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The Random Walk Behavior and Market Efficiency of Nepalese & Indian Stock Markets

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Abstract: - This study examines the weak-form market efficiency of Nepalese stock market and Indian stock market. Daily returns for Nepalese and Indian stocks are examined for random walks using serial correlation coefficient, runs tests, Augmented Dickey-Fuller, Phillips-Perron unit root tests and multiple variance ratio tests. The results, which are based on the different approaches employed, indicate that none of the markets are characterized by random walks and hence are not weak-form efficient, even under some less stringent random walk criteria. Serial correlation and variance ratio test explores the Nepalese stock market follows the random walk and the stock market is weak form of efficient. But the runs test and unit root test explores the Nepalese stock market does not follow the random walk. The Indian stock market does not follow the random walk based on the result of serial correlation test, unit root test and variance ratio test. Only the runs test explores the Indian stock market follow the random walk.

Keywords: Stock markets, random walk hypothesis, market efficiency, serial correlation, runs test, Unit root test, variance ratio test

1 INTRODUCTION

Much of the evidence regarding the random walk behavior of stock returns has been accumulated from developed markets. The focus of research has now moved towards emerging markets, mostly in identification of the valuable contribution efficient markets can play in financial development and economic growth, stock markets in different countries have received less attention than that elsewhere. The verification that does exist is incomplete in that it concentrates on a small number of markets, draws upon low frequency and short sample data, and relies on a narrow range of empirical techniques. In evidence, (Urrutia, 1995), (Ojah & Karemera, 1999), (Karemera, Ojah, & Cole, 1999) examined Random walks and market efficiency tests: Evidence from emerging equity markets using just variance ratio tests, and while (Haque, Hassan, & Varela, 2001) analysis added another three markets, none of these studies employed data with a higher frequency than weekly or with a sample longer than a decade. This paper examines the random walk behavior of Nepalese and Indian stock markets using daily data for up to a five–year period.

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2 REVIEW OF LITERATURE

A number of studies on Random Walk Hypothesis (RWH) have been conducted abroad as well as in Nepal also. In Nepalese Capital Market context, most of the studies show that RWH does not hold true. Studies conducted by (Baral & Shrestha, 2006) have tested the RWH in the context of Nepalese Capital Markets. Because of the huge implications of the Efficient Market Theory in the functions of financial markets is still constantly been measured, Over the years a number of research persons have analyzed the existence of the theory in various markets developed or undeveloped, and different results have been found. (Fama, 1970) Advise three models in order to examining the market efficiency and defined if, the market is being efficient and prices fully reflect all available information. In addition, (Fama, 1970) classified the empirical measure of the hypothesis into three forms based on the given information set, namely weak form, semi-strong form, and the strong form.

(Granger, 1975), (Fama, 1991), (Abeysekera, 2001) and (Groenewold, Sam, & Wu, 2003) tested empirically the Random walk model and the weak form of efficient market theory for the testing of efficiency, at the weak form several statistical techniques have been used such as runs test, unit root test, autocorrelation and spectral analysis. For instance, (Sharma & Kennedy, 1997), (Karemera, Ojah, & John, 1999) and (Abraham & Alsakran, 2002) adopted run test, While (Groenewold, Sam, & Wu, 2003) and (Seddighi & Nian, 2004) used both run test and unit root test in their studies. The statistical tests done by the many researchers for market efficiency in the weak form the auto correlation test, including the correlation coefficient test, Q-test which is adopted by (Dickinson & Muragu, 1994), (Fawson, Glover, Fang, & Chang, 1996) and (Groenewold, Sam, & Wu, 2003).The empirical evidence on developed markets confirming the weak-form efficiency of the EMH, for instance, (Cootner, 1962) and (Sung & Johnson, 2006).

In the opposite of, the empirical research conducting studies in emerging markets has been mixed results, between accept or reject the null hypothesis of weak form EMH. For example, (Dahel & Laabas, 1999) explored that the Kuwait stock market is strongly support the weak form of EMH, and reject the weak form of the EMH for Bahrain, Also, (Abeysekera, 2001) and (Abraham & Alsakran, 2002) their empirical finding reject the hypothesis of weak form efficiency for stock markets in Sri Lanka, Bahrain Kuwait, and Saudi Arabia.

3 Hypothesis, data and Methodology

3.1 Hypothesis

The purpose of this paper is, first, to examine the random walk hypothesis (RWH) by testing the weak-form efficiency in the NEPSE returns and BSE Sensex return. Therefore, the hypothesis to be tested as:

H0: Stock return follow the random walk model /weak form of efficient.

H1: Stock return do not follow the random walk model/weak form of inefficient.

3.2 Data

The data employed in the study is composed of NEPSE Index and BSE Sensex of Indian stock market. All data is obtained from official website of NEPSE and yahoo finance. The series encompass similar sampling periods of 2015 to 2020. Daily data is specified. The natural log is used to determine the daily returns.

