An Empirical Examination Of Random Walk Hypothesis

Janet Jyothi Dsouza

Abstract: The present study addresses the research question whether the Indian stock market follows random walk? The study considered BSE-100 index based companies as sample. The analysis is based on daily closing prices of companies over a period of time from 1990 to 2012. The data is collected from the data source PROWESS database. To test the RWH, econometric models are applied such as ADF test, PP test, autocorrelation test, variance ratio test, GARCH (1, 1), EGARCH (1, 1), TGARCH (1, 1), GARCH-M (1, 1) and PARCH (1, 1. The non-parametric Runs test is also applied to examine the randomness of observed series. The results show that Indian stock market exhibits the pattern of evidence in which some of periods show that the market is efficient and other periods show that the market lacks efficiency. This means that Indian stock market exhibits the pattern of somewhat mixed evidence, which indicates lack of efficiency. Our results are useful as a piece of information to the regulatory authorities, speculators and the individual and institutional investors of Indian stock market. The results show the true picture of the market and the investors' response to the stock prices in emerging markets like India which is going through various phases of financial, economic and regulatory reforms. This study has the global impact as Indian firms are integrated with global capital markets. The online trading in India is started in early 90's and the usage is increased rapidly. The quality of information available today is much superior to what it was in the past. All these dynamic trends have changed the nature and functioning of capital market. Therefore, the dynamics of market efficiency has also changed. This necessitates a study of market efficiency to understand whether or not historical information has any relevance for the market participants, both domestic and global. The sample is sufficiently large and the time considered is also long enough to draw robust conclusions.

Key words: Random walk Hypothesis (RWH), Indian capital market, BSE-100 companies, Econometric Models

1 INTRODUCTION

The Efficient market hypothesis (EMH) states that security prices reflect all available information and prices adjust rapidly to the new information and therefore, investors cannot beat the market based on new information flow. According to different levels of information, (Fama 1965, 1970) classified EMH as weak-form, semi-strong form and strong form. All the three forms of market efficiency have been empirically tested by the researchers. Essentially the different forms of market efficiencies focus on how the market absorbs the information. The weak-form market efficiency is also known as the Random Walk Hypothesis (RWH) in the finance literature. The random walk theory states that historical prices cannot be used to predict the future price direction. The semi-strong form efficient market claims that security prices instantly change to reflect the new publicly available information and deny abnormal profits to those who want to make investments based on the analysis of publicly available information. In strong-form of efficient market, security prices reflect all public as well as private information and investors cannot earn abnormal profit by analyzing the private information which is not known to the market as a whole. Different forms of market efficiencies have been investigated by different researchers and have come to differing conclusions. One of the most investigated forms of the market efficiency is the weak-form of efficiency. Majority of the research has shown that the market is efficient in the weak form..

Janet Jyothi Dsouza: Associate Professor, Dept. of Management studies, Ballari Institute of Technology and Management, Ballari - 583104However, the overwhelming literature on this form of market efficiency is the contribution of the western researchers in the context of developed markets. Emerging markets have not been fully researched. Even among the western researchers, there are some who have concluded that the markets are not weak form efficient. The stock exchanges of developing economies are gaining attention globally and investors are giving importance in analyzing the market efficiency. Even though the market efficiency can be tested in three forms, we focus on RWH to analyze the behavior of stock prices and want to see whether Indian stock market follows RWH. The most of the previous studies used various indices of developed and emerging markets as sample and used weekly, monthly and annual data to draw the conclusion on RWH. Our analysis is based on daily closing prices of BSE-100 companies over a long period of time from 1990 to 2012. The sample is sufficiently large and the time considered is also long enough to draw robust conclusions. The rest of the paper is organized as follows. Section 2 describes the literature review, section 3 data and methodology, section 4 presents the empirical results and conclusion is presented in section 5.

2 LITERATURE REVIEW

In the finance literature, most of the researchers have produced the evidences for and against the RWH. Further, RWH is extensively researched in western countries which concentrated on world's largest stock markets. Fama and French (1988), Lo and MacKinlay (1988) Poterba and Summers (1988) examined the RWH of US stock market by using variance ratio test and found evidences of mean reversion. Groenewold (1997),Al-Loughani and Chappell (1997) investigated Australian, New Zealand stock market and London stock market and accepted RWH. Urrutia (1995) examined the RWH of four markets of Latin America and found that the all the four markets are inefficient.Solink (1973) examined RWH of eight different European markets and the results supported RWH. Worthington and Higgs (2004) used daily returns of European equity markets which include sixteen developed markets such as Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the United Kingdom and four emerging markets like Czech Republic, Hungary, Poland and Russia to investigate RWH. The results supported the RWH for developed market and not the emerging markets. Kvedaras and Basdevant (2004) examined Estonian,

Latvian and Lithuanian Stock Exchange market and found that these markets follow random walk model. Whereas, Keim and Stambaugh (1986) used few predetermined variables to examine RWH and found predictability in stock price. Laurence (1986) examined weak form of market efficiency of Kuala Lumpur Stock Exchange and the Stock Exchange of Singapore (SES) by using Runs and autocorrelation test and based on the results it is concluded that both markets are weak form inefficient. The researchers also have undertaken few studies to test the RWH in Arab and Gulf markets. Gandhi et al. (1980) examined Kuwait Stock Exchange by using monthly data for the period 1975-1978 by using linear regression and Runs test and the evidences rejected the RWH. Butler and Malaikah (1992) used autocorrelation test and Runs test and found that Saudi Arabia stock market follow random walk. On the other hand Civelek (1991) investigated Amman financial market and provided the evidences against the RWH. Abraham et al. (2002) examined the market indices of Saudi Arabia, Kuwait and Bahrain by using variance ratio test and the results rejected the RWH. Kumar and Dhankar (2011) examined the relationship between stock returns and conditional volatility of US stock market. The results showed the presence of heteroskedasticity effect and asymmetric nature in US stock market. Further, the study showed that there is no correlation between stock returns and conditional volatility

