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AUTHORS	Josephine Njuguna
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Josephine Njuguna (South Africa)

Testing the efficient market hypothesis on the Nairobi Securities Exchange

Abstract

This paper tests the weak-form of the efficient market hypothesis (EMH) of the Nairobi Securities Exchange (NSE) using daily and weekly index data from the NSE 20 share index over the period, January 2001 to January 2015 and the NSE All Share Index (ASI) from its initiation, in February 2008 to January 2015. To test weak-form efficiency in this market, this study uses the serial correlation test, unit root tests (ADF and Phillips-Perron) and runs test. Results indicate that we cannot accept the EMH for the NSE using the serial correlation test, unit root tests and the runs test. Overall, the Kenyan market is found to not be weak-form efficient.

Keywords: efficiency market hypothesis, serial correlations test, unit root test, runs test, Nairobi securities exchange.
JEL Classification: G14, G15.

Introduction

The efficiency of a stock exchange is extremely important as it enables for the prices to fully incorporate information (Antoniu, Ergul and Holmes, 1997). It is only in this case that prices can provide the correct signals for efficient capital allocation. Fama and Litterman (2012) add that market efficiency indicates that prices reflect all available information and, hence, provide accurate signals for allocating resources to their most productive uses. Kim and Singal (2000) emphasize that advantages to the more efficient market are better allocation of capital and an increase in the productivity of capital.

The efficiency of stock markets is considered to have increased compared to the level of efficiency many years ago. This has been attributed to the advancement in technology that has enabled information to quickly reflect on the share prices. In a study conducted by Yang, Kwak, Kaizoji and Kim (2008) that analyzed the time series of the Standard and Poor's 500 Index (S & P 500), the Korean Composite Stock Price Index (KOSPI) and the Nikkei 225 Stock Average (NIKKEI), it was observed that, before the year 2000, information used to get by slowly, hence, resulting in the markets being less efficient. However, information flow is currently faster and more even because of the rapid development of communication through high speed internet, mobile technologies, and world-wide broadcasting systems. The expectation is of the present stock markets to become more efficient than past markets, confirming the EMH (Yang et al., 2008).

Automation of stock exchanges has enhanced information efficiency, as it facilitates the process of market prices quickly reflecting new information. Ciner (2002) investigated the information content of trading volume on the Toronto Stock Exchange before and after the move towards fully electronic trading. The empirical analysis supports more accurate price discovery after electronic trading. The findings of the study indicate that the predictive power of volume for price variability disappears after full automation. Naidu and Rozeff (1994) scrutinize the reasons why automation could influence aspects of trading with one being the market efficiency of the Singapore Stock Exchange after it fully automated in 1989. It suggests that improvements in market efficiency appear in reduced serial correlations of returns.

Since 2000, there have been both regulatory and technological developments. Cognizant of the observation by Yang et al. (2008) that, as a result of technology, market efficiency increased significantly from the year 2000 and that by Lim (2009) on using both linear and non-linear tests to determine market efficiency, it is only proper to re-visit the issue for the NSE.

The purpose of this study is to assess the current level of efficiency of the NSE using daily and weekly index data from the NSE 20 share index, and the NSE ASI. The methods that were used to analyze the daily and weekly index data are the serial correlation test, unit root tests and the runs test. These tests focus on the absolute efficiency approach and will be able to show whether the NSE is efficient or not. The contributions of this paper are, firstly, that the study tested the market-efficiency of the NSE using two indexes, the NSE 20 share index, and the NSE ASI. The latter has not been used as data for any prior study on the NSE. Preceding studies have used either the NSE 20 share index or share prices of individual shares. Secondly, this study also conducted one of the longest studies on the NSE that has ever been conducted, as the sample period was from January 2001 to January 2015 for the NSE 20 share index which is over a period of fourteen years. While for the NSE ASI,

Josephine Njuguna, Lecturer, Department of Finance, Risk Management and Banking, University of South Africa, South Africa.

the study was from when the index was initiated in February 2008 to January 2015 which is a period of approximately seven years.

The rest of this paper is organized as follows. Section 1 discusses the literature review. Section 2 describes the data. Section 3 discusses the data. Section 4 presents the results and final section summarizes the findings and provides conclusions.

