

Testing Weak form Efficiency in the Indian Capital Market

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Abstract

Market Efficiency Hypothesis is an important notion for investors who wish to hold internationally diversified portfolios. If markets were not efficient task of constructing an internationally diversified portfolio for an investor will be an onerous task. With the increased movement of investments into emerging markets, greater importance is being given to the understanding of the market efficiency in emerging markets. In this paper we test the weak form efficiency or random walk hypothesis for the two major equity markets (BSE and NSE) in India for the period 1997 to 2011. Results of market efficiency are mixed as: for quarterly data, all three methods ADF, PP and KPSS tests support the weak form efficiency for later sample period 2007 to 2011, but slight conflict for earlier period 1997 to 2007 as only PP test shows weak form inefficiency; for monthly data, all three test method are consistent on the weak form efficiency for the period 2007 to 2011 and not efficient for earlier period 1997-2007. For daily and weekly data, all three test methods reject weak form efficiency during all sample periods.

Keywords: Weak form market efficiency, India, Random walk hypothesis.

JEL Classification Codes: G10, G14

I. Introduction

Efficiency Market Hypothesis (EMH) is an important theory in terms of the understanding of the equity markets and the cost of equity capital. In terms of capital market theory, the conception of market efficiency is used to explain the degree to which stock prices reflect available, relevant information in a timely manner. The concept of EMH is based on the arguments put forward by Samuelson (1965) that anticipated price of an asset fluctuate randomly around its expected value. Fama (1970) presented a formal conception of the theory and evidence for market efficiency and subsequently revised it in his paper based on further developments (Fama 1991).

Market efficiency has important implications for the investment policy of investors because if the equity market in which you are investing is efficient researching to find underpriced or overpriced assets will be a futile exercise. In an efficient market, prices of the assets will reflect markets' best estimate for the risk and expected return of the asset, taking into account the available information at the time. Therefore, there will be no undervalued assets with an expectation of higher than expected

risk adjusted return or overvalued assets offering lower than the expected return. All assets will be fairly priced in the market offering optimal reward to risk. In an efficient market an optimal investment decision will be to look at risk and return characteristics of the asset and/or portfolio. On the contrary, if the markets were not efficient, an investor will be better off trying to identify miss-priced assets as correct identification of such assets can enhance the overall performance of the portfolio (Rutterford 1993). In this context EMH has two important functions - as a theoretical and predictive model about how financial markets operate; and as a tool in an impression management campaign to influence more people to invest their savings in the stock market (Will 2006).

With the increase in flow of investments into emerging markets, academics and practitioners are paying increased attention to the emerging markets resulting in a better understanding of these markets. The increase in investments into the emerging markets may be because of deregulation in the emerging markets and the resulting integration of emerging markets with the developed markets. Contribution of equity markets in the process of development in developing countries is less and that resulted in weak markets with restrictions and controls (Gupta 2006). Policy makers have a potential interest in improving the market efficiency as they seek to make stock market more attractive to international investors in current globalised environment.

In the last three decades, a large number of countries have initiated reform process to open up their economies. These are broadly considered as emerging economies. Emerging markets have received huge inflows of capital in the recent past and became viable alternative for investors seeking international diversification. Among the emerging markets India has received more than fair share of foreign investment inflows since its reform process began. One reason could be the Asian crisis which affected the fast developing Asian economies of the time (also sometimes collectively called 'tiger economies'). India was not affected by the Asian crisis and has maintained its high economic growth during the period (Gupta and Basu 2005).

India recently has been one of the fastest growing emerging economies in the world at present. The reform process in India formally started in 1991. As a result, demand for investment funds is growing significantly and capital market growth is expected to play an increasingly important role in the process. At this dynamic stage in capital markets of India it is necessary to assess the level of efficiency of the equity markets in India in order to establish its longer term role in the process of economic development. However, studies on market efficiency of equity markets in India are very few. They are dated and mostly inconclusive. The objective of this study is to test whether the Indian equity market is weak form efficient or not. EMH, similar to other theories involving future expected prices or returns, use past actual prices or returns for the tests. Sets of share price changes are tested for serial independence. Random walk theory for equity prices suggest an equities market in which new information is quickly and accurately discounted into prices and abnormal or excess returns cannot be made from observing past prices is weak form efficient (Poshakwale 1996; Gupta and Basu 2007). One of the motivations of this study is from the study by Gupta and Basu (2007) who find no evidence to support weak form market efficiency in India. With recent developments in global markets especially in emerging markets there is need to revisit the notion of market efficiency in the stock markets of India. Globalisation and increased level of integration of India's market with developed markets may have changed degree of market efficiency in stock markets of India.

