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Abstract

The paper investigates the issue of behaviour of stock returns in India. A non-parametric variance ratio test is used to examine the issue. Largely the results indicate non-random walk behaviour of Indian stock market. However, the sub-sample analysis of stock returns based on structural breaks show an increasing mean-reverting tendency after occurrence of structural breaks in the series. The events associated with break dates mainly are volatile exchange rate movements, oil shocks, internet bubble burst, sub-prime crisis, global economic meltdown and political uncertainties. Rejection of random walk is relatively stronger for smaller and medium indices than larger indices implying that market capitalization and liquidity play a greater role in improving efficiency of the market.

JEL Code: G14, C 14, C58.

Key words: Variance ratio, random walk, market efficiency, mean-reversion, BSE, NSE, Indian stock market.

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1. Introduction

Market efficiency has been a focal point of research in finance literature. An efficient equity market plays a vital role in the economy. In the absence of an efficient market, allocation of capital would not be according to the demand of the economy and consequently economic growth would be retarded. A market is said to be efficient if it is informationally efficient. In an informationally efficient market, current prices reflect all the available and relevant information (Fama, 1970). Such markets do not provide consistent abnormal returns. This is known as the Efficient Market Hypothesis (EMH), which is quite prominent in neoclassical finance literature. The weak form of the EMH suggests that the future returns cannot be predicted based on the past history of the stock returns. The random walk hypothesis (RWH) has been one of the important and effective models employed to examine the behaviour of stock returns in the empirical research. Let

$$R_t = \delta + R_{t-1} + \varepsilon_t \quad \ldots (1)$$

where R_t is stock returns at time *t* , R_{t-1} is stock returns at time *t-1,* δ is the drift parameter (or expected change in the return), ε_t is error term. The stochastic variable of stock returns R_t is said to be random walk, with a drift parameter δ, if

$$\varepsilon_t \sim (0, \sigma^2) \quad \ldots (2)$$

where white noise term, ε_t is independent and identically distributed with mean zero and constant variance σ^2. Thus the value of R_t at time *t* is equal to its value at time *t-1* plus a random shock. The independence of increments $\{\varepsilon_t\}$ implies that the process is strictly white

noise process. However, this definition practically less useful as its rejection does not tell anything about predictability of returns (Taylore, 2005). Hence, a martingale difference sequence is sufficient to say that market is efficient. R_t is a martingale if

$$E\left(R_{t+1} \mid R_t, R_{t-1} \ldots,\right) = R_t \qquad \ldots (3)$$

Thus, returns follow a martingale difference sequence (*mds*) if drift is zero and error term uncorrelated. Based on the past history of returns, tomorrow's returns cannot be predictable as it is expected to be equal to the today's return. In short, it is not possible to 'beat the market'.

In this backdrop, present paper examines the behaviour of stock returns in the Indian equity market during the period June, 1997 to March, 2009. The present study differs from the earlier studies on the following lines. First, the study makes use of new, diverse and larger data set on India. Second, it employs non-parametric test proposed by Wright (2000). The test is preferable to traditional Lo and MacKinlay (1988) variance ratio test when returns are non-normal. To best of our knowledge, the existing studies in India have not applied this test. Most of the previous studies focused on BSE Sensex Index and stocks constituting Sensex, with the notion that rest of the Indian market follows BSE Sensex. In the last decade, NSE emerged as the leading stock exchange in India with 90 per cent of market capitalization. The present study, hence, covers two major exchanges in India namely, Bombay Stock Exchange (BSE) and National Stock Exchange of India (NSE). The results of the study are therefore robust.

The rest of the paper is organized as follows: A brief review of previous studies is presented in section 2 and section 3 describes data and testing methods. The empirical discussion is carried out in section 4 and the last section provides concluding remarks.

2. Brief Review of Previous Studies

Literature on EMH has been truly abundant. Here an attempt is made to present a brief review of previous work. Bachelier (1900) is perhaps the first who theorized the concept of market efficiency. The seminal works of Samuelson (1965) and Fama (1965, 1970) triggered much interest in this area. The early studies have found evidences in favour of RWH [Fama, 1965, 1970; Working, 1960; Niederhoffer and Osborne, 1966; Jennergeen and Korsvold 1974; Solnik, 1973]. In later period, however, studies have found mean reversion and anomalies [Keim and Stambaugh, 1986; Fama and French, 1988; Jagadeesh, 1990; Frennberg and Hansson, 1993].

The early studies on market efficiency used serial correlation, runs and spectral tests to examine the issue of random walk. The conventional techniques such as serial correlation seem to suffer from restrictive assumptions. They tend to be less efficient to capture the patterns in returns. Lo and MacKinlay (1988) proposed a variance ratio test which is capable of distinguishing among several interesting and competing alternative hypotheses. The test is robust to heteroscedasticity. In their study of weekly stock returns, Lo and MacKinay (1988) rejected the earlier evidences of random walk characterization of the stock returns in the US. The variance ratio test proposed by Lo and MacKinlay (1988) (LMVR) is one of the most popular tests in empirical literature as numerous studies employed it [Ojah and Karemera, 1999; Grieb and Reyes, 1999; Darrat and Zhong, 2000; Dias *et al*, 2002; Al-Khazali *et al*, 2007, Eitelman and Vitanza, 2008; Fifield and Jetty, 2009 among others].

