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Study of Characteristic and Period of Communication and Electronics Industry in Chinese Securities Market

WEN Xiaobo[a],*; ZHAO Liang[b]; WANG Hui[b]; PAN Heping[c]

[a]Department of Information Technology, Sichuan Tourism College, China.
[b]School of Physics and Electronics, UESTC, China.
[c]Chongqing Institute of Finance, Chongqing, China.
*Corresponding author.

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Abstract

Purpose: This study aims to analyze the characteristics of communication and electronics industry in Chinese stock market and calculate the average periods of it.

Design/methodology/approach: We use R/S analysis method to study the characteristics of communication and electronics industry in Chinese stock market, and use Matlab software and Eviews software to calculate some representative exponents of this industry.

Findings: The results show that the probability distribution of the communication and electronics industry in the Chinese stock market is nearly non-normal distribution, but a partial distribution, showing a peak, thick tail, migraine and other features. Hurst exponent calculated shows that the communication and electronics industry in the Chinese stock market has obvious fractal characteristics, and does not follow a random walk assumption, but follows persistent trend. The average big circulation period is about 400 days; the average small circulation period is about 200 days.

Research limitations/implications: We use R/S analysis method to study the characteristics including periods and venture.of communication and electronics industry in Chinese stock market.

Practical implications: The average periods and related venture can give investors properly suggestions.

Originality/value: We use R/S analysis method and Matlab software and Eviews software to analyze the characteristics of communication and electronics industry in Chinese stock market which has barely been studied. The results unfold the characteristics of this industry and can give investors properly suggestions as well.

Key words: Stock market; Fractal; R/S analysis; Hurst exponent; Periods; Communication and electronics

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INTRODUCTION

As one of the cornerstones of Modern Finance, Efficient Market Hypothesis(EMH) has always been the theoretical premise of capital markets analysis.

EMH theory suggests: The current market price of capital markets can reflect all the relevant information timely, accurately and adequately. Investors are rational, and they will respond to the information with a nonlinear manner. The process of price changes follows the Markov Process which is a random wandering process, and the probability distribution of the price changes yield follows normal distribution. However, recently many domestic and foreign empirical researches on capital markets discover that EMH theory cannot explain many of the actual situations in the capital markets. The fundamental reason is that the real capital market is a complicated system, and it's not as the EMH theory which reflects information based on the linear paradigm. Instead, it's a nonlinear reaction and the price returns is not mutually independent. Its changes do not follow random wandering model and the probability distribution also closes to non-normal distribution. Instead, it's a skewed distribution which represents characteristic like peaks, fat tail, biased, etc. More and more practices prove that modern capital market theory which based on efficient market hypothesis does not match with the actual situation, and the fractal theory takes into account the complexity of the capital market and the defects of the EMH. By non-linear paradigm as the basis analysis, it can explain many market situations which efficient market hypothesis cannot explain. It also provides a new idea and method for more in-depth analysis of the capital market.

In recent decades, rapid economic development in China is along with the continued progress and application of high technology. The electronic information industry is gradually revealing a powerful development momentum and has been the pillar industry of national economy. However, China's electronic information industry is mainly in the processing and does not form an industrial development pattern of large enterprises leading with SMEs supporting. Listed companies of electronic information industry as a backbone of driving the electronic information industry development, its operating performance can directly affect the sustained and rapid development of electronic information industry. Therefore, it has a greater practical significance on the performance evaluation of listed companies in China's electronic information industry.

Currently, relevant researches on operating performance of listed companies in the electronic information industry are conducted by some domestic scholars, such as Tu Chunhui, Li Shuangjie (2002) utilize the reciprocal of the negative correlation coefficient as a weighted by the comprehensive benefits of the listed companies in China's electronics industry for an evaluation. Xu Lu (2003) takes electronics listed companies of Shanghai and Shenzhen as a sample, and utilizes the variable-intercept panel data model to investigate the relationship between ownership structure and operating performance of listed companies in this industry. Liu Xiuqin (2004) utilizes factor analysis approach to conduct a comprehensive performance evaluation on 2002 annual financial statements of 17 different electronic industry listed companies in the Shanghai Stock Exchange, and extracts sales, growth, debt, investment income capacity these four factors, etc. Due to different evaluation indicators and evaluation methods, the research conclusions are not consistent. Many domestic scholars based on this has successively conducted some empirical research on China's capital market, and obtained a conclusion of China's stock market volatility has state persistence and represents nonlinear characteristics. This paper will take communication and electronics industry in the china securities market as an example, and using the R/S fractal analysis method studies the stock of communication and electronics industry in the china securities market. The result shows that the stock of communication and electronics industry in the china securities market has obvious fractal characteristics.