The next section of this paper provides a brief background of the Indian equity market and a brief literature review of studies testing market efficiency in emerging markets. Section 3 explains the methodology used in this study and data sources, followed by the results of the analysis in section 4. The last section summarises the conclusions and their implications.

II. Background

Equity Market in India

The reform process in India began in early 1990s with stock exchanges and then spread to banks, mutual funds, NBFCs and of late, to insurance companies. However, reforms in equity market in particular commenced in mid-1980s (Datar and Basu 2004). Traditionally, stock exchanges were governed by brokers leading to conflict of interest situation between the interest of common investors and those of brokers/owners of stock exchanges. With the establishment of National Stock Exchange (NSE), a new institutional structure was introduced in India that could ensure smooth functioning of market through a combination of new technology and efficient market design. The Securities Exchange Board of India (SEBI) was set up as a market regulator with statutory powers to control and supervise operations of all participants in the capital market viz. stock exchanges, stock brokers, mutual funds and rating agencies. The development of debt market is another significant development, which has been facilitated by deregulation of administered interest rates. Opening of stock exchange trading to Foreign Institutional Investors (FIIs) and permission of raising funds from international market through equity linked instruments have introduced a degree of competition to domestic exchanges and other market participants. Operations of FIIs have facilitated introduction of best practices and research inputs in trading and risk management systems.

In this study, to determine market efficiency of equity markets in India, we considered two stock exchanges – BSE and NSE. The BSE has the largest number of listed companies in the world¹ and the equity market capitalization of the companies listed on the BSE was US\$1.63 trillion as of December 2010, making it the 4th largest stock exchange in Asia and the 8th largest in the world². The 9th largest stock exchange in the world by market capitalization is NSE, the other stock exchange located at Mumbai, it has market capitalization of around US\$1.59 trillion and over 1,552 listings as of December 2010³. BSE is the oldest stock exchange in India and as such has the longest time series data available. Stability in prices for the BSE was considered to be an important feature. During the period 1987 to 1994, average annual price fluctuations of ordinary shares on BSE were 25.1% as compared with London Stock Exchange (22%), and the New York Stock Exchange (23.9%) (Poshakwale 1996). NSE is one of the newer stock exchanges in India. Because of government's support, NSE is fast becoming more accessible market to domestic and foreign investors. Currently NSE is the largest stock exchange in India by daily turnover and number of trades for both equities and derivative trading⁴. The perceived liquidity and accessibility of the NSE market is an important factor and may have different impact on the market efficiency. High liquidity in the market is an important pre-condition for the market efficiency, since a thinly traded market is not in a position to adjust to the new information quickly and accurately. Thus, analysis of two major equity markets in India together should provide a more comprehensive and complete picture.

Studies on Market Efficiency

The efficient market hypothesis is related to the random walk theory. The idea that asset prices may follow a random walk pattern was introduced by Bachelier in 1900 (Gupta and Basu 2007). The random walk hypothesis is used to explain the successive price changes which are independent of each other.

Fama (1970) attempted to organize the growing empirical evidence on the theory and he presented the efficient market theory in terms of the current market price fully reflects all available information and the expected return based upon this price is consistent with its risk. Fama also divided market efficiency into three sub-hypotheses depending on the information set involved: (1) weak form

¹ "BSE - Key statistics". Bseindia.com.

² World-exchange.org

³ World-exchange.org

⁴ "National Stock Exchange". Nasscom.in.

efficiency, (2) semi-strong form efficiency and (3) strong form efficiency. In its weak form efficiency, equity returns are not serially correlated and have a constant mean. If market is weak form efficient, current prices fully reflect all information contained in the historical prices of the asset and a trading rule based on the past prices cannot be developed to identify miss-priced assets. Market is semi-strong efficient if stock prices reflect any new publicly available information instantaneously. There are no undervalued or overvalued securities and thus, trading rules are incapable of producing superior returns. When new information is released, it is fully incorporated into the price rather speedily. The strong form efficiency suggests that security prices reflect all available information including private information. Insiders profit from trading on information not already incorporated into prices. Because of this it may not be practicable for strong form efficiency to hold and may be difficult to test.

