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Discovering Structure Breaks in Amman Stocks Market

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Abstract: One of the main features in financial and economic time series data that trigger attention from researchers is regime shifts or structure breaks. Usually structure breaks occur because of abrupt of change in the government policy, financial and economic crisis and political instability. In recent years wavelet transform becomes more popular in the financial time series analysis and it has better advantages than the other filtering methods such as the traditional technique Fourier transform. In this study, we used Discrete Wavelet Transform (DWT) via Daubechies function and Fast Fourier Transform (FFT) to capture the possibility of regime shifts or structure breaks. The main objective is to detect precisely the changes in the behavior of the Amman stocks market (Jordan) from December 1998 until July 2009. We also discuss the advantages and disadvantages between both methods.

Key words: Wavelet transform, Fourier transform, regime shift, structure break, Amman stocks market

INTRODUCTION

Recently, the economists and financial researchers have concentrated on many features in financial and economic data. Among the main features they are focusing now are regime shift or structure break, long memory and volatility clustering. These three features are the main concerns to them because these are the usual observed behaviors that occur in financial time series. Furthermore, by monitoring these main features frequently, the researchers hope to understand more about a series and the probable development in the future. A comprehensive overview on the recent development of modelling structural breaks, the analysis of long memory and stock market volatility can be found by Banarjee and Urga (2005).

Structural breaks are the main highlight that will be discussed in this study. According to Brooks (2002), structural breaks is define as the behaviour of a series that may change for a period of time before reverting back to its original behaviour or switching to another style of behaviour. Structural break has been a major concern especially for economists. Various theories of economic assume that economic relationship changes over time. Such a change has been explained in descriptive way without being use a statistical test. With the introduction of regression analysis as the principle tool of economic data processing in the 1950s and 1960s, attempts were made to describe changes of economic relationship in regression framework. A detail discussion of structural break in economic and financial data can be found by Hackl (1989).

In this study, we will try to detect the structure break or regime shift in Amman stocks market from Bursa Jordan. This index is the leading stock market indicator in Bursa Jordan. We want to obtain statistical and financial results about the structure break in Amman stocks market by using two approaches. Firstly, the traditional technique Fast Fourier Transform (FFT) and the second approach is Discrete Wavelet Transform (DWT) by using Daubechies wavelet function. Both of these methods are designed to analyze the financial time series data and detect its behavior.

FFT is a spectral filtering method that has been used widely in sciences and engineering applications. Wavelet transform has a property to Zoom in 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. Wavelet transform is localized in both time (position) and frequency (scale) domain, while FFT is only localized in frequency domain not in time. Refer to Karim *et al.* (2008), Karim and Ismail (2008), Gencay *et al.* (2002), Daubechies (1992) and Chui (1992) for more detail on these topics.

Wavelet transforms have used in many scientific fields and areas; such that: signal processing, approximation techniques, quantum field, decomposition,

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digital watermarking algorithm, geotechnical engineering, forecasting, pattern recognition and other fields, for more details refer to Jin and Peng (2006), Chik *et al.* (2009), Rizzi *et al.* (2009), Rahnama and Noury (2008).

DEFINITIONS AND CONCEPTS

Fourier transforms: It 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 to the other operation in mathematics. We discuss one type of Fourier transform which is the Discrete Fourier Transform (DFT) (Janacek and Swift, 1993).

Definition: Discrete Fourier Transforms (DFT) was defined for discrete points N (Oraintara *et al.*, 2001) as follow:

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

where, X (n) represents time series data and $W_n=e^{\frac{-2j\pi}{N}}$.

Moreover, the Inverse Discrete Fourier Transform (IDFT) was defined by:

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

Consequently, FFT and IFFT directly depend on the DFT and IDFT respectively, FFT and IFFT are two algorithms which is designed from the previous equations DFT and IDFT respectively (Gencay *et al.*, 2002).

Wavelet transform: The wavelet transform function is constructed by dilation and translation operations on the scaling function by using the Multiresolution Analysis (MRA) for more details refer to Mallat (1989), Daubechies (1992), Nadhim (2006) and Chui (1992). For a signal C_0, its Fast Wavelet Transform (FWT) or Discrete Wavelet Transform (DWT) can be applied by using Eq. 3 and 4:

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

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

Wavelet transforms by daubechies function: Haar wavelet is the simplest wavelet transform and then it was improved by Daubechies (1992). She developed the frequency-domain characteristics of the Haar wavelet. However, we do not have specific formula for this method of wavelet transform. Therefore, we tend to use the square gain function of their scaling filter. The square gain function was defined by Gencay *et al.* (2002).

$$g(f)=2\cos^{l}(\pi f)\sum_{l=0}^{\frac{l}{2}-1}\left(\frac{l}{2}-1+l\right)\sin^{2l}(\pi f) \qquad (5)$$

where, l is positive number and represents the length of the filter, for more details and examples see Chiann and Moretin (1998), Yago (2000) and Struzik (2001).

