DETECTING THE REGIME SHIFT VIA WAVELET TRANSFORM

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Abstract— **Recently, regime shifts or structure breaks had acquired very high attention in analyzing financial time series data. Abrupt of changes in the government policy, financial crises and many of challenges lead to change in the behavior of the financial time series data. In addition, wavelet transform also becomes very famous in the financial sector and it has better advantages than the other filtering methods such as the traditional technique Fourier transform. Therefore, to prove the high ability for the wavelet transform, Haar wavelet transform (HWT) and fast Fourier transform are used to capture the possibility of regime shifts or structure breaks. Apart from detecting precisely the change, this paper also discuss advantages and disadvantages for each method using Amman stocks market (Jordan) between 1992 and 2008. Some numerical and statistical results will be presented in this paper.**

Keywords- Wavelet transform, Fourier transform, Structure break, Amman stocks market.

I INTRODUCTION

In recent years, the economic and financial researchers have concentrated about many field in finance and economic. Consequently, they have focus in regime shift or structure break, long memory and volatility cluster, regime shift appears one of the most important fields in financial time series. Furthermore, the researchers have been tried to understand in more detail about financial time series features and probable development in the future [1, 3].

In this paper we will detect the structure break and regime shift in Amman stocks market from Bursa Jordan, this index is leading stock market indicator in Bursa Jordan. We going to obtain statistically and financially result about the structure break in Amman stocks market by using two approaches. Firstly, the traditional technique Fast Fourier transform and the second approach is Discrete Wavelet Transform (DWT) by using Haar wavelet, both of these methods are designed to analyze the financial time series data and detect its behavior. FFT is spectral filtering method that gotten high attention in the past few years. However, wavelet transform has a property to "Zoom on" on short lived frequency phenomena. This property gives us a tool to learn quickly localized changes in a financial time series, more generally wavelet transform needs a series to be presented by some wavelet functions, hence a series should be transform for many wavelet function as well as this transform localized in both time (position) and frequency (scale) domain.

This paper consists of 5 sections, section 2 has some definitions and concepts, section 3 shows the empirical results and discussion, section 4 presents the conclusion. Finally, section 5 has the acknowledgment.

II DEFINITIONS AND CONCEPTS

A. *Fourier Transform*

Is an operation to transfer the set of complex valued function to other function; which is known as frequency domain. Consequently, the Fourier transforms is similar the other operation in mathematics. We discuss one type of Fourier transform which is the Discrete Fourier Transform (DFT) [2].

Definition: Discrete Fourier transforms (DFT) was defined for discrete points N as [2]

$$X(K)=\sum_{n=0}^{N-1} X(n) W_n^{k_n}, K=0,1,\ldots,N-1 \qquad (1)$$

Where $X(n)$ is the time series data, $W_n = e^{\frac{-j\pi 2}{N}}$.

Moreover, the inverse discrete Fourier transform (IDFT) was defined by:

$$X(n)=\frac{1}{N}\sum_{k=0}^{N-1} X(k) W_N^{-kN},\ n=0,1,...,N-1. \qquad (2)$$

Consequently, FFT and IFFT directly depend on the DFT and IDFT respectively, FFT and IFFT are two algorithms which designed from the previous equations DFT and IDFT respectively. [4]

B. *Wavelet Transform*

The wavelet transform function is constructed by dilation and translation equations consist of the scaling function by using the multiresolution analysis (MRA) for more details refer to [5, 6, 7 and 8]. For a signal c_0, its fast wavelet transform (FWT) can be applied by [5, 8 and 9]

$$c_{j,k} = \sum_{m=1}^{N} h_{m-2h} c_{j-1,m} \tag{3}$$

$$d_{j,k} = \sum_{m=1}^{N} g_{m-2h} c_{j-1,m} \tag{4}$$

Haar wavelet transform is the oldest and simplest example in the wavelet transforms defined as [10]:

$$\psi^{H}(t) = \begin{cases} 1, & 0 \le t \le 1/2 \\ -1, & 1/2 \le t \le 1 \\ 0, & otherwise \end{cases} \tag{5}$$

For the Haar wavelets transform:

$$l_k = \sqrt{2} \int_{-\infty}^{\infty} \phi(t)\phi(2t-k)\,dt = \begin{cases} 1, & 0 \le t \le 1 \\ 0, & otherwise \end{cases} \tag{6}$$

For N =2, $l_k = \left\{1/\sqrt{2}, 1/\sqrt{2}\right\}$ and $h_k = \left\{1/\sqrt{2}, -1/\sqrt{2}\right\}$.