1. Literature review

The theory of efficient markets is concerned with whether prices at any point in time "fully reflect" available information (Fama, 1970). There is a natural mechanism for financial markets to converge towards an efficient state through price competition among market operators and exploitation of available arbitrage opportunities. As more market operators perform these arbitrage operations to take advantage of the price differential, it forces the share prices to their efficient values. Subsequently, profit opportunities are eliminated as the market moves to equilibrium, at this point, the market is efficient. The convergence mechanism explains the process through which the market learns about new information. The speed of convergence is as quick as the market is liquid and large, and information is freely accessible and costless (Arouri, Jawadi and Nguyen, 2010).

For years, empirical testing has been a subject of major stock markets, the same cannot be said of many emerging markets (Jefferis and Smith, 2004). However, new empirical methods have been developed which provide new opportunity for analysis of efficiency in both developed and emerging markets. Antoniu et al. (1997) are of the opinion that the conventional tests of efficiency have been developed for testing markets which are characterized by high level of liquidity, sophisticated investors with access to high quality and reliable information and few institutional impediments. On the other hand, emerging markets are typically characterized by low liquidity, thin trading, considerable volatility and, possibly, less well informed investors with access to unreliable information.

Arouri et al. (2004) report the majority of emerging markets are less efficient than developed markets because of some market imperfections. As a result, recent studies on emerging markets have focused on the weak-form efficiency, whereas literature on developed markets is concerned about all three forms of efficiency. Several factors effectively contribute to prevent emerging markets from being efficient. These are infrequent and discontinuous trading, low market liquidity, low quality and quantity of information disclosure, untimely financial reporting and inappropriate accounting regulations, capital flow restrictions and market regulation, and discriminatory taxation (Arouri et al., 2010).

Ngugi, Murinde and Green (2002) investigate the response of emerging stock markets in Africa to various reforms implemented during the revitalizing process capturing mainly market efficiency and volatility during the period January 1988 to December 1999, specifically, for the NSE. The three main types of reforms implemented in these markets since the 1990s are identified, in other words, revitalization of the regulatory framework, modernization of trading systems and relaxation of restrictions on foreign investors. The authors find that there are benefits of investments to improve market microstructure. Markets with advanced trading technology, tight regulatory system and relaxed foreign investors' participation show greater efficiency and lower market volatility. In general, it is deduced that reforms help to reduce volatility which, in turn, leads to higher efficiency.

Mlambo and Biekpe (2003) observe that stock markets around the world are making efforts to improve market efficiency by improving information dissemination, making stock price information accessible to a broader range of investors and introducing electronic or computer-based trading systems. This has enabled market participants to have equal opportunities to access all relevant information. There is a positive correlation between most stock market development indicators and internet access; therefore, stock market liquidity and efficiency can be improved by providing information online and also promoting the infrastructure to improve internet accessibility.

Previous studies that have been conducted on the Kenyan market have been summarized on Table 1 below. Most of these studies have found the NSE to be weak-form efficient other than the study by Ngugi et al. (2002) and Smith, Jefferis and Ryoo (2002).

Table 1. Previous studies that have tested the efficiency of the NSE

Findings: stock market efficiency (weak-form) for the Kenyan market					
Author name	Year	Objective	Variables used	Tests used	Results
Zhang, Wu, Chang and Lee	2012	To examine evidence for mean reversion in stock prices for five African countries (Egypt, Kenya, Morocco, South Africa and Tunisia).	Weekly stock market index of the Kenya National stock exchange index. The sampling period is from January 2000 to April 2011.	Seeming unrelated regression of the Kapetanious-Shin-Snell (SURKSS) unit root test with a Fourier function.	Presence of weak-form market efficiency for the Kenyan market.

