DOES INDIAN STOCK MARKET FOLLOW RANDOM WALK?

: A Study of Bombay Stock Exchange of India

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ABSTRACT

Market efficiency influences the investment strategy of the investor. If market is efficient, the exercise of selecting winners will be useless. In an efficient market, it is not possible to earn excess return. This paper reports the results of a test on the weak form market efficiency applied to Sensex stock returns of Bombay Stock Exchange (BSE) of India from January 2009 to June 2014. The study finds that the returns are leptokurtic and not normally distributed. We use variance ratio test on daily return data to test the hypothesis that the stock price index follows random walk. Our results show that the Sensex is not weak form efficient.

Key Words: Efficient market, Random walk, Variance ratio test

1. Introduction

Efficient market theory and random walk hypothesis have been the major issues in financial literature. Random walk hypothesis implies that we cannot predict prices or we cannot earn excess return on the basis of information available in the variation in the past prices. The validity of random walk hypothesis has important implications for financial theories and investment strategies. It is relevant and useful to academicians, practitioners and policy makers. Academicians try to understand the behavior of stock prices or risk-return relationship depends on hypothesis of random walk. The knowledge of random walk is useful to Investors in designing the trading strategies. Efficient Stock Markets provide the vehicle for mobilizing savings and investment resources for developmental purposes. They afford opportunities to investors to diversify their portfolios across a variety of assets. A market in which prices fully reflect all available information is called efficient (Fama, 1970). If market is not efficient, price cannot provide signalsfor efficient allocation of resources that cause harmful effects on economy. This may direct the policy makers to take steps to correct it.

Fama (1970) classified stock market efficiency into three forms. They are namely 'weak form', 'semi-strong form' and 'strong form'. The classification depends upon the underlying assumptions relating to information set available to market participants. According to weak form of Efficient Market Hypothesis (EMH), current prices reflect all information found in the past prices and traded volumes. Futures prices cannot be predicted by analyzing the prices from the past. The semi strong form of the EMH states that the security price adjusts rapidly to all publically available information. The strong form of EMH maintains that not only the publically available information is useless to the investor but all information whether it is public or inside cannot be used consistently to earn superior return Ever since the work of Fama(1970), attempts were made to examine stock market efficiency in various developed and developing stock markets of the world. Several studies indicate that the stock market prices do not follow a random walk. Globalization of markets has created increasing interest on the study of the issue.

Borges(2009) examined weak form market efficiency of PSI-20 index prices of Lisbon stock market during January 1993 to December 2006. The study used a serial correlation test, a runs test, an Augmented Dickey Fuller (ADF) test and the multiple variance ratio tests as proposed by Lo and Mackinlay(1988) to test the hypothesis of random walk. The study showed that the Portuguese stock market approaches to a random walk behaviour since 2000.

Worthington and Higgs(2004) tested random walk behavior in daily returns for sixteen developed markets (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy,Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom) and four emerging markets (Czech Republic, Hungary, Poland and Russia) during 1986 to 2003 using a combination of serial correlation coefficient and runs tests, Augmented Dickey-Fuller (ADF), Phillips-Perron (PP) and Kwiatkowski, Phillips, Schmidt and Shin (KPSS) unit root tests and multiple variance ratio (MVR) tests. The study found that Germany, Ireland, Portugal, Sweden and the United Kingdom among developed markets and Hungary among developing markets were weak form efficient.

Poshakwale(2002) examined the random walk hypothesis of 100 actively traded stocks of Bombay Stock Exchange National Index from 1 January, 1990 to 30 November, 1998. The study finds that the daily return series do not conform to a random walk. Using BDSL[1] test statistics, the study revealed significant non linear dependence in the return in the form of Autoregressive Conditional Heteroskedasticity (ARCH)[2]. Sharma and Kennedy (1977) evaluated the stock price behavior of stock indices of the Bombay, London and New York Stock exchanges during 1963-73 using run tests and spectral analysis. The study confirmed the random movements of the stock indices for all the three stock exchanges.

The lesser attention is paid to investigate the weak form efficiency of Indian stock market using the most recent time period. Major changes took place during recent periodlike introduction of screen based trading and circuit filters, dematerialization of shares, rolling settlement, introduction of index based future and options, banning of carry forward facility etc. These changes might have influenced the efficiency of Indian stock markets and therefore it will be instructive to study efficiency during the recent period.