Note: The mother wavelet satisfies the following conditions:

- $\int_{-\infty}^{\infty} \psi(t)\,dt = 0$
- $\int_{-\infty}^{\infty} |\psi(t)| < 0$
- $\int_{-\infty}^{\infty} \frac{|\psi_1(\omega)|^2}{|\omega|} d\omega < \infty$

Where $\psi_1(\omega)$ represent the wavelet transform.

III RESULT AND DISCUSSION

In this section we start by giving some description for the data. Then we show the analysis of structure change using Fast Fourier transform and Haar wavelet transform. Finally, we compare the results for the two models.

A. Data

The data under studying are monthly Amman stock market from Bursa Jordan. The estimation period for the monthly data is from December 1998 until July 2009 observations. We utilize the monthly returns series because we believed that regime shift can be observed specifically across time if low frequency data is used.

B. Identifying Structure Breaks By Using Fast Fourier Transform

According to the Fig 1 and Fig 2, Fig 1 shows the distribution for the financial time series data by using 128 observations, Fig 2 shows the periodogram or the plot of the estimation power spectrum versus frequently, this figure is not sufficient to capture the regime shift or structure break since it represents the data as a function of position.

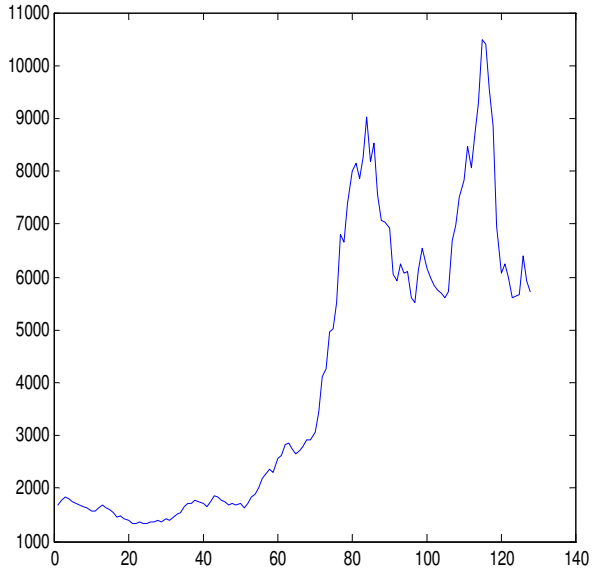

Figure 1 Shows the original monthly data for Amman Stocks Market "between" December 1998- July 2009

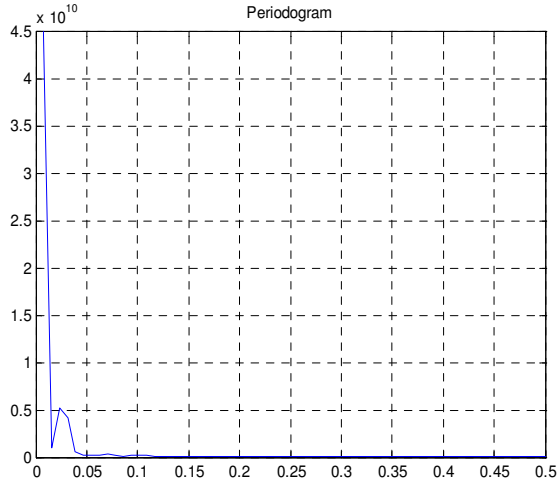

Figure.2 Shows the Power Spectrum Estimation or the magnitude of the complex vector square

C. Identifying Structure Breaks By Using Wavelet Transform

The process of detecting regime shift or structure break by using Haar wavelet transform (HWT) starts by computing the wavelet transformation of the noisy Amman stocks market index data. Thus, it has the spatial positions at which the wavelet transformation across fine scale levels exceeds the threshold to detect the regime shift. For the purpose of Amman stocks market analysis by using DWT we used Haar 5. For more details, refer to [10]. The Haar

wavelet is relatively smooth. Fig 3 shows the data analysis scaling function and wavelet function. By using Haar wavelet transforms, we are able to understand and compare between all levels of the analysis. Fig 3 shows the result when we analyze the Amman stocks market series up to the level 5.

