

Stock Price Behavior In A Less Developed Market: Evidence From Sri Lanka

Tanweer Hasan, (E-mail: thasan@roosevelt.edu), Roosevelt University
Lalith P. Samarakoon; (E-mail: samara@pan.lk), University of Sri Jayewardenepura, Sri Lanka
Shahriar Hasan; (E-mail: shasan@sagcorp.com), SAG Corporation, Falls Church, VA

Abstract

This study analyzes price behavior of stocks listed in the Colombo Stock Exchange (CSE) in Sri Lanka using daily closing prices of two indices, the All Share Price Index and the Sensitive Price Index, over the period January 1985 through December 1995. Results documented in the current study clearly indicate that the CSE does not conform to the weak-form of the Efficient Market Hypothesis.

I. Introduction

Research on the behavior of stock prices is receiving continued attention from academicians and practitioners alike. The first major work in this area was done by Fama (1965) on U.S. stock prices. Since then, a number of studies were undertaken focussing both on developed markets [Fama and Blume (1966), Praetz (1969), Dryden (1970), Kemp and Reid (1971) and Solnik (1973) among others] and underdeveloped/emerging markets [Jennergren and Korsvold (1975), Ang and Pohlman (1978), Hong (1978), D'Ambrosio (1980), Barnes (1986), Bello (1990), and Urrutia (1995) among others].

Much of the attraction of developing-economy equity markets derives from the outstanding return performances registered by many of these markets in recent years. A variety of factors are responsible for the tremendous growth in developing-economy/emerging mar-

kets. Trends toward market-oriented policies, fundamental structural changes and basic economic reforms have contributed to the increased investor demand for developing-economy equity shares.

This paper investigates the behavior and degree of efficiency of stock prices listed in the Colombo Stock Exchange (CSE), Sri Lanka, over the period January 1985 through December 1995. Although the origins of the Sri Lankan equities market dates back to 1896 it did not attract world wide attention up until mid 1980's. In fact, in 1990, the Colombo Stock Exchange (CSE) was the second best performer in the world after Venezuela. Liberal economic policies that include reduction of import restrictions and price controls, aggressive privatization programs, abolishment of a 100 percent tax on foreign investment in Sri Lankan equities, decision to allow foreign investors to remit their proceeds from sale of securities out of Sri Lanka etc. have dramatically affected the stock market. However, even with the recent surge in trading vol-

Readers with comments or questions are encouraged to contact the authors via e-mail.

ume and market capitalization, the CSE is still a small and "thinly" traded market compared to the U.S. and other developed markets. Given this background, it would be interesting to investigate the degree of efficiency in this market.

The paper is organized as follows. The second section provides a brief overview of the market microstructure of the Colombo Stock Exchange (CSE). The next section discusses the data and methodology used. The results are reported in the fourth and fifth sections that discuss the applicability of the findings of this study and provides concluding remarks.

II. A Brief Overview of Sri Lankan Market Microstructure

Although share trading in Sri Lanka started in 1896 organized share trading began only in 1984 with the formation of the Colombo Stock Exchange. There are 226 companies listed on the CSE as of December 1995. These companies are divided in 14 broad industry classes as (1) Banks, Finance & Insurance, (2) Beverage, Food & Tobacco, (3) Chemicals & Pharmaceuticals, (4) Construction & Engineering, (5) Footwear & Textiles, (6) Hotels & Travels, (7) Investment Trusts, (8) Land & Property, (9) Manufacturing, (10) Motors, (11) Oil Palms, (12) Stores & Supplies, (13) Services, and (14) Trading. Banks, Finance & Insurance is the largest sector which accounted for 38% of the market capitalization in 1995.

The members of the CSE are stock brokers, and presently, 15 stock brokerage houses are represented in the trading floor. Brokers are only allowed to act as intermediaries to a transaction, and therefore, can not trade on their own account. The centralized trading floor is open Monday to Friday between 9:00 am to 12:00 noon. Currently trading is done through an "open outcry" system. However, the CSE is switching to an automated "screen-based" trading in a couple of years. There are no "specialists" or market makers in the CSE. As a result, every transaction require a buyer and a seller.

Short-selling of securities is not permitted. However, investors can engage in margin trading.

