Weak Form Market Efficiency in Nepalese Stock Market Indices[1]

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Abstract

This paper analyses the weak-form market efficiency of the Nepalese stock market based on daily observation from Jan 23, 2019 to Jan 20, 2021, regarding returns of NEPSE, the composite index of Nepalese stock market, returns of banking sub-index and returns of manufacturing and processing sub-index. The study is conducted employing five tests of random walk i.e. Normality tests, Runs test, Autocorrelation functional test, Unit root test, and Variance ratio test. All tests produced consistent results except for the banking sub-index and manufacturing and production sub-index under variance ratio test and run test. It is concluded that the Nepalese stock market is not in weak-form market efficiency. The assumptions of an efficient stock market may not be materialized in the Nepalese context being a small and young market. The findings of the study report that investors have a favorable opportunity to predict stock price and generate abnormal gain from the Nepalese stock market.

Keywords: market efficiency, NEPSE, stock market, random walk

Introduction

There are two popular theories regarding the price behavior of securities- Dow theory and the Efficient Market Hypothesis (EMH). Dow formulated a hypothesis that the stock market does not perform on a random basis but is influenced by three distinct primaries, secondary and minor trends that guide its general direction (Fisher & Jordon, 2009). Roberts (1959) stated that the underlying economic facts and relationships are important; many also believe that the market's history contains "patterns" that give clues to the future if only these patterns can be properly understood. Another theory of security price behavior is the efficient market hypothesis. Hirt and Block (2009) stated that an efficient market is one in which new information is very rapidly processed so that prices are an unbiased reflection of all currently available information. Therefore, the security prices are unbiased and random, and they cannot be predicted.

Fischer and Jordan (2009) stated that the efficient market model (or hypothesis) is a special case of the random walk model (RWM). EHM and RWM are frequently used as synonyms of each other. Levy (1967) classified EMH into weak form EMH and strong form EMH, whereas Fama (1970) divided EMH into strong form, semi-strong

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form, and weak form EMHs. Reily and Brown (2012) stated that "the weak-form EMH assumes that current stock prices fully reflect all security market information, including the historical sequence of prices, rates of return, trading volume data and other market generated information, such as odd-lot transactions and transaction by market markers" (p.141). There are many profit-maximizing participants analyzing and valuing securities independently, new information regarding securities randomly comes to the market, and the timing or arriving and announcing are also random. Moreover, finally, the buy and sell decisions of all those profit-maximizing investors cause security prices to adjust rapidly to reflect the effect of new information, so the capital market should be efficient.

Review of Literature

Efficient capital or financial market is equally important for the investors, business community and the government. In recent decades governments and business organizations realize the importance of capital markets in economic growth (Nisar & Hanif, 2012). The country whose financial market, especially the stock market, is efficient is generally considered by foreign financial institutions and investors as a potential choice of global diversification (Sodsai & Suksonghong, 2018).

An efficient financial market is necessary for developing countries like Nepal to attract foreign investment, both direct and portfolio. Many studies have been conducted to test the market efficiencies in developed and developing countries. The empirical studies have produced mixed results concerning the efficient market hypothesis. Some empirical studies have produced results in the efficient market hypothesis, whereas some empirical studies have produced inconsistent results with the efficient market hypothesis.

Chaudhary and Wu (2003); Grieb and Reyes (1999); Lo and Mackinlay (1988); Poterba and Summers (1988); and Urrutia (1995) found inconsistent result with EMH, but at a similar time, Chaudhary (1997); Huber (1997); Kawakatsu and Morey (1999); Liu and Song (1997); Narayan and Smyth (2004); and Narayan and Smyth (2005) found consistent results with EMH. Different researchers use different statistical tools to test the market efficiency. The most frequently used tools are event studies, looking for patterns, examining performance, run tests, filter tests, reversal effect test etc. (Fischer & Jordan, 2009, Alexander, Sharpe & Baily, 2002). One of the causes of having different results may be the use of different tools for testing.

Fama (1970) conducted a study on efficient capital markets in the form of review of theory and empirical work. The study reviewed the theoretical and empirical literature on the efficient capital market model. The research concluded that weak-form market efficiency is fair and strongly supports the hypothesis of an efficient market. It found that the day-to-day price changes and returns on common stock follow the theory of random walk. Similarly, Fama and French (1988) stated that NYSE has a negative serial correlation in market returns over observation interval of three to five years. The evidence means that stock returns do not follow random walk theory and stock returns are predictable. This finding contradicts the previous evidence of Fama (1970).