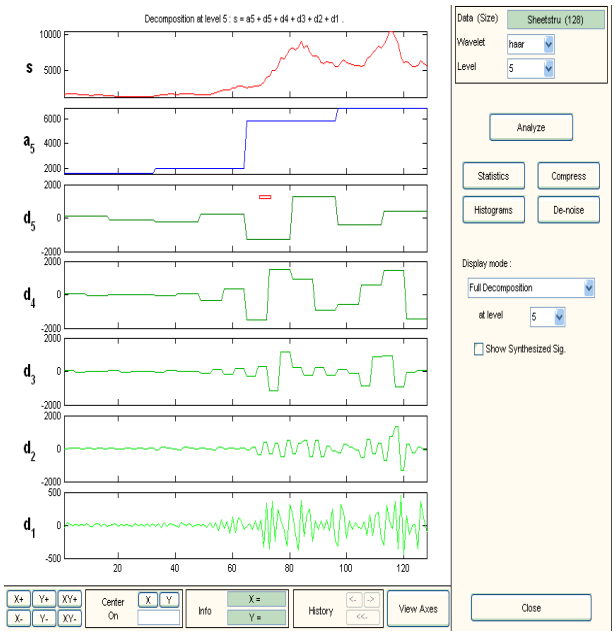

Figure.3 Data analysis: using MATLAB_ Haar wavelet transform level 5. It shows the fluctuations, magnitudes and phases for the monthly data

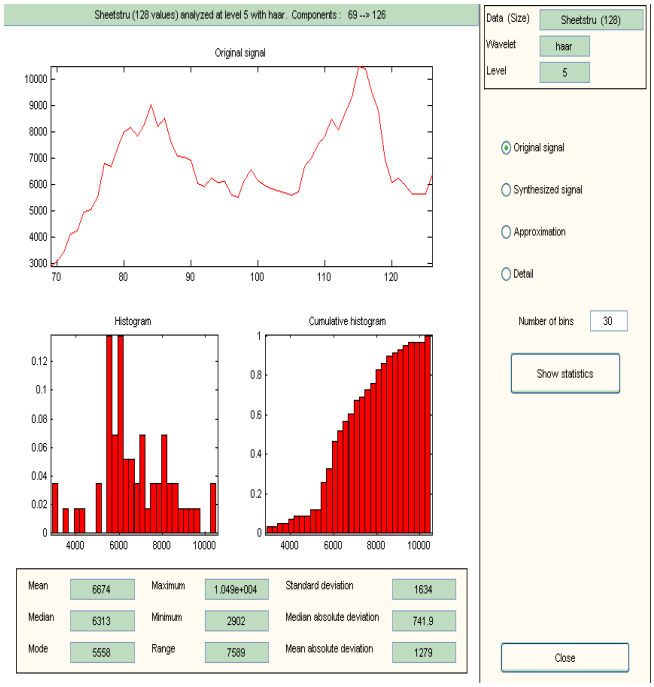

Figure.5 Statistical analysis: using MATLAB_ Haar wavelet transform level 5. It shows important statistical results for monthly data.

