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INVESTIGATING THE RELATIONSHIP BETWEEN REAL INTEREST RATE AND STOCK RETURNS OF BANKS AND INVESTMENT FUNDS OF IRAN USING WAVELET TRANSFORM

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Abstract: The present study uses a wavelet analysis approach to investigate the relationship between real interest rate and stock returns of banks, financial institutions and investment funds of Iran. Wavelet transforms, by analyzing time series into general series (approximation, trend, smooth) and details (de-emphasized), allows individual variables to be checked simultaneously in different time horizons or frequencies. The result of the research on monthly data during the years 1390-1395 and using the discrete wavelet Daubechies 2 shows that with the increase of the investment horizon of the wavelet variance in the series, the volatility of all-time series is approximated around the process (series of approximation) gets less. In total, the wavelet correlation coefficient shows that in the short term (2-4months) and the medium term (4-8 months), the interest rate relationship with the stock returns of banks, financial

Key Words: institutions and investment funds is positive but is negative the long run (8 to16 months).Real Interest Rate, Banks Stock, Investment Funds, Wavelet Transformation

INTRODUCTION

When speaking about the interest rate, nominal and real interest rates should be distinguished from each other. The real interest rate is the nominal interest rate minus the expected inflation rate. Therefore, if the inflation rate is higher than the interest rate (negative real interest rate), the depositor will be punishedwhile the borrower will be encouraged and rewarded. In these circumstances, it is expected that on the one hand the demand for a loan will increase and, on the other hand, banks will face more problems as a result of lowering the deposits of people in terms of resources and will not be able to meet demand for loans. In addition, the money and the capital market traditionally act as two rivals, and so it is expected that reducing returns on one of them will increase the attractiveness of another market.

The interest rate, which is generally expressed annually, shows the growth percentage in the initial investment. The central bank usually uses interest rates as a means of controlling and dominating over inflation in a country, and if the central bank changes interest rates, it indirectly affects the performance of the stock market; therefore, the determination of the ideal interest rate is a decision of crucial importance which should be considered on a regular basis (Toraman&Basarir, 2014).

Understanding the relationship between interest rate and stock prices is important for investors, portfolio managers, corporate executives and policymakers, due to

its vital application to various financial areas such as asset allocation, portfolio management, risk management and monetary policy transfer; and the relationship between rate change Stock returns are based on financial theory (Ferreret al., 2016).

On the other hand, banks, as the guiding heart of the economy and its savior which constantly deal with this rate, play an important role. Consequently, interest rate changes can have a direct effect on their performance and stock returns, as well as the returns. They can indirectly affect the returns of other industries and investment funds. Investment funds also play a major role in the capital market, as a new financial instrument and toolkit that includes a portfolio, which has not yet received proper amount of research. Hence, paying special attention to the stock of banks and investment funds and the relationship of interest rates with them is necessary to select and optimize a portfolio of them.

The main aspect of innovation is the study of the relationship between interest rates in particular with the stock of banks and investment funds. In previous and recent domestic investigations, the impact of interest rates and other macroeconomic factors on the stock of all industries and in general has been examined. In addition, investment funds have not been paid attention in foreign researches.

THEORETICAL PRINCIPLES AND OVERVIEW OF THE RESEARCH BACKGROUND

Interest rate is an important factor in the profitability of banks and corporations. The relationship between capital structure and capital returns is significant for banks and enterprises. The mismatch of the time gap between financial assets and financial liabilities of banks is due to their performance, which has been recognized as the main issue of interest rate sensitivity in banks (such as long-term loans with short-term deposits) (Balstler et al., 2011; CZAJA et al. , 2010).

The banking industry is sensitive to changes in financial leverage due to the low level of capital adequacy of the entire assets. Banks, through paying interest on deposits and receiving interest on loans, are subject to a change in their capital structure, which affects shareholders' interest rates. Capital structure is one of the most important issues in banking. The relevance of the bank's capital structure to credit risk and capital costs has led to conflicting tendencies in the bank to either reduce the proportion of capital to generate higher profits or increase capital to deal with the risk of default. In addition, firms receive facilities from banks and as a result, the structure of capital and the amount of interest payments to their shareholders has changed. The return on investment funds, whose composition of assets consists of investing in stocks and deposits, is also affected by interest rates.