Studies testing market efficiency in emerging markets are few. Poshakwale (1996) showed that Indian stock market was weak form inefficient, he used daily BSE index data for the period 1987 to 1994. Gupta and Basu (2007) found mixed evidence for weak form efficiency during the period 1997 to 2006. Barua (1987), Chan, Gup and Pan (1997) observed that the major Asian markets were weak form inefficient. Similar results were found by Dickinson and Muragu (1994) for Nairobi stock market and Ho and Cheung (1994) for Asian markets as well. On the other hand, Barnes (1986) showed a high degree of efficiency in Kuala Lumpur market. Groenewold and Kang (1993) found Australian market semi-strong form efficient. Kim and Shamsuddin (2008) test a group of Asian markets again. They find the Japanese and Taiwanese markets have been efficient in the weak form. The markets of Indonesia, Malaysia and Philippines have shown no sign of market efficiency and Singaporean and Thai markets have become efficient after the Asian crisis. Other recent studies, testing the random walk hypothesis (in effect testing for weak form efficiency in the markets) are: Korea (Ryoo and Smith, 2002, this study uses a variance ratio test and find the market to follow a random walk process if the price limits are relaxed during the period March 1988 to Dec 1988), China (Mahmood et al, 2011, apply ADF, DF-GLS, PP and KPSS tests on stock market returns on both Shenzhen and Shanghai stock exchanges separately. The results of the study shows that Chinese stock market is weak form efficient and past data of stock market movements may not be very useable in order to make excess returns; Liu, 2010, employs unit root test, autocorrelation function, BDSL, Engle-LM and AR (p)-EGARCH and AR (p)-TARCH to test the market efficiency of Chinese stock market over 2001 to 2008. Results show Chinese stock markets are not weak-form efficient), Hong Kong (Jarrett 2008; Cheung and Coutts 2001), Slovenia (Dezlan, 2000), Spain (Regulez and Zarraga, 2002), Czech Republic (Hajek, 2002), Turkey (Buguk and Brorsen, 2003), Africa (Smith et al. 2002; Appiah-kusi and Menyah, 2003) and the Middle East (Abraham et al. 2002; this study uses variance ratio test and the runs test to test for random walk for the period 1992 to 1998 and find that these markets are not efficient).

The semi-strong form EMH asserts that security prices adjust rapidly to the release of all public information, the classical study by Fama et al (1969) on the stock splits event, showed no significant price change following a stock split, because any relative information that caused the split would have already been discounted. A study by Pearce and Roley (1985) found a stronger relationship between stock prices and macroeconomic news, such as: money supply, inflation, real economic activities and interest rate. Chan (2003) studied on individual stocks' monthly returns which following public news and found strong drift after bad news, contrary stocks that experienced good news showed less drift. For the study on the announcements of Accounting Changes, Bernard and Thomas (1990) and Ou and Penman (1989) stated that the securities market prices react quite rapidly to accounting changes. Some researchers studied on the corporate finance events such as mergers and acquisitions, reorganization (Jensen and Warner, 1988), corporate spin-offs (Desai and Jain, 1999; Chemmanur and Yan, 2004). Taken M&A as a example, the reaction to the mergers can be interpreted as the stock of the firm which being acquiring increase with a premium offered by the acquiring firm, whereas the stock of the acquiring firm typically decrease for the reason that investors concern it overpaid for the deal.

According to above evidence, we can find the hypotheses which are built up on numerous events including stock splits, economic news, accounting changes and a variety of corporate finance

events for all public information with semi-strong EMH, but the results are mixed. Except Fama et al (1969) on the stock splits, all others studies were against the semi-strong EMH. In India, the studies on testing semi-strong EMH are few, and it is widely accepted that the semi-strong hypothesis encompasses the weak-form hypothesis, which means if one market is tested in semi-strong efficiency then it should be in weak form efficiency simultaneously, and we also can say if weak form hypothesis is rejected in one market, the semi-form hypothesis should be rejected simultaneously for this market as well. Therefore, our tests begin with the weak form hypothesis in India and, if weak form efficiency is supported in the stock markets of India we will test for semi-strong form efficiency.