Narayan (2006) investigated the behaviour of the US stock prices employing an unrestricted two-regime Threshold Autoregressive (TAR) model with an autoregressive unit root. The study used monthly stock price (NYSE common stocks) data for 1964 to 2003. The main finding of the study was that the US stock price was a nonlinear series that characterized by a unit root test which was consistent with the previous studies reported by Fama (1970); Chaudhary (1997); Huber (1997); Kawakatsu and Morey (1999); Liu, Song, and Romilly (1997); Narayan and Smyth (2004); and Narayan and Smyth (2005).

Hamid et al. (2010) conducted a study to test the weak-form market efficiency of the stock market returns of the Asia Pacific region employing Autocorrelation, Ljung-Box, Q-statistic test, Runs test, Unit root rest and variance ratio test. The study used monthly observation for the period January 2004 to December 2009. The study concluded that no one market was weak-form efficient and strongly rejected the random walk hypothesis. This result was consistent with the previous evidence of Fama and French (1988); Chaudhary and Wu (2003); Grieb and Reyes (1999); Lo and Mackinlay (1988); Poterba and Summers (1988); and Urrutia (1995).

GC (2010) conducted a study and examined the weak form of market efficiency and random walk behaviour of Nepalese stock market employing different tests; autoregressive conditional heteroscedasticity test, autocorrelation test, runs test, unit root test and variance ratio test. The study used 1970 daily observation from 2003 to 2009 of the general NEPSE index and seven sub-indices in the Nepalese stock market. The study found that the random walk hypothesis was strongly rejected by all the tests for daily observation sub-indices in NEPSE. The study concluded that the Nepalese stock market is inefficient in a weak form.

Dongol (2011) analyzed the random walk behaviour and weak form market efficiency on daily and weekly market returns of all share price index and nine sectored indices in NEPSE employing variance ratio test as methodology. The study found that the observed and corrected weekly indices rejected the random walk hypothesis and concluded that market participants have opportunities to predict stock price and earn abnormal returns from the Nepalese stock market. On the other hand, daily observed and corrected returns was consistent with the random walk hypothesis in the overall and development banking sector.

Nguyen et al. (2012) examined the weak-form efficient market hypothesis of the Taiwan stock market using Dockery and Kavussano's multivariate model. The study concluded that the Taiwan stock market was inefficient and hence, strongly rejected the efficient market hypothesis. The result was consistent with the previous studies of Fama and French (1988) and Hamid et al. (2010). However, the report contradicted with pieces of evidence reported by Fama (1970) and Narayan (2006).

Sodsai and Suksonghery (2018) analyzed the weak-form efficient market hypothesis for the Thai stock market employing multiple variance ratio tests. The results revealed that the Thai stock market was efficient in weak form and strictly followed the random walk behaviour of stock price, which was consistent with the studies reported by Fama (1970) and Narayan (2006). However, the small capitalization index provided shreds of evidence against a weak form efficiency hypothesis and hence, consistent with the results reported by Fama and French (1988), Hamid et al. (2010) and Nguyen et al. (2012).

Kumar and Ruhi (2019) examined the efficient market hypothesis in the Indian stock using closing prices of 31 companies listed on the SENSEX, Bombay, India. The data were analyzed employing Autocorrelation, correlogram, and runs test. The result showed that the prices of 30 companies followed the random walk model, which was consistent with the shreds of evidence of Fama (1970); Narayan (2006); and Sodsai and Suksonghery (2018). In contrast, only one company stock prices do not follow the random walk hypothesis.

From the above works of literature on weak-form market efficiency, it is concluded that the majority of the developed countries' stock prices are formulated randomly, and stock markets are efficient in weak form. Whereas, in the majority of developing countries' stock prices fail to support random walk behavior in the weak form. The main reasons behind this inconsistency are methodological differences, the timing of the study, location of the market, i.e. developed versus developing economies, sample size, etc. This study utilized another data sets of Nepalese stock market to test weak form of market efficiency for another time period.

Methods

Data

The necessary data were collected from the website of Nepal Stock Exchange Limited (NEPSE). The data were collected from Jan 23, 2019 to Jan 20, 2021, regarding daily returns of NEPSE, the composite index of Nepalese stock market, daily returns of Banking sub-index and daily returns of manufacturing and Processing sub-index.

Tests

Five methods, namely normality test, runs test, autocorrelation function test, unit root test and variance ratio test, were selected.

Normality Test

According to the statistical rule, the distribution of random occurrences will conform to a normal distribution. So, if proportionate price changes are randomly generated events, then their distribution should be approximately normal. The Kolmogorov-Smirnov test and Shapiro-Wilk test were applied to test the normality or randomness of the data. An insignificant result supports the randomness.