Initiation of investment funds can be rooted in the eighteenth century and in England, but the first type of modern investment funds was formed in America in 1924 (Mohseni, 1394). In Iran, these funds are not of a long precedence, and the first fund was launched in 2007, but they have been welcomed by investors over the same period. Investment funds in Iran are divided according to the expected returns and risks which can be classified under the rubrics of equity investment funds, fixed income investment funds and mixed investment funds (Tajbar, 1394).

The main aspect of innovation in this research is the study of the relationship between interest rates in particular with the stock of banks and investment funds. In previous and recent domestic investigations, the impact of interest rates and other macroeconomic factors on the stock of all industries has been examined in general. In addition, there has not been any research on foreign investment in investment funds so far.

Researchers,when studying the factors affecting the return on equity funds,found that a meaningful linear relationship exists between the return on investment funds with these 6 variables (in order of priority): market yield, fund growth rate, the magnitude of the deviation from the average return on the fund, the value of the issuance of investment units, the ratio of the activity of the fund and the value of the voiding of investment units (Sa'idi et al., 2010).

In the study of the effect of macroeconomic variables on stock prices with an emphasis on the role

of monetary policy using the structural vector error correction model, the results indicate that stock prices in Iran are affected by factors and economic conditions such as oil prices and rival assets. The negligible effect of monetary policy on justifying changes in the stock price index can be attributed to the reliance on the structure of the financial sector to the bank, the lack of awareness of the people of the capital market and the lack of diversification of securities, as well as the inactivity of the interest rate channel in Iran (Ebrahimiand Shokri, 1390).

The results of a study about the long-term convergence of bank's interest rate with the stock market returns in Iran -by using the bounds test-, demonstrated that there is no long-run relationship between the two variables of short-term bank earnings and stock returns, wheter cash returns or returns from price changes. (MohseniZonouzi et al., 2011).

In a research entitled "Analyzing the return on equity of EghtesadNovin Bank in relation to market risk factors, interest rates and exchange rates", using the automated time series auto-moving and moving average models, a significant and negative relationship between the interest rate and stock returns of the bank and a significant and negative relationship The percentage of exchange rate changes and stock returns of the bank and confirmed the positive and positive relationship between market returns and stock returns of the bank according to initial hypotheses (Imam Verdi et al., 2013).

Regarding the relationship between the rate of inflation and the interest rate of bank deposits in the banking system of Iran, using cointegration and error correction models that can distinguish short-term and long-run fluctuations, it was shown that in the long run, there is a significant positive relationship between nominal interest rate and inflation rate. In other words, the inflation rate is the reason for the concomitant changes in the nominal rate of return, or the interest rate on deposits (Abouniori et al., 2013).

In the study of the long-run relationship between macroeconomic variables on the stock price indices of the banks by the combined method of Johannes-Juselius-which was donewith the help of the seasonal data of the time period of 1982-1982- it was concluded that inflation and exchange rate had a negative effect and the interest rate on bank deposits and gross domestic product had a positive effect on The stock indexes of banks have had (Karimzadeh et al., 1392).

The results of the research titled "Effect of the market power on the liquidity of stock in stock market banks" indicate a direct and significant relationship between the market power of banks and stock liquidity, that is, with increasing market power of the bank, the liquidity of stock of the banks studied during the period 84 has grown to 91 (KanaaniKhosroshahi et al., 2014).

In terms of interest rates and portfolio adjustments of banks, it was found that the ratio of interest rates to the portfolio would depend on the level of interest rates and exogenous assets, as well as the rate and direction of change. They also looked at how commercial banks respond to changes in economic conditions using interest rates, especially interest rate changes, as indicators of change. Their research results are related to the assumption that the management of commercial banks will attempt to adjust their portfolios of assets and liabilities in response to changes in interest rates. For example, if interest rates are in a state of decline, they will have a natural reaction, it will be possible that the maturity of assets for long-term properties and securities will be shortened, and the maturity of the debt portfolio will be shortened (Thistle and Mcleod, 1989).