III. Methodology & Data

To test historical market efficiency one can look at the pattern of short-term movements of the combined market returns and attempt to identify the underlying process generating those returns. If the market is efficient, the model would fail to identify any pattern and it can be inferred that the returns follow a random walk process. In essence the inference of random walk means that either the returns follow a random walk process or that the model used to identify the process is unable to identify the true return generating process. If a model is able to identify a pattern, then historical market data can be used to forecast future market prices, and the market is regarded as not efficient.

There are several techniques available to determine patterns in time series data. Regression, exponential smoothing and decomposition approaches presume that the values of the time series being predicted are statistically independent from one period to the next. Some of these techniques are reviewed in the following section and appropriate techniques identified for use in this study.

Runs test (Bradley 1968) and LOMAC variance ratio test (Lo and MacKinlay 1988) are used to test the weak form efficiency and random walk hypothesis. Runs test determines if successive price changes are independent. It is a non-parametric test and does not require the returns to be normally distributed. The test observes the sequence of successive price changes with the same sign. The null hypothesis of randomness is determined by the same sign in price changes. The runs test only looks at the number of positive or negative changes and ignores the amount of change from mean. This is one of the major weaknesses of the test. LOMAC variance ratio test is commonly criticised on many issues and mainly on the selection of maximum order of serial correlation (Faust, 1992). Durbin-Watson test (Durbin and Watson 1951), the augmented Dickey-Fuller test (Dickey and Fuller 1979) and different variants of these are the most commonly used tests for the random walk hypothesis in recent years (Worthington and Higgs 2003; Kleiman, Payne and Sahu 2002; Chan, Gup and Pan 1997).

Under the random walk hypothesis, a market is (weak form) efficient if most recent price has all available information and thus, the best predictor of future price is the most recent price. In the most stringent version of the efficient market hypothesis, ε_t is random and stationary and also exhibits no autocorrelation, as disturbance term cannot possess any systematic forecast errors. In this study we have used returns and not prices for test of market efficiency as expected returns are more commonly used in asset pricing literature (Fama 1998).

Returns in a market conforming to random walk are not serially correlated, corresponding to a random walk hypothesis with dependant but uncorrelated increments. Parametric serial correlations tests of independence and non-parametric runs tests can be used to test for serial dependence. Serial correlation coefficient test is a widely used procedure that tests the relationship between returns in the current period with those in the previous period. If no significant autocorrelation are found then the series are expected to follow a random walk.

A simple formal statistical test was introduced was Durbin and Watson (1951). Durbin-Watson (DW) is a test for first order autocorrelation. It only tests for the relationship between an error and its immediately preceding value. One way to motivate this test is to regress the error of time t with its previous value.

$$u_t = \rho u_{t-1} + v_t \quad (1)$$

where $v_t \sim N(0, \sigma_v^2)$.

DW test cannot detect some forms of residual autocorrelations, e.g. if $\text{corr}(u_t, u_{t-1}) = 0$ but $\text{corr}(u_t, u_{t-2}) \neq 0$, DW as defined earlier will not find any autocorrelation. One possible way is to do it for all possible combinations but this is tedious and practically impossible to handle. The second-best alternative is to test for autocorrelation that would allow examination of the relationship between u_t and several of its lagged values at the same time. The Breusch-Godfrey test is a more general test for autocorrelation for the lags of up to r 'th order.

$$u_t = \rho_1 u_{t-1} + \rho_2 u_{t-2} + \rho_3 u_{t-3} + \dots + \rho_r u_{t-r} + v_t, \quad (2)$$

$$v_t \sim N(0, \sigma_v^2)$$

Because of the above mentioned weaknesses of the DW test we do not use the DW test in our study. An alternative model which is more commonly used is Augmented Dickey Fuller test (ADF test). Three regression models (standard model, with intercept and with intercept and trend) are used in this study to test for unit root in the research, (Chan, Gup and Pan 1997; Brooks 2002). In this study we followed the test methodologies from Brooks (2002) with slight adjustments.

$$S_t = \alpha S_{t-1} + \varepsilon_t \quad (3)$$

$$S_t = u^* + \alpha^* S_{t-1} + \varepsilon_t^* \quad (4)$$

$$S_t = u^{**} + \beta(t-T) + \alpha^{**} S_{t-1} + \varepsilon_t^{**} \quad (5)$$

Where: S_t = the stock price

u^* and u^{**} = the intercept terms

T = total number of observations

$\varepsilon_t, \varepsilon_t^*, \varepsilon_t^{**}$ = error terms that could be ARMA processes with time dependent variances.

