Testing the Weak Form of Efficiency in Nepalese Stock Markets

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Article info

Article History:
Article received: January 2020
Article accepted: August 2020
Article available: January 2021

JEL Classification:
G10, G14, O16

Key Words:
Weak Form of Efficiency
NEPSE Index
Efficient Market Hypothesis
Nepalese Stock Markets

ABSTRACT

The purpose of the study is to examine the Nepalese stock markets for the weak form of efficiency. Previous studies in this area in Nepalese stock markets have shown mixed results; most studies concluded that the market is inefficient in the weak form, while the market was found to be efficient in weak form when the return series were adjusted for infrequent trading. This study has explored the Nepalese stock market for the weak form of efficiency using normality test, autocorrelation test, run test, and unit root test on the daily returns of NEPSE Index from January 2010 till December 2019. This study revealed that the return series deviated significantly from the normal distribution which was tested using Jarque-Bera (JB) Test. Significant autocorrelation was found with their lagged values. Run tests showed that the return series of NEPSE Index did not occur randomly. The same was evident from Phillips-Perron (PP) test and Augmented Dicky-Fuller (ADF) test. The study concluded that the Nepalese stock market is inefficient in weak form indicating that future price movements can be predicted based on their past price movements.

I. Introduction

The highly pronounced and debatable theory is the Efficient Market Hypothesis (EMH) with three different level of efficiency as weak form, semi-strong form and the strong form, (Fama, 1970 and 1995). In case of developed economies, the markets are found efficient at the weak form and partially at the semi-strong form as well.

Fama (1965) has described an efficient market as a market where all available set of information is reflected on the stock price at given point of time so that the price represents a fair value of the stock. No mechanical trading strategies shall help you in predicting future stock returns in light of historical return series and thus such strategies shall perform poorly as compared to the strategy to buy and hold in a market with the weak form of efficiency (Fama,1995). Few of the popular moving averages-based trading strategies were put into test by Van Horne and Parker (1967) and found that these strategies performed poorly as compared to the strategy to buy and hold thus presenting a case for the random walks of stock prices.

Asian markets had gone through several checks for random walk behaviour and the market's efficiency. While Poshakwale (2002) stated that stock prices didn't originate randomly in the Indian stock markets, Hasan (2004) couldn't categorically state the stock markets in Bangladesh as either efficient or inefficient in weak form. The findings in the Chinese stock markets were different based

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on the type of security being tested (Charles & Darné, 2009). Hamid, Suleman, Ali Shah, and Akash (2010) labeled the stock markets of 14 Asia-Pacific countries that they tested for as inefficient markets. Khan, Ikram, and Mehtab (2011); Jagannathan (2014); and Rahmanizadeh (2015) provided empirical evidence of market inefficiency in the Indian stock markets. Other researches, however, found mixed results while testing the Indian stock markets (Joshi, 2012; Bapusaheb, 2012). On the contrary, Mahajan and Luthra (2013) and Mishra (2017) based on their findings claimed that the Indian stock markets was efficient in weak form.

In an efficient market, stock prices at any point of time represent the fair value of the stock because stock prices in the market are set as such that all available information is priced in (Fama, 1965). The change in market price is subjected to only new information coming to the market and all market participants have equal access to new information when they come to light in an efficient market. Once any new piece of information comes to light, the large number of rational market participants trade instantaneously based on this information such that the price is adequately adjusted for this new piece of information (Maku & Atanda, 2009; Fama, Fisher, Jensen, & Roll, 1969). The never-ending tussle among these active market participants renders to a scenario where prices stay at a level that fairly values all available information (Fama, 1995). Scholars of EMH often question the rationale of the fundamental analysis and the technical analysis; they often claim that the timing of the stock purchase is irrelevant as the stock price at any point of time is a fair representation of its intrinsic value. Fama (1965) argues that no mechanical trading practice will earn you better returns than the simple strategy of buy and hold. The efficiency of any market can be explained in three levels based on the type of information that the stock price is reflective of (Fama, 1970). One, Weak form of efficiency; when past price movements, their patterns, and trends will not help you in predicting their future movements. Two, Semi-strong form of efficiency; all the publicly available information too will not help you in predicting future stock prices. Moreover, even private information is not good in predicting future stock prices in a Strong form of efficiency.