In a study to investigate the return sensitivity of major financial corporations of the USA to interest rates, exchange rate and market risk factors, they used a multi-factor index model and the results of their research showed that the exchange rate had a significant impact on the return of bank stocks. This return is independent from market factors (Choi et al., 1992).

In an article entitled "The effect of interest rate changes on the return of bank stocks," the effect of changes in the official interest rate on stock returns of Australian banks was examined from 1990 to 2005 using the capital asset pricing model. They argued that, according to previous American evidence, bank stocks are generally negatively (positively) affected by the rise (decrease) in official interest rates, but they unexpectedly found in their country's research that Australian bank

have not been affected negatively by the increase in the official interest rate. In addition, banks apparently experienced positive absolute abnormal returns while the money rate has increased. This phenomenon is consistent with the theory of distributed valuation. The theory suggests that if returns are to be dominated by profits, there is no need for stock returns to be negatively affected. They concluded that Australian banks operating in a less competitive and concentrated environment than their counterparts in the and therefore are able to effectively control the impact of interest rates when these changes are announced (Vaz et al., 2008).

Using a wavelet-based approach, they examined the relationship between interest rate changes and the Spanish stock market at the industry level between January 1993 and December 2012. Experimental results from this study showed that Spanish industries generally have a significant interest rate sensitivity, although the degree of exposure to interest rates varies considerably between industries and depending on the horizons of interest. In addition, the relationship between interest rate movements and stock returns on a larger scale is stronger. This result is consistent with the idea that investors with a long-term horizons are more likely to follow macroeconomic variables such as interest rates in their investment decisions (Martinez et al., 2015).

In an article entitled "The Effects of Interest Rate Dynamics on Stock Returns and Transparency of the Central Bank" in emerging markets, they used a large set of emerging countries in the context of panel data in the context of the asset pricing model and introduced evidence of a negative relationship between stock returns and Interest rate differences. They found that this negative effect had diminished under the transparency of the central bank, which underscores non-linear effects on stock returns. Their findings show that restrictive monetary policies under high levels of transparency lead to a more flat margin for stock returns with significant benefits to financial stability (Papadamouet al. 2016).

RESEARCH METHOD

Having in mind the scale-based and time-based disabilities, scale-time analyzes are introduced by scientists in the field of science. For a better understanding of a time-scale analysis, an explanation of Fourier analysis (scale or frequency analysis) is presented, because it is not only historical in its analysis of wavelet analysis (scale-time), but also constitutes the initial basis of time-scale analyzes.

FOURIER TRANSFORM

The basis of Fourier analysis is the decomposition or approximation of a function or signal based on a set of trigonometric functions. Fourier series can be represented in different ways,however in a simple and initial form, it can be written as follows (Cherubini et al., 2010):

In the above mentioned relationship, we have:

After the demonstration of Fourier series, Fourier transform can be applied ,using the Euler formula, for :

For a series of non-alternating times. With Fourier transform, you can see a function or time series in the frequency spectrum, that is: in which ω represents frequency, t represents time and H(ω) is the symbol of Fourier transform.

As is clear from the aboverelationship, , the results obtained from the Fourier decomposition, after applying the Fourier transform, are in the frequency domain, and there is no indication of the time and its role in this space. In fact, the main weakness of this method is that it cannot simultaneously consider the time and frequency problem and, as a result, it does not have the ability to model the unstable series indefinitely, because in these series the frequency (scale) varies with time. However, the wavelet transform method has the ability to model unstable time series.

The stock return series is a discrete series. Also, the important functions of the transformation of a discrete wavelet are the functions Haar, Daubechies, Symmelets, Coiflets, and Meyer (Wadi and Ismael, 2011).