RESULTS AND DISCUSSION

Here, we start by giving some description for the data. Then we show the analysis of structure change using Fast Fourier transform and Discrete Wavelet Transform (DWT). Finally, we compare the results for the two models.

Data: The data under study are monthly Amman stock market from Bursa Jordan. The estimation period for the monthly data are from December 1998 until July 2009. We utilize the monthly series because we believed that regime shift can be observed specifically across time if low frequency data is used. The total data is 128.

Identifying structure breaks by using fast fourier transform: Figure 1 shows the distribution for the financial time series data with 128 observations, while Fig. 2 shows the periodogram or the plot of the estimation power spectrum versus frequency. It appears from Fig. 2,

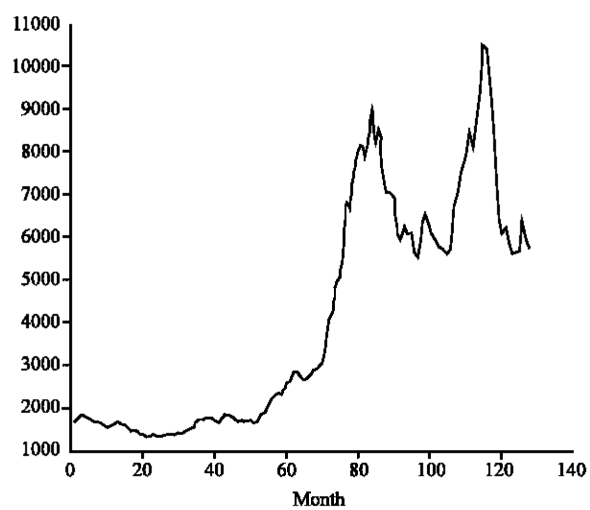

Fig. 1: Original monthly data

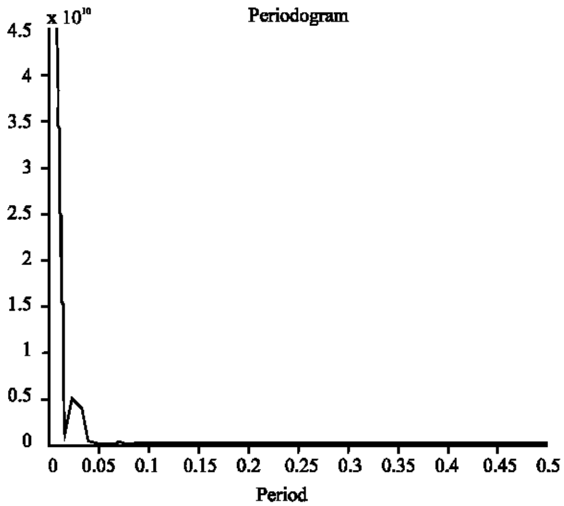

Fig. 2: Power spectrum estimation

Fast Fourier Transform (FFT) is not sufficient to capture the regime shift or structure break since it represents the data as a function of position or frequency domain. Moreover, a plot of the FFT (Fig. 2) of this signals show nothing particular interesting. Since FFT represents the data as a curve. This curve approach or inherent on the X-axis and Y- axis, which hardly capture the regime shift or structure breaks and interpret the financial behavior. Hence, it is impossible to obtain the residual data, denoised data, statistical analysis and the compressed data from Fig. 2.

Identify structure break by using wavelet transform: Now we transform the data using Daubechies function. Figure 3 present the decomposition of the data until level 7. It shows the fluctuations, magnitudes and phases for the monthly data. As the decomposition of the data move from details d1 until d7, all the abnormal values had been eliminated and we have smooth series. While Fig. 4 shows the descriptive statistics and the distribution of the data. From Fig. 4 (X- axis shows the observations, Y-axis is the observation values) it appears the variation among data are very high where the range is 9164 and standard deviation is 2682. Thus, by denoising we hope to reduce these two values.