In India, researchers examined RWH and found mixed evidences.Chaudhuri (1991) used Runs and serial correlation test to examine weak form of market efficiency. The daily prices of 93 actively traded securities are used for the period January 1988 to April 1990 and the results fail to support RWH. Madhusoodanan (1998)applied variance ratio test to test the RWH on Indian stock market and found that market is inefficient. Poshakwale (2002) used daily closing prices for the 100 actively traded stocks from Indian stock market for the period from 1 January, 1990 to 30 November, 1998 and the evidences of the study rejected the RWH. Gupta and Basu (2007), Thomas and Kuma (2010) and Khan et al. (2011) examined RWH by using market indices of Indian stock market and found that market indices do not follow RWH. However, Vaidyanathan and Gali (1994) and Mall et al. (2011) found that Indian capital market is efficient and follow RWH. On the other hand Sharma and Mahendru (2009) examined the market efficiency of 11 securities listed in BSE. They used Runs test and autocorrelation test and found mixed evidences. Sahoo and Kumar (2009) examined the market efficiency by using the closing prices of top for five commodities; gold, copper, petroleum crude, soya oil, and chana in commodity futures markets in India. The empirical results suggest that Indian commodity futures market is efficient.Basu and Chawla (2010) examined the validity of CAPM model in Indian context by constructing 50 portfolios of different stocks for the period of 1st January 2003 to 1st February 2008. The empirical evidences showed negative relationship between beta and excess return which indicates that market is not efficient in Indian capital market. Lakshmi and Roy (2012) examined RWH in Indian equity market by using daily, weekly and monthly return of 6 indices. The results of Box Pierce Q-Statistics and Ljung-Box (LB) statistics and Augmented Dickey-Fuller test are consistent with RWH but the results of variance ratio test are contradictory in nature. Mahajan and Singh (2013) examined the impact of rolling settlement and causal relationship between return, volume, and volatility in Indian stock market. They used the closing prices of NIFTY and SENSEX from January 1997 to June 2007. The study found positive relationship between volume and returns for pre rolling settlement period. The study also revealed that introduction of rolling settlement enhanced the market efficiency in Indian capital market.Garg and Varshney (2015) demonstrated the robustness of momentum trading strategy in Indian stock market over the period of 2000 to 2013 and found the strong presence of momentum return in Indian stock market which is against RWH. The review of the above study shows that the market exhibits efficiency in weak form. However, some of the studies had shown that the market does not exhibit efficiency in its weak form. Therefore, there is a need to test whether; the Indian market behaves inconsonance with the developed markets and exhibits efficiency.

3 OBJECTIVES OF THE STUDY

The present study addresses the research question whether the Indian stock market follows random walk? In particular, an attempt is made to understand the following research questions.

1. To analyse the serial dependence of share prices in Indian stock market
2. To examine the volatility clustering in of share prices
3. To investigate whether the price movements provide arbitrage opportunity

4 RATIONALE OF THE STUDY

In financial theory, the ideas are generated to explain how the market woks. The EMH is such theory which explains the relationship between new information and market returns. The theory states that there is no arbitrage opportunity to make profit based on new information flow. Critics have criticized by saying that it is not possible to test the market efficiency empirically and theoretically because market behaves irrationally. Even after the criticisms, EMH gained a lot of attention from researchers and economists from world-wide. It has been empirically tested by academic researchers in developed and emerging economies and it reached its highest dominance during 1970s. At the same time many economists tested its validity and identified the existence of various anomalies which are the departures from fundamental ideas of EMH. Further, it is believed that information dissemination is faster than ever because of the developments in information technology and the technological advancements have affected the performance and efficiency of capital markets. Market participants have access to all types of information such as financial reports, trading quotes, analysts' forecasts, new and historical information, and updates of their investment portfolios. The quality of information available today is much superior to what it was in the past. All these dynamic trends have changed the nature and functioning of capital market. Therefore, the dynamics of market efficiency has also changed. This necessitates a study of market efficiency to understand whether or not historical information has any relevance for the market participants, both domestic and global.

5 DATA AND METHODOLOGY

In this study we use daily returns of BSE-100 based firms which are listed in Bombay stock exchange (BSE). The daily data is collected for the period from 1st January 1990 to 31st December 2012 from PROWESS database of the Centre for Monitoring Indian Economy (CMIE). The RWH states that the historical prices cannot be used to predict the future prices of any securities. In the literature, the researchers have tested its validityand used many technics to investigate the pattern in the time-series data. In this study, we useRuns test, Augmented Dickey Fuller (ADF) test, Phillips-Perron (PP), Autocorrelation Test, LOMAC variance ratio test (Lo and MacKinlay 1988) GARCH (1, 1) GARCH-M (1, 1), EGARCH (1, 1) TGARCH (1, 1) and PGARCH (1, 1) models are used to test the RWH in Indian stock market.