Where S_t is the logarithm of the price index seen at time t , u is an arbitrary intercept parameter, α is the change in the index and ε_t is a random disturbance term. Equation (3) is for the standard model; (4) for the standard model with intercept and (5) for the standard model with intercept and trend.

Augmented Dickey-Fuller (ADF) unit root test of nonstationarity is conducted in the form of the following regression equation. The objective of the test is to test the null hypothesis that $\theta = 1$ in:

$$y_t = \theta y_{t-1} + u_t$$

against the one-sided alternative $\theta < 1$. Thus the hypotheses to be tested are:

H_0 : series contains a unit root

Against H_1 : series is stationary

In this study we calculate daily returns, weekly returns, monthly returns and quarterly returns using index values for the Mumbai Stock Exchange (BSE) and National Stock Exchange (NSE) of India. The data is collected from the official websites of both stock exchanges. The time period for both BSE and NSE is from 1st July 1997 to 4th March 2011. Stock exchanges are closed for trading on weekends and this may seem to violate the basic time series requirement that observations be taken at a regularly spaced intervals. The requirement however, is that the frequency be spaced in terms of the processes underlying the series. Here the underlying process of the series is trading of stocks and generation of stock exchange index based on the stock trading, as such for this study the index values at the end of each business day is appropriate (French 1980).

Table 1 presents the characteristics of two data sets used in this study. During the period covered in this study, the daily and weekly return of the NSE index are almost the same with that of the BSE, similarly the standard deviation of NSE is close to BSE index. NSE has lower monthly returns and standard deviation suggesting lower expected returns and risk. It is relevant to note that NSE was established by the government of India to improve the market efficiency in Indian stock markets and to break the monopolistic position of the BSE. NSE index is a more diversified as compared to BSE. This can also be due to the unique nature of India's equity markets, the settlement system on BSE was intermittent (*Badla* system up until 2nd July 2001) and on NSE it was always cash.

Table 1: Data Characteristics: NSE and BSE 1997-2011

| Index | Frequency | Mean | Std Dev | Minimum | Maximum | Observations | Skewness | Kurtosis |
|-------|-----------|----------|----------|-----------|----------|--------------|----------|----------|
| NSE | Daily | 0.000596 | 0.017244 | -0.122377 | 0.177441 | 3416 | -0.00788 | 9.72098 |
| | Weekly | 0.00288 | 0.037792 | -0.159497 | 0.15569 | 708 | -0.2414 | 4.850023 |
| | Monthly | 0.001698 | 0.042391 | -0.109522 | 0.12717 | 164 | 0.046534 | 3.325141 |
| BSE | Daily | 0.000583 | 0.017402 | -0.111385 | 0.173393 | 3416 | 0.091276 | 8.748521 |
| | Weekly | 0.002731 | 0.037113 | -0.159542 | 0.140776 | 708 | -0.17288 | 4.687229 |
| | Monthly | 0.011992 | 0.078511 | -0.238901 | 0.282551 | 164 | -0.12262 | 3.487757 |

IV. Results

Our study conducts a test of market efficiency for the stock markets of India. It employs unit root tests (Augmented Dickey-Fuller (ADF)). We perform ADF test for standard model, with intercept and with intercept and trend. We also test market efficiency using the Phillips-Perron tests (with intercept and 4 lags in error process) and the KPSS tests (with 4, 3 and 2 lag parameters respectively).

Using full sample period of 1997 to 2011, the null hypothesis of unit root (ADF test) is fail to reject as the test statistic is more negative than the critical value, suggesting that these markets do not show characteristics of random walk and as such are not efficient in the weak form. Results are presented in Table 2. For both BSE and NSE markets, the results are statistically significant and test of serial correlation show that the markets are not weak form efficient under any time frequency (Daily, Weekly and Monthly) using the full sample period. And similar results come from PP results; however, results of KPSS test with 4, 3 and 2 lag parameters show markets are weak form efficient using daily, weekly and monthly data which is opposite to the result of ADF and PP.

