

Predictability of Common Stock Prices in the Korean Stock Market

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I. INTRODUCTION

In the past years most empirical studies dealing with the predictability of common stock prices and the random walk hypothesis have been performed with U.S. data ⁽³⁾ ⁽⁴⁾. Research on United States markets has largely supported the random walk hypothesis that there is not much serial dependence in stock price changes and that is not sufficient to provide prediction rules for profitable investment. The past history of a common stock price changes has no memory that the past cannot be used to predict the future stockprice.

This paper is a part of a series of studies on various aspects of the behavior of share prices in the Korean Stock Market and presents the serial correlation test analysis and runs test analysis of the predictability of common stock prices and the random walk hypothesis in the Korean Stock Market. The present work is a companion to our recent studies on filter rules and profits from Stock Market Trading ⁽⁶⁾ and a frequency analysis and predictability of common stock prices ⁽⁵⁾. It is our hope that the serial correlation analysis and runs test analysis can detect the dependence in price changes in the time series data. That the Korean Stock Market is relatively new, and smaller, and less developed than the U.S. market lends additional interest to our study.

II. THE KOREAN STOCK MARKET

In the past decade the Korean stock markets have made remarkable progress in their development and have significantly contributed to mobilization of domestic savings for financing business investment. In order to understand the functioning of the Korean stock markets and the behavior of stock price movements as well as the possible policy

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implications for the future development of the markets, it is essential to understand the present condition of the Korean Stock Market.

Securities markets in Korea first developed in early 1950, the securities traded in the market at the time were mainly government bonds, which were issued to finance Korea's war-torn economy. The Korean Stock Exchange was first formally organized in 1956, the only twelve corporations were listed at the exchange. Until the late 1960's and the part of 1970, the Korean stock markets remained primitive and highly speculative. Since the early 1970's the Korean stock markets have made remarkable progress in their development. There are many factors that have contributed to this development, but the two most important are: (1) an increase in personal savings, which resulted from recent economic progress, and, (2) government economic and financial policies that have promoted the development of the stock markets.

In the twenty years since the Korean War the Korean economy has attained rapid economic growth through the four five-year economic development plans started in 1962, which produced a high growth rate during this period. During the process of this development there was great need for a large amount of capital to import capital goods and to invest in modern technology. The financing came from domestic as well as foreign savings. Korea, as a developing country, at this stage had and still has little accumulated capital and no developed capital markets through which to channel private funds into long-term corporate funds. Without the efficient functioning of such capital markets in the future, private saving will be invested in real estate, and private enterprise will be dependent to an excessive degree on foreign loans.

At the present time the organized exchanges in Korea are located at two main places, one in Seoul and another in Pusan. By using corporate stocks and bonds (as shown in Table I), corporate funds raised through the securities markets increased in 9,247 billion Won in 1968 to 1,138 billion Won in 1980. The total number of listed common stocks has increased from 34 in 1968 to 352 in 1980. The total number of shares of listed common stocks has increased from 115 million shares to 3,395 billion shares in 1980. The total market value of listed common stock increased from 64 billion Won to 2,791 billion Won. And the composite index of 35 common stocks, which is similar to the Dow Jones Index in the U.S., increased from 35 in 1972 to 135 in 1980.

This is all factual evidence that the Korean Stock Markets have made a significant

Growth of The Korean Stock Markets

Year	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	1980
Total Corporate Funds Raised in Securities Markets (Stocks & Bonds) (Billion Won)	9,247	8,356	7,151	2,940	24,741	54,548	74,287	156,255	262,226	362,453	653	841	1,138
Total number of listed Corporations	34	42	48	50	66	104	128	189	274	323	356	355	352
Total number of shares of listed common stocks (Billion Won)	.115	.141	.159	.170	.210	.305	.488	.825	1.582	2.117	2.959	3.395	
Aggregate Market Value (Billion Won)	64	87	98	109	246	426	533	916	1,436	2,351	2,892	2,791	
Sales Volume (Million Shares)	76.5	98.4	79.2	50.5	84.7	130.06	157.4	310.5	591.8	1,271.5	1,386.5	1,560.6	1,645.3
Sales Volume (Million Won)	19,984	42,031	42,874	34,376	71,050	160,652	179,428	333,906	628,677	1,375,268	1,741,124	1,327,813	1,134,019
Composit Index of 35 Common Stocks	—	—	—	—	35.3	76.3	101.9	100.	134.1	139.4	166.0	189.0	135.2

Source: Korea Stock Exchange

contribution to the mobilization of domestic savings into corporate investment. However, further improvement of the stock market and promotion of economic efficiency in the market will require more evidence from empirical studies that such improvement would be vital to a healthy Korean economy.