Runs test (Bradley 1968)

The non-parametric Runs test is used to see the independence between successive price series without considering the normal distribution in the series. It test the randomness based on runs which is a sequence of positive and negative signs, states that the price change may be positive or negative. If the observed runs are non-significantly different from expected runs, we infer that the successive price changes are independent. It is calculated as

$$\mu_r = \left(\frac{2n_1 n_2}{n_1+n_2}\right) + 1 \quad (1)$$

Where, μ_r= mean number of runs, n_1 =Number of positive return, n_2 = Number of negative return, r = Number of runs (actual sequence of counts)

Using the following formula, the standard error of the expected number of runs is calculated.

$$\sigma_r = \sqrt{\frac{2n_1 n_2(2n_1 n_2 - n_1 - n_2)}{(n_1+n_2)^2(n_1+n_2-1)}} \quad (2)$$

A standardized variable 'z' as under can express the difference between actual and expected number of the runs:

$$z = \frac{r-\mu_r}{\sigma_r} \quad (3)$$

Unit Root Tests

The presence of unit root in the observed series is examined by using ADF test, and the PP test. One of the assumptions of random-walk model is that series are non-stationary. The ADF test is expressed as

$$\Delta R_t = b_0 + b_1 + \pi_0 R_{t-1} + \sum_{t-1}^{j} \varphi_i \Delta R_{it-1} + e_t \quad (4)$$

R_t= is the price at time t, ΔR_t= change in price

PP test is a nonparametric method which controls the serialcorrelation in unit root testing. The PP test is based on the following statistic

$$\widetilde{t_\alpha} = t_\alpha \left(\frac{\gamma_0}{f_0}\right)^{\frac{1}{2}} - \frac{T(f_0-\gamma_0)\,(se(\widehat{\alpha}))}{2f_0^{\frac{1}{2}}s} \quad (5)$$

Where $\hat{\alpha}$ is the estimate, and t_a the t - ratio ofα, $(se(\widehat{\alpha}))$ is coefficient standard error, ands is the standard error of the test regression. In addition,γ_0 is a consistent estimate of the error variance (calculated as, $(T-K)s^2/T$ where K is the number of regressors). The remaining term,f_0 is an estimator of the residual spectrum at frequency zero.

Autocorrelation Test

The serial correlation test is used to understand the relationship between the time series and its own values at different lags. The Ljung-Box Q-statistics and their p values are used to test the null hypothesis that there is no autocorrelation up to order k and are computed as:

$$\tau_K = \frac{\sum_{t=k+1}^{T}((Y_t-\overline{Y})(Y_{t-k}))/(T-K)}{\sum_{t=1}^{T}(Y_t-\overline{Y})^2/T} \quad (6)$$

$$Q_{LB} = T(T+2)\sum_{j=1}^{k}\frac{\tau^2_j}{T-j} \quad (7)$$

where$\tau_j$is the jth autocorrelation and T is the number of observations.

Variance Ratio Test

We use Lo and MacKinlay (1988) test statistics for testing RWH. Lo and MacKinlay has made two assumptions which states that ϵ_t are i.i.d. (independent and identically distributed) i.e. homoscedastic RWH and second assumption is that ϵ_t to be a martingale difference sequence (m.d.s.) which is termed as heteroskedastic RWH.

The estimators for the mean of first difference and the scaled variance of the q-th difference:

$$\hat{\mu} = \frac{1}{T}\sum_{t=1}^{T}(Y_t - Y_{t-1}) \quad (8)$$

$$\hat{\sigma}^2(q) = \frac{1}{Tq}\sum_{t=1}^{T}\left(Y_t - Y_{t-q} - q\hat{\mu}^2\right)$$

(9)

And the corresponding variance ratio VR (q) $=\hat{\sigma}^2(q)/\hat{\sigma}^2(1)$. The variance estimator may be adjusted for bias, as suggested by Lo and MacKinlay (1988) by replacing T in above equation with $(T - q + 1)$ in the no drift case or with $(T - q + 1)(1 - q/T)$ in the drift case.

Lo and MacKinlay show that the variance ratio z-statistic

$$Z(q) = (VR(q) - 1) \times [\hat{s}^2(q)]^{-1/2}$$

(10)

is asymptotically N(0, 1) for appropriate choice of estimator $\hat{s}^2(q)$.

Under the i.i.d. hypothesis we have the estimator,

$$\hat{s}^2(q) = \frac{2(2q-1)(q-1)}{3qT} \quad (11)$$

While under the m.d.s. assumption we use the kernel estimator,

$$\hat{s}^2(q) = \sum_{j=1}^{q-1}\left(\frac{2q-j}{q}\right)^2 \cdot \widehat{\delta_j} \quad (12)$$

Where,

$$\widehat{\delta_j} = \left\{\sum_{t=j+1}^{T}\left(y_{t-j} - \hat{\mu}\right)^2\left(y_t - \hat{\mu}\right)^2\right\} / \left\{\sum_{t=j+1}^{T}\left(y_{t-j} - \hat{\mu}\right)^2\right\}^2$$

(13)

GARCH (1, 1) Model

Under GARCH (Bollerslev 1986) model the forecasts of time varying variance depend on the lagged variance of any asset. This model is estimated on two specifications i.e., the conditional mean equation and conditional variance equation. The basic GARCH (1, 1) is expressed as

$$r_t = \mu + \phi r_{t-1} + \epsilon_t \quad (14)$$

$$\epsilon_t/\phi_{t-1} \sim N(0, h_t) \quad (15)$$

$$h_t = k + \alpha\, \epsilon^2{}_{t-1} + \beta h_{t-1} \quad (16)$$

Where α+β measures the volatility clustering, equation 1 is the conditional mean equation and equation 2 is the conditional variance equation. If the value of α+β is close to 1 we assume that there is a high persistence of volatility clustering and this indicates market inefficiency.