The sampling distribution of LMVR test is approximated based on its limiting distribution and therefore is biased and right-skewed in finite samples (Wright 2000, Charles and Darne, 2008), For mean-reverting alternatives, the LMVR test is found to be inconsistent (Deo and Richardson, 2003). In small samples, size distortion problem may be more severe. Further,

the test assumes that returns are normally distributed which of late, is quite uncommon in case of financial returns.

An alternative variance ratio test using ranks and signs has been proposed by Wright (2000). The test has better power properties than the LMVR test. The subsequent studies have used the Wright's (2000) ranks and signs variance ratio test (WRSVR) to examine the issue of weak form of market efficiency. Ma and Barnes (2001) performed this test on Shenzhen and Shanghai stock exchanges in China and found that individual shares were more efficient than indices. Buguk and Brorsen (2003) reported inconsistent results for different *k* values (holding periods) for Istanbul stock exchange (Turkey). Using WRSVR test, Belaire-Franch and Opong (2005) attempted to present some evidence on anomalies. The study refuted RWH for FTSE 100, FTSE 250, FTSE 350 and FTSE All Shares. However, they pointed that the rejection of RWH for indices having higher market capitalization and liquidity was relatively less than their lower counterparts. This view was further supported by Hung *et al* (2009) who carried out the WRSVR test to check the behavior of TOPIX and FTSE returns.

In a similar fashion, Segot and Lucey (2005) assessed market efficiency of Middle East and North African (MENA) markets[1]. It was observed that small markets such as Tunisia and Jordon empirically proved to be inefficient whereas Israel and Turkey were weak form efficient. In a reply to this, Al-Khazali *et al* (2007) empirically showed that the MENA markets (Bahrain, Egypt, Jordon, Kuwait, Morocco, Oman, Saudi Arabia and Tunisia) were weak form efficient. The earlier rejection of weak form efficiency, the study argues, has been because of thin and infrequent trading. The study applied WRSVR test after correcting for thin and infrequent trading and found that the MENA markets were weak form efficient. This view has drawn

[1] The selected MENA markets are Morocco, Tunisia, Egypt, Lebanon, Jordon, Turkey and Israel.

further support from the study of Hoque *et al* (2007) which concluded that thin trading has been one of the important factors responsible for the rejection of RWH in the emerging markets. Further, Hoque *et al* (2007) pointed out that information asymmetry and lack of well developed financial institutions were the other reasons for such a rejection. Based on WRSVR test results, the study concluded that astute investors could exploit the emerging markets as their stock returns are inter-temporally predictable. The stock exchanges of Barbados, Jamaica, Trinidad and Tobago and CARICOM Regional exchanges were also found to be inefficient (Watson, 2009)[2].

For Chinese markets, studies by Fifield and Jetty (2008), and Zhang and Xindan (2008), and Hung (2009) documented that Chinese Share A was relatively more efficient than Share B. However, these studies also noted that the efficiency improved for both the shares due to deregulation, liberalization and the improved liquidity. The hypothesis that liquidity improves market efficiency found further empirical support from Hung *et al* (2009).

The evidences from the WRSVR test show that various markets do not follow random walk (or martingale process). Though there is a large volume of research on the issue of weak form of efficiency, but the studies on Indian stock markets are limited. The quest for study of stock market efficiency in India began with early work of Rao and Mukherjee (1971). Later, in a comparative study between BSE and NYSE, Sharma and Kennedy (1977) by using runs test and spectral technique found that monthly returns in the BSE followed RWH. Similar evidences of random walk behaviour for stock returns were also noted by Barua (1981), Gupta (1985) and Chawla *et al* (2006)[3]. Furthermore, Amanulla and Kamaiah (1998) examined the behavior of stock returns in India. In addition to serial correlation and rank correlation tests, they used

[2] CARICOM is a Caribbean Community and Common Market consisting 14 countries.
[3] Amanullah and Kamaiah (1996) presented an excellent and comprehensive review of Indian evidences on market efficiency. Also see, Barua (1994).

ARIMA (0, 1, 0) model to examine distribution pattern of increments which received less focus on weak form efficiency studies in India. They concluded that equity market in India was weak form efficient. Hiremath *et al* (2009) used LMVR test to understand the behavior of stock returns and found mixed evidence for the Indian equity market.

Although, the literature on market efficiency is vast, there is no consensus among the researchers regarding efficiency of the market. Most of the studies focused on well developed markets and a limited number of studies addressed the issue in the emerging markets. Thin trading or non-synchronous trading, various restrictions and incomplete reforms are cited as important factors for the rejection of random walk characterization of the returns in the emerging markets.