Figure 5 exhibits the construction of denoise series, The soft thresholding has been used and in general it produced a smother estimation, so that it is a good way to decide the convenient model, as well as it has a good effect on the structure break. If the model has a smooth denoising, then this model will be more suitable to capture the structure break. Whereas, Fig. 6 displays the residuals series of the denoise series. It seems that the

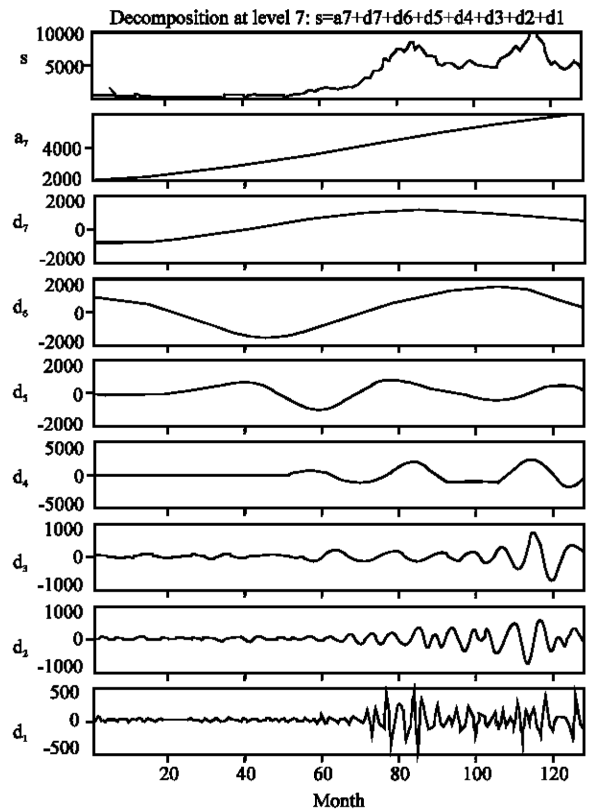

Fig. 3: Wavelet decomposition by using daubechies wavelet

residuals fluctuated around zero value quite constantly which indicates white noise process. Nevertheless, after around point 70 the fluctuation of the residuals are more erratic which implies an abnormal behavior happened. Moreover, this figure shows the autocorrelation function which measured the correlation coefficients of a signal with itself (Phillips *et al*., 1999). Thus the autocorrelation function appears after analyze the transform data by using fast Fourier transform around zero, it means the data columns have no positive linear relationship, hence we could not detect the structure breaks via FFT model.

The process of detecting regime shift or structure break by using Daubecies wavelet starts by computing the wavelet transformation of the noisy Amman stocks market index data. Then we compare the wavelet coefficient with the estimate thresholding values. 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 Daubechies 7 (14 filters) up to level 7. The Daubechies 7 wavelet is relatively smooth as compared with the Haar wavelet filter. By using DWT,