The wavelet transform removes data from high-frequency noise by maintaining the process of these noises. The wavelet series approximation of the main signal f (t), in the form of the following relationship, is composed of smooth signal and a detail signal sections:

When the time series are decomposed in J scale, if the data is monthly, the wavelet scale is such that the scale is one, fluctuations with dynamics

of 2 to 4 months, the scale of two, fluctuations with dynamics of 4 to 8 months, the scale of three, fluctuations With a dynamics of 8 to 16 months and ..., the scale J shows dynamical oscillations 2^J to 2^{J+1} months, so that after the fraction of fluctuations in J scale from the original time series, the series S_j (t) is found. The series fluctuates in dynamics above 2^{J+1} months and in fact indicates the trend of time series (HosseiniNasab et al., 2011).

MAXIMUM OVERLAP WAVELET TRANSFORM

The transform of the maximum overlap wavelet (MODWT) is the modified version of the discrete wavelet transform (DWT), and contrary to the discrete wavelet transformation, after each step of the algorithm, the time series is divided into half-lengths of the previous stage. in the transformation of the maximum overlapping discrete wavelet In each step, the size of the series details and series is smoothly equal to the original series size. In this transformation, the energy of the signal is preserved, so analysis of variance and its multi-dimensional analysis are like discrete wavelet transform (Tehrani et al., 2011).

In the transformation of a discrete wavelet, the maximum time series overlap can be checked for any length, but in the transformation of a discrete wavelet, we limit ourselves to time series with lengths of 2^j (Gencay et al., 2002). Therefore, in this study, the maximum overlapping wavelet discrete transform has been used.

Understanding the concepts of variance, covariance and wavelet correlation

To understand the concept of wavelet variance, we must refer to the definition of ordinary variance. Assume x is a random variable and has an instance of n. In this case, the unbiased variance estimator is defined as:

$$\hat{\tau}^2 = \frac{1}{n-1}[(X_1 - \overline{X})^2 + (X_2 - \overline{X})^2 + ... + (X_n - \overline{X})^2]$$

The sentences $\{X_1 - \overline{X}, X_2 - \overline{X}, ..., X_n - \overline{X}\}$ are in fact a series of detrended series. Here, the series process is equal to the average, and this is the simplest type of trend estimation, because it considers a number as a process. Therefore, the variance is the average of the total power of the second depleted series. It is, however, a series of times when transforming a wavelet, process, or series of generalities. Based on what has been said, the series deviations in the wavelet variance is a series of details. Therefore, at the level of j^{th} decomposition, the wavelet variance is:

$$\hat{v}_j^2 = \frac{1}{N_j}\sum_{t=0}^{N_j-1} d_{j,t}^2$$

$N_j$represents number of coefficients at the level of j, ν^2 represents variance and $d_{j,t}$ is the symbol ofwavelet coefficients.

By calculating the variance of wavelet details at different levels, the variability of the series can be studied in different time scales of 2 months, 4 months, and so on. Obviously, the degree of variability around the general series at each level is calculated as the series process.

To better understand the wavelet correlation coefficient, we need to review the correlation coefficient. If two random variables $(X_1, y_1), (X_2, y_2), ..., (X_n, y_n)$ is a sample of length n of them, the covariance estimator shown with η is calculated as:

$$\gamma = \frac{1}{n}[(X_1 - \overline{X})(y_1 - \overline{y}) + (X_2 - \overline{X})(y_2 - \overline{y}) + ... + (X_n - \overline{X})(y_n - \overline{y})]$$

Here, too, covariance is defined as the average of the total product of the depleted series. Therefore, it is possible to define waveguide covariance and to define the wavelet correlation coefficient. For this purpose, let's assume that $\{x_t\}_{t=1}^T$ and $\{Y_t\}_{t=1}^T$ are two series of times which are decomposed respectively to and

.In this case, the wavelet correlation coefficient can be defined for all levels. The wavelet correlation coefficient at the j level is:

$$\hat{\rho}_{jxy} = \frac{\hat{\gamma}_{xy}}{\hat{v}_{xj}\,\hat{v}_{yj}} \text{ in which } \hat{\gamma}_{xy} = \frac{1}{N_j}\sum_{t=0}^{N_j-1} d_{x,j,t}^2 d_{y,j,t}^2$$