III. PREDICTABILITY OF COMMON STOCK PRICES AND THE RANDOM WALK MODEL

The model used for testing the predictability of common stock prices in our study is the random walk model, which may be described as follows: Suppose the closing price of a stock on a given day is P_0 . Then, the succeeding daily closing prices of the stock can be shown with a sequence $(P_0, P_1, \dots, P_t, P_{t+1}, \dots)$. For the sequence, the relationship between successive stock prices may be expressed as

$$(1) p_{t+1} = p_t(1+i_t) \quad (t=0, 1, \dots) \text{ where } i_t \text{ is the daily rate of return of the stock.}$$

Taking natural logarithms on both sides of equation (1), we obtain

$$(2) \log p_{t+1} = \log p_t + \log(1+i_t) \\ = \log p_t + r_t \quad (t=0, 1, \dots),$$

where $r_t = \log(1+i_t)$ is the nominal continuous yield.*

Let $\log p_{t+1}$ be a random variable. In equation (2) if we assume that the initial stock price $p_0 = p_0$, then equation (2) is equivalent to

$$(3) p_{t+1} = p_0 + r_0 + r_1 + \dots + r_t.$$

The distribution of $\log p_{t+1}$ may be explained by describing the distributions of r_0, \dots, r_t in equation (3).

We may define a random walk with the stochastic process (equation (2)) by stating that the random variables r_0, r_1, \dots are mutually independent and identically distributed, which means that $f(r_{t+1}/r_t) = f(r_{t+1}) - f(r_t)$, where $f(\cdot)$ is a density function.

Hence, the random walk hypothesis in the stock price behavior can be stated as follows:

- a) Successive yields are independent, and
- b) Successive yields are identically distributed random variables.

Therefore, past prices cannot be used to predict any meaningful future pattern of the

* If we express equation (1) with the continuous rate as $p_{t+1} = p_t e^{i_t}$ and take natural logarithms on both sides, we arrive at the same result as equation (2).

stock price movements. On the other hand, the technical analyst tries to devise trading rules based on past price movements to obtain greater returns than the market.

IV. THE METHODS, THE DATA, AND THE RESULTS

The statistical methods used for testing the predictability of common stock prices and the random walk hypothesis in this study are the serial correlation analysis and runs test analysis.

The serial correlation is a method for testing the independence of successive price changes. The serial correlation coefficient (ρ_t) is defined as a measuer of the relationship between the value of a random variable in time $t+1$ and its value at some earlier periods. This correlation coefficient maybe defined as follows:

$$\rho_t = \frac{\text{covariance}(r_t, r_{t+1})}{\text{variance}(r_t)}$$

where r_{t+1} is the change in log price of a given security from the end of day t to the end of day $t+1$.

In our study, one of the hypothesis in the random walk model is that the successive yields are statistically independent. One of the random walk tests is the independency test which uses the serial correlation analysis on the daily yields. The serial correlation coefficient may be estimated by computing the least-square regression as shown below :

$$(4) r_{t+1} = A + Br_t + \xi$$

where r_{t+1} is continuous rate of return; B is the regression coefficient.

B in (4) can be used to measure the relationship between successive daily yields of the stock.

The data used in the serial correlation analysis was daily closing price for common stocks of 20 companies listed on the Korean Stock Exchange. The time period considered was the daily closing prices for 20 companies from January 1, 1977 to July 31, 1978. The total daily closing prices for each of 20 companies ranged from 302 to 465,

Using the data, the sample serial correlation coefficient on daily changes in log price have been computed for each stock for lag $\tau=1, 3$ and 5 days. The results for lag $\tau=1$ is shown in Table II and lag $\tau=3$ and 5 days are shown in Table III. Our findings, as expressed in Table II and III, on the serial correlation analysis show that, on an average, the serial correlation coefficients are small. In Table II, the results of our significance tests

on the null hypothesis show that serial correlation coefficient was equal to zero at 5% and 1% levels. At both the 5% and 1% significance levels, the majority of the coefficient are not significant. Only 7 out of 20 at the 5% level and 5 out of 20 at the 1% level were rejected with the findings in Table II. In Summary, the evidence produced by the serial correlations model seems to indicate that dependence in successive price changes is practically non-existent. Therefore past prices cannot be used to predict any meaningful future pattern of the stock price movements.

The second statistical method used for testing the predictability of common stock prices and random walk hypothesis in this study is the runs test analysis. The runs test is a method for testing the randomness of successive price changes of the sign. Each

TABLE II Summary of Serial Correlation Coefficients
for lag $\tau=1$

Stock	Correlation Coefficients	Significance	
		5%	1%
Cheil Wool Textile	0.11083	NS	NS
Chinyang Chemical	-0.01804	NS	NS
Daedong Industrial	-0.04311	NS	NS
Dong-A Pharmaceutical	-0.29386	S	S
Gold Star	0.00245	NS	NS
Hanil Synthetic	-0.00015	NS	NS
Han-Kook Glass	0.15424	S	S
Hankuk Paper	-0.14960	S	S
Hyundai Motor	0.01113	NS	NS
Ilsin Steel	0.04766	NS	NS
Korean Tungsten Mining	-0.00138	NS	NS
Kyung Bang	0.11291	NS	NS
Lucky	0.01389	NS	NS
Oriental Brewery	0.08622	NS	NS
Pusan Pipe	0.01386	NS	NS
Samyang	-0.46301	S	S
Seoul Miwon	-0.03217	NS	NS
Ssang Yong Cement	-0.09726	S	NS
Taehan Electric Wire	-0.00576	NS	NS
Yuhan	0.12533	S	S