In an efficient market, all available information is already priced in, thus, stock prices will change only with new information. Since new information is in itself random, stock prices should move randomly; meaning that stock prices have no predictable pattern (Sharpe, Alexander, & Bailey, 1999). Fama (1970) argued that when stock prices move in random, each price change is independent of previous price changes. In other words, current price changes have no memory of past price movements.

It is the market participants' rational trading decisions that make the stock market efficient and prices reflect all available information. However, it is not always true, market participants do not always make rational decisions. Shefrin (2002) stresses that even savvy or experienced investors become the victim of these human biases and quirks like overconfidence and emotions and let them cloud their investment decisions, thus creating market anomalies. The impact of psychological and sociological factors on an individual's financial decision is studied under behavioural finance (Ricciardi & Simon, 2000). Stock markets have been found to have anomalies but these anomalies became statistically insignificant sometime after their publications (Bapusaheb, 2012). This was because, with the discovery of market anomalies, market participants started to trade on these

anomalies counteracting their effects. This take on market efficiency is known as Adaptive Market Hypothesis (AMH). AMH argues that Behavioural Finance and EMH can coexist in real life; a new school of thought introduced by Lo (2004, 2005).

In the context of Nepal, KC and Joshi (2005) claimed that the Nepalese market is inefficient citing the calendar anomalies found in their research. Pradhan and Upadhyay (2006) results were inconsistent with EMH. The Nepalese stock market was tested for a weak form of efficiency for economically neutral behavioural variables like weather and biorhythms also; where the results were mixed (Joshi & Bhattarai, 2010). Bhatta (2010) and GC (2010) unveiled that the stock markets in Nepal is inefficient. Gaire (2017) examined the predictability of the NEPSE Index using daily data proved that the index is very much predictable. However, Pradhan and KC (2010) found efficient market behaviour in a few of the stocks tested.

The results of the studies conducted in the Nepalese stock markets are divided regarding its efficiency. For instance, Pradhan and Upadhyay (2006) and Bhatta (2010) found conclusive proof that the Nepalese stock market does not follow a random walk and thus is not efficient in weak form. Dangol (2012, 2018) reported contradictory results when tests were conducted with observed NEPSE Index data and when NEPSE Index data was adjusted for thin trading. Much of the research has been conducted with data until 2010. Since then, the Nepalese stock markets has undergone many changes. Trading has significantly increased over the years. Information dissemination is being more efficient every passing day and investors are more and more aware of security analysis.

Mphoeng (2019) has identified the need of continued research on possible aspects of the stock markets in order to enhance the knowledge in a bid to improve efficiencies and also for the sufficient liquidity of the stock markets. Further, Kofarbai and Zubairu (2016) highlighted on shortcoming of the EMH as well as how it has helped in deepening stock markets worldwide because of its acceptability. They have also pointed out the need of more researches to be conducted in the emerging markets. Although stock markets in developed economy have been found to be efficient at the week form, it is always controversial in case of emerging economy (Sarkar, 2019).

Based on the above discussions, this study aims at testing the weak form of efficiency in Nepalese stock markets. It mainly deals with whether stock market returns in Nepal are correlated with historic returns and if the Nepalese stock markets is efficient in weak form. For the purpose following hypotheses were tested:

$\mathbf{H_1}$: The distribution of stock returns is not significantly different from a normal distribution.

$\mathbf{H_2}$: Stock returns have a significant serial correlation with past returns.

$\mathbf{H_3}$: Stock returns are not originated randomly.

$\mathbf{H_4}$: Stock return series have no unit root.