1. CALCULATION METHOD OF FRACTAL R / S ANALYSIS AND HURST EXPONENT

In the 1940s, a British hydrologist, Hurst while he is researching the relationship between the flow and storage capacity of Nile reservoir, he discovers that using biased random wandering can describe the long-term storage capacity better. And based on this, he proposes using the Rescaled Range(R/S) analysis method to set up the Hurst exponent (H). 1) When $H = 0.5$, time sequences is random wandering. The value of different time in the sequences is random and irrelevant, that present will not affect the future. A standard Brownian Motion will express the feature of Markov Chain. 2) When $0 \le H < 0.5$, this is an anti-persistent time sequences, often called "mean reversion". If a sequences in the previous period is upwards, then it's next period probably is downwards, vice versa. This anti-persistent intensity depends on how H is closer to zero, the closer to zero, this time sequences will have greater mutagenicity or variability than random sequences. 3) When $0.5 < H \le 1$, indicating the sequences have persistence, and there's the features of long-term memory. That is the previous period of time sequences is upwards (downwards), then next period will probably be upwards (downwards).

1.1 Hurst Exponent

To calculate the Hurst exponent, follow the below steps:

(1) Initiate with length of time T, price sequence conversion as $N = T - 1$ logarithm yields:

$$N_{i+1} = 1n(P_{(i+1)}/P_i),\ i = 1, 2, 3, ..., (T-1) \tag{1}$$

which N_{i+1} is logarithm yield of $i+1$, and P_i is the price of i.

(2) The interval of this time length N is equipartition to A continuous subintervals of length n, so that $n \times A = N$. Indicate every subintervals as I_α, $\alpha = 1, 2, 3, ..., A$. In every subinterval I_α, each elements labeled as $N(k, a)$, $k = 1, 2, 3, ..., n$. The mean of the subinterval of length n is defined as follow:

$$e_\alpha = (1/n) \times \sum_{k=1}^{N} N_{k,\alpha} \tag{2}$$

which, e_α is the mean of $N(k, a)$ included in the subinterval I_α of length n.

(3) As the time sequence of cumulative deviation of the mean for every subinterval I_α is define as:

$$X_{k,\alpha} = \sum_{i=1}^{k} (N_{i,\alpha} - e_\alpha), k = 1, 2, 3, \ldots, n \tag{3}$$

(4) Range is defined as in every subinterval I_α, the max. value of $X_{k,\alpha}$ minus the min. value of $X_{k,\alpha}$:

$$R_{I_\alpha} = \max(X_{k,\alpha}) - \min(X_{k,\alpha}),\ 1 \le k \le n \tag{4}$$

(5) Find the sample standard deviation of every subintervals I_α:

$$S_{I_\alpha} = \sqrt{1/(n-1) \times \sum_{i=1}^{k} (N_{i,\alpha} - e_\alpha)^2} \quad (5)$$

(6) For every range R_{I_α}, all are separated from its corresponding standard deviation S_{I_α} and then formalized. Therefore, every subinterval I_α, is corresponding to a rescaled range $R_{I_\alpha}/S_{I_\alpha}$.

(7) For the resting A–1 successive length n subintervals, repeats the above (2)~(6) progress. It can obtain a total of A $R_{I_\alpha}/S_{I_\alpha}$, so that length n average R/S value can be obtained, and define as below:

$$(R/S)_n = \frac{1}{A} \times \sum_{\alpha=1}^{A} (R_{I_\alpha}/S_{I_\alpha}) \quad (6)$$

(8) Increase the value of n, then repeats the above (2)~(7) progress, until n is added up to $n = N/2$, so that a series of n can be obtained and its corresponding $(R/S)_n$. From the fourmula $R/S = C^* N^H$, it's able to obtain:

$$\log((R/S)_n) = \log(\alpha) + H \times \log(n) \quad (7)$$

Now let this series of log (n) as independent variable and let $\log((R/S)_n)$ as the dependent variable, using the formula (7) to perform ordinary least squares regression, the calculated slope which is the estimated value of Hurst exponent (H).

