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Testing Random-Walk Behaviour in Nepalese Stock Market

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Abstract : *The paper examines random walk behaviour on daily market returns of the Nepal Stock Exchange (NEPSE) using Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests for the period between July 14, 2000 and January 14, 2010. The study finds that unit root do not exist, and the returns series are stationary. This provides the evidence that the Nepalese stock market does not show characteristics of random walk and thus, it is not efficient in the weak form. It implicates that market participants have opportunities to predict future price and earn abnormal returns from the stock market.*

I. INTRODUCTION

The study intends to measure the behaviour of the stock returns in the Nepal Stock Exchange (NEPSE), the only secondary stock market in Nepal. The prior hypothesis of the study is that the stock market is efficient and return series follow random-walk. If this is true, then past information including past prices are irrelevant in predicting future stock prices for the companies listed in the NEPSE. Then, market is said to be efficient in its weak form. To test the efficiency of the NEPSE, test for randomness of stock returns is an important one. Therefore, the research question is:

Do stock returns in the NEPSE follow a random walk?

This question is important for the following reasons: first, if stock returns series follow a random walk, then the series is non-stationary. In non-stationary series, technical analysis does not provide excess returns. Second, once the behaviour of the stock returns is determined, then one can better understand the market and the economy. It makes stock prices reflect the true picture of the company as well as the condition of the overall

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economy. It can provide better confidence to decision-makers and help in reducing the level of risk.

The Section II of the paper briefly reviews the related literature. Section III contains details about the data and methodology, while Section IV consists of the findings and Section V the conclusion.

II. LITERATURE REVIEW

For weak form tests, information can include only past history of security prices. Tests for weak form market efficiency are, more generally, referred to as test of return predictability (Fama 1991). The weak form of market efficiency is investigated by examining whether stock prices in equity markets exhibit specific patterns, which allow future prices to be predicted. For a market to be efficient in weak form then no such patterns should exist and prices should follow a random walk. The inefficient market in weak-form provides an opportunity to traders for predicting the future prices and earning abnormal profits.

To test the random walk behaviour of the stock prices, most of the studies (Groenewold and Kang (1993), Jarrett and Kyper (2005) and Worthington and Higgs (2009)) have applied unit root tests. As per the unit root test, if returns series contain unit root, i.e., data series are non-stationary, it suggests that market follows a random walk and it meets the criterion of weak-form market efficiency. On the other hand, if unit roots do not exist, the returns series will be stationary. Non-existence of unit root evidences that the stock markets do not show characteristics of a random walk and thus market is inefficient in the weak form.

Groenewold and Kang (1993) investigate the weak of market efficiency in the Australian share market. The tests are based on aggregate share price indices with log differences employing unit roots in the share prices. The study has found a unit root. The study data are found to be consistent with the Efficient Market Hypothesis. Another study of Worthington and Higgs (2009) also tests a random walk hypothesis using unit root tests (i.e., Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP), Kwiatkowski, Phillips, Schmidt and Shin (KPSS)). It shows that the monthly Australian stock returns follow a random walk, but daily returns do not; it is mainly because of short-terms autocorrelation in returns. The empirical evidences from the two different studies conducted by Groenewold and Kang (1993), and Worthington and Higgs (2009) are conflicting in the Australian case.

Similarly, Worthington and Higgs (2003b) also test random-walk behaviour of sixteen European developed markets using daily data. The study finds a mixed result: few countries follow random walk and efficient in the weak-form. Narayan and Prasad (2007) investigate market efficiency of seventeen European countries on monthly data using Panel unit root tests. The study reports that stock prices for the seventeen European countries are characterised by a unit root, consistent with the efficient market hypothesis. Similarly, Narayan, and Narayan (2007) examine market efficiency of G7 countries stock price indices on monthly data using Panel unit root tests. They provide strong evidence towards market efficiency and state that the G7 country markets are characterised by a unit root, consistent with the efficient market hypothesis. Jarrett and Kyper (2005) examine market efficiency using unit root test (ADF) in the United States. They report that unit roots exist, indicating the returns series are non-stationary. This provides the evidence that the US stock markets show characteristics of a random-walk and thus, they are efficient in the weak-form. The above studies provide evidences of market efficiency in the developed markets.

On the contrary, Worthington and Higgs (2003a) report all seven Latin American stock markets reject the presence of random walks, that is, the markets are inefficient in the weak form. These evidences show that testing market efficiency is a continuous process with different time-intervals and power of the tools.