Table 2: Results of ADF, PP and KPSS 1997-2011

| Index | Frequency | ADF Test Statistic (5 lags with intercept and no trend) | null hypothesis : RETURN has a unit root | ADF Test Statistic (5 lags with intercept and trend) | null hypothesis : RETURN has a unit root | PP unit root test, with intercept and 4lags in error process | null hypothesis : RETURN has a unit root | KPSS (Tau Statistic) for lag parameter 4 | null hypothesis : RETURN is stationary | KPSS (Tau Statistic) for lag parameter 3 | null hypothesis : RETURN is stationary | KPSS (Tau Statistic) for lag parameter 2 | null hypothesis : RETURN is stationary |
|-------|-----------|---|--|--|--|--|--|--|--|--|--|--|--|
| NSE | Daily | -25.203 | Fail to Reject | -25.219 | Fail to Reject | -55.195 | Fail to Reject | 0.136 | Fail to Reject | 0.136 | Fail to Reject | 0.135 | Fail to Reject |
| | Weekly | -10.800 | Fail to Reject | -10.829 | Fail to Reject | -26.029 | Fail to Reject | 0.123 | Fail to Reject | 0.124 | Fail to Reject | 0.126 | Fail to Reject |
| | Monthly | -5.782 | Fail to Reject | -5.866 | Fail to Reject | -12.669 | Fail to Reject | 0.156 | Fail to Reject | 0.150 | Fail to Reject | 0.144 | Fail to Reject |
| BSE | Daily | -26.536 | Fail to Reject | -26.554 | Fail to Reject | -54.122 | Fail to Reject | 0.173 | Fail to Reject | 0.174 | Fail to Reject | 0.174 | Fail to Reject |
| | Weekly | -11.677 | Fail to Reject | -11.712 | Fail to Reject | -26.020 | Fail to Reject | 0.164 | Fail to Reject | 0.167 | Fail to Reject | 0.170 | Fail to Reject |
| | Monthly | -5.106 | Fail to Reject | -5.112 | Fail to Reject | -12.009 | Fail to Reject | 0.152 | Fail to Reject | 0.158 | Fail to Reject | 0.166 | Fail to Reject |

Note: The null hypothesis in the case of ADF and PP is that the series is non-stationary, whereas in the case of KPSS test it is series stationary. Null of stationarity is rejected if the tests statistic is more than the critical value.

For the Daily returns: ADF critical values with an intercept and no trend are: -3.432, -2.862 and -2.567 at 1%, 5% and 10% levels; with and intercept and trend are: -3.960, -3.411 and -3.127 at 1%, 5% and 10% levels; PP critical values are: -3.960, -3.410, and -3.127 at 1%, 5% and 10%; KPSS with 4 lags critical values are: 0.739, 0.463, and 0.347 at 1%, 5% and 10% levels.

For the Weekly returns: ADF critical values with an intercept and no trend are: -3.434, -2.865 and -2.569 at 1%, 5% and 10% levels; with and intercept and trend are: -3.971, -3.416 and -3.130 at 1%, 5% and 10% levels. PP critical values are: -3.439, -2.865 and -2.569 at 1%, 5% and 10%; KPSS with 4 lags critical values are: 0.739, 0.463, and 0.347 at 1%, 5% and 10% levels.

For the Monthly returns: ADF critical values with an intercept and no trend are: -3.472, -2.880 and -2.577 at 1%, 5% and 10% levels; with and intercept and trend are: -4.017, -3.438 and -3.114 at 1%, 5% and 10% levels; PP critical values are: -3.470, -2.880 and -2.576 at 1%, 5% and 10%; KPSS with 4 lags critical values are: 0.739, 0.463, and 0.347 at 1%, 5% and 10% levels.