3.1 Data

The present study uses daily stock returns of six indices from BSE and eight indices from NSE. The data span from June 1997- March 2009 and the data range is different for different indices. (See table 1). The BSE Sensex accounts for 46 per cent of total market capitalization and represents large and financially sound 30 companies. BSE 100 is made up of 100 companies based on market capitalization and BSE 500 covers all 20 industries of the economy. The BSE Midcap and BSE Small cap represent medium and small stock indices. Similarly, CNX Nifty represents most liquid 50 stocks traded at NSE and it accounts for 65 percent of market capitalization. The CNX Nifty Junior consists of next 50 liquid stocks. CNX 100 is a diversified 100 stock index accounting for 35 sectors of the economy and CNX 500 equity index is disaggregated into 72 industry sectors. Further, CNX Defty is nothing but CNX Nifty, measured in dollars. Considering the importance of Information Technology (IT), Banking, and Infrastructure in the economy, respective indices of these sectors namely, CNX IT, CNX Bank

Nifty and CNX Infrastructure are considered. Companies that have more than 50 percent of their turnover from IT related activities are included in CNX IT while CNX Bank Nifty is an index comprised of the most liquid 12 Indian Banking stocks. CNX Infrastructure Index includes companies belonging to Telecom, Power, Port, Air, Roads, Railways, shipping and other Utility Services providers. The set of indexes serve the purpose of unmasking variation in the behaviour of stock returns of different indices and reveal sensitiveness of results to the composition of indices. The daily values of indices are collected from official websites namely, www.bseindia.com and www.nseindia.com of BSE and NSE respectively.

Table 1: Sample Indexes – Time Period Covered

S.No	Index	Time Period	% of Total Market Capitalization
1	BSE Sensex	01/01/1998 – 31/03/2009	46.53
2	BSE 100	01/01/1998 – 31/03/2009	75.67

3	BSE 200	01/01/1998 – 31/03/2009	85.24
4	BSE 500	03/01/2000 – 31/03/2009	93.51
5	BSE Midcap	01/01/2004 – 31/03/2009	12.8
6	BSE Smallcap	01/01/2004 – 31/03/2009	3.7
7	CNX Nifty	02/06/1997 – 31/03/2009	65.34
8	CNX Junior	02/06/1997 – 31/03/2009	9.89
9	CNX Defty	02/06/1997 – 31/03/2009	
10	CNX 100	01/01/2003 – 31/03/2009	75.24
11	CNX 500	07/06/1999 – 31/03/2009	95.11
12	CNX IT	02/06/1997 – 31/03/2009	6.97
13	CNX Bank Nifty	01/01/2000 – 31/03/2009	7.74
14	CNX Infrastructure	01/01/2004 – 31/03/2009	21.43

3. 2. Ranks and Signs Variance Ratio Test

Wright (2000) proposes ranks (R_1 and R_2) and signs (S_1 and S_2) based variance ratio test. He demonstrates that the non-parametric test has better power properties than conventional variance ratio test. Let r (y_t) be the rank of y_t among $y_1 \ldots y_T$. Define,

$$r_{1t} = \frac{\left(r\,(y_t) - \frac{T+1}{2}\right)}{\sqrt{\frac{(T-1)(T+1)}{12}}} \qquad \ldots (4)$$

Under the null hypothesis that y_t is generated from i.i.d sequence, r (y_t) is random permutation of the numbers 1 . . ., T with equal probability. Wright (2000) proposes the statistics

$$R_1 = \left(\frac{\frac{1}{Tk}\sum_{t=k+1}^{T}(r_{1t}+r_{1t-1}\ldots+r_{1t-k})^2}{\frac{1}{T}\sum_{t=1}^{T}r_{1t}^2} - 1\right)\left(\frac{2(2k-1)(k-1)}{3kT}\right)^{-1/2} \qquad \ldots (5)$$

which follows an exact sampling distribution. Further, he proposes use of an alternative standardization

$$r_{2t} = \Phi^{-1}\left(\frac{r(y_t)}{T+1}\right) \quad \ldots (6)$$

where Φ is the standard normal cumulative distribution function. This gives rise to the R_2 statistics as given in equation (7):

$$R_2 = \left(\frac{\frac{1}{Tk}\sum_{t=k+1}^{T}(r_{2t}+r_{2t-1}\ldots+r_{2t-k})^2}{\frac{1}{T}\sum_{t=1}^{T}r_{2t}^2} - 1\right)\left(\frac{2(2k-1)(k-1)}{3kT}\right)^{-1/2} \quad \ldots (7)$$

The R_2 test shares the same sampling distribution as R_1. The critical values of these tests can be obtained by simulating their exact distributions. In a similar fashion, a signs based variance ratio test is given in equation (8):

$$S_1 = \left(\frac{\frac{1}{Tk}\sum_{t=k+1}^{T}(S_t+S_{t-1}\ldots+S_{t-k})^2}{\frac{1}{T}\sum_{t=1}^{T}S_t^2} - 1\right)\left(\frac{2(2k-1)(k-1)}{3kT}\right)^{-1/2} \quad \ldots (8)$$

Under the null hypothesis, y_t is a martingale difference sequence (*mds*) whose unconditional mean is zero, S_t is an *i.i.d* sequence with mean zero constant variance equal to 1, which takes the value of 1 and -1 with equal probability of ½. Thus, S_1 assumes a zero drift value.

4. Empirical Analysis

The descriptive statistics for the fourteen indices are given in table 2. The highest average returns are obtained in CNX 100. The CNX Infrastructure and CNX Bank Nifty are the other indices which show higher mean returns. This reflects the performance of these indices owing to

the considerable growth of infrastructure sector in India because of the significant increase in the government outlay along with encouraging private investment. However, the CNX 500 registered negative mean returns. This may be attributed to the small stocks which constitute the index from wide range of industries where the output growth has remained below for a decade. Further, the BSE 200 has the highest standard deviation (0.0639) which represents higher volatility and lowest is of CNX Nifty (0.0174) and the BSE Sensex (0.0178). The returns of all indices are negatively skewed implying that the returns are flatter to the left compared to the normal distribution. The significant kurtosis indicates that return distribution has sharp peaks compared to a normal distribution. The significant Jarque-Bera statistic confirmed that index returns are non- normally distributed. This suggests that a non-parametric test like Wright (2000) is more appropriate.