Worthington and Higgs (2006) examine the weak form market efficiency of daily returns for Asian equity markets: ten emerging markets and five developed markets. They have mainly used ADF and PP tests for random walks. The unit root tests suggest weak form efficiency in all markets, with the exception of Australia and Taiwan. The findings of the study using different tools, other than unit root test, reports differently but developed markets are relatively more efficient than merging markets. Similarly, Samaratunga (2008) reports inefficiency of market while using weekly returns for Asia-Pacific regions: four emerging and four developed markets.

In the case of Middle East countries, Lucey and Segot (2005) report Turkey and Israel seem to follow random walk. Similarly, Omran and Farrar (2006) suggest that Israel exhibited weak form efficiency. The studies of Lucey and Segot (2005) and Omran and Farrar (2006) report that there is a limited evidence to support weak form efficiency for the stock markets of Egypt, Jordan, Morocco and Turkey. This implies that a degree of predictability of future returns for these emerging stock markets is possible. Israeli stock market seems relatively more efficient than that of other counties in the Middle East.

Using unit root test (ADF and PP) on daily stock market index for Emirates Securities Market (Abu Dhabi Securities Exchange and Dubai Financial Market), Marashdeh and Shrestha (2008) conclude that stock returns contain unit root and follow a random walk, which suggests that market meets the criterion of weak-form market efficiency. Asiri (2008) reports random walk with no drift and trend is confirmed for all daily stock prices and each individual sector of Bahrain Stock Exchange, and other tests support the efficiency of the BSE in the weak form. It indicates these stock exchanges in Arab countries' are efficient in the weak form.

Sunde and Zivanomoyo (2008) examine unit root test (i.e. ADF test) on monthly data of Zimbabwe Stock Exchange (ZSE) (second largest in sub-Saharan Africa after Johannesburg Stock Exchange) and concludes that the ZSE does not follow a random-walk.

In the South-Asia region, the present study reviewed the empirical studies using unit root tests in the context of Sri Lanka, Bangladesh and India. In Sri Lanka, Abeysekera

(2001) examines unit root on daily, weekly and monthly returns series. The paper rejects the null hypothesis of a unit root and concludes that the returns series are not random. In Bangladesh, Islam and Khaled (2005), and Uddin and Khoda (2009) report Dhaka Stock Exchange (DSE) does not follow the random walk model. In India, the various authors have examined the two stock exchanges, namely Nifty and Sensex representing National Stock Exchange and Bombay Stock Exchange. Based on the unit root tests, Ahmad et al. (2006) conclude that both stock exchanges exhibit a random-walk. On the contrary, Gupta and Basu (2007) report that both markets are weak-form inefficient. Similarly, Mishra (2009), Mishra et al. (2009), Mishra and Pradhan (2009), and Siddiqui and Gupta (2009) state that unit roots do not exist, and the returns series are stationary. This provides the evidence that the stock markets of India do not show characteristics of random walk.

The above studies show that stock prices are randomly formulated in developed stock markets. But interestingly, emerging markets like Emirates Securities Market and Bahrain Stock Exchange follow a random walk, i.e., efficient in the weak form. But, the emerging markets including those in the South-Asian region are inefficient in the weak form. Thus, market participants are able to predict future prices and earn abnormal profits in these emerging markets.

III. DATA AND METHODOLOGY

Data

The study employs daily returns of value-weighted portfolios of stocks listed with the Nepal Stock Exchange (NEPSE) for the periods between July 14, 2000 and January 14, 2010. It has total 2,225 observations of daily market returns. The All-Share Price Index is based on market prices of all stocks listed with the NEPSE. There are 168 companies listed in NEPSE as of January end 2010[1].

The study uses stock market returns as an individual time-series variable. Market returns are calculated from the daily price indices. Daily Market returns (P_t) are calculated from the price indices as follows:

$$P_t = Ln\left(\frac{P_t}{P_{t-1}}\right)$$

Where, P_t refers to market return in period *t*, PI_t, price index at period *t*, PI_{t-1}, the price index at period *t-1* and Ln refers to natural log. The reasons to take logarithm returns are justified by both theoretically and empirically. Theoretically, logarithmic returns are analytically more tractable when linking returns over longer intervals. Empirically, logarithmic returns are more likely to be normally distributed, which is a prior condition of standard statistical techniques (Strong, 1992).

1 As per NEPSE, www.nepalstock.com

Methodology

To test the efficient market hypothesis in the Nepalese stock market, the paper has considered conventional unit root tests, namely the Augmented Dickey-Fuller (Dickey-Fuller 1979) and Phillips-Perron (Phillips and Perron 1988) tests.