GARCH-M

The risk-return tradeoff is examined by GARCH-M model (Engle et.al1987) which measures the strength of risk aversion. In any security, the expected return is related to expected risk which depends on volatility. The coefficient of the expected risk is a measure of the risk-return tradeoff. The mean equation and variance equation of GARCH-M (1, 1) model is written as

$$Y_t = \omega + \lambda\sigma_t + \varepsilon_t \quad (17)$$

$$Y_t = \omega + \lambda \log(\sigma^2{}_t) + \varepsilon_t \quad (18)$$

EGARCH Model

EGARCH model was developed by Nelson (1991). The specification for the conditional variance is

$$log(\sigma_t{}^2) = \omega + \sum_{j=i}^{q}\beta_j\, log\left(\sigma^2{}_{t-j}\right) + \sum_{i=j}^{p}\alpha_i\left|\frac{\epsilon_{t-i}}{\sigma_{t-i}}\right| + \sum_{k=}^{r}$$

(19)

The left-hand side is the log of the conditional variance. This implies that the leverage effect is exponential, rather than quadratic, and that forecasts of the conditional variance are guaranteed to be nonnegative. The presence of leverage effects can be tested by the hypothesis that $\gamma_i < 0$. The impact is asymmetric $\gamma_i \neq 0$.

TGARCH Model

TGARCH (Zakoian 1994) model is used to see the leverage effect in the return series. The generalized specification for the conditional variance is given by:

$$\sigma_t{}^2 = \omega + \sum_{j=1}^{q}\beta_j\,\sigma^2{}_{t-j} + \sum_{i=1}^{p}\alpha_i\,\epsilon^2{}_{t-i} + \sum_{k=1}^{r}\gamma_k\,\epsilon^2{}_{t-k}I$$

(20)

Where $I_t = 1$ if $\epsilon_t < 0$ and otherwise 0.

In this model, good news, $\epsilon_{t-i} < 0$ and bad news, $\epsilon_{t-i} > 0$have differential effect on the conditional variance: good news has the impact of α_i while bad news has an impact of$\alpha_i + \gamma_i$. Ifγ_i> 0, bad news increases volatility and there is a leverage effect. If $\gamma_i \neq 0$, news impact is asymmetric.

PARCH MODEL

Ding et al. (1993) developed the Power ARCH (PARCH) specification to deal with the asymmetry. The power parameter δ of the standard deviation is estimated rather than variance and theoptional γparameters are included to captureasymmetry in the PARCH model.

$$\sigma^{\delta}{}_t = \omega + \sum_{j=1}^{q}\beta_j\sigma^{\delta}{}_{t-j} + \sum_{i=1}^{p}\alpha_i\left(|\varepsilon_{t-i}| - \gamma_i\varepsilon_{t-i}\right)^{\delta}$$

(21)

Where δ > 0, $|r_i| \leq 1$ for i =1,…, r, $\gamma_i = 0$ for all i>r and r $\leq$ p.

The symmetric model sets $\gamma_i = 0$ forall i. If and δ=2 and γ_i = 0 for all i, the PARCH model is simply a standard GARCH specification. As in the previous models, the asymmetric effects are present if $\gamma_i \neq 0$.

6 RESULTS AND ANALYSIS

RWH is examined by using the above methodology in Indian stock market. The descriptive statistics on the daily returns are reported in Table II. The table shows the year-wise results of the BSE-100 based companies. The period 2003 has the highest mean daily return(0.36%), while 2008 has the lowest (-0.33%). However, 1992 has the highest standard deviation (3.67%) and 2010 the lowest (0.98%). The standard deviation for all the years reveals relatively high volatility as expected in emerging markets. The negative skewness is observed for all the years except 2011, 2009, 1996, 1995, 1994 and 1991. The kurtosis stated for each year shows that the distributions of security return have sharp peaks when compared to a normal distribution. The Jarque-Bera's statistics shows the non-normality of returns for all period except for 2011, 1999 and 1998. Therefore, we infer that the overall result deviates from the assumption of RWH and shows significant deviation from normality. Runs testThe empirical result of Runs test is presented in Table III. Runs test uses the direction of the change of the given data to know whether the data series exhibits any pattern or trend. .If the actual numbers of runs are equal or close to expected runs, the price series are random or independent. The results show that the p values are statistically significant at 5% level of significance for the years2012, 2011, 2008, 2005, 2003, 2002, 1998, 1997, 1996, 1995, 1994, 1993, 1992 and 1990 and therefore, we infer that the series are not random for these years. The RWH does not hold good for these years and the observed series are serially correlated which indicates the predictability nature. This means that historical prices have information content and can be used to see the pattern or trend to predict the future price direction.Whereas, the p values of 2010, 2009, 2007, 2006, 2004, 2001, 2000, 1999 and 1991 are statistically insignificant and, therefore, series are random. This result supports the RWH and we infer that market is efficient during these period.This result states that investors do not have any arbitrage opportunity to make abnormal profits during these periods. The overall results of 23 years indicate that the market is inefficient for 14 years showing the trend in the market and efficient for 9 years where there is no trend in the market. Therefore, investors can use majority of the data series in 14 years to invest and earn profits.