The RWH is based on the premise that returns are unpredictable and it is not possible to earn abnormal profits. Rejection of RWH indicates possibility of predictable returns on past memory. The RWH or *mds* is tested in this paper by using the WRSVR test. Table 3A and 3B report test statistics, R_1, R_2 and S_1 at different k values namely, 2, 5, 10 and 30 for BSE and NSE respectively. The R_1 and R_2 tests possess better power properties than the conventional M_1 and M_2 of LMVR test. The tables report only S_1 as it is shown by Wright (2000) that, if S_1 rejects the null, S_2 must reject as well.

It is evident from table 3A that with the exception of BSE Sensex, the RWH is clearly rejected by all other indices namely, BSE 100, BSE 200, BSE 500, BSE Midcap and BSE Smallcap. This suggests that the stock returns are not generated by random walk process. The R_1 test statistics for BSE Sensex at $k = 2$ and 5, and R_2 statistics at $k = 1$, are significant and thus rejects the null of *iid*. In other words, rejection of the null is weak as k-value (i.e. holding

period) increases. The *iid* assumption can be relaxed as it is difficult to find the *iid* because of regulatory and structural changes in the market over a period of years. Therefore, the non rejection of *mds* is sufficient to say market is weak form efficient.

Besides, R_1 and R_2 tests are not robust to heteroscedasticity. The results of S_1 test which is robust to heteroscedasticity are given in the last panel of table 3A. The statistics clearly rejects the null of *mds* for all the BSE indices. However, similar to R_1 and R_2 test statistics given in the table, the S_1 statistics for BSE Sensex become weaker as the holding horizon increases. This suggests that BSE Sensex may be moving towards weak form efficiency at the longer holding periods. It may be because of the existence of abnormal profits in short horizons which disappear in longer horizons as the information begins to reflect in the current returns.

Furthermore, it can be inferred from table 3A that indices having lower market capitalization and liquidity such as BSE Smallcap and BSE Midcap show stronger rejection of RWH than the relatively higher market capitalized indices such as BSE 100, BSE 200 and BSE 500. The results are consistent with the findings of Belaire-Franch and Opong (2005) and Hung *et al* (2009).

The test statistics (R_1, R_2 and S_1) for the NSE are furnished in table 3B. The results consistently support rejection of the null of *iid* for CNX Nifty Junior, CNX Defty, CNX 500, CNX IT. The evidences for CNX Nifty, CNX 100 and CNX Infrastructure are not consistent. It can be seen from the table that the R_1 and R_2 test statistics reject the null of RWH at short horizons and as *k* values increase, rejection increasingly becomes weak. It is to be noted that the mean returns for these indices are higher than the rest. But, the S_1 statistics which are

consistently significant reject the null of *mds* for all the indices indicating that returns are unpredictable based on the past memory of the returns.

Broadly, it is observed that evidences against RWH for CNX Nifty and CNX 100 for longer horizons (k = 30) are weaker than for short holding periods (k = 5, 10). However, in the presence of significant S_1 statistics, these indices are not weak form efficient. Largely, stock returns of the indices traded at NSE exhibit non-random behaviour and thus provide space for speculation and resulting excess returns. The results for CNX Bank Nifty suggest that the stock returns do follow random walk at all holding periods as the test statistics cannot reject the null of *iid* (or *mds*).

The behaviour of stock returns of BSE and NSE largely do not follow random walk (or martingale). The possible explanation for the stock returns of the BSE Sensex, and to some extent CNX Nifty and CNX 100 appear to follow random walk at longer horizons, is that the information in short-horizon is not instantly reflected in returns and thus provide opportunity for excess returns to those who have access to such unrevealed information. Later, as time horizon increases, information begins to get reflected in the returns leading market towards the efficiency.

Structural breaks occurring due to financial and economic events may have bearing on the variance ratios. To examine such possibilities, multiple breaks test proposed by Lee and Strazicich (2003) is employed to identify breaks in the series. The test found significant breaks in the returns series. However, the break dates were different for different indices. The whole sample is divided into three sub-sample periods based on the break dates. Period 1 consists of sample from beginning to the occurrence of first break. The period between first break and

second break is considered as Period 2 and the post second break period is named as Period 3. [4] Then, WRSVR test is carried out on three different sample periods. The test statistics for Period 1 are furnished in table 4A and 4B for BSE and NSE respectively. The results (R_1, R_2 and S_1) given in table 4A for BSE Sensex, BSE 100 and BSE 200 are insignificant across the holding periods. It is to be noted that for the full sample, null of *iid* and *mds* were rejected for these indices. Rest of the indices from BSE in period 1 rejected the null of random walk as in case of full sample period. However, the test statistics are less strong for these indices compared to those reported for the full sample period furnished in table 3A. The RWH and *mds* for indices namely, CNX Defty, CNX 500, CNX Infrastructure is rejected at most of the holding periods (see table 4B). This is true even in case of full sample period. Similar to BSE indices, the statistics are less significant during period 1 compared to the full sample period. For other indices namely CNX Nifty, CNX NJ, CNX Bank the RWH and *mds* cannot be rejected as the statistics are weak and insignificant. CNX 100 though cannot reject null of *iid* but still not support weak form of EMH as S_1 test rejects the null of *mds*. It is to be noted that evidences against weak form of efficiency for period 1 are either weak or insignificant. In case of rejection of null of random walk, the statistics are relatively less significant during period 1 where no structural breaks occurred, than during the full sample period.