The settlement and registration procedure is fully automated. An investor has to open an account with the Central Depository System (CDS) which was introduced in 1992. The settlement period is t+5 for buy and t+7 for sell transactions. As soon as trade details are entered, transfer of share ownership is automatically done in the CDS. Transaction costs are the commission charged by the brokers. According to the present fee structure, transactions up to Rs. 1 million are charged a commission of 1.45% while transactions over Rs. 1 million are charged only 1.2% of the value traded.

Orders must be placed in increments of 100 shares, and orders less than that are treated as odd lot transactions. Investors can place either a market or a limit order. Limit orders may be either day orders or orders that are valid for more than a day. However, Good-till-Cancelled orders are valid for 5 market days only. The minimum price change is quarter of a rupee.

Some basic data on the CSE are given in Table 1. The market activity increased after 1990 due to a number of policy changes. A 100% transfer tax which the foreigners had to pay on share purchases was abolished in June 1990. Capital gains tax which ranged from 12.5% to 40%, varying with time period for which the security was held, was replaced by a flat rate of 20% on transactions carried out within one year of purchase effective November 29, 1990. As a result of these policy changes, foreign portfolio investments started to play an important role in the Sri Lankan market. Furthermore, the capital gain tax was totally eliminated in 1992, and consequently, the turnover increased three-fold in 1993. The foreign purchases as a percent of total turnover has increased steadily to 48% in 1995 while foreign sales have increased to 49%. Steady flow of international funds and increased interest from domestic investors are evident in the CSE. The total number of investors, both local and foreign,

Table 1
Basic Data on the Colombo Stock Exchange for the period 1985-1995.

	1985	1990	1991	1992	1993	1994	1995
Annual Turnover (Rs. Mill.)	79	165	5,542	6,159	22,124	34,505	11,249
Foreign Purchases as a % of Turnover (Rs. Mill.)	N/A*	N/A*	N/A*	30	42	42	48
Foreign Sales as a % of Turnover (Rs. Mill.)	N/A*	N/A*	N/A*	17	27	38	49
Average Daily Turnover (Rs. Mill.)	N/A*	7	23	26	92	148	47
No. of Listed Companies	110	175	178	190	201	215	226
Market Capitalization (Rs. Bill.)	N/A*	37	82	66	124	143	107
Nominal GDP (Rs. Bill.)	N/A*	290	337	387	453	523	598
Growth in GDP	N/A*	6.2	4.6	4.3	6.9	5.6	5.5
Market Capitalization as a % of GDP	N/A*	13	24	17	27	27	18
No. of Client Accounts (000's)	N/A*	N/A*	14	59	101	174	186
Rupees per US Dollar (Year End)	N/A*	40.24	42.58	46.00	49.56	49.98	54.05

* Not Available

Source: *Colombo Securities Exchange Facts and Figures*, various issues.

have increased from 14,000 in 1991 to 186,000 in 1995. The market capitalization increased from Rs. 37 billion (less than US \$1 billion) in 1991 to Rs. 143 billion (about US \$3 billion) by 1994. However, the decline in capitalization and turnover in 1995 is due to bearish market conditions.

III. Data & Methodology

III A. Data

Two indices are quoted by the CSE: the All Share Price Index (ASPI) and the Sensitive Price Index (SPI). Both indices are value-weighted and do not include dividends. The ASPI represents the broadest measure of the market and consists of all the stocks which numbered 110 in 1985, and 226 in 1995. The SPI measures the price levels of 25 blue-chip stocks. Daily closing index values of both the indices are used in this study over the period January 1985 through December 1995. Data was obtained from the Colombo Stock Exchange. Although the preferred data set for such a study are series of prices of

individual stocks listed in the CSE, unavailability of such time-series data prompted the use of the index values as a proxy.