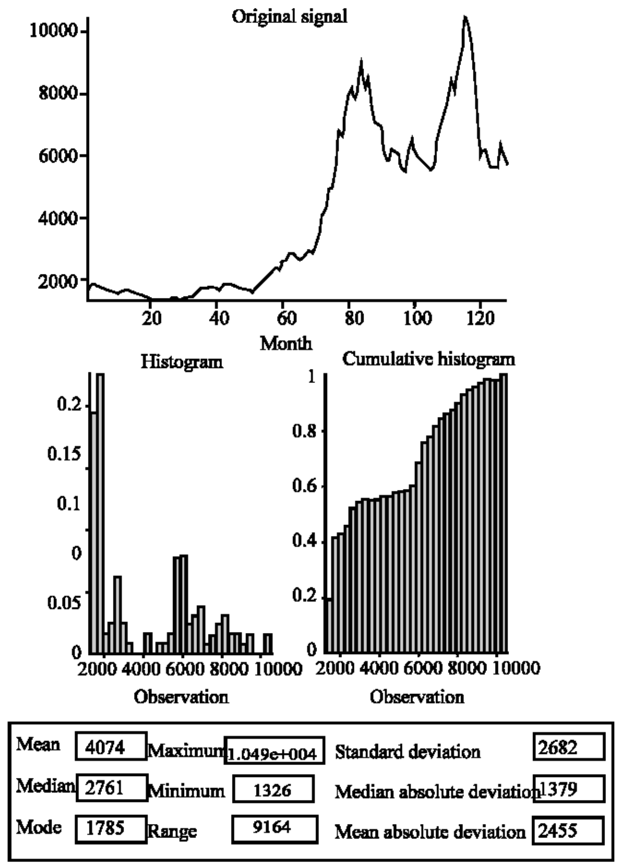

Fig. 4: Statistical analysis results

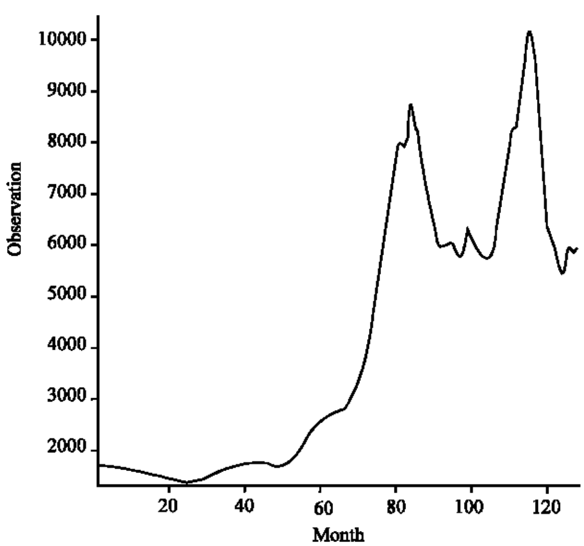

Fig. 5: Distribution of the denoising data

we are able to understand and compare between all levels of the analysis. Figure 3 shows the result when we analyze the Amman stocks market series up to the level 7.

There are many notations about the structure breaks. It can be seen that most of the financial crises happened after the months of 70 through 90 which means after the year 2004. This is because we can notice that there are very high fluctuations around this period. This high volatility period indicated that structural breaks happened during this period and it continues until 2009.

From our inspection, the main reasons why the Jordan stock market highly fluctuate from 2004-2009 because of the increase the numbers of non Jordanian investments. Therefore, we notice that precisely in 2004-2006, the investments are unbalance (sometimes positive and sometime negative). Moreover, in February 2006 the investment be more balance and continued 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 (http://www.ase.com.jo/).

This instability in the investments affected the stocks market during all the time from 2004 until 2009. Consequently, the investment was the main variable which affected the Amman stocks market and we also

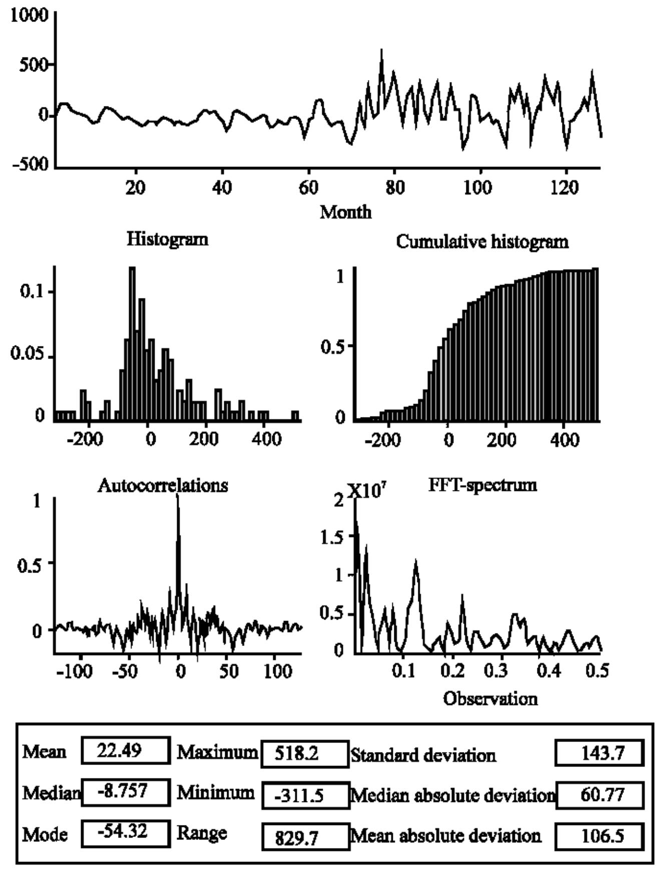

Fig. 6: Residuals Distribution of denoising data

notice that before 2004 the investment was very low and there are very small structure breaks or non structure break.

CONCLUSION

In recent years, sudden changes in financial and economic time series data have gained much attention from economic and financial scholars. These sudden changes are called structural breaks. In this study, we discussed two different methods in order to study the existence of structure breaks in Amman stocks market. The two methods are Fast Fourier Transform (FFT) and Discrete Wavelets Transform (DWT). Overall, results indicated that FFT are unable to capture structural breaks because FFT localized in frequency domain only and not in time domain. However, information which contained in the volatility series is perfectly captured by using the DWT method. No anomalies have been introduced by DWT. In addition, by using DWT, we also found the period of structural breaks between 2004 until 2009.

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