Unit Root Test

The table IV reports ADF and PP tests for unit root of Indian stock market. The unit root test is necessary condition for random walk model to find out the order of integration of stock returns. Randomness implies non-stationarity of the observed return series. Unit root component has predictable element and is used extensively in financial economics literature to test the predictable pattern in time series. The results of ADF test shows that the series are significant for all the years and this shows that series are stationary. Therefore, the null hypothesis of unit root is rejected for all the years at 5% level of significance. Further, to confirm the results, we also use PP test for unit root. The results of PP test provide further evidences against unit root and confirm the results of ADF test. Overall the results suggest that there is a significance evidence to reject RWH in Indian stock market. The historical prices can be used to forecast the future returns and therefore, Indian stock market is inconsistent with RWH. We report the results of two unit root test (ADF and PP) which gives an indication of the robustness of our results. Based on unit root results, we conclude that stock prices are mean reverting in Indian stock market.

Autocorrelation Test

Empirically, the presence of unit root is necessary condition to explain the time series behaviour of stock prices. However, the unit root test is not a sufficient condition to conclude about the randomness of the data. Many tests have been developed to test RWH and we use autocorrelation test. It measures the relationship between the values of random variable at time t and its value in the preceding period. The autocorrelation test is performed by taking 6 lags and the results are reported in table V. The autocorrelation coefficients are statistically significant for 2011, 2005, 2004, 2001, 1997, 1996, 1995, 1994 and 1993 and therefore, the null hypothesis of no autocorrelation is rejected for these years. However, the autocorrelation coefficients for 2008 are significant at lag 1, for 2006 at lag 1,2,4,5 and 6 and for 2002 at lag 1, 4 and 5 and the null hypothesis of no autocorrelation is rejected for these lags. These results fail to support the RWH and we infer that market is inefficient. Further, the autocorrelation coefficients are statistically insignificant for the period 2012, 2010, 2009, 2007, 2003, 2000, 1999, 1998, 1992, 1991 and 1990 and therefore, we accept the null hypothesis of no autocorrelation for these periods. Therefore, we infer that the result supported RWH during these periods. Overall, the results show mixed evidence suggesting that the observed return series may not be completely random.

Variance ratio test

We conduct a variance-ratio test (Lo and MacKinlay 1988) to test the RWH. Table VI reports the results of variance-ratio statistics under the hypothesis of homoskedasticity and heteroskedasticity {Z(n) and Z*(n)} at 2, 4, 8 and 16 lag intervals for BSE-100 index based companies. The variance ratio test statistics represent the ratio of two variances of different length intervals. It is used to compare the variances of the increments from different length of time interval. The available literature sates that the results obtained from the variance ratio test are robust to heteroskedasticity. From the empirical results it is observed that most point estimates of the variance ratios are less than unity and variance ratios are decreasing when there is an increase in lag intervals for all the years. The basic assumption is that the variances grow consistently with time when the variance ratios are equals to one. Further, the

variance ratios are statistically significant under the hypothesis of homoskedasticity and heteroskedasticity for all the years under study. These empirical evidences fail to support RWH and therefore, we infer that market is inefficient. In the finance literature, variance ratio test is considered as powerful technique compared to other nonparametric techniques, and therefore, the results are robust. The empirical evidences of variance ratio test support the results of unit root test (ADF and PP) which states that Indian capital market has predictable trend based on historical information.

GARCH Models

The results of various GARCH models are reported in table VII. We used GARCH (1, 1) and GARCH-M models to test for symmetric volatility and EGARCH, TGARCH and PGARCH models are used to test asymmetric volatility. The table VI represents three coefficients and it includes $\alpha + \beta$ which indicates the estimated ARCH and GARCH coefficients, σ^2, estimated risk premium coefficients and γ, are the estimated coefficients of leverage effect. From the result, we observed that the sum of ARCH and GARCH coefficients of GARCH (1, 1) model are very close to one for all the years except 2005, 2003, 2000, 1999, 1998, 1997, 1996 and 1995 which indicates the high level of volatility clustering. The risk return parameters (σ^2) in GARCH-M model are positive for 2011, 2008, 2007, 2006, 2005, 2003, 2002, 1998, 1996, 1995, 1994, 1993 and 1992 which shows that return is positively related to its volatility. This indicates that higher the volatility higher the return which supports the assumption of higher return with higher risk. Whereas, the negative risk premium is observed during 2012, 2010, 2009, 2004, 2001, 2000, 1999, 1997, 1991 and 1990.

The existence of leverage effect is examined by using EGARCH and TGARCH and PGARCH models of the return series of BSE-100 companies. The estimated coefficients of EGARCH model (γ) are negative and statistically significant at 5% level of significance for all the years under the study. The results shows the leverage effect in the series which indicates that the negative shocks have higher impact on volatility than positive shocks. In the case of TGARCH model (γ), the estimated coefficients positive and statistically significant at 5% level of significance. Further, the leverage effect is observed and this shows that bad news has greater impact on conditional variance than good news. The results of PGARCH model (γ), shows that the coefficients are positive and significant for years 2012, 2011, 2010, 2009, 2008, 2007, 2006, 2005, 2004, 2003, 2001, 2000, 1999, 1998, 1995, 1994, 1991 and 1990. In the case of 2002, 1997, 1996, 1993 and 1992, the coefficients are negative and significant. Overall the GARCH models results indicates the volatility clustering, positive and negative risk premium and leverage effects which are the indicators of market inefficiency. Therefore we infer that GARCH models results fail to support the RWH in Indian stock market. Further, the results of all the tests are given in the summary form in Table 1.