III B. Methodology

(1) Tests of Independence

a. Serial Correlation Tests:

Serial correlations are run to check for the possibility of successive price change dependencies between a variable in time t and its value τ periods later. To apply this test, the daily All Share Price Index values are transformed to their log differences such that:

$$x_t = \ln P_t - \ln P_{t-1} \quad (1)$$

where,

x_t is the variable to be measured,

$\ln P_t$ is the natural logarithm of the index value at time period t

$\ln P_{t-1}$ is the natural logarithm of the index

value at time period t-1

The relationship between the temporal log changes in index values, x_t , given by equation (1) may be expressed in the form of an autoregressive scheme:

$$x_t = \rho_k x_{t-k} + u_t \quad (2)$$

where ρ_k is the correlation coefficient of changes in index value at lag k. The error term, u_t , is random with $E(u) = 0$. For the present study lag k corresponds to a period of one day. The hypotheses to be tested are as follows:

$H_0 : \rho_k = 0$, i.e., the log changes in index value at lag k are not serially correlated.

$H_A : \rho_k \neq 0$, i.e., the log changes in index value at lag k are serially correlated. The testable form

of equation (2) as applied to our data is:

$$x_t = r_k x_{t-k} + a_t \text{ for } t = 1, 2, \dots, 2606. \quad (3)$$

where x_t and x_{t-k} are the computed log index value changes at the end of periods t and t-k respectively, and r_k is the sample correlation of the log index value changes at lag k.

b. Runs test

Runs test gives alternative measures of correlation. This test is non-parametric and independent of the normality and constant variance of the data. A run is defined as a series of price changes of the same sign. The expected number of runs, $E(M)$, is computed as:

$$E(M) = \frac{[N(N+1) - \sum_{i=1}^3 n_i^2]}{N} \quad (4)$$

where, n_i = number of percentage change for each sign, and N = total number of percentage price changes.

The standard error of runs, $\sigma(M)$, is computed as

follows:

The standard normal Z-statistic is used to conduct runs test and is computed as:

$$\sigma(M) = \sqrt{\frac{\sum_{i=1}^3 n_i^2 [n_i^2 + N(N+1)] - 2N \sum_{i=1}^3 n_i S_i^3 - N^3}{N^2(N-1)}} \quad (5)$$

where, M is actual number of runs and $1/2$ is the correction factor for continuity adjustment in which the sign of continuity adjustment is plus if $M \leq E(M)$ and minus otherwise.

$$Z = \frac{[M - E(M) \pm 1/2]}{\sigma(M)} \quad (6)$$

(2) Tests of Distributional Assumptions

(a) Goodness-of-Fit tests

Kolmogorov-Smirnov test is used to test the goodness-of-fit of the distribution. The focus here is on two cumulative distribution functions: a hypothesized cumulative distribution $F_0(x)$ and the observed cumulative distribution $F(x)$. Suppose a random sample is drawn from some unknown distribution function $F(x)$. Then the next step is to determine whether it can be concluded that $F(x) = F_0(x)$ for all x. If $F(x) = F_0(x)$, a close agreement between $F_0(x)$ and $S(x)$, the sample empirical distribution function, can be expected. The objective of the Kolmogorov-Smirnov goodness-of-fit test is to determine whether the lack of agreement between $F_0(x)$ and $S(x)$ is sufficient to cast doubt on the null hypothesis that $F(x) = F_0(x)$.

If $F_0(x)$ is the normal distribution function (normal cumulative probability), then the null and the corresponding alternative hypothesis can be stated as follows:

H₀: F(x) = F₀(x) for all values of x.

H_A: F(x) ≠ F₀(x) for at least one value of x.

In the present study, S(x) refers to the cumulative probability function of the log changes in index value. Specifically,

$$S(x) = \frac{n'}{N'} \tag{7}$$

where, n' is the number of sample observations less than or equal to x and N' is the sample size.

The test statistic, based on the largest absolute deviation between F₀(x) and S(x), is calculated as follows:

$$D = \text{Max} |F_0(x) - S(x)| \tag{8}$$

(b) Unit Root Tests

Unit root tests are traditionally applied to check stationarity of the data. If the null hypothesis of a unit root in the stock index series is not rejected it implies that the consecutive changes in the stock index values over the period are random and consequently, the stock market is weak-form efficient.