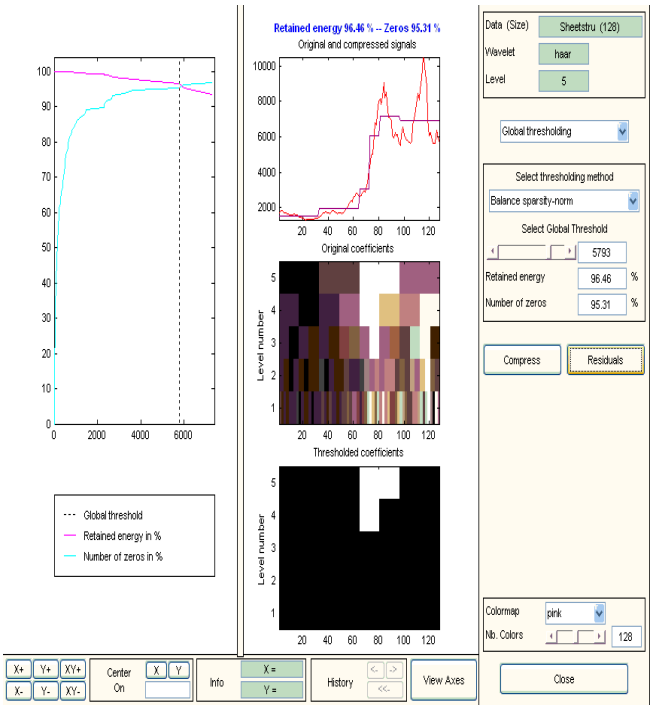

Figure6 Data analysis: using MATLAB_ Haar wavelet transform level 5. It shows the compressed time series observations with its details

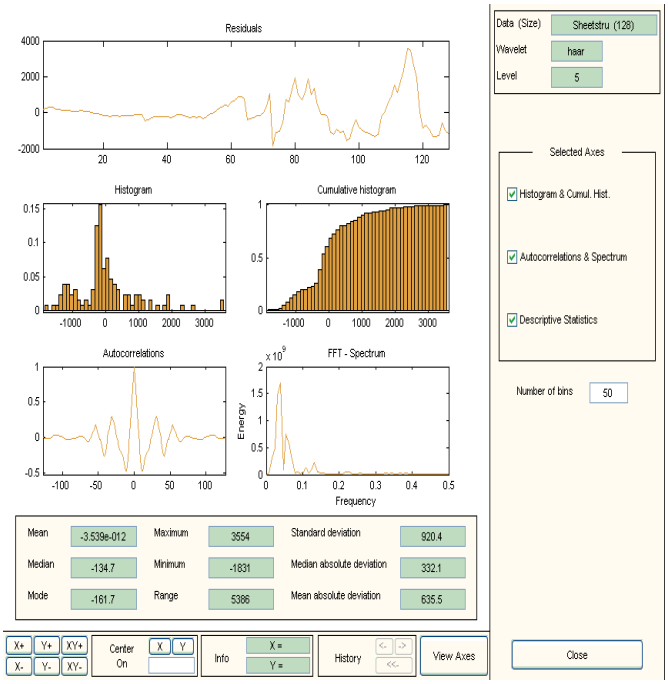

Figure7 Data analysis: using MATLAB_ Haar wavelet transform level 5. It shows the distribution of the residual

There is many notations about the structure break, most the financial crises already happened after the month number 70 which means after the year 2004, the main reason return to increase the numbers of the non Jordanian investments during this time (2004-2009), so we notice that precisely in 2004-2006, the investments are unbalance (sometime positive and sometime negative). Moreover, in February 2006 the investment becomes more balance and continues until August 2006. However, in August 2006 the investment showed a negative balance, but in September the non Jordanian investments already increased and the investments fluctuated from time to time until nowadays.
This instability in the investments effected on the stocks market during all the time from 2004 until 2009. Consequently, the investment is the main variable which effected in Amman stocks market. As well as, we notice that before 2004 the investment is very low and there is a very small structure break.

IV CONCLUSION

In this paper, we have discussed very most two methods in order to study the structure break in original time series (Amman stocks market) namely applying Fast Fourier transform method and discrete wavelet transform method. Basically we could say that FFT failed to capture the regime shift exactly. But the wavelet method via DWT has much more advantages compare with FFT model. All information which contained in the volatility series is perfectly captured. No anomalies have been introduced by DWT. Furthermore we are capable to find that year 2004-2009 also has structural break which is not able to analyst it via FFT model.

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