All above hypotheses are set with a motive of identifying if the stock returns in Nepalese markets can still be predicated based on the historical prices.

The remainder of this study is organised as follows. Section II deals with the research methodology adopted in this study while empirical results are reported in section III. Section IV presents the concluding remarks.

II. Research Methodology

Following the stated theoretical framework, this is a descriptive research and explores the nature of the Nepalese stock markets. It has focused on testing the weak form of market efficiency by testing four hypotheses in the daily stock returns. GC (2010) and Mishra (2017) had based their research on daily returns. In Nepal, there is NEPSE Index - a value-weighted index- that considers market capitalisation of all the listed stocks that represents the change in prices of overall stocks (Gaire, 2017). The study has used NEPSE Index for testing the market efficiency because NEPSE Index reflects the overall stock market unlike other indices which gives only partial representation of the overall markets. The study has taken a daily NEPSE Index of 10 years; from January 2010 until December 2019 which represents a complete market cycle including a bearish trend and a bullish trend of the market and has a sample size of 2,312 daily return of NEPSE Index. The paper has used daily log returns, which are calculated as:

$$R_t = \ln\left(\frac{P_t}{P_{t-1}}\right) * 100 \quad \text{.....} \quad (1)$$

Such that R_t, P_t, and P_{t-1} is the return for the period t, the value of NEPSE Index at the end of time t and time t-1 respectively, and ln refers to natural log. The daily data is extracted from the Nepal Stock Exchange's official website. Logarithmic returns are used as they give better prediction while working with data spread across a longer period (Strong, 1992).

The study has used normality test, autocorrelation test, run test and unit root test on daily returns to arrive at conclusion regarding the weak form of efficiency in Nepalese stock markets. These tests have been previously used by Bhatta (2010); GC (2010); Pradhan and KC (2010); Jagannathan (2014); Rahmanizadeh (2015); Mishra (2017); and Dangol (2018).

The methodology used for the 1st hypothesis (H_1): The distribution of stock returns is not significantly different from a normal distribution.

JB test statistic has been used to examine whether the stock returns follow a normal distribution. JB test measures the degree of deviation in the kurtosis and skewness of the distribution of daily returns with the kurtosis and skewness of a normal distribution. JB test statistic has been calculated as under:

$$JB = \frac{T}{6}\left[S^2 + \frac{(K-3)^2}{4}\right] \quad \text{.....} \quad (2)$$

Such that T, K, and S denote the number of observations, skewness, and kurtosis, respectively.

If JB > χ^2 (2) where 2 is the degree of freedom, then the null hypothesis is rejected; or when the p-value is lower than the level of significance, 1% in this case.

The methodology used for the 2nd hypothesis (H_2): Stock returns have a significant serial correlation with past returns.

The autocorrelation coefficient measures the degree of serial correlation between the data series. Autocorrelation coefficient has been calculated as follows:

$$AC_k = \frac{\sum_{t=1}^{n-k}(R_t - \bar{R})(R_{t+k} - \bar{R})}{\sum_{t=1}^{n}(R_t - \bar{R})^2} \quad \text{.....} \quad (3)$$

Such that AC_k, n, and k denote autocorrelation coefficient, degree of lag, and the number of observations respectively. Whether the serial correlation is significant or not was tested in two ways, (1) Standard Error test and (2) Durbin Watson test.

The autocorrelation coefficient is the test statistics in the Standard Error test which is compared with Standard Error of the estimates. If the test statistics is greater than twice the Standard Error of the estimates, then the null hypothesis is rejected. The autocorrelation coefficient has been calculated for the return series with a lag of one to twenty.

Whereas for the Durbin Watson test, the test statistic has been calculated as follows:

$d = 2 * (1 - AC_k)$ …… (4)

The methodology used for the 3rd hypothesis (H_3): Stock returns are not originated randomly.

Run test detects the randomness in a data series. Run test compares the number of expected runs and the observed runs in the data series. Run test was carried out twice; first taking mean as a base followed by median as a base.