The daily stock returns series are tested for the presence of unit root in the log of the index using Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP), i.e., tests of the stationarity of the series.

The Augmented Dickey-Fuller (ADF) test makes a parametric correction in Dickey-Fuller (DF) test for higher-order correlation by assuming that the series follows an AR(p) process. The ADF approach controls for higher-order correlation by adding lagged difference terms of the dependent variable to the right-hand side of the regression equation. The Augmented Dickey-Fuller (ADF) test has the following three alternative models:

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

$$\Delta P_t = \alpha_0 + \beta P_{t-1} + \sum_{t=1}^{k} \delta \Delta P_{t-i} + \varepsilon_t \qquad (2)$$

$$\Delta P_t = \beta P_{t-1} + \sum_{t=1}^{k} \delta \Delta P_{t-i} + \varepsilon_t \qquad (3)$$

Where P_t is the stock price index at time t. The first model (equation 1) includes a constant term (α_0), a trend term ($\alpha_1 t$), k denotes the number of lagged terms[2] and ε_t is a white noise disturbance term. The second model (equation 2) includes a constant term (α_0) only, and the third model (equation 3) does not include constant and trend terms.

To test for stationarity, the null hypothesis is:

H_0: $\beta = 0$

And alternative hypothesis is:

H_1: $\beta < 0$

The acceptance of null hypothesis implies the existence of a unit root or non-stationarity of stock return series. It is the indication of presence of the characteristics of random walk and weak form efficiency of the market. The rejection of null hypothesis implies stationarity of stock return series, which indicates weak form inefficiency of the market.

The Phillips-Perron (PP) test introduces a non-parametric method to overcome the problem of serial correlation in the error term. In most of the cases the PP tests give similar results as the ADF test. The PP test has following specification:

$$\Delta P_t = \alpha + \rho P_{t-1} + u_t \qquad (4)$$

The advantage of the PP test is that it is free from parametric errors. In view of this, PP values have also been checked for stationarity. Equation (4) is estimated by using the ordinary least square (OLS) method.

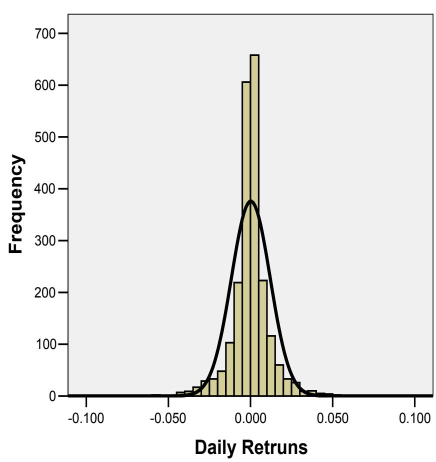
2 Lag orders are considered as per recommendation of Schwert (1989).

IV. RESULTS

To test the weak form of market efficiency, the study has first determined whether the stock returns follow a normal distribution or not. If stock returns series follow a normal distribution, it belongs to the assumption of random walk model; hence the market is accepted as having the weak form of efficiency. The paper tests normality using the skewness, kurtosis and Jarque-Bera statistic.

Descriptive statistics can be interpreted to test the informational efficiency of stock market. Generally, values for zero skewness and kurtosis at 3 represent that the observed distribution is normally distributed. Figure 1 shows the descriptive statistics with histogram. The distribution of daily stock returns have slightly negative-skewed but it is highly leptokurtic (peaked). Therefore, skewed and leptokurtic frequency distribution of daily market returns series indicates that the distributions are not normal. Jarque-Bera test also rejects the null hypothesis of normal distribution. It gives evidence that the frequency distribution is not normal. But the positive mean return and low variance indicate that the Nepalese stock market involves low risk.

Figure 1: Descriptive Statistics



Series: Daily Returns (NEPSE)
Sample: July 14, 2000 – January 14, 2010
Observations: 2225

Mean	0.000174
Median	0.000200
Maximum	0.099189
Minimum	– 0.094524
Std. Deviation	0.011804
Skewness	– 0.049782
Kurtosis	13.01173
Jarque-Bera	9293.519
Probability	0.000000

Table 1 reports the results of Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) test for unit roots. The ADF and PP tests conducted at level and first differences to all three models of random walk, i.e., constant and trend, constant and no trend, and no constant and trend terms in the series. As a necessary condition for a random walk, the ADF unit root test does not reject the requisite null hypothesis at level indicating that returns series is non-stationary and gets rejected at first difference. It indicates that the returns series is non-stationary; they follow a random walk.