Further, table 5A and 5B report test statistics of BSE and NSE for the Period 2, which consist sample from first break date to the second break. It is evident from both the tables that test statistics are highly significant. The values of test statistics are higher than the statistics reported for the period 1. It can be inferred that during period 2, the stock returns exhibited a non-random walk behavior. The values of S1 are less compared to R1 and R2 but still greater

[4] The first and second breaks dates found by Lee-Strazicich are different for the chosen fourteen indices. The WRSVR test carried out each index separately based on respective break dates.

than statistics reported for period 1. Finally, test statistics for period 3 are reported in table 6A and 6B for BSE and NSE respectively. The test statistics show higher significance than those reported for period 2. Nevertheless, evidence supports martingale process for BSE Sensex. This indicates that after the second break, there was a stronger tendency in stock returns of all indices to revert to its trend path. The results for different sub-periods indicate different kinds of behavior of the stock returns in India. A random walk behavior is observed before occurrence of structural breaks in the series. But, a non-random walk behavior is observed in the post structural breaks period. It implies that Indian stock market is not weak form efficient for the whole period and sensitive to the external shocks.

As mentioned earlier, Lee-Strazicich test results show break dates for various indices are different. Most of the break dates appears to have occurred during 2000-03 and 2006-08. The first break point for CNX Nifty, CNX Nifty Junior, BSE Sensex, BSE 100, BSE, 200, CNX 500 falls in between 1999 and 2001. This was a period of global economic recession originated in the US, dot-com bubble burst and Air India hijack followed by war hysteria between India and Pakistan. It may also be noted that in March 2000, the government notified to remove the ban on future trading to pave the way for derivative trading in India. The sluggishness in foreign institutional investors (FIIs), slip in consumer spending and bad monsoon during 2003 made the market to move in a narrow range. This is the year when the first break point for CNX Defty, BSE 500, CNX 100, detected. The rise in international oil prices during March-May, 2003 is one of the possible factors for the break in these indices. The first structural break for BSE Midcap and BSE Smallcap occurred in 2007 is associated with notorious sub-prime mortgage crisis.

The second structural break point identified by Lee-Strazicich test for BSE 100 and BSE 500 falls between 2003-2004, which coincides with bad monsoons, and international oil shock.

There was sustained pull out of FIIs from the market and unprecedented slide of rupee in 2006.The second break points for CNX Defty, CNX IT, and BSE Sensex occurred during this year. The second break occurred in case of most indices such as CNX Nifty, BSE 200, CNX Bank Nifty, CNX 100, CNX Infrastructure, BSE Midcap and BSE Smallcap during 2008. This is the period of global meltdown triggered by sub-prime crisis, which spread to financial sector and resulted in economic crisis. It is to be noted here that in late 2007, Securities and Exchange Board of India (SEBI) announced ban on P-Notes meant for FIIs. The BSE Midcap, BSE Smallcap, CNX Infrastructure, CNX Bank Nifty were more vulnerable to financial crisis and market meltdown as they have low capitalization and compress less liquid stocks than other indices

The WRSVR test results clearly rejected null of RWH and *mds* for most of the indices from BSE and NSE for the full sample period. It indicates mean reverting behavior of stock returns in Indian equity market. However, mean-reverting tendency in stock returns is not observed throughout the sample period. The period 1 has shown weaker evidences against weak form efficiency. The results suggest that stock returns exhibited stronger non-random walk behavior during the period in which structural breaks occurred majorly due to external events. The mean-reverting tendency in stock returns indicates possibility of predictability of stock returns. It is to be noted that indices such as BSE Sensex, BSE 100, BSE 200, CNX Nifty, CNX Nifty Junior which are having higher market capitalization exhibited weak evidences against random walk than smaller indices such as BSE Midcap, BSE Smallcap, CNX Infrastructure etc which provided strong evidences against random walk. However, it is to be noted that these indices do not support the martingale process and thus are not weak form efficient.

5. Concluding remarks

The present paper examines the behaviour of daily stock returns in two premier stock exchanges in India namely, BSE and NSE by using an alternative variance ratio test based on ranks and signs proposed by Wright (2000). The test is known to be having better power properties than the conventional variance ratios test. As the stock returns are non-normal, such a non-parametric test is more appropriate. The results of the study broadly indicate that the stock returns of different indices in both exchanges exhibit non-random walk behaviour. However, evidences against null of random walk for BSE Sensex are weaker at longer holding period. This can be attributed to the existence of excess returns in short period and as information begins to reflect in returns, these profits disappear. Similar observations are made for CNX Nifty and CNX 100. Although the results of the study indicate non-random walk behaviour of stock returns in India for the whole period, the sub-sample analysis of stock returns shows that structural breaks identified by Lee and Strazicich (2003) test have bearing on variance ratios. The events associated with the significant dates were identified as turmoil in the international oil prices, bubble burst, terrorist attack on World Trade Centre, Air India hijack followed by war hysteria between India and Pakistan, slip in consumer spending due to bad monsoon during 2003, highly volatility exchange rates, sub-prime crisis and collapse of large investments banks in the US followed by massive outflow of FIIs, and global economic recession of 2008. An increasing mean-reverting tendency is observed in stock returns after structural breaks occurred in the economy. It implies that the Indian stock market is sensitive to the shocks especially because of external events. Rejection of random walk is relatively stronger for smaller and medium indices than larger indices. This is because of the fact that the medium and small sized indices are having lower market capitalization and are less liquid. This inference is consistent with Belaire-Franch and Opong (2005) and Hung *et al* (2009). Sectorwise, CNX IT and CNX