The test statistics of the run test is Z-statistic, which was calculated as:

$$Z(R) = \frac{R - E(R)}{\sigma(R)} \quad \text{..... (5)}$$

The methodology used for the 4th hypothesis (H_4): Stock return series have no unit root.

Augmented Dickey-Fuller (ADF) test and Philip Perron (PP) test are used to test for the unit root in the daily return series. Although ADF is a widely used test to check the stationarity of data, PP test has also been applied to complement and authenticate the results. ADF test has been carried out in three different models, i.e., (1) with a constant term and a trend term, (2) with only a constant term and (2) with neither a constant term nor a trend term which are presented below:

$$\Delta P_t = \alpha_0 + \alpha_1 t + \beta P_{t-1} + \sum_{t=1}^{k} \delta \Delta P_{t-i} + \varepsilon_t \quad \text{..... (6)}$$

$$\Delta P_t = \alpha_0 + \beta P_{t-1} + \sum_{t=1}^{k} \delta \Delta P_{t-i} + \varepsilon_t \quad \text{..... (7)}$$

$$\Delta P_t = \beta P_{t-1} + \sum_{t=1}^{k} \delta \Delta P_{t-i} + \varepsilon_t \quad \text{.....(8)}$$

Such that P_t is the daily return at time t, k is the degree of lag, () is the constant term, (t) is the trend term and ε_t is a white noise disturbance term. The unit root test was conducted with a null hypothesis: H_0: $\beta = 0$.

Unlike ADF test, PP test is a non-parametric test therefore is free from parametric errors. PP test was carried out with the same three different models, i.e., (1) with a constant term and a trend term, (2) with only a constant term, and (2) with neither a constant term nor a trend term.

III. Data Analysis and Results

As of mid-July 2020, Nepalese stock market capitalisation amounts to NPR 1,793 billion, which is 47.6 percent of the country's GDP. Of 212 companies listed in Nepal Stock Exchange, 147 are Bank and Financial Institutions and insurance companies, 19 of them are manufacturing and processing companies, 33 hydropower companies, 4 hotels, 4 trading institutions, and another 5 of other sectors (Nepal Rastra Bank (NRB), 2020). The overall stock market is measured by a weighted

average market index, NEPSE.

Since 2010, the Nepalese stock market has gone through many changes. Central Depository System and Clearing (CDSC) Limited was established in 2010 that initiated the dematerialisation of securities, which made trading easier. Online trading was commenced in the Nepalese Stock markets in November 2018. Investors have more access to information today. The size of the market has more than quadrupled since 2010 as measured by market capitalisation; NPR 408 billion during mid-January 2010 compared to NPR 1,793 billion in mid-July 2020 (NRB, 2020). Annual turnover has increased by more than 17 folds from FY 2009/10 to FY 2016/17 (NMB Capital Limited (2018). Though annual turnover has declined during recent fiscal years, it is still nine-fold higher than those of FY 2009/10. Further, this period witnessed a smooth operation through the computerised system as opposed to earlier open outcry system and NEPSE Index swung from the low of 292.31 points (2011/06/15) to the peak of 1,881.45 points (2016/07/27).