The purpose of this paper is to investigate capital market efficiency in the case of Sensex of Bombay Stock Exchange. The remainder of the paper is organized as follows. Section 2 discusses data and methodology used. Section 3presents descriptive statistics and empirical findings are presented in Section 4. Section 5 summarizes.

2. Data and Methodology

Period of study

[1]The BDSL (Brock, Dechert, Scheinkman and LeBaron) test is a nonparametric test with the null hypothesis that a time series is independent and identically distributed. The alternative hypothesis encompasses both deterministic chaos as well as linear and nonlinear stochastic behaviour. It measures the statistical significance of the correlation dimension calculations. The correlation integral is the probability that any two points are within a certain length apart in phase space.

[2] A Time series model with conditional heteroscedasticity. Conditional heteroscedasticity means having a non constant conditional variance.

We collected data on daily closing price of Sensex of Bombay Stock Exchange from January1, 2010 to June 24, 2014. Major changes took place during the period like huge inflows of FII, increasing integration of global stock markets, introduction of India VIX and currency derivatives and global melt down etc. These developments might have influenced the efficiency of the stock market.

The Sample

The Indian Stock Market is represented by two most prominent stock indices, i.e. Bombay Stock Exchange's (BSE) Sensitive Index (Sensex) and NSE's S&P CNX Nifty. BSE is the older and the more often quoted index. Sensex is considered to be an important and broad-based market index. We, therefore, study efficiency of Sensex.

The sample of the study comprises of daily closing price, is of 1359 observations forSensex. We use www.bseindia.com data base for analyzing efficiency.

Methodology

We use daily return. Daily returns are identified as the difference in the natural logarithm of the closing index value for the two consecutive trading days. It can be presented as:

$R_t = \log(P_t / P_{t-1})$ **or** $R_t = \log(P_t) - \log(P_{t-1})$ **Equation 1**

Where R_t is logarithmic daily return at time t. P_{t-1} and P_t are daily prices of an asset at two successive days, t-1 and t respectively.

In this paper we employ variance ratio tests in order to investigate whether Sensex is efficient individually.

Variance Ratio Test

AspointedoutbyGilmoreandMcManus(2003), aunitroot[3]isanecessarybutnotsufficient conditionforarandomwalk.Thereasonisthatunitrootprocesscanhavepredictableelements,but a

[3]Unit root is a situation of non stationary where mean and variance of a time series are not constant.

random walk for stock prices means that returns must be uncorrelated. Hence, we test for the random walk hypothesis through the VR test (LoandMacKinlay,1988) which is based on the assumption that the variance of a random walk term increases linearly with time. This approach has gained popularity and has become the standard tool in random-walk testing. The VR test is as follows:

$$VR(q) = \frac{\sigma^2(q)}{\sigma^2(1)}$$ **Equation 2**

$\sigma^2(q)$ is the ubniazed estimator of 1/q of the varianceof the q-th difference and $\sigma^2(1)$ is the variance of the first difference. Under the assumption of homoscedasticity increments, a standard normal staisticsz(q) is calculated as follows:

$$z(q) = \frac{VR(q)-1}{\sqrt{v(q)}} \prec N(0,1)$$ **Equation 3**

Where $v(q) = [2(2q-1)(q-1)]/3q(nq)$. A second test statistics $z^*(q)$ is developed under the assumption of heteroskedasticity increments and expressed as follows:

$$z^*(q) = \frac{VR(q)-1}{\sqrt{v^*(q)}}$$ **Equation 4**

where

$$v^*(q) = \sum_{k=1}^{q-1}\left[\frac{2(q-k)}{q}\right]^2 \phi(k)$$ **Equation 5**

And

$$\phi(k) = \frac{\sum_{t=k+1}^{nq}(p_t - p_{t-1} - \hat{\mu})^2}{\left[\sum_{t=1}^{nq}(p_t - p_{t-1} - \hat{\mu})^2\right]^2}$$ **Equation 6**

Both the z(q) and z*(q) statistics test the null hypothesis that VR(q) = 1 or the chosen index follows a random walk. When the random walk hypothesis is rejected and VR(q) > 1, returns are positively serially correlated.