For each pair of research variables, the wavelet correlation coefficient is calculated tso that their relationship at different time scales becomes clear

.To calculate the correlation coefficient of wavelet variance, the Chi-2-eta-3 method is used:

$$\iota_3 = \max\left(\frac{N_j}{2^j}, 1\right) \qquad \frac{\iota_3 N_j \hat{v}_j^2}{v_j^2} \sim X^2_{\iota_3}$$

DATA AND STATISTICAL POPULATION

The data of this research are fallen into three categories. The first category is real interest rate data (with a deduction for inflation) which is related to the annual interest rate of government-owned bank deposits. These data have been elicited from the Central Bank database. Reasons for choosing a one-year interest rate -instead of short-term rates- in the forms of (daily), special short-term (three-month, six-month, and nine-month) and long-term biennial to five years in this research are:

Changing of all the long-term deposits to one-year long-term deposits by the central bank since 2014; the attractiveness and closeness of this rate to investors in comparison with the return of investment rates in banks and other equity and investment funds; in Iranian, banks due to the competitive nature of the market, consider their short-term interest rates in most projects roughly equal to the one-year long-term rate, and investors are inclined toward this rate; interest rate changes in Iran are at least one year. Of course, because of the unifying of the data of all the variables, this rate has also turned into a monthly rate. In addition, to calculate real interest rates, the monthly inflation data published on the time series statistics and data is used.

The second type of data relate to the rate of return of banks' stock, which are extracted and calculated using monthly stock price data.

The third category of data relates to the rate of return on investment funds in the Iranian capital market. These data are divided into three categories of equity investment funds with fixed income and mixed income. According to the information on the investment funds' website, by the end of March, the number of these funds is 172, of which 98 are investment funds, 59 are fixed income investment funds and 15 are mixed funds.

Of these, only two other categories of funds have been investigated due to delays in the entry of mixed-market outlets and lack of access to complete information. Funds' return rates are calculated based on their monthly NAV returns.

The period of this research is from April 1390 to March 1395.

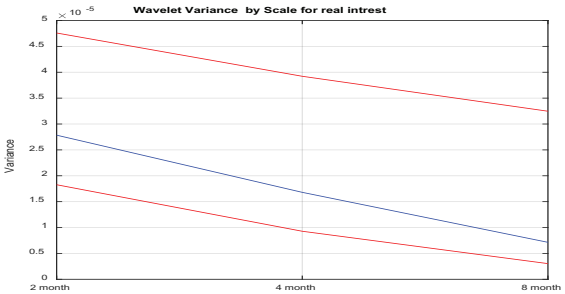
RESEARCH QUESTIONS

First question: How is the short-term, medium- and long-term volatility of real interest rates, stock returns of banks and financial institutions, fixed income investment funds, and equity funds?

Second question: What is the short-, medium- and long-term correlation between real interest rates and stock returns of banks and financial institutions, fixed income investment funds and equity funds?

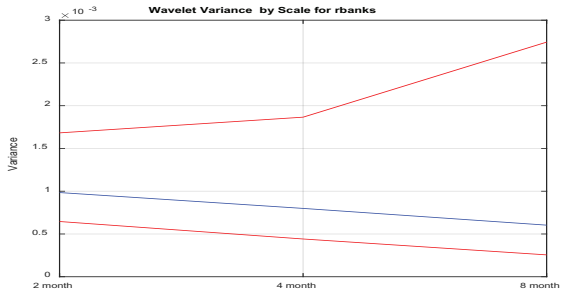
Research findings (analysis of results)