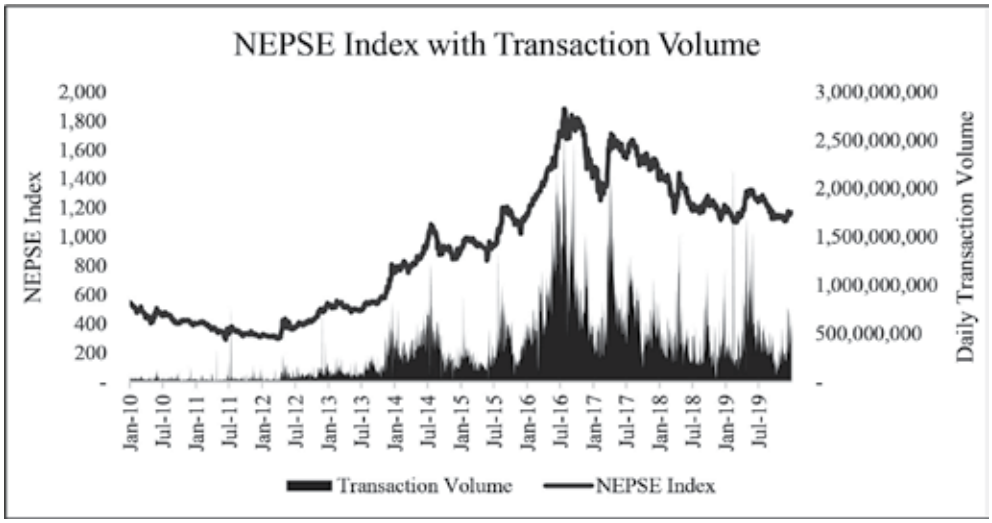

Figure I: The Market Behaviour Over a Decade

The Figure I portrays the market behaviour of NEPSE Index over a decade of major growth and fluctuations. The major bulls and bears alongside growth in transaction volume also validate the need for this study. Rana (2020) has highlighted that the Nepalese stock markets faces the conditional volatility demanding the need of risk assessment by market participants for a sound strategy. Further, the introduction of Electronic Debit Instruction Slip (E-DIS) has eased the problem of unnecessary hassles while selling stocks. In view of recent development in the stock markets, the findings from

the previous studies might not reflect the current market behaviour.

The first and foremost test carried out in the research was the normality test. The test examined whether or not the distribution of NEPSE Index's daily returns significantly deviates from a normal distribution. The study uses Kurtosis, Skewness, and JB test statistics.

Table I

Descriptive Statistics of Daily Stock Returns

The table provides descriptive statistics of the daily returns of NEPSE Index taken from January 2010 to December 2019. Descriptive statistics include mean, median, maximum, minimum and standard deviation Also, the table depicts how the return series fared against the normal distribution in light of kurtosis and skewness.

Particulars	Values
Observation	2,312
Mean	0.03%
Median	-0.05%
Maximum	5.81%
Minimum	-5.22%
Standard Deviation	1.20%
Kurtosis	7.52
Skewness	0.56
JB test statistic	2,089.07
p–value	.000

Table I shows that the observed return series has a skewness of 0.56 which shows the positive skewness of NEPSE's return series. The distribution of NEPSE Index's daily return was found to be slightly leptokurtic with kurtosis of 7.52. JB test rejected the null hypothesis. The p-value test was far less than the significance level of 0.01. Therefore, NEPSE Index's daily return series from 2010 to 2019 did not follow a normal distribution.

Serial Correlation Analysis

The degree of dependence of returns to past returns is measured by the autocorrelation coefficient. When autocorrelation coefficient approaches to zero, it means the returns are less and less dependent on past returns while when it approaches one, it means the returns are more and more dependent on past returns. Autocorrelation can range from 1 to -1, i.e., from being perfectly positively correlated to perfectly negatively correlated. When the autocorrelation coefficient deviated significantly from zero, it infers that returns are not independent of past returns. Standard Error test and Durbin Watson test were used for testing autocorrelation among daily returns.

Table II

Autocorrelation for Daily Stock Return (R)

The table provides the autocorrelation between NEPSE Index's daily return and its lagged returns (from lag 1 to lag 20). Autocorrelation between NEPSE Index's return and its lagged returns shows the degree to which they are related. These autocorrelations are compared to its standard error for their statistical significance.