Run Test

The run test is a non-parametric test, and it is used to determine whether the order or sequence of observations in a sample is random (Black, 2013). An insignificant result of the run test indicates the randomness in the sequence. The test statistic is obtained following the equation given below:

$Z= (R-U_r)/\sigma_r$ (1)

Where,

$U_r = 2n_1 n_2/(n_1+n_2) + 1$

$\sigma_r = \sqrt{[\frac{2n1n2(2n1n2-n1-n2)}{(n1+n2)^2(n1+n2-1)}]}$

R= observed number of runs

U_r= Expected number of runs

n_1 & n_2= observed positive and negative runs

Autocorrelation Function Test

The third test applied to examine weak form EMH was the autocorrelation function test. Autocorrelation is self-correlation or serial correlation. To have sequence random, there should be statistically positively or negatively insignificant Autocorrelation up to one-fourth lags (rule of thumb). Here, the data is very large, so the Autocorrelation up to 16 lags was tested.

Autocorrelation is obtained as;

$P_k = COV\ (Y_t - Y_{t-1})/Var(Y_t)$ (2)

P_k =Autocorrelation

COV (Y_t, Y_{t-1}) = Covariance between Y_t and Y_{t-1}

Var (Y_t)= Variance of Y_t

Unit Root Test

Unit root test is a statistical tool that is used to test whether there is stationarity in the time series data (Wooldridge, 2013). When there is a unit root in time series data then it is inferred that it is nonstationary in time series data. Hassan, Shoaib, and Shah (2007) suggested that unit root can be used to test the market efficiency. Market efficiency needs unit root or non-stationarity or randomness in time series data. Augmented Dickey-Fuller (ADF) test was selected to test unit root, and insignificant result supports the market efficiency. ADF test was carried out by testing the following equations.

$\Delta Y_t = \theta Y_{t-1} + \lambda \Delta Y_{t-1} + e_t$ (3)

$\Delta Y_t = A + \theta Y_{t-1} + \lambda \Delta Y_{t-1} + e_t$ (4)

$\Delta Y_t = A + \beta t + \theta Y_{t-1} + \lambda \Delta Y_{t-1} + e_t$ (5)

Where,

$\theta = P - 1$

When $\theta = 0$ then p = 1 and unit root exists in time series data. The null hypothesis of the unit root test is unit root exists in data series, so we need insignificant test results for verification of weak-form market efficiency. Equation (3) is without intercept (A), equation (4) is with intercept and equation (5) is with intercept and time trend (t).

Variance Ratio Test

The last method selected for the test of market efficiency was the variance ratio test. The method was proposed by Lo and Mackinlay (1988). According to them, in order to have time-series data random, the variance of the q period should be q times the variance of the one period difference, i.e. the variance ratio must be unity. This test can be carried out under the assumptions of both homoscedasticity and heteroscedasticity asymptotic distribution. Chow and Denning (1993) proposed multiple variance ratio tests. It is similar to the variance ratio test, but it tests all intervals variances jointly. So, here the multiple variance ratio was used to test the randomness. An insignificant result supports the randomness in time series data. Sodsai and Suksonghong (2018) provided a simplified version of Lo and Mackinlay (1988) variance ratio test and Chow and Denning (1993) multiple variance ratio test.

$$VR(q)=\frac{\sigma\, 2(q)}{\sigma 2(1)} \quad (6)$$

Where,

$\sigma^2(q)$ = 1/q times the variance of q- period

$\sigma^2(1)$ = variance of one period

$$\sigma^2(1) = \frac{1}{T-1}\sum_{t=1}^{T}(Xt - Xt - 1 - \mu^\wedge)^2 \quad (7)$$

Where,

$$\mu^\wedge = \frac{1}{T}\sum_{t=1}^{T}(Xt - Xt - 1)$$

$$\sigma^2(q) = \frac{1}{Tq}\sum_{t=1}^{T}(Xt - Xt - q - q\mu^\wedge)^2 \quad (8)$$

Where,

$$Tq = (T-q-1)\left(1 - \frac{q}{T}\right)$$

According to Lo and Mackinlay (1988), the randomness test statistics under homoscedasticity and heteroscedasticity asymptotic distribution are obtained differently as follows:

$$Z(q) = [\ VR(q) - 1]\ [s^2(q)]^{-1/2} \quad (9)$$

The estimator s^2 under the assumption of homoscedasticity in time series is obtained from:

$$S^\wedge 2 = \frac{2(2q-1)(q-1)}{3qT} \quad (10)$$

The estimator s^2 under the assumption of heteroscedasticity is obtained from:

$$S^\wedge 2 = \sum_{j=1}^{q-1}\left[\frac{2(q-j)2}{q}\right]\sigma^\wedge j \quad (11)$$