Rt =log(P1t/P1t-1)

Where,

Rt is the stock returns for the period t, PIt is the price index at period t, PIt-1 is the price index at period t-1, and Ln is the natural log.

3.3 Methodology

The methodology gives a number of supporting assess procedures for random walks or weak-form market efficiency. To begin with, the parametric serial correlation test of independence and the non-parametric runs test can be used to test for serial independence in the series. On the other hand, unit root tests can be used to determine if the series is difference or trend non-stationary as a necessary condition for a random walk. Another test is variance ratio test which gives the attention on the uncorrelated residuals in the series, under assumptions of both homoscedastic and heteroskedastic random walks.

4 Serial correlation coefficient test

The serial correlation coefficient test is a broadly utilized course of action that tests the relationship between returns in the current period and those in the previous period. If the autocorrelation is found as significant then the series are assumed to follow a random walk.

4.1 Runs Test

The runs test determines whether following price changes are unconventional and dissimilar the serial correlation test of independence, is non-parametric and does not require returns to be normally distributed. Remarking the number of 'runs' - or the sequence of following price changes with the same sign - in a series of price changes tests the null hypothesis of randomness. In the change when the return is less than the mean, and zero change when the return equals the mean.

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4.2 Unit Root Tests

In order to test the null hypothesis of unit root only two different test are used: namely, the Augmented Dickey-Fuller (ADF) test, and the Phillips-Peron (PP) test. To start with, the well-known ADF unit root test of the null hypothesis of non-stationary is conducted. Incorporates an alternative (nonparametric) 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.

4.3 Variance Ratio Tests

The Lo and MacKinlay variance ratio test is trusted than the Dickey-Fuller unit root or the autocorrelation Q tests for testing the predictability in stock price series (Lo & MacKinlay, 1988).The variance ratio test statistics is based on the assumption that the variance of increments in the random walk series is linear in the sample interval. Namely, if a series follows a random walk, the variance of a qth differenced variable is q times the variance of its first differenced variable

$Var(R_t - R_{t-q}) = q\, Var(R_t - R_{t-1})$

The variance ratio is then calculated as:

$VR_q = Var[R_t(q)]/q.Var[R_t]$

The null hypothesis is the variance ratio at lag q is defined as the ratio of the variance of the q-period return to the variance of the one-period return divided by q, which should equal to one under the random walk hypothesis. If any of the estimated variance ratios differ significantly from one, then the random walk hypothesis is rejected. Lo and MacKinlay (1988) evolved two test statistics to test the null hypothesis, one is with the assumption of homoscedasticity increments Z (q) and the other is with the assumption of heteroscedasticity increments Z*(q).

5 EMPIRICAL RESULTS

Turning first to the tests of independence, the null hypotheses of no serial correlation for Nepal is accepted at the 0.01 level or higher, while that for India is rejected at the 0.01 level or higher. The significance of the autocorrelation coefficient indicates that the null hypothesis of weak-form market efficiency may be rejected and we may infer that Indian markets are weak-form inefficient. Whereas the Nepalese stock market is weak form of efficient and Nepalese stock market return follow the random walk. But the Indian stock market return does not follow the random walk.

TABLE 1
SERIAL CORRELATION TEST

Serial correlation	P-value
NEPSE	1.0000
BSE SENSEX	0.0000

In terms of the runs tests of the return of the Nepalese stock market the study finds the p value is 0.0000 which is less than the 5% level of significant and null hypothesis is rejected. Which indicates the Nepalese stock market does not follow the random walk and the return is weak form of inefficient. Whereas the return of Indian stock market follow the random walk and the market is efficient because the p value is higher than the 5% level of significant. So the null hypothesis is accepted.

TABLE 2
RUNS TEST

Run test	P-value
NEPSE	0.0000
BSE SENSEX	0.9090

Table 3 explores the result of Augmented Dickey Fuller test of the index return of Nepalese stock market and Indian stock market does not follow the random walk. Where the P value is less than the 5% level of significant and null hypothesis is rejected. So the Nepalese and Indian markets are not efficient.

TABLE 3
AUGMENTED DICKEY-FULLER (ADF) TEST

Augmented Dickey-Fuller (ADF)	P-value
NEPSE	0.0000
BSE SENSEX	0.0000

Table 4 explores the result of Phillips-Perron (PP) test of the index return of Nepalese stock market and Indian stock market does not follow the random walk. Where the P value is less than the 5% level of significant and null hypothesis is rejected. So the Nepalese and Indian markets are not efficient.