Suppose we want to test the hypothesis that a non-seasonal variable x_t, which is log changes in index values for the present study, is non-stationary, that is x_t is generated by

$$x_t = \rho x_{t-1} + \varepsilon_t \tag{9}$$

where x_t represents a series of identically distributed stationary variables with zero means. A straightforward procedure would seem to be to test for ρ = 1 in the autoregressive equation

$$x_t = \rho x_{t-1} + \varepsilon_t \tag{10}$$

when ρ = 1, this process is non-stationary. But if |ρ| < 1, then the process generating x is stationary. It is tempting to estimate this equation

by ordinary least squares, and to test the hypothesis that ρ = 1 by a student t-test. However, the ordinary least squares estimate of ρ may be substantially biased downward in an autoregressive equation.

A simple method of testing the stationarity of x_t has been proposed by Dickey-Fuller (1979), hereafter called the DF test. This test is based on the estimation of an equivalent regression equation to (9), that is

$$\Delta x_t = \delta x_{t-1} + \varepsilon_t \tag{11}$$

which can also be written as

$$x_t = (1 + \delta)x_{t-1} + \varepsilon_t \tag{12}$$

which is same as equation (10) with ρ = (1 + δ). So, if in equation (11) δ is negative, this implies that in equation (10) ρ is smaller than 1. The DF test consists of testing the negativity of δ in the ordinary least squares regression (11).

If in equation (10), ε_t is autocorrelated, then the OLS estimates of the coefficients as described above are not efficient. A simple solution, as advocated by Dickey and Fuller (1981), is to use lagged left-hand side variables as additional explanatory variables to approximate the autocorrelation. This test, called the Augmented Dickey-Fuller (ADF) test, is widely used in practice. The ADF equivalent of equation (10) is the following:

$$\Delta x_t = \alpha + \delta x_{t-1} + \sum \delta_i \Delta x_{t-i} + \varepsilon_t \tag{13}$$

The practical rule for establishing the number of lags for Δy_{t-i} is that it should be relatively small to save degrees of freedom, but large enough to allow for the existence of autocorrelation in ε_t.

IV. Empirical Results

A summary of the basic statistics of daily All Share Price Index and Sensitive Share Price Index returns in local currency is reported in Ta-

Table 2
Summary Statistics of the
Colombo Stock Market Daily Returns,
Local Currency: Jan. 1985 - Dec. 1995.

	All Share Price Index	Sensitive Price Index
Mean (%)	0.079	0.107
Standard deviation	0.010	0.016
Skewness	2.587	5.548
Kurtosis	38.321	136.800
Maximum return	0.169	0.356
Minimum return	-0.063	-0.185
Studentized range (a)	22.512	34.910
No. of observations	2606	2606

(a) The studentized range is calculated as:

$$\frac{\text{Maximum return} - \text{Minimum return}}{\text{Standard deviation of returns}}$$

ble 2. The returns exhibit significantly positive skewness and kurtosis. This implies two things - both the index return distributions are more flattened to the right and have a sharp peak at the center compared to the normal distribution. The large studentized ranges reported in the Table 2 further indicate that the return distributions depart from normality.

Serial correlation coefficients for lags 1 through 20 are presented in Table 3. Preponderance of positive signs in the reported coefficients is evident. The null hypothesis, that the log changes in index value is uncorrelated, is rejected in 7 out of 20 lags for the All Share Price Index return series and only 4 out of 20 lags for the Sensitive Price Index return series. The magnitude of the coefficients reported is consistent with the way the indices are constructed - coefficients for the Sensitive Price Index returns are consistently smaller in magnitude than those for the All Share Price Index returns. Both series, specifically the All Share Price Index return series, exhibit positive correlation for lags 1 through 5 with fairly large coefficients in each lag. The coefficient reported for the All Share Price Index returns in lag 1 is almost double

compared to that of the Sensitive Price Index returns. Actually this is quite large compared to the coefficients reported in any of the other studies, that uses indices, on developed or emerging/developing markets. However, the significant positive dependence for lags 1 through 5 does not necessarily imply availability of profitable trading schemes to traders. The CSE is a small market and despite the recent increases in turnover in the CSE, liquidity is still low. Even large blue-chip conglomerates do not trade on daily basis. Therefore, in such a "thinly" traded market, attempts to exploit any information about future returns contained in past return may simply not be worth the trouble.