TABLE 1 *SUMMARY OF RWH TESTS RESULTS*

S. No	Name of the test	Results
1.	Jarque-Bera's statistics	Rejected the RWH
2.	Runs Test	Rejected the RWH
3.	Unit Root Tests	Rejected the RWH
4.	Autocorrelation Test	Showed mixed evidences
5.	Variance Ratio Test	Rejected the RWH
6.	GARCH (1, 1)	Rejected the RWH
7.	GARCH-M	Rejected the RWH
8.	E-GARCH	Rejected the RWH
9.	T-GARCH	Rejected the RWH
10.	P- GARCH	Rejected the RWH

Source: Authors' calculations

TABLE II *RESULTS OF DESCRIPTIVE STATISTICS*

Year	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability	Sum	Observations
2012	0.12%	1.08%	-0.1763	3.6954	6.3317	0.0422	0.3011	250
2011	-0.15%	1.25%	0.0893	2.9696	0.3366	0.8451	-0.3649	246
2010	0.06%	0.98%	-0.6409	4.0464	28.6340	0.0000	0.1606	251
2009	0.28%	1.99%	0.7396	10.0282	520.1334	0.0000	0.6872	242
2008	-0.33%	2.66%	-0.3830	4.7583	37.5498	0.0000	-0.8130	245
2007	0.21%	1.50%	-0.7223	4.9509	60.8948	0.0000	0.5122	248
2006	0.15%	1.64%	-0.9999	7.0437	211.1412	0.0000	0.3805	249
2005	0.14%	1.08%	-0.6327	4.0114	27.3338	0.0000	0.3543	250
2004	0.10%	1.74%	-1.7242	14.4181	1499.7060	0.0000	0.2442	253
2003	0.36%	1.22%	-0.4995	3.3765	12.0138	0.0025	0.9027	253
2002	0.11%	1.16%	-0.1968	5.9971	95.1839	0.0000	0.2814	250
2001	-0.06%	1.74%	-1.0298	6.3915	162.0324	0.0000	-0.1394	247
2000	-0.1	1.73%	-0.33	4.0632	16.3627	0.0003	-0.3	249

	4%		42				386	
1999	0.26%	2.00%	-0.0286	3.7330	5.5625	0.0620	0.6392	247
1998	-0.06%	2.02%	-0.0031	3.6748	4.6107	0.0997	-0.1425	243
1997	0.00%	1.41%	-0.2609	7.9173	248.6000	0.0000	-0.0015	244
1996	-0.03%	1.32%	0.6020	4.1106	26.3826	0.0000	-0.0673	236
1995	-0.14%	1.08%	0.1796	3.7149	6.1353	0.0465	-0.3274	230
1994	0.12%	1.29%	0.3393	4.1987	18.1046	0.0001	0.2716	229
1993	0.19%	1.49%	-0.4748	4.5198	28.2365	0.0000	0.3964	211
1992	0.05%	3.67%	-0.2469	12.607	682.3038	0.0000	0.0928	175
1991	0.31%	1.80%	0.6072	7.1494	144.8666	0.0000	0.5685	186
1990	0.20%	2.08%	-0.3594	4.9980	35.8800	0.0000	0.3902	191

Source: Authors' calculations

TABLE III *RESULT OF RUNS TEST*

Year	K=Mean	Cases < K	Cases >= K	Total Cases	Number of Runs	Z-Statistic -	p-value
2012	0.00120	131	119	250	105	-2.63125	0.00425
2011	-0.00148	124	122	246	91	-4.21586	0.00001
2010	0.00064	133	118	251	119	-0.89521	0.18534
2009	0.00284	123	119	242	119	-0.38234	0.35110
2008	-0.00332	128	117	245	97	-3.36821	0.00038
2007	0.00207	138	110	248	119	-0.56969	0.28444
2006	0.00153	146	103	249	115	-0.88858	0.18711
2005	0.00142	140	110	250	100	-3.11225	0.00093
2004	0.00097	145	108	253	119	-0.74606	0.22782
2003	0.00357	137	116	253	112	-1.85586	0.03174
2002	0.00113	131	119	250	101	-3.13941	0.00085
2001	-0.00056	127	120	247	113	-1.4549	0.07284
2000	-0.00136	131	118	249	117	-1.03926	0.14934
1999	0.00259	128	119	247	113	-1.44746	0.07388
1998	-0.00059	114	129	243	98	-3.10221	0.00096
1997	-0.00001	120	124	244	88	-4.48754	0.00000
1996	-0.00029	115	121	236	78	-5.34266	0.00000
1995	-0.00142	114	116	230	72	-5.81455	0.00000
1994	0.00119	106	123	229	89	-3.44554	0.00028
1993	0.00188	100	111	211	75	-4.31969	0.00001
1992	0.00053	89	86	175	76	-1.89194	0.02925
1991	0.00306	91	100	191	89	-1.05983	0.14461
1990	0.00204	95	96	191	73	-3.40950	0.00033