Table 1 (cont.). Previous studies that have tested the efficiency of the NSE

Findings: stock market efficiency (weak-form) for the Kenyan market					
Author name	Year	Objective	Variables used	Tests used	Results
Magnusson and Wydick	2002	To test whether the eight largest African stock markets meet the criterion of weak-form stock market efficiency with returns characterized by a random walk.	Monthly data for the eight African markets listed in the International Finance Corporation (IFC) index.	Serial correlation test.	The hypothesis that the Kenyan market is characterized by a random walk cannot be rejected.
Mlambo and Biekpe	2007	To study the weak-form efficiency of ten African markets.	Daily closing stock prices and volume traded for individual stocks. The sampling period for the Kenyan market is January 1997 to May 2002.	Serial correlation test and Runs test.	The Kenyan market is found to be weak-form efficient since a significant number of stocks conformed to the random walk.
Appiah-Kusi and Menyah	2003	To model weekly index returns adjusted for thin trading as a non-linear autoregressive process with conditional heteroscedasticity to investigate the weak-form pricing efficiency of 11 African stock markets.	Weekly index data obtained directly from the various stock exchanges.	EGARCH-M model.	The Kenyan market is found to be weak-form efficient.
Ngugi, Murinde and Green	2002	To investigate if the revitalization process enhanced the stock market micro-structure of the NSE. One of the parameters that was tested was market efficiency.	Monthly data for the NSE 20 Index from January 1970 to December 1999.	Serial correlation test and unit root test.	Weak-form efficiency of the NSE is rejected.
Smith, Jefferis and Ryoo	2002	To test the hypothesis that a stock market price index follows a random walk for South Africa, Egypt, Kenya, Morocco, Nigeria, Zimbabwe, Botswana and Mauritius.	Weekly data of the NSE 20 Index from the third week of January 1990 to the last week of August 1998.	Multiple variance ratio test of Chow and Denning.	The hypothesis that stock market price index follows a random walk is rejected as returns are auto-correlated.
Dickson and Muragu	1994	To investigate whether the behaviors of the price series in the Kenya market were consistent with the weak-form of the EMH.	Weekly data of 30 most actively traded equity securities listed on the Kenyan market over the duration of 1979 to 1988.	Serial correlation test and Runs test.	The Kenyan market provides empirical results consistent with weak-form efficiency.

2. Methodology

2.1. Serial correlation test. The null and alternative hypotheses for the serial correlations test are:

$H_0 : p_k = 0$ (Price changes are independent/There is zero serial correlation)

$H_a : p_k \neq 0$ (Price changes are not independent/There is serial correlation)

Urquhart and Hudson (2013) state that autocorrelations (p_k) occur when the covariances and correlations between different disturbances are not all non-zero (i.e., $Cov(\varepsilon_{i,} \varepsilon_j) = \sigma_{ij}$ for all $i \neq j$, where ε_t is the value of the disturbance in the ith observation).

$$p_k = \frac{\gamma_k}{\gamma_0}, \quad (1)$$

where γ_1 is the covariance at lag k and γ_0 is the variance. Therefore, when autocorrelations are present, the first order autoregressive process contains values of ε_t lagged by just one period, indicating that the disturbance in period t is influenced by the disturbance in the previous period, ε_{t-1}, in this case, it means that $\rho > 0$ and there is positive autocorrelation. Positive autocorrelation indicates predictability of return (Patel, Radadia and Dhawan, 2012).

Serial correlations test is a parametric test, it requires returns to be normally distributed. It is the best test for examining weak-form efficiency, because the relationship between price changes in the current period and its value in the previous period is measured (Abedini, 2009).

2.2. Unit root tests. Application of the Augmented Dickey Fuller (ADF) test is appropriate to determine a unit root. It is based on the following ordinary least squares (OLS) regression (Abedini, 2009):

$$\Delta\gamma_1 = a + b\gamma_{t-1} + \sum_{j-1}^{k} A_k cp\gamma_{t-1} + \mu t, \quad (2)$$

where γ_t equals the logarithm of a stock price at time t_1, Δ stands for changes, and Δ is a sequence of independent, normally distributed random variables with a mean of zero and constant variance while k is the number of lagged changes.

Buguk and Brorsen (2003) indicate that the ADF test statistic is the ratio of the estimated b to its calculated standard error obtained from an OLS regression. The authors add that the null hypothesis is $b = 0$ against the one-sided (lower-tail) alternative hypothesis, $b < 0$. The null hypothesis is rejected if the pseudo t statistic is larger than the critical value.