TABLE 4
PHILLIPS-PERRON (PP) TEST

Phillips-Perron (PP)	P-value
NEPSE	0.0000
BSE SENSEX	0.0000

Table 5 explores the result of variance ratio test of the index return of Nepalese stock market does not follow the random walk because the null hypothesis is not rejected. In all individuals, since the study specified more than, there are two sets of test results. The period and joint test, variance ratio static P-value are higher than alpha (5% level of significance) as well as Z statistics also less than the degree of freedom at 5% level of significance. So, stock prices on the NEPSE follow the random walk model, and the investors unable to earn abnormal profit from the stock market. Whereas the return of Indian stock market follow the random walk and the market is efficient because the p value is higher than the 5%level of significant. So the null hypothesis is accepted.

TABLE 5
VARIANCE RATIO (MVR) TEST

Variance ratio (MVR)	P-value
NEPSE	0.7778
BSE SENSEX	0.0000

6 CONCLUSION

This study examines the weak form market efficiency of Nepalese and Indian stock markets. Daily returns for Nepal and India are examined for random walks using serial correlation coefficient, runs tests, Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) unit root tests and multiple variance ratio (MVR) tests. The results for the tests of serial correlation accepting the presence of random walks in daily returns in the Nepalese stock market, but rejecting the random walk hypothesis in daily returns in the Indian stock market. Similarly, the unit root tests conclude that unit roots, as necessary conditions for a random walk, are absent from all of the return series of both markets. Based on the non-parametric test, runs test the Nepalese stock market is unable to follow the random walk hypothesis and market is seems as weak form of inefficient. Contrary the Indian stock market follow the random walk model and seems the market is efficient. Finally, the multiple variance ratio procedure conclusively accepts the presence of random walks in Nepalese stock market but the Indian stock market rejects the random walk hypothesis. Further research can be made based on the other indices from Nepalese and Indian stock markets and other research tools can be used.

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APPENDICES NEPSE

Appendix -1

Date: 08/15/20 Time: 14:36
Sample: 1 1164
Included observations: 1164

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.011	-0.011	0.1336	0.715
		2	-0.001	-0.001	0.1347	0.935
		3	-0.001	-0.001	0.1355	0.987
		4	-0.001	-0.001	0.1364	0.998
		5	-0.001	-0.001	0.1372	1.000
		6	-0.001	-0.001	0.1386	1.000
		7	-0.001	-0.001	0.1393	1.000
		8	-0.001	-0.001	0.1405	1.000
		9	-0.001	-0.001	0.1422	1.000
		10	-0.001	-0.001	0.1434	1.000
		11	-0.001	-0.001	0.1446	1.000
		12	-0.001	-0.001	0.1455	1.000
		13	-0.001	-0.001	0.1458	1.000
		14	-0.001	-0.001	0.1470	1.000
		15	-0.001	-0.001	0.1480	1.000
		16	-0.000	-0.001	0.1482	1.000
		17	-0.001	-0.001	0.1492	1.000
		18	-0.001	-0.001	0.1503	1.000
		19	-0.001	-0.001	0.1511	1.000
		20	-0.001	-0.001	0.1520	1.000
		21	-0.001	-0.001	0.1529	1.000
		22	-0.001	-0.001	0.1536	1.000
		23	-0.001	-0.001	0.1543	1.000
		24	-0.001	-0.001	0.1556	1.000
		25	-0.001	-0.001	0.1567	1.000
		26	-0.001	-0.001	0.1571	1.000
		27	-0.001	-0.001	0.1585	1.000
		28	-0.001	-0.001	0.1594	1.000
		29	-0.001	-0.001	0.1605	1.000
		30	-0.001	-0.001	0.1611	1.000
		31	-0.001	-0.001	0.1619	1.000
		32	-0.001	-0.001	0.1626	1.000
		33	-0.001	-0.001	0.1634	1.000
		34	-0.001	-0.001	0.1642	1.000
		35	-0.001	-0.001	0.1649	1.000
		36	-0.001	-0.001	0.1658	1.000

Appendix -2

Null Hypothesis: D(R1) has a unit root
Exogenous: Constant
Lag Length: 10 (Automatic - based on SIC, maxlag=22)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-17.64718	0.0000
Test critical values:	1% level	-3.435811	
	5% level	-2.863840	
	10% level	-2.568045	

*MacKinnon (1996) one-sided p-values.