Source: Authors' calculations

TABLE IV *THE RESULT OF ADF TEST AND PP TEST*

Year	ADF	Test critical value	p-value	PP	Test critical value	p-value
2012	-15.22241	-2.87295	0.00000	-15.23516	-2.87295	0.00000
2011	-13.13046	-2.873142	0.00000	-13.14603	-2.873142	0.00000
2010	-15.45279	-2.872904	0.00000	-15.4593	-2.872904	0.00000
2009	-14.11	-2.87334	0.00000	-14.14109	-2.87334	0.00000
2008	-13.7108	-2.87319	0.00000	-13.63067	-2.87319	0.00000
2007	-13.9221	-2.87305	0.00000	-13.864	-2.87305	0.00000
2006	-13.4645	-2.87300	0.00000	-13.37999	-2.87300	0.00000
2005	-12.8897	-2.87295	0.00000	-12.87853	-2.87295	0.00000
2004	-13.3473	-2.87286	0.00000	-13.33738	-2.87281	0.00000
2003	-14.0117	-2.87281	0.00000	-14.04218	-2.87281	0.00000
2002	-13.784	-2.87295	0.00000	-13.847	-2.87295	0.00000

	4			47		
2001	-13.0432	-2.87309	0.00000	-13.04332	-2.87309	0.00000
2000	-15.1935	-2.87300	0.00000	-15.21052	-2.87300	0.00000
1999	-14.4147	-2.87309	0.00000	-14.42679	-2.87309	0.00000
1998	-14.7832	-2.87329	0.00000	-14.78272	-2.87329	0.00000
1997	-11.6763	-2.87324	0.00000	-11.67632	-2.87324	0.00000
1996	-10.8266	-2.87365	0.00000	-11.01391	-2.87365	0.00000
1995	-10.0405	-2.87397	0.00000	-9.945829	-2.87397	0.00000
1994	-10.5353	-2.87403	0.00000	-10.37904	-2.87403	0.00000
1993	-9.97748	-2.87513	0.00000	-9.771005	-2.87513	0.00000
1992	-12.5419	-2.87660	0.00000	-12.6277	-2.87660	0.00000
1991	-13.0108	-2.87701	0.00000	-13.11293	-2.87701	0.00000
1990	-11.5193	-2.87802	0.00000	-11.62834	-2.87802	0.00000

Source: Authors' calculations

TABLE V RESULTS OF AUTOCORRELATION TEST

Year	2012			2011			2010			2009			2008			2007		
Lags	AC	Q-Stat	Prob	AC	Q-Stat	Prob	AC	Q-Stat	Prob	AC	Q-Stat	Prob	AC	Q-Stat	Prob	AC	Q-Stat	Prob
1	0.0470	0.5585	0.4550	0.17000	7.1913	0.0070	0.0210	0.1101	0.7400	0.0910	2.0479	0.1520	0.1260	3.9578	0.0470	0.1150	3.3206	0.0680
2	0.0850	2.3731	0.3050	0.10500	9.9601	0.0070	0.0520	0.7951	0.6720	0.0120	2.0813	0.3530	0.0150	4.0149	0.1340	-0.0440	3.8007	0.1500
3	0.0460	2.9241	0.4030	-0.10900	12.9450	0.0050	-0.0440	1.2816	0.7340	0.0400	2.4818	0.4790	0.0070	4.0288	0.2580	0.0370	4.1442	0.2460
4	-0.0430	3.3909	0.4950	-0.00400	12.9490	0.0120	-0.0290	1.5046	0.8260	0.0280	2.6813	0.6120	-0.1150	7.3447	0.1190	-0.0810	5.8178	0.2130
5	-0.0240	3.5450	0.6170	-0.02500	13.1030	0.0230	-0.0380	1.8814	0.8650	-0.0270	2.8628	0.7210	-0.0810	8.9972	0.1090	-0.0330	6.0888	0.2980
6	0.0230	3.6768	0.7200	0.02900	13.3170	0.0380	-0.0600	2.8086	0.8320	-0.0880	4.8176	0.5670	0.0020	8.9988	0.1740	-0.0570	6.9164	0.3290
Year	2006			2005			2004			2003			2002			2001		
Lags	AC	Q-Stat	Prob	AC	Q-Stat	Prob	AC	Q-Stat	Prob	AC	Q-Stat	Prob	AC	Q-Stat	Prob	AC	Q-Stat	Prob
1	0.1530	5.8883	0.0150	0.1930	9.4186	0.0020	0.1590	6.4344	0.0110	0.1210	3.7229	0.0540	0.1300	4.2695	0.0390	0.1720	7.3579	0.0070
2	-0.0590	6.7590	0.0340	-0.0450	9.9421	0.0070	-0.2300	19.9790	0.0000	-0.0280	3.9307	0.1400	-0.0540	5.0100	0.0820	-0.0790	8.9255	0.0120
3	-0.0460	7.3008	0.0630	0.0820	11.6480	0.0090	0.0070	19.9920	0.0000	0.0560	4.7265	0.1930	0.0790	6.5971	0.0860	0.0260	9.0952	0.0280
4	0.1350	11.9520	0.0180	0.0730	13.0260	0.0110	0.1360	24.8020	0.0000	0.0780	6.3215	0.1760	0.1080	9.6019	0.0480	0.0570	9.9302	0.0420
5	0.1180	15.4950	0.0089	-0.0050	13.0320	0.0230	-0.0820	26.5560	0.0000	-0.0040	6.3257	0.2760	0.0930	11.8130	0.0370	0.1350	14.5690	0.0120
6	-0.0770	17.0290	0.0090	0.0270	13.2240	0.0400	-0.0520	27.2710	0.0000	-0.0110	6.3596	0.3840	0.0140	11.8650	0.0650	-0.0010	14.5700	0.0240
Year	2000			1999			1998			1997			1996			1995		
Lags	AC	Q-Stat	Prob	AC	Q-Stat	Prob	AC	Q-Stat	Prob	AC	Q-Stat	Prob	AC	Q-Stat	Prob	AC	Q-Stat	Prob
1	0.0290	0.2192	0.6400	0.0830	1.7418	0.1870	0.0450	0.4959	0.4810	0.2770	18.9170	0.0000	0.3310	26.1170	0.0000	0.3820	34.0120	0.0000
2	0.0690	1.4286	0.4900	0.0320	1.9956	0.3690	-0.0230	0.6299	0.7300	0.0550	19.6640	0.0000	0.0830	27.7550	0.0000	0.0360	34.3220	0.0000
3	-0.0500	2.0658	0.5590	0.0200	2.0975	0.5520	0.0770	2.0936	0.5530	-0.0120	19.6980	0.0000	0.1280	31.6910	0.0000	0.0790	35.7870	0.0000
4	0.0290	2.4499	0.6540	0.0550	2.8496	0.5830	-0.0520	2.7685	0.5970	-0.0030	19.7000	0.0010	0.1450	36.7900	0.0000	0.0420	36.2040	0.0000
5	0.0810	4.1133	0.5330	0.0360	3.1733	0.6730	-0.0130	2.8081	0.7300	-0.0740	21.0740	0.0010	0.0740	38.1310	0.0000	-0.0750	37.5510	0.0000
6	0.0060	4.1229	0.6600	-0.1260	7.2402	0.2990	0.0830	4.5482	0.6030	-0.2370	35.2610	0.0000	0.0090	38.1510	0.0000	-0.0440	38.0080	0.0000
Year	1994			1993			1992			1991			1990					
Lags	AC	Q-Stat	Prob	AC	Q-Stat	Prob	AC	Q-Stat	Prob	AC	Q-Stat	Prob	AC	Q-Stat	Prob			
1	0.3470	27.9980	0.0000	0.3540	26.8050	0.0000	0.1280	2.9386	0.0860	0.0420	0.3383	0.5610	0.0920	1.6371	0.2010			
2	-0.0150	28.0470	0.0000	0.0110	26.8020	0.0000	0.0220	3.0225	0.2210	-0.0220	0.4312	0.8060	0.0270	1.7822	0.4100			
3	0.0140	28.0940	0.0000	-0.0500	27.4190	0.0000	0.1340	6.2710	0.0990	-0.0190	0.5004	0.9190	0.0870	3.2680	0.3520			
4	0.0570	28.8460	0.0000	0.0630	28.2830	0.0000	0.0350	6.4867	0.1660	-0.1320	3.0544	0.4260	0.0710	4.2674	0.3710			
5	-0.0030	28.8490	0.0000	0.1050	30.6720	0.0000	-0.0210	6.5673	0.2550	-0.1580	8.6909	0.1220	-0.0580	4.9371	0.4240			
6	0.0390	29.0660	0.0000	0.1040	33.0230	0.0000	-0.0160	6.6165	0.3580	0.0450	9.0820	0.1690	-0.1220	7.9139	0.2440			