In order to reflect the influence degree of "now-to-future" more intuitively, Mandelbrot introduced correlation metrics C:

$$C_M = 2^{(2H-1)} - 1 \quad (8)$$

Obviously, the corresponding C_M value of random wandering sequence is 0, it's irrelevant; the corresponding C_M value of anti-persistent sequence takes the range of $0.5 \le H < 0.5$, it's negative correlated; the corresponding C_M value of persistent sequence takes the range of $0.5 \le H \le 1$, it's positive correlated.

1.2 Average Conversion Cycle Period – V Statistics

The so-called Average Conversion Cycle Period is refers to time sequence contains length of "long-term memory" characteristic. That is the current information will affect the average duration time in the future. Beyond this average conversion cycle length, the long-term memory of sequence is disappeared. Therefore, the object of study must be according to the data within this average conversion cycle length.

According to the research of Peters (1994), we can by the means of V statistics to estimate the average conversion cycle length of the sequence, it's calculation formula as follow:

$$V = (R/S)_N / \sqrt{N} \quad (9)$$

Since:

$$R/S = C^* N^H \quad (10)$$

Therefore:

$$V(R/S)_N = C^* N^{H-0.5} \quad (11)$$

From the result of this formula, if the sequence is independent random processes, which $H = 0.5$ is then $V = C$, V associated with N shows horizontal lines; if the sequence is persistent, which $0.5 \le H \le 1$, then V associated with N is upward-sloping; If the sequence is anti-persistent which $0 \le H < 0.5$, then V associated with N is downward-sloping. Thus, in the trend of V statistics from upwards changes to downwards or remain the same point, which is the critical point of the disappearance of the long-term memory progress. The corresponding N of this critical point also is the average conversion cycle length of the sequence.

2. EMPIRICAL ANALYSIS

I. In a random selection of a listed company of communications and electronics industry, "Shenzhen Kaifa Technology" Co., Ltd. (Symbol: 000021), from 2002/11/07—2010/07/16, 1800 daily closing prices data to perform empirical research. The remaining selected 14 companies follow the same method to perform empirical analysis.

1) Draw the daily closing prices curve and daily yield curve of "Shenzhen Kaifa Technology", as Figure 1 and Figure 2 shown.

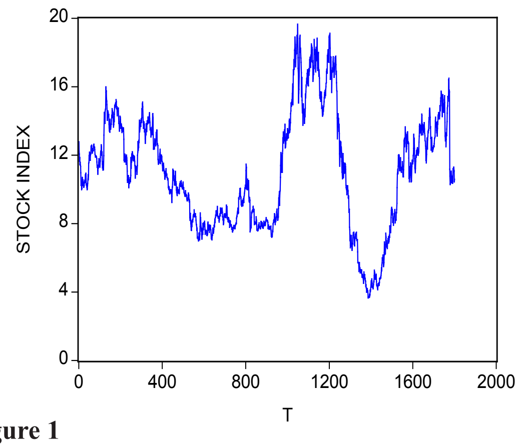

Figure 1
Daily Closing Prices Curve (x-axis is Time, y-axis is Daily Closing Prices of the Stock)

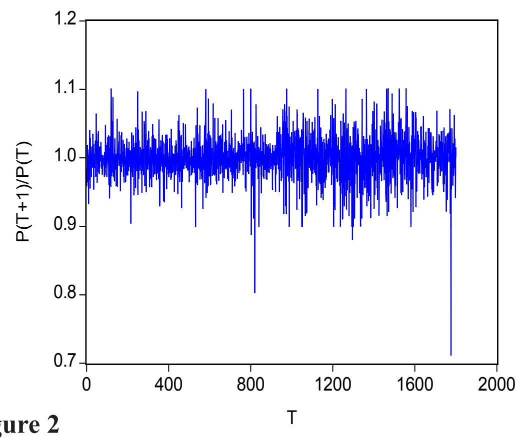

Figure 2
Daily Yield Curve (x-axis is Time, y-axis is Daily Yield of the Stock)