Table 4 reports the results from the Runs Test. The Z statistic for both All Share Price Index and Sensitive Price Index returns indicate that the hypothesis of independence can be rejected at 1% significance level. Furthermore,

Table 3
Serial Correlation Coefficients of the
Colombo Stock Market Daily Returns,
Local Currency: Jan.1985 to Dec. 1995.

Lags	Coefficients All Share	Coefficients Sensitive
	Price Index	Price Index
1	0.464*	0.272
2	0.272	0.121
3	0.111*	0.010
4	0.128*	0.074*
5	0.092*	0.046*
6	0.010	-0.014
7	0.001	-0.024
8	0.022	-0.013
9	0.028	0.023
10	-0.001	-0.008
11	0.010	0.005
12	0.033	0.013
13	0.051*	0.014
14	0.033	0.009
15	0.014	-0.002
16	0.037	0.026
17	0.055	0.055*
18	0.022	0.026
19	-0.007	-0.014
20	0.018	0.012

* Coefficient is twice its computed standard error.

Table 4
Runs Test of the
Colombo Stock Market Daily Returns,
Local Currency: Jan. 1985 to Dec.1995.

	All Share Price Index	Sensitive Price
Number of observations	2606	2606
Actual number of runs	841	878
Expected number of runs	1325.83	1346.47
Standard error of runs	25.26	25.00
Z-statistic	-19.18*	-18.72*

* significant at 1% level.

the sign of the Z statistic for both indices is negative, indicating fewer actual runs than expected for a random series, which implies positive serial correlation between log index value changes and this is consistent with the results reported in Table 3.

Panel A and Panel B of Table 5 contain the Kolmogorov-Smirnov goodness-of-fit test statistic and results from the unit roots tests on the All Share Price Index and Sensitive Price Index returns respectively. The reported D-statistic clearly shows that neither of the return series

Table 5
Goodness-of-fit and Unit root tests of the Colombo Stock Market Daily Returns,
Local Currency: January 1985 to December 1995.

Panel A: All Share Price Index

Kolmogorov-Smirnov test

D-statistic	0.1365
Prob > D	<0.01

Unit root tests

	DF ^a	Q ^b	ADF ^c	Q ^d	LAG ^e
One unit root with trend	-30.85*	92.4	-4.77*	61.99	3
One unit root without trend	-30.83*	93.2	-4.79*	62.30	3

Panel B: Sensitive Price Index

Kolmogorov-Smirnov test

D-statistic	0.1629
Prob > D	<0.01

Unit root tests

	DF ^a	Q ^b	ADF ^c	Q ^d	LAG ^e
One unit root with trend	-38.64	73.32	-4.04*	47.00	3
One unit root without trend	-38.56	75.06	-4.11*	47.64	3

*significant at 1% level (Charemza and Deadman, 1993, appendix, table 3).

**significant at 10% level (Charemza and Deadman, 1993, appendix, table 3).

^astudent t-statistic from the Dickey-Fuller tests.

^b & ^dQ statistic, a measure of autocorrelation in regressions involving lagged dependent

variables, for the respective regressions.

^cstudent t-statistic from the Augmented Dickey-Fuller tests.

^ethe number of lags for the dependent variable included as regressors in the Augmented Dickey-Fuller tests.

follows normal distribution. This test formally confirms the initial observation about the distribution of both return series in Table 2. Also, the results from the unit root tests indicate that the presence of one unit root can be rejected for both return series which, in turn, suggests that the consecutive changes in stock index values (index return series) are not random.

V. Applicability of the Findings/Concluding Remarks

This study investigates the behavior of stock prices, using All Share Price Index and Sensitive Price Index as proxies, in the Sri Lankan stock market over the period January 1985 through December 1995. Results from the serial correlation tests, runs test, and unit root tests suggest that the consecutive changes in stock index values are not random. This does not necessarily imply that profitable trading schemes could have been developed to take advantage of this documented nonrandom nature of successive index value changes during the sample period. This is because, like most other emerging markets of the world, the Sri Lankan stock suffers from infrequent trading problem. Consequently, liquidity in the Sri Lankan market is very low.