For further analysis we partition data into different periods 1997-2007, 2007-2009 and 2009-2011 respectively, and only use ADF test with intercept and trend, PP test with intercept and 4 lags and KPSS test with 4 lags for testing. Besides, we introduce lower frequent-quarterly data in this step. Table 3 shows results for the period from 1997 to 2007 that ADF test and PP test for all frequencies prove markets not weak form efficient. However, results for KPSS test show BSE not weak form efficient and NSE to be weak form efficient for weekly and quarterly frequency. Results for the period 2007 to 2009 in Table 4¹ show that ADF test support weak form efficient for weekly and monthly frequency but not for daily frequency. KPSS test also finds NSE and BSE weak form efficient based on weekly and monthly data but not on daily data which is consistent with ADF test. PP test still shows markets weak form not efficient for all time frequency. Finally for the period 2009 to 2011 period results are mixed, for quarterly frequency, all three tests are consistent that India markets are weak form efficient, for monthly frequency, ADF and KPSS show weak form efficient but PP doesn't and for daily and weekly frequency, three methods are consistent again on weak form not efficient.

Table 3: Results of ADF, PP and KPSS 1997-2007

| Index | Frequency | ADF Test Statistic (5 lags with intercept and trend) | null hypothesis: RET URN has a unit root | PP unit root test, with intercept and 4lags in error process | null hypothesis: RET URN has a unit root | KPSS (Tau Statistic) for lag parameter 4 | null hypothesis: RET URN is stationary |
|-------|-----------|---|---|---|---|--|--|
| NSE | Daily | -21.654 | Fail to Reject | -47.337 | Fail to Reject | 0.360 | Reject at 10% level |
| | Weekly | -9.970 | Fail to Reject | -21.673 | Fail to Reject | 0.241 | Fail to Reject |
| | Monthly | -5.766 | Fail to Reject | -10.339 | Fail to Reject | 0.349 | Reject at 10% level |
| | Quarterly | -2.768 | Reject | -5.941 | Fail to Reject | 0.215 | Fail to Reject |
| BSE | Daily | -21.881 | Fail to Reject | -47.080 | Fail to Reject | 0.425 | Reject at 10% level |
| | Weekly | -10.100 | Fail to Reject | -21.259 | Fail to Reject | 0.368 | Reject at 10% level |
| | Monthly | -4.825 | Fail to Reject | -10.730 | Fail to Reject | 0.376 | Reject at 10% level |
| | Quarterly | -2.721 | Reject | -6.470 | Fail to Reject | 0.366 | Reject at 10% level |

| critical values | 1% | 5% | 10% | 1% | 5% | 10% | 1% | 5% | 10% |
|-----------------|--------|--------|--------|--------|--------|--------|-------|-------|-------|
| Daily | -3.960 | -3.411 | -3.127 | -3.432 | -2.862 | -2.567 | 0.739 | 0.463 | 0.347 |
| Weekly | -3.971 | -3.416 | -3.130 | -3.439 | -2.865 | -2.569 | 0.739 | 0.463 | 0.347 |
| Monthly | -4.017 | -3.438 | -3.114 | -3.470 | -2.880 | -2.576 | 0.739 | 0.463 | 0.347 |
| Quarterly | -4.157 | -3.563 | -3.182 | -3.560 | -2.918 | -2.597 | 0.739 | 0.463 | 0.347 |

Table 4: Results of ADF, PP and KPSS 2007-2009

| Index | Frequency | ADF Test Statistic (5 lags with intercept and trend) | null hypothesis: RE TURN has a unit root | PP unit root test, with intercept and 4lags in error process | null hypothesis: RE TURN has a unit root | KPSS (Tau Statistic) for lag parameter 4 | null hypothesis: RE TURN is stationary |
|-------|-----------|---|---|--|---|--|---|
| NSE | Daily | -10.386 | Fail to Reject | -19.750 | Fail to Reject | 0.349 | Reject at 10% level |
| | Weekly | -3.886 | Reject at 1% | -9.689 | Fail to Reject | 0.242 | Fail to Reject |
| | Monthly | -2.080 | Reject | -4.437 | Fail to Reject | 0.161 | Fail to Reject |
| BSE | Daily | -10.673 | Fail to Reject | -19.272 | Fail to Reject | 0.448 | Reject at 10% level |
| | Weekly | -3.917 | Reject at 1% | -10.037 | Fail to Reject | 0.280 | Fail to Reject |
| | Monthly | -1.307 | Reject | -4.115 | Fail to Reject | 0.305 | Fail to Reject |

| critical values | 1% | 5% | 10% | 1% | 5% | 10% | 1% | 5% | 10% |
|-----------------|--------|--------|--------|--------|--------|--------|-------|-------|-------|
| Daily | -3.960 | -3.411 | -3.127 | -3.432 | -2.862 | -2.567 | 0.739 | 0.463 | 0.347 |
| Weekly | -3.971 | -3.416 | -3.130 | -3.439 | -2.865 | -2.569 | 0.739 | 0.463 | 0.347 |
| Monthly | -4.017 | -3.438 | -3.114 | -3.470 | -2.880 | -2.576 | 0.739 | 0.463 | 0.347 |