Analysis based on wavelet variance



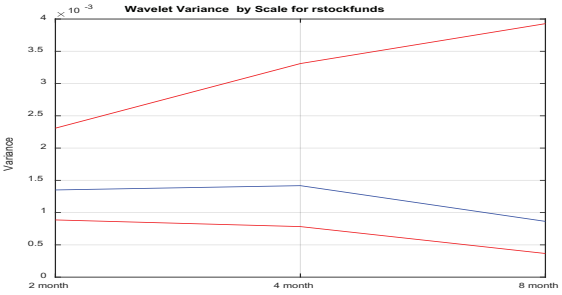
Real Interest	Lower Bound	Variance	Upper Bound
D1	1.83E-05	2.78E-05	4.76E-05
D2	9.28E-06	1.68E-05	3.92E-05
D3	3.03E-06	7.14E-06	3.25E-05
S3	3.72E-05	8.77E-05	0.000399

The graph shows that with increasing time scale, the real interest rate fluctuation (around the calculated process through wavelet transform) decreases. This paper shows that the trend series generated by the discrete wavelet transform with an increase in the decomposition level and due to the increase of the time scale, has a good accuracy.



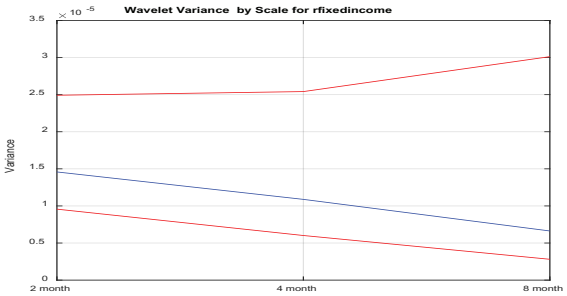
Rbank	Lower Bound	Variance	Upper Bound
D1	6.46E-04	9.84E-04	1.68E-03
D2	4.42E-04	7.99E-04	1.87E-03
D3	2.56E-04	6.03E-04	2.74E-03
S3	5.13E-04	1.21E-03	0.005503

The graph shows that with the increase of the time scale, the volatility of the bank's and credit institution's returns (around the calculated trend through wavelet transform) decreases. This article shows that with the appropriate approximation of the trend by wavelet transform, long-term behavior of the banks and financial institutions index (based on the calculated wavelet transform) is more predictable and reliable.



rstockfund	Lower Bound	variance	Upper Bound
D1	8.86E-04	1.35E-03	2.31E-03
D2	7.83E-04	1.42E-03	3.31E-03
D3	3.66E-04	8.64E-04	3.93E-03
S3	5.41E-04	1.28E-03	5.81E-03

The chart shows that as the time scale increases, the volatility of stock returns (around the calculated wavelet transform) increases in the medium to short term and then decreases. This suggests that there is a higher risk for investors who invest in the medium term.

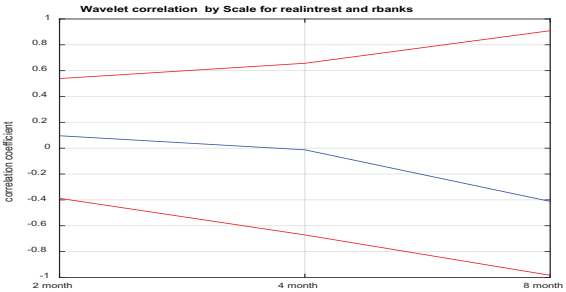


rfixedncome	Lower Bound	Variance	Upper Bound
D1	9.57E-06	1.46E-05	2.49E-05
D2	6.01E-06	1.09E-05	2.54E-05
D3	2.81E-06	6.63E-06	3.01E-05
S3	2.65E-06	6.26E-06	2.85E-05

The chart also shows that with the growth of the time scale, the volatility of the return on fixed income funds also decreases, and falls down more strongly, in short and medium horizons, compared to equity funds.