Where,

$$\sigma^\wedge j = \left[\sum_{t=j+1}^{T}(Xt - 1 - u^\wedge)2\ (Xt - u^\wedge)^2\right] / \left[\sum_{t=j+1}^{T}(Xt - 1 + u^\wedge)2\right]2\ Z(MV) = \max_{1\le i\le m}|s^{\wedge 2}qi| \quad (12)$$

Where,

i=1,2, 3…………, m

Z(MV) is multiple variance ratio test statistic.

S^2 as defined in equations (10) and (11).

Following hypotheses were developed to test applying the above methods.

1. Daily returns of the NEPSE index follows the weak form of market efficiency.
2. Daily returns of the Banking sub-index follow the weak form of market efficiency.

Daily returns of manufacturing and processing sub-index follow the weak form of market efficiency.

Results and Discussion

Descriptive Statistics

Descriptive statistics of daily returns of NEPSE and its other two sub-indexes before applying above mentioned five methods are shown in table (1).

Table 1

Descriptive Statistics of Daily Returns of NEPSE and its Two Sub-indexes

Statistics	NEPSE	Banking	Mfg. & Proc.
Mean	0.174	0.1473	0.586
Median	0.083	0.0053	0.005
Std. Dev.	1.437	1.902	10.215
Skewness	0.001	0.462	14.126
Kurtosis	5.606	19.632	272.549
Minimum	-6.04	-14.66	-65.11
Maximum	6.06	14.83	187.52

Source: Annual report of NEPSE and authors' calculations.

Normality Test

Table (2) represents the results of the normality test of three indices' daily returns. H0 of normality test of the distribution is normal, so we need the statistically insignificant result to have a normal distribution. According to statistical rule, as explained in the method, random sequence approximately normally distributes

Table 2

Results of Normality Test

Indexes	K-S Statistic	Sig.	S-W statistic	Sig.
Daily Return on NEPSE	0.116	0.000	0.885	0.000
Daily Return on Banking sub-index	0.177	0.000	0.754	0.000
Daily return on Manufacturing and Processing sub-Index	0.343	0.000	0.165	0.000

Source: Annual report of NEPSE and authors' calculations.

Normality of the data was tested using Kolmogorov-Smirnov(K-S) test and Shapiro-Wilk(S-W) test. The results of both tests were statistically significant, proving that the distribution was not normal or random.

Runs Test

Table 3

Results of Runs Test

Statistics	Daily Return on NEPSE	Daily Return on Banking sub-index	Daily return on Manufacturing and Processing sub- index
Test Value Median	0.08	0.01	0.000
Cases < Test Value	212	212	211
Cases > Test Value	213	213	211
Total Cases	425	425	422
Number of Runs	177	184	209
Z	-3.545	-2.865	-0.292
Sig.	0.000	0.004	0.770

Source: Annual report of NEPSE and authors' calculations.

The null hypothesis of the runs test (H0) is that the order or sequence of observations is random, so we need the statistically insignificant result to verify the efficient market hypothesis. The test result showed that the daily returns of the Manufacturing and Processing sub-index are random since its p-value is greater than 0.05, but other results were significant, proving no randomness. The result of the run test was not consistent with the results of the normality test with respect to the Manufacturing and Processing sub-index.

Autocorrelation Test

Table (4) shows the results of the autocorrelation test.

Table 4

Results of Autocorrelation Test (AC)

Lag	AC	Q-Stat	sig.	AC	Q-Stat	sig.	AC	Q-Stat	sig.

	NEPSE			Banking			Mfg.& Proc.		
1	0.087	3.2355	0.072	-0.067	1.9032	0.168	-0.309	40.571	0.000
2	-0.051	4.3437	0.114	-0.135	9.7662	0.008	-0.002	40.572	0.000
3	0.055	5.6327	0.131	0.09	13.254	0.004	-0.001	40.572	0.000
4	0.133	13.256	0.01	0.068	15.275	0.004	0.014	40.652	0.000
5	0.047	14.226	0.014	-0.005	15.287	0.009	0.004	40.657	0.000
6	0.019	14.386	0.026	-0.013	15.36	0.018	-0.004	40.665	0.000
7	0.042	15.138	0.034	0.026	15.65	0.029	-0.01	40.708	0.000
8	0.032	15.581	0.049	0.005	15.659	0.048	0.005	40.717	0.000
9	0.006	15.595	0.076	-0.07	17.776	0.038	-0.004	40.724	0.000
10	-0.067	17.574	0.063	-0.112	23.263	0.01	-0.013	40.794	0.000
11	0.066	19.492	0.053	0.09	26.783	0.005	0.005	40.803	0.000
12	0.036	20.064	0.066	0.116	32.678	0.001	-0.014	40.893	0.000
13	-0.096	24.116	0.03	-0.088	36.099	0.001	0.009	40.928	0.000
14	-0.039	24.798	0.037	-0.067	38.068	0.001	-0.018	41.071	0.000
15	-0.035	25.348	0.045	-0.012	38.13	0.001	-0.006	41.085	0.000
16	-0.046	26.285	0.05	-0.053	39.369	0.001	0.006	41.103	0.001

