	21.99*
R^2	0.047	0.065	0.074	0.119	0.6959	0.67

*indicates the significance at 5% level.

Generally speaking, the values of R^2 are increasing as the time scale increases. In d4 (equivalent to a 8-month period), the relationship between the stock returns and inflation is significantly negative. While in d1, d2, d3, d5,s5(equivalent to a 1,2,4,16,32-month period), the relationship is significantly positive. The results show a positive relationship in most time horizons, based on the wavelet regression. The value for coefficient b_1 reaches the highest value at the longest time scale, indicating the degrees of correlation are increasing when the time scale becomes large.

In sum, the relationship between the stock returns and inflation is negative in the intermediate time scale, while the relationship in the short and long time scales is different. Overall, the Fisher model holds at the most time scales.

CONCLUSION AND DISCUSSION

The main purpose of this paper is that it illustrates an application of wavelets as a possible tool to study the Fisher hypothesis. Returns of the Chinese stock company and inflation are studied. In most time scales, the relationship between the stock returns and inflation is positive, implying that stocks are a good hedge against inflation.

The Fisher model is almost correct when the stock returns and inflation are considered. The relationship between the other type stock (such as agriculture stock, insurance stock, etc) returns and inflation is positive or not needs us the further investigation.

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