All t-statistics are smaller than MacKinnon critical values for ADF and PP test at level and first difference to all three model of random walk; it indicates that the series is stationary. Thus, the results reject a unit root and conclude that the returns series are not random. So, there is no evidence against weak form of market efficiency during the study period.

Table 1: Unit Root Tests

The table reports Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests for stationarity of daily market returns series of Nepal Stock Exchange (NPSE) for nine and half years from July 14, 2000 to January 14, 2010. Augmented Dickey-Fuller (ADF) test hypothesis are H_0: unit root (non-stationary), H_1: no unit root (stationary). The lag orders in the ADF equations are determined by the significance of the coefficient for the lag terms[3]. The Phillips-Perron (PP)[4] test hypothesis are H_0: unit root (non-stationary), H_1: no unit root (stationary). ADF and PP tests include constant and trend, constant and no trend, and no constant and trend terms in the series. The null hypothesis is rejected if the t-statistics is smaller than the critical value.

Test type		Test statistics	Critical value at 1%	Critical value at 5%	Critical value at 10%	Inference
Constant and trend						
ADF test						
	Level	-7.0937	-3.9676	-3.4144	-3.1290	Reject null hypothesis
	First difference	-15.4307	-3.9676	-3.4144	-3.1290	Reject null hypothesis
PP test						
	Level	-35.9580	-3.9676	-3.4144	-3.1290	Reject null hypothesis
	First difference	-103.3107	-3.9676	-3.4144	-3.1290	Reject null hypothesis
Constant and no trend						
ADF test						
	Level	-7.0415	-3.4363	-2.8633	-2.5678	Reject null hypothesis
	First difference	-15.4317	-3.4363	-2.8633	-2.5678	Reject null hypothesis
PP test						
	Level	-35.9587	-3.4363	-2.8633	-2.5677	Reject null hypothesis
	First difference	-103.3411	-3.4363	-2.8633	-2.5677	Reject null hypothesis
No constant and trend						
ADF test						
	Level	-7.0466	-2.5667	-1.9395	-1.6157	Reject null hypothesis
	First difference	-15.4339	-2.5667	-1.9395	-1.6157	Reject null hypothesis
PP test						
	Level	-35.9631	-2.5667	-1.9395	-1.6157	Reject null hypothesis
	First difference	-103.3718	-2.5667	-1.9395	-1.6157	Reject null hypothesis

This paper has provided an additional empirical evidence of inefficiency of stock market to the South-Asian region. The study result is also consistent with the prior

3 Maximum and minimum lag orders are calculated as per recommendation of Schwert (1989):

$$k_{min} = 4\left(\frac{T}{100}\right)^{\frac{1}{4}} \text{ and } k_{max} = 12\left(\frac{T}{100}\right)^{\frac{1}{4}}$$, where T is the sample size.

4 The truncation lag (q) in the PP equations are determined as per Newey-West correction technique as:

$$q = 4\left(\frac{T}{100}\right)^{\frac{2}{9}}$$ where T is the sample size.

studies: Abeysekera (2001) of Sri Lanka; and with Islam and Khaled (2005), and Uddin and Khoda (2009) of Bangladesh. ilarly, in case of India, the current study result is in consonance with Gupta and Basu (2007), Mishra (2009), Mishra et al. (2009), Mishra and Pradhan (2009), and Siddiqui and Gupta (2009).

The reason for the market inefficiency may be the poor institutional infrastructure, weak legal framework, lack of supervision, slow development of the market infrastructure, poor corporate governance and accountability, low level of capacity of major market players and lack of transparency of market transaction. The study provides the time series behaviour of a less developed market of Nepal. The processing of new information in Nepal is rather weak. This may have resulted from persistent large number of non-actively traded shares, and limited role of mutual funds and professionally managed investment and broker houses. The absence of qualified analysts, institutional investors and investment-friendly environment is well-known constraints in the developing market like Nepal.

V. CONCLUSION

This paper examines the efficient market hypothesis in the Nepalese stock market employing Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) test for unit roots. The random walk hypothesis for NEPSE index is rejected during the period of analysis. The Nepalese stock market is inefficient in daily returns series suggesting that past movements in stock prices can be used to predict their future movements. It provides market players bring the possibility of earning higher returns than expected. The presence of random walk in the stock data has an important implication for portfolio investors, the allocation of capital within an economy and hence overall economic development. It is therefore relevant to suggest that there should be an effective regulatory framework and its implementation; and more effective role by all the stakeholders should be helpful in making the market reflective of a true picture of the economy.

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