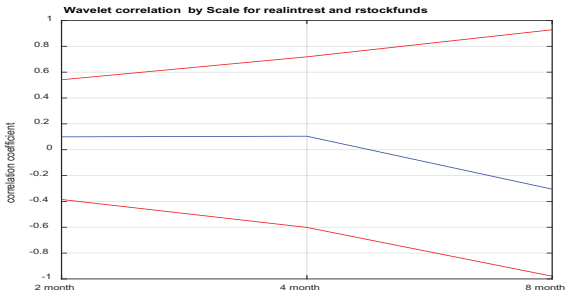
ANALYSIS BASED ON WAVELET CORRELATION COEFFICIENT

Regarding the analysis of time series at three levels of detail and one smooth level, the wavelet correlation coefficient along with the confidence interval were calculated by MATLAB software



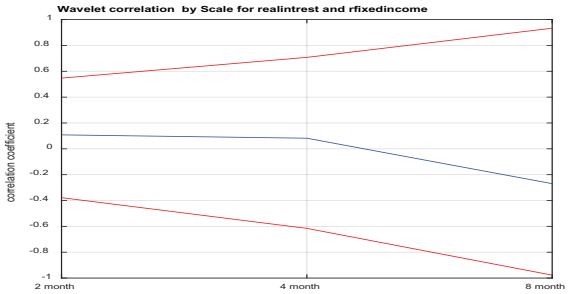
Realintrest and rbank	Lower Bound	correlation coefficient	Upper Bound	Probability Rate
D1	-0.3880	0.0962	0.5389	0.7039
D2	-0.6710	-0.0125	0.6570	0.9744
D3	-0.9836	-0.4118	0.9090	0.5881
S3	-0.9806	-0.3400	0.9225	0.6599

The above chart shows that in the view of the wavelet correlation coefficient, in the short run, the correlation coefficient of the real interest rate and the index of banks is positive, in the medium term it is almost zero and in the long run, it is negative. Therefore, investors must have a different perspective in the short and medium terms of the combined series of two series compared to the long run. Obviously, due to wavelet analysis, it is assumed that investors calculate trends through wavelet transforms.



Realintrest and rstockfund	Lower Bound	correlation coefficient	Upper Bound	Probabaility Rate
D1	-0.3853	0.0994	0.5411	0.6946
D2	-0.6014	0.1043	0.7186	0.7894
D3	-0.9791	-0.3054	0.9280	0.6945
S3	-0.9836	-0.4130	0.9088	0.5869

The above chart shows that in terms of wavelet correlation coefficient, the correlation coefficient of real interest rate and the return on funds in the stock are positive in the short and medium term and are negative in the long run.



Realintrest and rfixedincome	Lower Bound	correlation coefficient	Upper Bound	Probabaility Rate
D1	-0.3779	0.1079	0.5472	0.6697
D2	-0.6155	0.0820	0.7076	0.8337
D3	-0.9774	-0.2695	0.9333	0.7304
S3	-0.9827	-0.3902	0.9134	0.6097

The above chart shows that, in terms of the wavelet correlation coefficient, in the short and medium term, the correlation coefficient between the real interest rate and the yield of fixed income funds is positive. However, it is negative in the long run.

In response to the second question, from the viewpoint of the wavelet correlation coefficient, the real interest rate relationship with the stock returns of the banks, the return on equity investment funds with fixed income has been positive in the short and medium term and negative in the long-run .

According to the results of this method, it is observed that the true interest rate relationship with the returns of the series is not the same at different time horizons. It should be noted, however, that this method for highly fluctuating data expresses more obvious results, and the higher the fluctuation, the more variables can be achieved. In this research, most of the variables have much less fluctuating in comparison to the variable of stock market exchange.

The present study suggests, with regard to wavelet variance, proposes that in order to arrive at a reliable and appropriate prediction of the return of funds in stocks, the return on fixed income funds and the returns of banks and financial institutions should be extended in terms of time. Indeed, the longer the horizons are, the more we are able to adequately predict the future trend of return changes by the trend series, or the generalized extraction from the series of returns by wavelet transform.

Also, the research, having in mind the wavelet correlation, suggests the investors to, in case of increase of interest rate, benefit from investing in stocks of banks, financial institutions and investment funds inshort and medium term horizons. These correlations can help stock managers and investment funds to obtain appropriate policies at different horizons in the event of interest rate changes.

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