2) Perform normality test on the sample sequence. From the test result, the daily yield distribution of "Shenzhen Kaifa Technology" company stock index different from the normal distribution significantly (Figure 3). The daily yield sequence skewness and kurtosis difference of "Shenzhen Kaifa Technology" company stock index significantly greater than the value of normal distribution, and J-B statistics exceeds the critical value significantly. It can clearly be seen that the daily yield sequence distribution of "Shenzhen Kaifa Technology" company stock index is non-normality, which represents characteristic of peak, fat tail, right-skewed. These distribution characteristics are traces that indicate the index daily yield sequence is a nonlinear dynamic system.

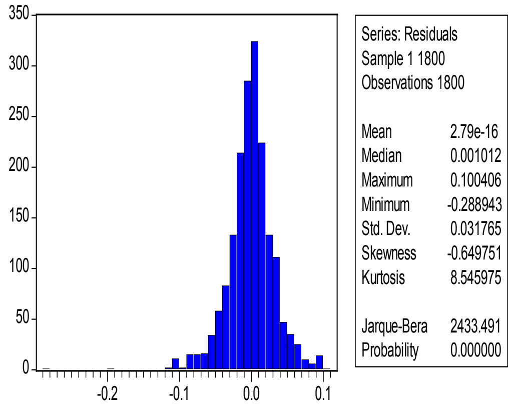

Figure 3
Statistical Description Graph of Daily Yield

3) Using R/S analysis method to obtain the value of Log(*R/S*) and Log(*n*). Draw the *R/S* analysis diagram of daily yield (figure 4). Also, using least squares method to utilize Log(*R/S*) on Log(*n*) to find the regression, and Hurst = 0.616031 is obtained (Table1).

Table 1
Least Squares Method Calculating Hurst Exponent

Variable	Coefficient	Std. error	t-statistic	Prob.
C	-0.183651	0.017314	-10.60691	0.0000
LOG *N*	0.616031	0.009804	61.81411	0.0000

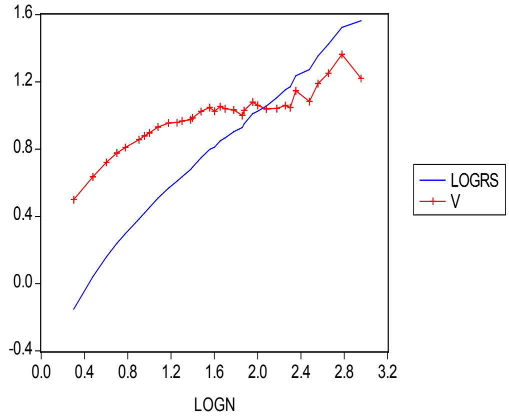

Figure 4
R/S Analysis Diagram (x-axis is Log(n), y-axis is Log(R/S) and V Statistic)

4) Draw *V* statistic diagram of daily yield (figure 4), significant turning point at Log(*n*) = 2.468 is found. Calculate *n* = 293.7650, so that average conversion cycle period is 294 days approximately.

5) Perform significance testing on Hurst exponent, using least squares method to utilize Log(*E*(*R/S*)) on Log(*n*) to find the regression, and *E*(*H*) = 0.516165 is obtained (Table 2). And |S| > 2.5758 is calculated, then it can be considered as the sequence significantly deviate from random wandering. The *R/S* analysis result is significant, therefore the null hypothesis of random wandering is rejected. Sequence is a persistent time sequence that exists long-term trend.

Table 2
Least Squares Method Calculating the Expected Value of Hurst Exponent

Variable	Coefficient	Std. error	t-statistic	Prob.
C	-0.218388	0.024533	-8.901635	0.0000
LOG *N*	0.516165	0.013892	45.35992	0.0000

Sample yield statistics of the 15 listed companies as Table 3:

Table 3
Basic Tables of Sample Yield Sequence

Company name	Mean	Standard deviation	Skewness	Kurtosis	J-B statistic
Shenzhen Kaifa Technology	2.79e-16	0.031765	-0.649751	8.545975	2433.491
ZTE Corporation	1.00e-16	0.030324	-1.836751	23.23558	31722.98
China Unicom	-1.07e-16	0.025455	0.291227	6.282131	833.3729
Fiberhome Telecommunication	-7.39e-17	0.034356	-1.354841	18.92808	19578.46
Wuhan Yangtze Communication	-6.60e-17	0.034991	-0.931206	12.18758	6591.022
Founder Technology	7.89e-17	0.033431	-2.410241	35.70953	81986.26
China National Software & Service	-4.27e-18	0.033836	-0.527481	11.00308	4887.173
Jiangsu Zhongtian Technologies	1.71e-16	0.032301	-0.420203	5.499419	521.5034
Greatwall Information Industry	2.03e-17	0.035731	-0.133910	9.490172	3164.554
China Greatwall Computer	3.17e-16	0.033736	-2.173410	32.84016	68199.77
Shanghai Baosight Software	3.97e-17	0.030908	-0.044600	8.203103	2031.018
NARI Technology Development	2.34e-16	0.034358	-3.458480	42.29999	164365.0
Aerospace Communications Holdings	5.02e-17	0.036902	-0.094681	3.873746	59.94676
Datang Telecom Technology	3.30e-16	0.033713	0.076860	3.602841	29.02849
Daheng New Epoch Technology	3.36e-16	0.036571	-1.072380	11.58165	5868.351

Data Statistics of 15 listed companies as Table 4:

Table 4
Companies Statistics Data

Company name	Hurst exponent	Expected value of Hurst exponent	Significant of Hurst exponent	Average conversion cycle period	Correlation	The fractal dimension of the probability space
Shenzhen Kaifa Technology	0.616031	0.516165	Significant	294	0.174512	1.623295
ZTE Corporation	0.611111	0.516165	Significant	300	0.166529	1.636364
China Unicom	0.606031	0.516165	Significant	397	0.158343	1.650081
Fiberhome Telecommunication	0.562715	0.516165	Significant	360	0.090833	1.777099
Wuhan Yangtze Communication	0.605035	0.516165	Significant	377	0.156744	1.652797
Founder Technology	0.626774	0.516165	Significant	225	0.192135	1.595471
China National Software & Service	0.622214	0.516165	Significant	300	0.184623	1.607164
Jiangsu Zhongtian Technologies	0.608418	0.516165	Significant	230	0.162182	1.643607
Greatwall Information Industry	0.631049	0.516165	Significant	360	0.199221	1.584663
China Greatwall Computer	0.622995	0.516165	Significant	410	0.185906	1.605149
Shanghai Baosight Software	0.607135	0.516165	Significant	352	0.160117	1.64708
NARI Technology Development	0.605281	0.516165	Significant	300	0.157139	1.652125
Aerospace Communications Holdings	0.623353	0.516165	Significant	450	0.186495	1.604227
Datang Telecom Technology	0.641063	0.516165	Significant	226	0.215985	1.559909
Daheng New Epoch Technology	0.591533	0.516165	Significant	200	0.135294	1.690523

CONCLUSION

This paper using *R/S* fractal analysis method to analyze the daily yield of Shanghai Composite Index and concluded that:

1. Stock index of communication and electronics industry in the china securities market exists average conversion cycle period, in which the average conversion cycle of grand period is around 400days and the average conversion cycle of small period is around 200days. That is, the current prices of these stocks will affect within the following time of around 400, 200days, and the stock prices after 400, 200days and the current prices are mutually independent.

2. Hurst exponent proved that the stock prices of communication and electronics industry in the china securities market has fractal structure and persistent characteristic. The Hurst exponent of communication and electronics industry in the china securities market is greater than 0.5 significantly. The higher H value shows that the stocks of communication and electronics industry in the china securities market have an obvious fractal structure and a strong persistence. Between Those observed values are not independent to each other, the previous value can affect the next value.

3. The probability distribution of the yield of communication and electronics industry in the china securities market has a biased random wandering process, with a peak and fat tail features. In addition, it does not follow the standard normal distribution, however it also exists signal information.

4. Due to the stock of the yield does not represent random wandering process, Hurst exponent measures varying degree of time sequences, the lower the H value, the more the noise in the system; High H value which shows less noise, a strong persistent trend, of course the smaller the risks. Therefore, using Hurst exponent can measure the risk of the stocks more accurately.

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