Infrastructure are found to be against EMH. However, CNX Bank Nifty appears to follow random walk (or *mds*). It may be because of the fact that the CNX Bank Index is an index comprised of the most liquid and large capitalized Indian Banking stocks and the sector is dominated by public sector banks and appropriately regulated by Reserve Bank of India (RBI). Non-random walk behaviour of stock returns and vulnerability of stock market to the shock in particular indicate that Indian equity market is still a developing market.

Table 2: Descriptive Statistics for Stock Index Returns

Indexes	Mean	Min.	Max.	Std.Dev	Skewness	Kurtosis	J-B Test	P value

Index	Mean	Min	Max	Std.Dev	Skweness	Kurtosis	J-B Test Statistics	P Value of JB Test
BSE Sensex	0.000345	-0.118091	0.079310	0.017810	-0.399402	3.339056	1377.159	0.000
BSE 100	0.000400	-0.59934	0.552933	0.023934	-1.459145	241.725	6827.378	0.000
BSE 200	0.000412	-2.299381	2.297634	0.063972	-0.068990	1188.688	1650.416	0.000
BSE 500	0.000273	-0.249827	0.075327	0.018659	-1.690044	17.02682	2901.322	0.000
BSE Midcap	0.000144	-0.120764	0.104317	0.018377	-1.266593	7.827763	3689.154	0.000
BSE Small	0.000171	-0.108357	0.132050	0.019092	-0.874436	5.399936	1755.873	0.000
CNX Nifty	0.000352	-0.130538	0.079690	0.017485	-0.512508	4.366738	2479.673	0.000
CNX NJ	0.000458	-0.131333	0.082922	0.020528	-0.668462	3.746319	1950.095	0.000
CNX Defty	0.000234	-0.141130	0.089858	0.018532	-0.472054	4.548736	2659.124	0.000
CNX 100	0.000667	-0.130493	0.080065	0.018059	-0.835206	5.683283	2282.310	0.000
CNX 500	-0.000052	-1.252805	0.076944	0.030894	-27.32103	1102.303	1245.864	0.000
CNX IT	0.000187	-2.365839	0.145567	0.051938	-32.15014	1462.399	2631.864	0.000
CNX Bank	0.000614	-0.151380	0.114014	0.021785	-0.423283	4.036178	1638.380	0.000
CNX Infra	0.000659	-0.150214	0.102127	0.021826	-0.758949	5.930724	2042.523	0.000

Min = Minimum values, Max = Maximum value, Std.Dev = Standard deviation, CNX Bank = CNX Bank Nifty, CNX Infra = CNX Infrastructure

Table 3A: Wright (2000) Ranks and Signs Variance Ratio Tests for Bombay Stock Exchange (BSE)

	BSE Sensex	BSE 100	BSE 200	BSE 500	BSE Midcap	BSE Smallcap
			R_1			
k=2	2.85*	3.73*	4.17*	5.56*	7.08*	8.17*
k=5	2.40*	4.06*	4.31*	5.60*	6.48*	8.78*
k=10	1.38	3.31*	3.66*	5.69*	4.91*	7.49*
k=30	-0.09	2.37*	2.50*	5.12*	3.09*	5.30*
			R_2			
k=2	2.06*	2.84*	3.35*	5.03*	6.73*	8.23*
k=5	1.60	2.92*	3.16*	4.37*	5.62*	8.19*
k=10	0.85	2.35*	2.66*	4.29*	3.72*	6.33*
k=30	-0.15	2.06*	2.16*	4.30*	2.12*	3.98*
			S_1			
k=2	2.54*	3.35*	3.70*	5.60*	6.88*	7.34*
k=5	2.10*	3.41*	3.89*	5.35*	7.80*	8.96*
k=10	1.21	2.75*	2.88*	4.94*	8.46*	9.57*
k=30	-0.19	1.79*	1.86*	4.73*	10.29*	12.01*

The test statistics for R1, R2, and S1 for holding periods 2, 5, 10 and 30 are given in panels 1, 2, and 3. '*' indicates significance at 5 % level.