The Phillips-Perron test is a non-parametric method to test unit root and is similar to the Dickey-Fuller test (Liu, 2011). It incorporates an alternative (non-parametric) method of controlling for serial correlation when testing for a unit root by estimating the non-augmented Dickey-Fuller test equation and modifying the test statistic so that its asymptotic distribution is unaffected by serial correlation (Worthington and Higgs, 2006). The Z_t statistic of Phillips and Perron (1987, 1988) is a modification of the Dickey-Fuller t statistic which allows for autocorrelation and conditional heteroskedasticity in the error term of the Dickey-Fuller regression. This is based on the estimation of the equation:

$$\Delta X_t = \alpha_0 + \alpha_1 T + \alpha_2 X_{t-1} + \omega_t. \quad (3)$$

The equation that shows the random walk relationship is:

$$\Delta\gamma_t = \delta\gamma_{t+1} + \varepsilon, \quad (4)$$

$\delta = (p - 1)$, and

$\Delta\gamma_t = (\gamma_t - \gamma_{t-1})$.

If the AR 1 regression equals $p = 1$, the time series γ_t has a unit root it is equal to zero ($\delta = 0$). Therefore, if the time series has a unit root, it is non-stationary. The presence of a unit root indicates support for the random walk hypothesis (RWH) implying market efficiency (Lagoarde-Segot and Lucey, 2008).

2.2. Runs test. The null hypotheses for the runs test are:

H_0: $R = E(r)$ (Successive changes in the prices of the indexes are random)

H_a: $R = E(r)$ (Successive changes in the prices of the indexes are not random).

The formula for the runs test as given by Wallis and Roberts (1956) is:

$$m = \frac{\left\{N(N+1) - \sum_{i=1}^{3} n_i^2\right\}}{N}, \quad (5)$$

where m is the total expected number of runs, N is total number of observations, and n_i is the number of observations in each category i. For a large number of observations ($N > 30$), the sampling distribution of m is approximately normal and the standard error of m is given by:

$$\sigma_m = \left\{\frac{\sum_{i=1}^{3} n_i^2 \left[\sum_{i=1}^{3} n_i^2 + N(N+1)\right] - 2N\sum_{i=1}^{3} n_i^3 - N^3}{N^2(N-1)}\right\}^{1/2}, \quad (6)$$

and the standard normal Z-statistic to test the hypothesis is:

$$Z = \frac{R \pm 0.5 - m}{\sigma_m}, \quad (7)$$

where R = actual number of runs, m = expected number of runs and 0.5 = continuity adjustment. If $R \leq m$, the Z value is negative which implies a positive serial correlation. The positive serial correlation means that there is a positive dependence of stock price indicating a violation of the RWH (Patel et al., 2012).

Runs test determines whether successive price changes are independent (Abraham, Seyyed and Alsakran, 2002). It is a non-parametric test as it does not require returns to be normally distributed (Urquhart and Hudson, 2013), that is, its validity is not dependent on the shape of the underlying distribution hence a fitting statistical technique to test the weak-form market efficiency (Abedini, 2009). It is considered to be a linear test and it can also detect non-linearity in a returns series, although the results differ from the linear test. Moreover, this test is not affected by any extreme values in the return series, therefore, it does not require constant variance of the data (Mlambo and Biekpe, 2007). It serves as a good complement to the serial correlation test, because, while serial correlation coefficients may be significantly affected by a single outlier, the results from the runs test are not seriously affected by a few outliers.

3. Data

The data were availed from the NSE and from Bloomberg. The market efficiency of the NSE is analysed using the NSE 20 share index and the NSE ASI using both daily and weekly data respectively. In total, four time series were analyzed. The start of the period for the NSE 20 share index is January 2001 and for the NSE ASI is February 2008 when it was initiated. The end of the period for both indexes is in January 2015. Each of the indexes is traded on the main investment market segment of the exchange. The currency base denominated is in Kenyan Shillings (KES). The data that were analysed consisted of index returns that are transformed to natural logs of both the daily and weekly prices of the index.

$$r_t = ln\left(\frac{P_t - P_{t-1}}{P_{t-1}}\right) \times 100. \quad (8)$$

The price returns (r_t) are expressed in percentage terms were calculated as the ending index price minus the beginning index price divided by the beginning index price multiplied by 100. The natural logarithm (ln) of the price returns was calculated for each of the time series on MS Excel.