Multiple Variance Ratio Test

Chow and Denning (1993) proposed a multiple variance ratio (MVR) test where a set of variance ratios is tested against one, that is the null hypothesis V(q) =1 for i=1,…,n is tested against the alternative that VR(q) > 1. The null hypothesis is rejected at the a level ofsignificance if the MV1 is greater than the $(1-[\alpha^{*}/2])^{th}$ percentile of standard normal distribution, where $\alpha^{*} = 1-(1-\alpha)^{1/n}$. The heteroskedasticity-robust version can be written as $\mathrm{MV}_2 = \sqrt{T}\max|z^{*}(q_i)|$ where $z^{*}(q_i)$ is defined in equation 4 and it has the same critical value as MV1. Chow and Denning (1993) controlled the size of the MV ratio test by comparing the calculated values of the standardized test statistics, eitherz(q) and z*(q)with the Standardized Maximum Modulus (SMM) critical values. If the maximum absolute value of, say z(q) is greaterthan the SMM critical value then the random walk hypothesis is rejected. SMM distribution has acritical value of 2.491 for the 5 percent level of significance.

3. **Descriptive Statistics**

Table 1: Descriptive Statistics for the returns of Sensex

Statistics	SENSEX
Mean	0.000706
Standard Deviation	0.013416
Skewness	1.141962
Kurtosis	18.95906
Jarque-Bera Statistics*	14706.45(2-tailed p=.000)

*The Jarque-Bera teat statistic is T[skewness^2/6+(kurtosis-3)^2/24].

The mean return for Sensex is 0.000706 which is very close to zero indicating that the series is mean reverting. The returns are negatively skewed. It suggests that the larger negative tend to be larger than the higher positive return. The level of kurtosis is high. Large value of Kurtosis suggests that the underlying data are leptokurtic or thick tailed and sharply peaked about the mean when compared with the normal distribution.

4. Empirical finding and interpretation

Table 2 shows the Variance ratio test results computed for lags 2, 4, 8 days, with the one-day return used as a base[4].

Table 2: Variance Ratio Test Results for daily return of Sensex

No of days, q, in holding period	2	4	6	8
VR(q)	0.549	0.267	0.179	0.129
z(q)	-16.63**	-14.45**	-12.22**	-10.85**
z*(q)	-7.31**	-7.33**	-6.54**	-6.28**

Notes: Variance ratios reported in the main row with homoscedasticity Z(q) and heteroskedasticity Z*(q). Under the random walk null hypothesis, the value of the variance ratio test is 1 and the test statistic have a standard normal distribution (asymptotically). Test statistics marked with asterisks indicate that the corresponding variance ratios are statistically different from 1 at the 5% level of significance.

Results show that the hypothesis that the variance ratio test is one can be rejected based on the homoscedasticity assumption. The variance ratio test also indicates the presence of positive serial correlation in daily returns across the intervals considered. We report also the z- statistic adjusted for this violation of homoscedasticity, although results remain the same. Inconclusion the random walk hypothesis is rejected for Sensex. It indicates that returns are positively serially correlated.

Results for Chow and Denning's (1993)Mutltiple Variance Ratio tests are reported in Table 3.

Table 3: Multiple variance ratio tests

[4]The number of lag periods has been limited to eight for the daily data since the power of the VR test decline as q become large relative to the data set.

Multiple Variance Rato	Sensex
MV_1	-10.85**
MV_2	-6.28**

Note: MV1 is the homoskedasticand MV2is the heteroskedastic-robust version of the Chow-Denning test. ** rejectthe null hypothesis at the 5% level of significance.
The critical value for the Chow-Denning test are 3.089(1%),2.68(5%) and 2.310(10%) respectively.

We can see that, at the 5%level of significance, the null of random walk for Chow and Denning's homoskedastic and heteroskedastic are rejectedfor Sensex suggesting that it does not follow a random walk process.

I. Summary

The assumption that the stock prices are random is basic to the Efficient Market Hypothesis. The study carried out in this paper has found that Sensex does not follow random walk.It suggests that the returns of the stock market can be predicted by using past returns. There are significant implications of the market efficiency for investors who seek to maximise theirrisk-adjusted returns. deviations from efficiency may offer profit opportunities to better informed investors at the expenses of less-informed investors. Policy makers have a task on their hands in terms of mitigating the costs of inefficient markets. This could be assisted by introducing further reforms for improving legal and regulatory framework as well as increasing standards of transparency and internal controls.

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