Table 3B: Wright (2000) Ranks and Signs Variance Ratio Test Results for National Stock Exchange (NSE)

	CNX Nifty	CNX NJ	CNX Defty	CNX 100	CNX 500	CNX IT	CNX Bank	CNX Infra
				R_1				
k=2	3.37*	4.48*	5.27*	3.13*	5.46*	5.27*	2.31*	3.95*
k=5	2.94*	4.54*	6.63*	1.42*	5.43*	6.63*	1.11	2.47*
k=10	2.11*	3.46*	5.63*	0.58	5.07*	5.63*	0.63	1.29
k=30	0.47	3.75*	5.87*	0.20	4.66*	5.87*	0.39	0.79
				R_2				
k=2	2.43*	4.21*	5.39*	2.82*	5.31*	5.39*	2.88*	3.47*
k=5	1.77*	3.67*	6.07*	0.95	4.57*	6.07*	0.98	1.64
k=10	1.26	2.81*	5.03*	0.21	4.15*	5.03*	0.09	0.43
k=30	0.26	3.65*	5.41*	-0.13	3.97*	5.41*	-0.16	0.23
				S_1				
k=2	3.18*	4.28*	2.14*	3.76*	5.55*	2.14*	0.58	3.87*
k=5	3.24*	4.67*	3.85*	3.09*	5.60*	3.85*	0.37	4.44*
k=10	2.12*	3.67*	3.29*	4.03*	5.35*	3.29*	0.48	4.22*
k=30	-0.08	3.12*	4.41*	6.22*	6.23*	4.41*	0.80	5.78*

The test statistics for R1, R2, and S1 for holding periods 2, 5, 10 and 30 are given in panels 1, 2, and 3. '*' indicates significance at 5 % level.

Table 4A: Wright (2000) Ranks and Signs Variance Ratio Tests for Bombay Stock Exchange (BSE) Period 1

	BSE Sensex	BSE 100	BSE 200	BSE 500	BSE Midcap	BSE Smallcap
			R_1			
k=2	0.84	1.56	1.98*	4.37*	5.49*	6.12*
k=5	0.70	1.80	1.61	4.73*	4.30*	5.91*
k=10	0.10	1.32	0.83	4.31*	3.07*	5.14*
k=30	-0.51	0.46	-0.03	2.88*	0.69	2.60*
			R_2			
k=2	-0.12	0.47	0.95	3.87*	5.41*	6.43*
k=5	0.10	0.88	0.80	3.59*	3.60*	5.54*
k=10	-0.19	0.60	0.36	3.09*	2.16*	4.29*
k=30	-0.56	0.17	-0.16	2.16*	0.11	1.74
			S_1			
k=2	0.34	1.57	1.81	4.73*	5.79*	6.14*
k=5	0.11	1.86*	1.31	4.30*	6.48*	7.12*
k=10	-0.90	1.42	0.14	3.15*	7.53*	7.59*
k=30	-1.05	0.90	-0.55	2.37*	9.51*	9.83*

The test statistics for R1, R2, and S1 for holding periods 2, 5, 10 and 30 are given in panels 1, 2, and 3. '*' '**' indicates significance at 1 and 5 % level respectively.

Table 4B: Wright (2000) Ranks and Signs Variance Ratio Test Results for National Stock Exchange (NSE) Period 1

	CNX Nifty	CNX NJ	CNX Defty	CNX 100	CNX 500	CNX IT	CNX Bank	CNX Infra
				R_1				
k=2	2.39*	1.65	4.46*	1.90*	3.78*	5.15*	3.72*	3.19*
k=5	2.59*	1.96	4.43*	1.65	4.21*	6.02*	2.01	2.22*
k=10	1.73	0.95	3.76*	1.66	3.61*	5.11*	1.12	1.27
k=30	0.32	0.85	2.26*	1.99	2.98*	5.76*	0.53	-0.44
				R_2				
k=2	1.47	0.85	3.36*	1.65	4.00*	5.35	4.20*	3.16*
k=5	1.43	1.00	3.06*	1.42	3.99*	5.86	1.86	1.71
k=10	0.92	0.40	2.63*	1.40	3.17*	4.87	0.67	0.76
k=30	0.11	0.73	1.73	1.50	3.05*	5.59	0.15	-0.75
				S_1				
k=2	2.80*	2.81*	5.28*	3.10*	2.79*	2.02	1.73	2.92*
k=5	2.94*	3.42*	4.99*	2.65*	3.33*	3.41	1.05	4.01*
k=10	1.50	2.04	3.71*	2.83*	3.14*	2.81	0.85	4.19*
k=30	-0.45	1.49	1.64	4.41*	2.88*	3.75	0.79	5.03*

The test statistics for R1, R2, and S1 for holding periods 2, 5, 10 and 30 are given in panels 1, 2, and 3. '*' indicates significance at 5 % level.

Table 5A: Wright (2000) Ranks and Signs Variance Ratio Tests for Bombay Stock Exchange (BSE) Period 2

	BSE Sensex	BSE 100	BSE 200	BSE 500	BSE Midcap	BSE Smallcap
			R_1			
k=2	13.18*	17.09*	11.66*	16.14*	14.44*	11.55*
k=5	21.45*	29.75*	17.08*	29.09*	25.89*	20.59*
k=10	29.24*	41.79*	22.09*	41.62*	36.88*	28.98*
k=30	48.47*	70.16*	34.19*	68.54*	58.48*	43.12*
			R_2			
k=2	13.07*	15.60*	12.94*	14.87*	13.66*	11.09*
k=5	22.03*	27.21*	19.54*	26.73*	24.10*	19.55*
k=10	30.41*	38.28*	25.78*	38.10*	34.26*	27.53*
k=30	49.89*	63.83*	39.78*	63.08*	53.65*	40.61*
			S_1			
k=2	3.57*	2.76*	5.81*	3.74*	3.45*	2.29*
k=5	3.04*	3.01*	5.79*	4.65*	3.21*	1.86
k=10	2.24*	2.30*	5.58*	3.89*	3.08*	1.44
k=30	1.42	1.70	6.36*	2.51*	3.11*	0.69

The test statistics for R1, R2, and S1 for holding periods 2, 5, 10 and 30 are given in panels 1, 2, and 3. '*' indicates significance at 5 % level.