The results of which were transferred to the Eviews software for analysis of the descriptive statistics, serial correlations test and unit root tests. The same results were also transferred to the SPSS software to conduct the runs test.

3.1. Data analysis. *3.1.1. Descriptive statistics.* The skewness of all four time series is positive which means that the distribution has a right tail. The kurtosis of all four time series is greater than 3 this means the tail of the graph of the density function is short/fat thus leptokurtic. All four time series have Jarque-Bera statistics that are significantly higher than the 0.05 critical value of 5.99. We reject the null hypothesis of a normal distribution and accept the alternative hypothesis of non-normal distribution. Results of the descriptive statistics are reported in Table 2 below.

Table 2. Results of the descriptive statistics

Series (Observations)	Mean	Median	Maximum	Minimum	SD	Skewness	Kurtosis	Jarque-Bera Statistic	Probability
NSE 20 Share Index Daily data	0.003612	0.001321	1.313339	- 1.262414	0.109775	0.547178	19.85817	41869.89	0.000000
NSE 20 Share Index Weekly data	0.017900	0.011458	1.963580	- 1.274222	0.322315	0.640592	8.699999	1043.853	0.000000
NSE ASI Daily data	0.006670	0.004268	1.768218	- 0.996621	0.195704	1.091112	16.82577	14195.60	0.000000
NSE ASI Weekly data	0.031326	0.058297	3.618155	- 2.411904	0.569308	0.113425	9.897935	716.4793	0.000000

3.2. Serial correlation test. The results of the correlogram test show that auto correlation (AC) test of all four time series are not equal to 0, therefore, the time series are stationary. The *p*-values of all four times series are equal to 0. The Q-statistics should be significant with p-values that are close to 0 and less than 0.05. The null hypothesis will be rejected meaning the price changes are not independent and will violate the RWH. Results of the serial correlation test are reported in Table 3 below.

3.3. Unit root tests. The unit root tests were conducted to test for the stationarity status of the times series for both the daily and weekly data. Two unit root tests were examined for this study, the ADF unit root test and the Phillips-Perron test.

For the ADF unit root test, the test statistics are significant at 10%, 5% and 1% levels, respectively. The null hypothesis will, therefore, be rejected which leads to acceptance of the alternative hypothesis, that the time series are stationary and have no unit root. The time series, therefore, do not follow a random walk.

Similar results are applicable for the Phillips-Perron unit root test. The test statistics are significant at 10%, 5% and 1% levels, respectively. The null hypothesis will be rejected leading to acceptance of the alternative hypothesis, that the time series are stationary and have no unit root thus confirming the time series do not follow a random walk. Results of the stationarity tests are reported in Table 4 below.

Table 3. Results of stationarity tests

	ADF In levels $H0: Y_t \sim I(1)$ $H1: Y_t \sim I(0)$		Phillips-Perron In levels $H0: Y_t \sim I(1)$ $H1: Y_t \sim I(0)$	
Series (observations)	Intercept	Trend + intercept	Intercept	Trend + intercept
NSE 20 Share Index: daily data	- 29.29562***	- 29.29205***	- 40.94618***	- 40.94123***
NSE 20 Share Index: weekly data	- 22.83209***	- 22.81804***	- 23.18655***	- 23.17261***
NSE AS: daily data	- 23.89800***	- 23.94337***	- 23.38092***	- 23.29334***
NSE ASI: weekly data	- 15.38453***	- 15.52423***	- 15.34235***	- 15.48951***

Notes: *,**,*** significant at 10, 5 and 1% levels, respectively.

3.4. Runs test. The runs test was conducted through the SPSS software. The cut point that was considered was the median. This test is especially suitable for this data set, as it is suitable for testing non-normal data which, in this study, have been confirmed by the Jarque-Bera test, skewness test and the kurtosis test.

