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Verification of the Relationship Between the Stock Performance and the Randomness of Price Fluctuation

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Abstract

The authors examine the validity of the empirical rule connecting the randomness of high frequency stock prices to its future performance in a bully market conditions. For this purpose, the U.S. market in the period of 1993-1997 is chosen for investigation. The rule was first discovered in a bear market of 2007-2009 in Tokyo market, as one of the useful applications of the RMT-Test which is a new tool to measure the randomness of given time series based on the random matrix theory, showing that the stock of the highest randomness is more profitable than the Nikkei Average Price throughout the following year. The previous analysis was limited to the period of bear market, and inclusive analysis for a wider market conditions are necessary in order to establish the validity of the rule.

Keywords: Randomness, RMT-test, tick-wise stock price, bear market, bull market

1. Introduction

The authors have proposed to measure the randomness of a given long time series based on RMT[1], named the RMT-test[68], and have demonstrated the effectiveness of this method by measuring the randomness of the physical random numbers and the pseudo-random numbers, and applied the same tool to measure various real-world time series including price fluctuation this process, a new empirical rule has been discovered, stating that the stocks *having higher randomness in the previous year tend to perform better than the stocks of lower randomness*[5] Although it is a striking discovery, the analysis was limited only the period 2007-2009 in the Tokyo market, which was a typical example of the weak market condition. In order to establish the validity of the rule, it is necessary to examine

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whether the same rule holds in a strong market. For this purpose, the U.S. market in the period of 1993 - 1997 is employed and thoroughly examined.

2. The RMT test

2.1. Mathematical Preparation[2,3]

The method of the RMT-test is outlined as follows. We aim to test the randomness of a long 1-dimensional sequence of numerical data, S.

At the first step, we cut S into N pieces of equal length T, then shape them in an N×T matrix, $S_{i,j}$, by placing the first T elements of S in the first row of the matrix $S_{i,j}$, and the next T elements in the 2nd row, etc., by discarding the remainder if the length of S is not divisible by T. Each piece, $S_i = (S_{i,1}, S_{i,2}, \ldots, S_{i,T})$, is converted to a normalized vector $x_i = (x_{i,1}, x_{i,2}, \ldots, x_{i,T})$ by means of

$$x_{i,t} = \frac{S_{i,t} - < S_i >}{\sigma_i} \tag{1}$$

where,

$$< S_i > = \frac{1}{T} \sum_{t=1}^{T} S_{i,t} \tag{2}$$

and

$$\sigma_i = \sqrt{< S_i^2 > - < S_i >^2} \tag{3}$$

such that every row in the new matrix x has mean=0, variance =1. Since the original sequence S is random, in general all the rows are independent, i.e., no pair of rows is identical.

The cross correlation matrix $C_{i,j}$ between two stocks, i and j, is constructed by the inner product of the two time series, $x_{i,t}$ and $x_{j,t}$,

$$C_{i,j} = \frac{1}{T} \sum_{t=1}^{T} x_{i,t} x_{j,t} \tag{4}$$

thus the matrix $C_{i,j}$ is symmetric under the interchange of i and j.

A real symmetric matrix C can be diagonalized by a similarity transformation $V^{-1}CV$ by an orthogonal matrix V satisfying $V^t=V^{-1}$, each column of which consists of the eigenvectors of C. Such that

$$C v_k = \lambda_k v_k \; (k=1,\ldots,N) \tag{5}$$

where the coefficient λ_k is the k-th eigenvalue and v_k is the k-th eigenvector.

According to the RMT, the eigenvalue distibution spectrum of the cross correlation matrix C of random series is given by the following formula called Marcenko-Pastur distribution[4]

$$P_{RMT}(\lambda) = \frac{Q}{2\pi} \frac{\sqrt{(\lambda_+ - \lambda)(\lambda - \lambda_-)}}{\lambda} \tag{6}$$

$$\lambda_\pm = (1 \pm Q^{-1/2})^2 \tag{7}$$

valid at the limit of N and T going to infinity, keeping

$$Q = K/N \tag{8}$$

as a constant.