Lag	Autocorrelation	Standard Error	Remarks
1	0.2311	0.0208	Statistically significant
2	-0.0369	0.0208	Statistically insignificant
3	-0.0173	0.0208	Statistically insignificant
4	0.0256	0.0208	Statistically insignificant
5	0.0093	0.0208	Statistically insignificant
6	0.0419	0.0208	Statistically significant
7	0.0855	0.0208	Statistically significant
8	0.0651	0.0208	Statistically significant
9	-0.0037	0.0208	Statistically insignificant
10	0.0047	0.0208	Statistically insignificant
11	0.0390	0.0208	Statistically insignificant
12	0.0000	0.0208	Statistically insignificant
13	0.0024	0.0208	Statistically insignificant
14	0.0293	0.0208	Statistically insignificant
15	0.0292	0.0208	Statistically insignificant
16	-0.0099	0.0208	Statistically insignificant
17	0.0039	0.0208	Statistically insignificant
18	0.0379	0.0208	Statistically insignificant
19	0.0418	0.0208	Statistically significant
20	-0.0036	0.0208	Statistically insignificant

As in the Table II, Autocorrelation Coefficients with lag from 1 to 20 were compared with respective Standard Error of the estimates. The return series with lags of 2, 3, 9, 16, and 20 had a negative autocorrelation whereas others return series had positive autocorrelation. However, the autocorrelation was found greater than their Standard Error only for lag 1, 6, 7, 8, and 19, which means that the autocorrelation was significant. Therefore, the null hypothesis is rejected inferring some level of autocorrelation was present in NEPSE Index's daily return series.

Table III

Serial Correlation Test Using Durbin Watson Test

The table provides the autocorrelation between NEPSE Index's daily return and its lagged returns at lag 1. Autocorrelation between NEPSE Index's return and its lagged returns shows the degree to which they are related. The autocorrelation is put to test using Durbin Watson Test for its statistical significance.

Particulars	Value
Autocorrelation Coefficient at lag one	0.231188445
Durbin Watson Test Statistic (d)	1.5376
Upper critical Value (du)	1.6840
Lower Critical Value (dL)	1.6640

The serial correlation is examined with Durbin Watson test operated for a lag of one only. The test results presented in Table III showed a positive autocorrelation among NEPSE Index's daily returns. Durbin Watson test was operated with a null hypothesis of no significant autocorrelation coefficient and the alternative hypothesis of positive autocorrelation coefficient. The test had a test statistic (d) of 1.5376, the upper critical value (d_u) of 1.6840, and the lower critical value (d_L) of 1.6640 at a 1% significance level. Since d is lower than d_L, the null hypothesis is rejected. Hence statistically proving the existence of positive autocorrelation in daily returns with its lagged value. This result is consistent with the findings from Rana, (2020) using Lagrange Multiplier (LM) test.

Randomness Analysis

The study examined the randomness of the stock return series with Run test. Run test compared the observed runs and the expected runs in the daily returns. Z-statistics was used to test whether the difference between them is statistically significant or not.

From the 2,067 observations, 1,149 observations had returns below the mean whereas 918 observations had daily returns on or above the mean as shown in Table IV.

Table IV

Run Test of Daily Stock Returns with the Mean as a Base

The table provides the results from Run test with mean as a base used to test the randomness of the daily returns of NEPSE Index from January 2010 to December 2019. The expected runs are compared with the actual runs for its statistical significance at 1 percent level of significance.

Particulars	Value
Total Runs (R)	883
Sample size	2,312
Number of observations below the mean	1,283
Number of observations on or above the mean	1,029
Expected Runs	1,144
Standard Deviation	23.746
Z- Statistic	-10.951
p-value	.000

A total of 1,144 runs were expected in NEPSE Index's daily returns with a standard deviation of

23.746. As compared to 1,144 expected runs, 883 runs were observed in the return series. Since the p-value was lower than the level of significance (i.e., 0.01), the null hypothesis is rejected. Hence, the conclusion is drawn that NEPSE Index's daily returns did not follow a random walk.

Table V
Run Test of Daily Stock Returns with the Median as a Base

The table presents the results from Run test with median as a base used to test the randomness of the daily returns of NEPSE Index from January 2010 to December 2019. The expected runs are compared with the actual runs for its statistical significance at 1 percent level of significance.