All four time series have actual number of runs that are less than the expected number of runs, i.e., $R \leq m$ and the Z value of all four time series are negative suggesting positive serial correlation. This means that there is positive dependence of all four times series, thus, violating the RWH. Results of the runs test are reported in Table 4 below.

Table 4. Results of the runs test

Series (observations)	No. of runs (R)	Total Cases (m)	Z statistic
NSE 20 Share Index: Daily data	1 327	3 521	- 14.647
NSE 20 Share Index: Weekly data	297	732	- 5.178
NSE ASI: Daily data	626	1 738	- 11.709
NSE ASI: Weekly data	154	361	- 2.899

Conclusion

The aim of this study was to determine the current level of efficiency of the NSE using both daily and weekly data of the NSE 20 share index and the NSE ASI. The serial correlation test show that the time series are stationary and do not follow the RWH. The ADF test and the Phillips-Perron test indicate the time series are stationary and have no unit root. The runs test results confirms that there is a positive dependence, hence, the time series do not follow the RWH. The NSE 20 share index and the NSE ASI (both daily and weekly data) are found to not be weak-form efficient based on the serial correlation test, unit root tests and the runs test, thus, fail to support the EMH. The securities exchanges in East Africa have been poorly researched. The suggestions for future research are the market efficiency of the other East Africa markets should also be tested so as to determine how informational efficient they are and what steps need to be undertaken to ensure that they are efficient if they are not currently. Market efficiency studies should also be extended to other African stock markets that have not been well researched. In addition, prior studies on efficiency of African stock markets should be re-visited using more robust methods of testing market efficiency.

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Appendix

Table 3. Results of the serial correlation test

	NSE 20 Share Index Daily data				NSE 20 Share Index Weekly data				NSE ASI Daily data				NSE ASI Weekly data			
Lags	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob	AC	PAC	Q-Stat	Prob
1	0.369	0.369	478.62	0.000	0.168	0.168	20.687	0.000	0.506	0.506	445.48	0.000	0.206	0.206	15.492	0.000
2	0.246	0.128	692.60	0.000	0.078	0.052	25.212	0.000	0.275	0.026	577.04	0.000	0.062	0.020	16.891	0.000
3	0.119	-0.009	742.41	0.000	0.055	0.035	27.447	0.000	0.122	-0.035	603.05	0.000	-0.010	0.027	16.924	0.001
4	0.031	-0.043	745.80	0.000	-0.018	0.038	27.694	0.000	-0.015	-0.094	603.47	0.000	-0.103	0.101	20.808	0.000
5	0.022	0.012	747.49	0.000	-0.008	-0.005	27.743	0.000	-0.043	0.005	606.68	0.000	0.055	0.103	21.931	0.001
6	-0.032	-0.044	751.20	0.000	0.083	0.089	32.838	0.000	-0.035	0.012	608.88	0.000	0.171	0.159	32.741	0.000
7	-0.017	0.005	752.28	0.000	0.119	0.100	43.373	0.000	-0.033	-0.010	610.80	0.000	0.132	0.062	39.185	0.000
8	-0.009	0.009	752.59	0.000	0.015	-0.031	43.536	0.000	-0.018	-0.001	611.36	0.000	0.077	0.012	41.373	0.000
9	0.031	0.045	755.99	0.000	0.024	0.004	43.971	0.000	0.014	0.029	611.70	0.000	-0.003	-0.015	41.377	0.000
10	0.030	0.007	759.12	0.000	0.019	0.011	44.228	0.000	0.017	-0.002	612.19	0.000	-0.022	0.011	41.561	0.000
11	0.028	0.003	761.82	0.000	0.018	0.024	44.460	0.000	0.017	0.000	612.70	0.000	0.061	0.074	42.950	0.000
12	0.026	0.005	764.22	0.000	0.069	0.060	47.972	0.000	0.023	0.012	613.64	0.000	0.145	0.106	50.857	0.000
13	0.022	0.008	765.99	0.000	0.064	0.026	51.071	0.000	0.025	0.014	614.75	0.000	0.081	-0.009	53.298	0.000
14	0.041	0.029	771.80	0.000	0.011	-0.023	51.165	0.000	0.007	-0.015	614.85	0.000	0.007	-0.049	53.316	0.000
15	0.032	0.011	775.50	0.000	0.067	0.063	54.523	0.000	-0.030	-0.044	616.44	0.000	0.004	0.021	53.323	0.000
16	0.024	0.001	777.53	0.000	0.040	0.020	55.703	0.000	-0.040	-0.008	619.31	0.000	-0.076	-0.054	55.512	0.000
17	0.012	-0.005	778.03	0.000	0.072	0.062	59.644	0.000	-0.055	-0.022	624.59	0.000	-0.020	-0.017	55.671	0.000
18	-0.008	-0.018	778.28	0.000	0.058	0.019	62.144	0.000	-0.042	0.005	627.70	0.000	0.127	0.096	61.806	0.000
19	-0.025	-0.022	780.41	0.000	0.052	0.015	64.189	0.000	-0.027	-0.003	629.00	0.000	0.062	-0.010	63.264	0.000
20	-0.023	-0.003	782.35	0.000	0.018	-0.004	64.438	0.000	-0.015	-0.001	629.42	0.000	0.015	-0.038	63.347	0.000
21	-0.028	-0.010	785.11	0.000	0.014	0.006	64.586	0.000	-0.038	-0.046	631.91	0.000	-0.067	-0.071	65.061	0.000
22	-0.015	0.005	785.92	0.000	0.031	0.015	65.338	0.000	-0.031	-0.002	633.65	0.000	-0.005	0.076	65.071	0.000