Table 5B: Wright (2000) Ranks and Signs Variance Ratio Test Results for National Stock Exchange (NSE) Period 2

	CNX Nifty	CNX NJ	CNX Defty	CNX 100	CNX 500	CNX IT	CNX Bank	CNX Infra
				R_1				
k=2	8.64*	19.04*	24.59*	22.04*	14.51*	22.04*	18.61*	17.90*
k=5	11.38*	34.50*	44.67*	39.93*	22.73*	39.93*	33.69*	32.01*
k=10	14.05*	49.80*	64.76*	57.71*	31.03*	57.71*	48.47*	46.03*
k=30	21.44*	84.70*	111.04*	97.71*	51.44*	97.71*	80.65*	76.89*
				R_2				
k=2	9.79*	16.47*	22.09*	20.33*	15.36*	20.33*	17.34*	16.06*
k=5	13.74*	29.98*	40.16*	36.76*	23.99*	36.76*	31.26*	28.34*
k=10	17.69*	43.28*	58.16*	53.08*	32.56*	53.08*	44.88*	40.63*
k=30	26.86*	73.35*	99.69*	89.93*	52.76*	89.93*	74.77*	66.71*
				S_1				
k=2	4.99*	2.73*	2.77*	1.63	5.85*	1.63	-0.79	1.40
k=5	4.62*	3.04*	2.88*	2.16*	5.66*	2.16*	-0.58	1.95*
k=10	3.84*	1.49	1.42	2.51*	5.82*	2.51*	-0.50	1.93
k=30	3.03*	0.29	-0.54	3.74*	6.99*	3.74*	0.14	2.22

The test statistics for R1, R2, and S1 for holding periods 2, 5, 10 and 30 are given in panels 1, 2, and 3. '*' indicates significance at 5 % level.

Table 6A: Wright (2000) Ranks and Signs Variance Ratio Tests for Bombay Stock Exchange (BSE) Period 3

	BSE Sensex	BSE 100	BSE 200	BSE 500	BSE Midcap	BSE Smallcap
			R_1			
k=2	25.06*	29.27*	11.66*	26.50*	12.62*	15.43*
k=5	45.47*	52.54*	17.08*	46.99*	22.58*	27.75*
k=10	65.67*	75.52*	22.09*	67.68*	31.92*	39.64*
k=30	112.19*	130.14*	34.19*	116.89*	48.80*	63.76*
			R_2			
k=2	22.79*	25.77*	12.94*	23.74*	12.13*	14.57*
k=5	41.37*	45.98*	19.54*	41.42*	21.47*	25.90*
k=10	59.48*	65.77*	25.78*	59.27*	30.31*	36.88*
k=30	101.54*	112.44*	39.78*	101.40*	45.93*	58.54*
			S_1			
k=2	0.96	4.33*	5.81*	5.54*	2.88*	2.85*
k=5	0.73	4.01*	5.79*	5.32*	2.05*	3.56*
k=10	-0.38	3.20*	5.58*	4.97*	1.65	4.00*
k=30	-0.76	2.84*	6.36*	4.52*	1.52	5.33*

The test statistics for R1, R2, and S1 for holding periods 2, 5, 10 and 30 are given in panels 1, 2, and 3. '*' indicates significance at 5 % level.

Table 6B: Wright (2000) Ranks and Signs Variance Ratio Test Results for National Stock Exchange (NSE) Period 3

	CNX Nifty	CNX NJ	CNX Defty	CNX 100	CNX 500	CNX IT	CNX Bank	CNX Infra
				R_1				
k=2	17.03*	26.69*	25.25*	16.77*	14.50*	25.74*	17.12*	17.37*
k=5	30.77*	46.33*	45.89*	30.28*	22.55*	46.61*	30.88*	31.31*
k=10	44.13*	65.89*	66.57*	43.39*	30.66*	67.48*	44.25*	44.90*
k=30	72.46*	113.70*	114.17*	70.73*	50.66*	115.26*	72.68*	73.46*
				R_2				
k=2	16.36*	24.46*	23.16*	15.75*	15.46*	23.85*	16.26*	16.16*
k=5	29.51*	41.78*	42.12*	28.29*	23.92*	42.60*	29.02*	28.84*
k=10	42.29*	59.21*	61.09*	40.34*	32.51*	61.20*	41.35*	41.27*
k=30	69.56*	101.08*	104.83*	64.85*	52.76*	103.53*	67.77*	66.30*
				S_1				
k=2	2.09*	5.40*	2.77*	3.32*	5.85*	2.91*	-0.35	1.56
k=5	2.19*	5.24*	2.96*	2.85*	5.66*	4.19*	-0.27	2.06*
k=10	0.92	4.24*	1.54	3.51*	5.82*	4.02*	-0.12	2.18*
k=30	-0.34	4.18*	-0.54	6.12*	6.99*	5.44*	0.40	1.95

The test statistics for R1, R2, and S1 for holding periods 2, 5, 10 and 30 are given in panels 1, 2, and 3. '*' indicates significance at 5 % level.

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