¹ the quarterly data in sample period 2007-2009 are insufficient, we combine them into sample period 2009-2011 instead

Table 5: Results of ADF, PP and KPSS 2009-2011

| Index | Frequency | ADF Test Statistic (5 lags with intercept and trend) | null hypothesis: RE TURN has a unit root | PP unit root test, with intercept and 4lags in error process | null hypothesis: RE TURN has a unit root | KPSS (Tau Statistic) for lag parameter 4 | null hypothesis: R ETURN is stationary |
|---------------------|-----------|---|---|--|---|--|---|
| NSE | Daily | -7.594 | Fail to Reject | -16.711 | Fail to Reject | 0.111 | Fail to Reject |
| | Weekly | -4.271 | Fail to Reject | -9.803 | Fail to Reject | 0.288 | Fail to Reject |
| | Monthly | -1.786 | Reject | -4.750 | Fail to Reject | 0.163 | Fail to Reject |
| 2007-2011 Quarterly | | -0.741 | Reject | -2.546 | Reject | 0.116 | Fail to Reject |
| BSE | Daily | -7.049 | Fail to Reject | -15.481 | Fail to Reject | 0.149 | Fail to Reject |
| | Weekly | -4.470 | Fail to Reject | -11.034 | Fail to Reject | 0.109 | Fail to Reject |
| | Monthly | -2.211 | Reject | -4.141 | Fail to Reject | 0.279 | Fail to Reject |
| 2007-2011 Quarterly | | -1.124 | Reject | -2.288 | Reject | 0.119 | Fail to Reject |

| critical values | 1% | 5% | 10% | 1% | 5% | 10% | 1% | 5% | 10% |
|---------------------|--------|--------|--------|--------|--------|--------|-------|-------|-------|
| Daily | -3.960 | -3.411 | -3.127 | -3.432 | -2.862 | -2.567 | 0.739 | 0.463 | 0.347 |
| Weekly | -3.971 | -3.416 | -3.130 | -3.439 | -2.865 | -2.569 | 0.739 | 0.463 | 0.347 |
| Monthly | -4.017 | -3.438 | -3.114 | -3.470 | -2.880 | -2.576 | 0.739 | 0.463 | 0.347 |
| 2007-2011 Quarterly | -4.157 | -3.564 | -3.182 | -3.560 | -2.918 | -2.597 | 0.739 | 0.463 | 0.347 |

V. Conclusions & Implications

This paper primarily examines the weak form efficiency in two of the Indian stock exchanges (BSE and NSE) which represent the majority of the equity market in India. We employ three different tests ADF, PP and KPSS and find similar results. Results are mixed as for later periods in 2007-2011 are more favorable in terms of weak form efficiency, especially with lower time frequency bases like quarterly, whereas for earlier period in 1997-2007 markets are inefficient. In the first place, we planned to test the semi-strong form efficiency of India market if the markets are proved as weak form efficient. Results of weak form market efficiency are weak; this study finds support for weak form efficiency primarily in monthly and quarterly data. This suggests a low level of informational efficiency because of speed of transmission of information. These results do not favor testing these markets for possible semi-strong form efficiency.

Our results support the common notion that the equity markets in the emerging economies are not efficient and to some degree can also explain the less optimal allocation of portfolios into these markets, results also support the common notion that markets in the emerging countries may be moving towards being more informationally efficient. Evidence from results indicate that in recent year, equity markets in India has become more efficient, that means investors who seek to diversify their investments internationally should allocate their investments into stock market of India. On the other hand as financial market development have significant benefits on economic growth, the regulators and policy makers should pay much more attention on the market efficiency of India's stock market. These policies may assist in deepening the markets and further improve the market efficiency in the future.

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