Table 3 (cont.). Results of the serial correlation test

	NSE 20 Share Index Daily data				NSE 20 Share Index Weekly data				NSE ASI Daily data				NSE ASI Weekly data			
23	-0.012	-0.004	786.45	0.000	-0.020	-0.040	65.630	0.000	-0.006	0.024	633.71	0.000	-0.004	-0.007	65.078	0.000
24	-0.011	-0.008	786.90	0.000	0.054	0.040	67.840	0.000	0.046	0.064	637.44	0.000	0.031	-0.015	65.456	0.000
25	0.005	0.010	786.97	0.000	0.059	0.033	70.473	0.000	0.079	0.035	648.40	0.000	0.068	0.022	67.254	0.000
26	0.022	0.022	788.73	0.000	0.035	0.014	71.432	0.000	0.099	0.035	665.60	0.000	0.026	0.011	67.517	0.000
27	0.029	0.014	791.73	0.000	0.009	-0.018	71.489	0.000	0.110	0.040	686.85	0.000	0.050	0.071	68.508	0.000
28	0.060	0.046	804.65	0.000	0.015	-0.003	71.669	0.000	0.092	0.017	701.73	0.000	-0.011	-0.006	68.556	0.000
29	0.049	0.010	813.02	0.000	0.047	0.044	73.335	0.000	0.065	0.006	709.10	0.000	0.076	0.095	70.852	0.000
30	0.062	0.030	826.81	0.000	0.008	-0.012	73.383	0.000	0.043	0.011	712.36	0.000	0.099	0.038	74.703	0.000
31	0.030	-0.014	829.99	0.000	0.004	-0.025	73.397	0.000	0.024	0.008	713.38	0.000	0.039	-0.007	75.319	0.000
32	0.017	-0.001	831.07	0.000	0.010	-0.012	73.481	0.000	0.018	0.010	713.93	0.000	0.032	0.015	75.720	0.000
33	0.017	0.012	832.08	0.000	-0.070	-0.080	77.238	0.000	0.032	0.028	715.76	0.000	-0.101	-0.120	79.786	0.000
34	0.029	0.031	835.06	0.000	-0.048	-0.035	79.017	0.000	0.034	0.010	717.77	0.000	-0.103	-0.064	84.071	0.000
35	0.033	0.016	838.84	0.000	0.026	0.038	79.557	0.000	0.041	0.020	720.74	0.000	0.006	0.029	84.084	0.000
36	0.020	-0.002	840.32	0.000	-0.013	-0.030	79.691	0.000	0.048	0.015	724.88	0.000	-0.035	-0.080	84.567	0.000