Appendix -3

Null Hypothesis: D(R1) has a unit root
Exogenous: Constant
Bandwidth: 1.16e+003 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1184.111	1.0000
Test critical values:	1% level	-3.435763	
	5% level	-2.863818	
	10% level	-2.568033	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	13.19234
HAC corrected variance (Bartlett kernel)	0.018784

Appendix -4

Null Hypothesis: R1 is a martingale
Date: 08/15/20 Time: 14:40
Sample: 1 1164
Included observations: 1163 (after adjustments)
Heteroskedasticity robust standard error estimates
User-specified lags: 2 4 8 16

Joint Tests	Value	df	Probability
Max |z| (at period 2)*	1.008005	1163	0.7778

Individual Tests

Period	Var. Ratio	Std. Error	z-Statistic	Probability
2	0.496027	0.499971	-1.008005	0.3135

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4	0.248848	0.749972	-1.001573	0.3165
8	0.125305	0.874980	-0.999675	0.3175
16	0.063495	0.937484	-0.998956	0.3178

*Probability approximation using studentized maximum modulus with
parameter value 4 and infinite degrees of freedom

Test Details (Mean = 5.39670508288e-06)

Period	Variance	Var. Ratio	Obs.
1	17.7043	--	1163
2	8.78179	0.49603	1162
4	4.40567	0.24885	1160
8	2.21843	0.12530	1156
16	1.12413	0.06349	1148

Appendix -5

Runs Test

	R1
Test Valuea	-.000414
Cases < Test Value	582
Cases >= Test Value	582
Total Cases	1164
Number of Runs	484
Z	-5.806
Asymp. Sig. (2-tailed)	.000

a. Median

Appendix -6

Runs Test 2

	R1
Test Valuea	.08615763
Cases < Test Value	1163
Cases >= Test Value	1
Total Cases	1164
Number of Runs	3
Z	.041
Asymp. Sig. (2-tailed)	.967

a. Mean

BSE Sensex

Appendix -7

Bse sensex

Null Hypothesis: D(RB01) has a unit root

Exogenous: Constant

Lag Length: 5 (Automatic - based on SIC, maxlag=22)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.80392	0.0000
Test critical values:	1% level	-3.435649	
	5% level	-2.863768	
	10% level	-2.568007	

*MacKinnon (1996) one-sided p-values.

Appendix -8

Null Hypothesis: D(RB01) has a unit root

Exogenous: Constant
Bandwidth: 12 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-24.38747	0.0000
Test critical values:	1% level	-3.435536	
	5% level	-2.863718	
	10% level	-2.567980	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	0.001036
HAC corrected variance (Bartlett kernel)	0.000852

Appendix -9

Null Hypothesis: RB01 is a martingale
Date: 08/09/20 Time: 07:24
Sample: 1 1230
Included observations: 1216 (after adjustments)
Heteroskedasticity robust standard error estimates
User-specified lags: 2 4 8 16

Joint Tests	Value	df	Probability
Max |z| (at period 2)*	15.45818	1216	0.0000

Individual Tests

Period	Var. Ratio	Std. Error	z-Statistic	Probability
2	0.496846	0.032549	-15.45818	0.0000
4	0.257594	0.054596	-13.59820	0.0000
8	0.126192	0.083067	-10.51932	0.0000
16	0.073813	0.120198	-7.705502	0.0000

*Probability approximation using studentized maximum modulus with
parameter value 4 and infinite degrees of freedom

Test Details (Mean = -0.000807206303035)

Period	Variance	Var. Ratio	Obs.
1	0.00111	--	1216
2	0.00055	0.49685	1211
4	0.00029	0.25759	1209
8	0.00014	0.12619	1205
16	8.2E-05	0.07381	1197

Appendix -10

Date: 08/09/20 Time: 07:26
Sample: 1 1230
Included observations: 1216

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
*| |	*| |	1	-0.135	-0.135	22.367	0.000
| |	| |	2	0.006	-0.012	22.414	0.000
| |	| |	3	0.020	0.019	22.889	0.000
| |	| |	4	-0.048	-0.044	25.750	0.000
| |	| |	5	0.057	0.046	29.750	0.000
*| |	| |	6	-0.070	-0.058	35.765	0.000
| |	| |	7	0.047	0.033	38.522	0.000
| |	| |	8	0.005	0.012	38.553	0.000
| |	| |	9	-0.030	-0.022	39.673	0.000
| |	| |	10	0.045	0.031	42.203	0.000
| |	| |	11	-0.045	-0.027	44.678	0.000
| |	| |	12	0.028	0.014	45.665	0.000
| |	| |	13	0.002	0.008	45.669	0.000
| |	| |	14	-0.013	-0.006	45.880	0.000
| |	| |	15	0.026	0.014	46.719	0.000
| |	| |	16	-0.029	-0.014	47.735	0.000

Appendix -11

Runs Test

	BSE
Test Valuea	.00054
Cases < Test Value	610
Cases >= Test Value	610
Total Cases	1220
Number of Runs	609
Z	-.115
Asymp. Sig. (2-tailed)	.909

a. Median

Appendix -12

Runs Test 2

	BSE
Test Valuea	.0003129
Cases < Test Value	601
Cases >= Test Value	619
Total Cases	1220
Number of Runs	602
Z	-.508
Asymp. Sig. (2-tailed)	.611

a. Mean