VI. Suggestions for Future Research

Future research should address whether this non-random characteristics of stock index value changes in Sri Lanka can be explained by factors like infrequent trading, firm size etc. Also, more general and reliable inferences can be drawn when price series of individual stocks are used instead of indices. The data can be upgraded to see if the inflow of new data since 1995 caused any changes from the outcomes mentioned in this paper. The data here are value weighted indices. Price weight indices could also be used to compare the results. In general, the individual price data would be much more preferable compared to the indices. □

References

1. Ang, J. S., and R. A. Pohlman, 1978, A Note on the Price Behavior of Far Eastern Stocks, *Journal of International Business Studies*, pp.103-107.
2. Barnes, P., 1986, "Thin Trading and Stock Market Efficiency: The Case of Kuala Lumpur Stock Exchange, *Journal of Business and Accounting*, Vol. 13, pp. 609-617.
3. Bello, Z., 1990, Stock Price Behavior in An Underdeveloped Capital Market: Nigeria in Contrast to the U.S., *The Journal of Applied Business Research*, Vol. 6, pp. 71-87.
4. Charemza, W. W., and D. F. Deadman, *New Directions in Econometrics Practice*, Cambridge, Cambridge University Press, 1993.
5. Conrad, K. and D. J. Juttner, 1973, Recent Behavior of Stock Market Prices in Germany and the Random Walk Hypothesis, *Kyklos*, Vol. 26, pp. 576-599.
6. D'Ambrosio, C. A., 1980, "Random Walk and The Stock Exchange of Singapore, *Financial Review*, Vol. 15, pp. 1-12.
7. Daniel, W., 1978, *Applied Nonparametric Statistics*, Boston, Massachusetts:Houghton Mifflin Company.
8. Dickey, D. A., and W. A. Fuller, 1979, Distributions of the Estimators for Autoregressive Time Series with a Unit Root, *Journal of the American Statistical Association*, Vol. 74, pp. 427-431.
9. _____, 1981, Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root, *Econometrica*, Vol. 49, pp. 355-367.
10. Dickey, D. A., and S. G. Pantula, 1987, Determining the Order of Differencing in Autoregressive Processes, *Journal of Business and Economic Statistics*, Vol. 5, pp. 455-461.
11. Dryden, M., 1970, Filter Tests of U.K. Share Prices, *Applied Economics*, Vol. 1, pp. 49-60.

12. Fama, E. F., 1965, The Behavior of Stock Market Prices, *Journal of Business*, Vol. 38, pp. 34-105.
13. _____, and M. Blume, 1966, Filter Rules and Stock Market Trading, *Journal of Business*, Vol. 39, pp. 226-241.
14. Fuller, W. A., 1976, *Introduction to Statistical Time Series*, New York, J. Wiley & Sons, Inc.
15. Gruber, Studies in Financial Economics, V-I, Amsterdam: N. Holland Publishing Co., Chap 2.1.
16. Hong, H., 1978, Predictability of Price Trends on Stock Exchanges: A Study of Some Far Eastern Countries, *The Review of Economics and Statistics*, Vol LX, pp.619-621.
17. Jennergren, L.P. and P.E. Korsvold, 1975, The Non-Random Character of Norwegian and Swedish Stock Market Prices, *International Capital Markets*, Edited by E.J. Elton and M.J. _____
18. Kemp A. G., and G. C. Reid, 1971, The Random Walk Hypothesis and The Recent Behavior of Equity Prices in Britain, *Economica*, Vol. 38, pp. 28-51.
19. Poterba, J. M. and L. H. Summers, 1988, Mean-Reversion in Stock Prices: Evidence and Implications, *Journal of Financial Economics*, Vol. 22, pp. 27-59.
20. Praetz, P. D., 1969, Australian Share Prices and The Random Walk Hypothesis, *Australian Journal of Statistics*, Vol. 11, pp. 123-139.
21. _____, 1972, The Distribution of Share Price Changes, *Journal of Business*, Vol. 45, pp.49-55.
22. Solnik, B. H., 1973, Note on The Validity of Random Walk for European Stock Prices, *Journal of Finance*, Vol. 28, pp. 1151-1159.
23. Urrutia, G. L., 1995, Tests of Random Walk and Market Efficiency for Latin American Emerging Equity Markets, *Journal of Financial Research*, Vol. XVII, pp. 299-309.

Notes