Particulars	Value
Total Runs (R)	935
Sample size	2,312
Number of observations below the median	1,156
Number of observations on or above the median	1,156
Expected Runs	1,157
Standard Deviation	24.036
Z- Statistic	-9.236
p-value	.000

Table V shows that 1,156 observations had returns below the median while 1,156 observations had daily returns on or above the median. NEPSE Index's daily returns had expected runs of 1,157 with a standard deviation of 24.036 whereas the observed runs totaled 935. Since the p-value was lower than the level of significance (i.e., 0.01), the null hypothesis is rejected. Hence, the conclusion is drawn that NEPSE Index's daily returns were not random.

Run tests with a base of mean and median both rejected the null hypothesis that means NEPSE Index's daily returns were not random.

Unit Root Analysis

A random walk has a unit root so, the daily returns series was tested for unit root. ADF test and PP test were used in the all three random walk model, i.e., with a constant term and a trend term, with only a constant term and with neither a constant term nor a trend term for a unit root in the NEPSE Index's daily returns with the null hypothesis that the daily returns have unit root and thus a non-stationary series or a random walk. ADF tests and PP tests were conducted at the level and the first difference. The optimum lag orders in the ADF equations are selected with Schwarz Info Criterion (SIC). Newey-West Bandwidth was used in PP test while Bartlett Kernel method was used for spectral estimation.

Table VI

Unit Root Test on the Random Walk Model with Constant and Trend

The table shows t-statistics of ADF test and PP test conducted on the daily returns of NEPSE Index from January 2010 to December 2019. The test examined stationarity of the daily returns at 1 percent level of significance using a random walk model with constant and trend.

Particular	ADF test		PP test	
	Level	1st Diff.	Level	1st Diff.
NEPSE	-32.78271	-19.33238	-38.49334	-249.37950

Table VII

Unit Root Test on the Random Walk Model with Constant but No Trend

The table shows t-statistics of ADF test and PP test conducted on the daily returns of NEPSE Index from January 2010 to December 2019. The test examined stationarity of the daily returns at 1percent level of significance using a random walk model with constant but no trend.

Particular	ADF test		PP test	
	Level	1st Diff.	Level	1st Diff.
NEPSE	-32.78974	-19.33655	-38.50126	-249.42440

Table VIII

Unit Root Test on the Random Walk Model with neither Constant nor Trend

The table shows t-statistics of ADF test and PP test conducted on the daily returns of NEPSE Index from January 2010 to December 2019. The test examined stationarity of the daily returns at 1 percent level of significance using a random walk model with neither constant nor trend.

Particular	ADF test		PP test	
	Level	1st Diff.	Level	1st Diff.
NEPSE	-32.76620	-19.34075	-38.52627	-249.48980

Test statistics were calculated for all three models for both ADF test and PP test. All the t-statistics were found to be smaller than Mackinnon's critical values for both ADF test and PP test at the level and the first difference which is shown in Tables VI, VII, and VIII. Thus, the null hypothesis was rejected. The finding indicates that the daily returns have no unit root. In other words, NEPSE Index's daily return series was stationary, i.e., not random.

IV. Concluding Remarks

The major conclusion of this study is that the Nepalese stock market is not efficient in the weak form as stock returns have a significant serial correlation with past returns and stock returns are not originated randomly.

The applied JB test found the daily returns in NEPSE Index not being normally distributed followed serial correlation. Then, daily returns were examined for random walks with the help of

run tests which conclusively shows that stock returns in the Nepalese stock markets weren't random. Lastly, the daily returns series was tested for unit root with ADF test and PP test. The daily returns were found to be stationary, i.e., returns were not random. From all the test results, it was concluded that the Nepalese stock markets is inefficient in weak form.

Based on findings of this research, an investor can look into the past return and use them to predict future returns. Different stock market predicting tools like Technical Analysis can turn out to be fruitful to generate abnormal market returns. Investors may look into specific industry and individual stocks employing the methods discussed in this study for informed decision making.

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