Statistically insignificant autocorrelations show that the time series data are independent of each other, i.e. they are randomly generated, but our result showed that most of the autocorrelations were statistically significant, and we concluded that the daily returns of three index did not follow random walks theory, but they followed Dow Theory.

Unit Root Test

Table 5

Results of Augmented Dickey-Fuller Test

	NEPSE	Banking	Mfg. & proc.

	t-statistic	sig.	t-statistic	sig.	t-statistic	sig.
Without intercept	-18.5991	0.000	-17.07109	0.000	-28.07128	0.000
With intercept	-18.825	0.000	-17.23891	0.000	-28.17334	0.000
with intercept and trend	-19.0696	0.000	-17.33336	0.000	-28.16986	0.000

We applied an augmented Dickey-Fuller test to test the unit root. It was conducted on daily returns of NEPSE, banking sub-index (Banking) and Manufacturing and Processing sub-index (Mfg. & Proc.). The null hypothesis of this test is daily return series contains a unit root. Our test results fail to accept the hypothesis, i.e. the daily return series contain a unit root since Mackinnon's one-sided p-value is less than 0.05, and we can conclude that daily returns of NEPSE, banking sub-index and Mfg. and Proc. Sub-index are not in a weak form of market efficiency.

Variance Ratio Test

Table 6

Results of the Variance Ratio Test

Index	Homoscedasticity		Heteroscedasticity	
	|z|-statistic	Sig.	|z|-statistic	Sig.
NEPSE	8.6870	0.000	3.7636	0.000
Banking	9.6341	0.000	2.4426	0.057
Mfg. & Proc.	12.6680	0.000	1.4124	0.497

Variance ratio test was conducted on daily return series of NEPSE, banking sub-index (Banking) and Manufacturing and Processing sub-index (Mfg. & Proc.) under the assumptions of homoscedasticity and heteroscedasticity asymptotic distribution, respectively. Here, we applied a multiple variance test ratio, and the null hypothesis of the test is daily return series is random. The results under the assumption of the homoscedastic distribution of three indices were consistent, and the test rejected the null hypothesis since p-values are less than 0.05. Therefore, we conclude that the daily return series of NEPSE, banking, and manufacturing and Processing are not consistent with the efficient market hypothesis under the assumption of homoscedasticity asymptotic distribution.

The results under the assumption of heteroscedasticity of three indices were not consistent. The test result of NEPSE daily return rejected the null hypothesis, but the test results of banking and Manufacturing and Processing supported the null hypothesis.

Most of the test results of the above rejected the weak-form efficient market hypothesis, so we can conclude that the securities prices or returns in the Nepalese stock market are not in the line of weak-form market efficiency, and they do not follow random walks theory, but they follow Dow theory.

Conclusion

This paper examines the weak-form market efficiency hypothesis in the Nepalese context using normality test, runs test, autocorrelation function test, unit root test and multiple variance ratio test method. All tests produce consistent results except for the Banking sub-index and Mfg. and proc—sub-index under variance ratio test and Mfg. and Proc. sub-index under runs test. This paper concludes that the Nepalese stock market is not in weak-form market efficiency. This conclusion is in line with past studies in the Nepalese context (G. C., 2010; Dangol, 2012; and Bam, Thagurathi, & Shrestha, 2018). There are many assumptions for the stock market being efficient (Copeland, Weston, & Shastri, 2007). The assumptions may not be materialized in our context, being small and young market. Investors' behaviour and decision-making style also impact market efficiency. Herd behaviour and hasty decision among Nepalese investor are common phenomena (Rishal & Khatiwada, 2019). From these we conclude that being Nepalese stock market inefficient is logical but it is not favorable for investors as well as for economy. Policy makers and regulators of stock market should materialize requirement for efficient stock market.

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