NS: Not significant

S: Significant

TABLE III Summary of Serial Correlation Coefficients
for lag $\tau=3$ and 5

Stock	Correlation Coefficients	
	$\tau=3$	$\tau=5$
Cheil Wool Textile	-0.01569	-0.02105
Chinyang Chemical	-0.04710	-0.04420
Daedong Industrial	0.01182	0.03755
Dong-A Pharmaceutical	-0.1961	-0.00539
Gold Star	0.03278	-0.05934
Hanil Synthetic	-0.01346	-0.01502
Han-Kook Glass	0.00452	0.01998
Hankuk Paper	0.03304	0.07437
Hyundai Motor	0.04413	0.05902
Ilsin Steel	-0.01330	0.00680
Korean Tungsten Mining	-0.07406	0.00192
Kyung Bang	0.04207	0.05593
Lucky	-0.07730	-0.01896
Oriental Brewery	-0.00113	-0.04064
Pusan Pipe	-0.04248	-0.07388
Sam Yang	0.08561	0.01068
Seoul Miwon	-0.00061	0.03160
Ssang Yong Cement	0.07591	0.00164
Taehan Electric Wire	0.01913	0.02323
Yuhan	0.07567	-0.03246

successive price change may be assigned three directions: +1 for positive, -1 for negative, and 0 for no change. The number of runs is defined as the number of times the sign changes. The sampling distribution of the total number of runs is approximately normal

$$N(N+2) - \sum_{i=1}^3 n_i \tag{9}$$

with mean $E(R) = \frac{N(N+2) - \sum_{i=1}^3 n_i}{N}$ and standard deviation

$$\sigma_R = \left(\frac{\sum_{i=1}^3 n_i^2 \sum_{i=1}^3 n_i^2 + N(N+1) - 2N \sum_{i=1}^3 n_i^3 - N^3}{N^2(N-1)} \right)^{\frac{1}{2}}$$

where n_i 's represent the numbers of price changes of three different directions and N represents the total number of price changes

$N = \sum_{i=1}^3 n_i$. Hence the runs test can be performed with the standard normal random variable

$$Z = \frac{(R + \frac{1}{2}) - E(R)}{\sigma_R}$$

where R is the total number of actual runs.

Our findings on the runs test analysis show that the actual total number of runs for daily changes is significantly less than the expected total number of runs. Table IV presents a summary of these findings. Our test of the null hypothesis significantly reveals that, at both the 5% and 1% significance levels, 16 out of the 20 companies were rejected. The Z values for every 20 companies out of the 20 studies are negative values.

The summary of serial correlation coefficients from our previous studies is shown in Table II & III. It shows that the serial correlation analysis supports the random walk hypothesis but these findings conflict with the results of our runs test analysis.

Table IV Summary of Runs Analysis: Total Number of Runs

Stock	Actual	Expected	Z
Cheil Wool Textile	210	283.17	-7.51
Chinyang Chemical	250	294.20	-4.42
Daedong Industrial	248	265.00	-1.62
Dong-A Pharmaceutical	233	298.06	-6.50
Gold Star	226	268.16	-4.10
Hanil Synthetic	220	297.91	-7.73
Han-Kook Glass	181	259.27	-8.13
Hankuk Paper	126	199.03	-7.75
Hyundai Motor	260	268.56	-0.80
Ilsin Steel	240	282.36	-4.20
Korean Tungsten Mining	261	299.65	-3.79
Kyung Bang	53	87.60	-6.40
Lucky	181	275.12	-9.64
Oriental Brewery	215	290.99	-7.70
Pusan Pipe	232	278.78	-4.62
Sam Yang	192	253.36	-6.63
Seoul Miwon	259	296.67	-3.71
Ssang Yong Cement	254	257.83	-1.35
Taehan Electric Wire	250	263.53	-1.28
Yuhan	197	292.78	-9.63

V. Summary and Conclusions

This paper is a part of a series of studies on various aspects of the behavior of share prices in the Korean Stock Market and presents an empirical test of the predictability of

common stock prices and random walk hypothesis. The methods used for testing are the serial correlation analysis and the runs test analysis, using price data derived from twenty major Korean corporations.

Interestingly enough, the results of the serial correlations statistics reject the predictability of common stock prices. Past prices cannot be used to predict any meaningful future patterns of the stock price movements.

On the other hand our runs test analysis supports the contention that successive price changes are dependent. Past prices can be used to predict future patterns of stock price movement. The technical analyst tries to devise trading rules based on past price movements to obtain greater returns than the market. The results of the runs test analysis are consistent with the results from our recent studies on filter rules and profits from stock market trading and a frequency analysis and predictability of common stock price in the Korean Stock Market.

The results of our study provide important implications for investors in the Korean Stock Market and for the formulation of economic and financial policies designed to promote further economic growth in Korea as a developing country.

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