Source: Authors' calculations

TABLE VI *VARIANCE RATIO TEST*

Year	No. Of. Observations	Number (n) of multiple sampling periods (weeks) used to generate variance ratios			
		2	4	8	16
2012	250	0.47978	0.273607	0.120184	0.05915
		(-8.20893)*	(-6.12685)*	(-4.6934)*	(-3.37287)*
		[-5.74654]*	[-4.71485]*	[-3.86149]*	[-2.94212]*
2011	246	0.537858	0.299198	0.142416	0.06867
		(-7.23366)*	(-5.86333)*	(-4.53791)*	(-3.31181)*
		[-6.30193]*	[-5.2568]*	[-4.14453]*	[-3.10924]*
2010	251	0.483788	0.262315	0.132094	0.059355
		(-8.16202)*	(-6.23458)*	(-4.63915)*	(-3.3789)*
		[-5.8105]*	[-4.82082]*	[-3.70265]*	[-2.79245]*
2009	242	0.542594	0.259731	0.123188	0.059768
		(-7.10085)*	(-6.14277)*	(-4.60163)*	(-3.31606)*
		[-4.48259]*	[-4.44394]*	[-3.73426]*	[-2.80259]*
2008	245	0.562675	0.317847	0.126203	0.063407
		(-6.83124)*	(-5.69564)*	(-4.61425)*	(-3.32373)*
		[-4.49579]*	[-3.86758]*	[-3.39175]*	[-2.64264]*
2007	248	0.589227	0.303978	0.140021	0.063564
		(-6.4558)*	(-5.84706)*	(-4.56912)*	(-3.34353)*
		[-4.39845]*	[-4.18057]*	[-3.4217]*	[-2.68416]*
2006	249	0.624741	0.254718	0.149416	0.07249
		(-5.90958)*	(-6.27354)*	(-4.52834)*	(-3.31836)*
		[-2.88835]*	[-3.43268]*	[-2.57902]*	[-2.06681]*
2005	250	0.635853	0.276697	0.158037	0.075476
		(-5.74614)*	(-6.10078)*	(-4.49147)*	(-3.31434)*
		[-4.08547]*	[-4.70653]*	[-3.82141]*	[-3.05227]*

2004	253	0.731453	0.25577	0.161048	0.077066
		(-4.26304)*	(-6.315)*	(-4.50229)*	(-3.32851)*
		[-2.99555]*	[-3.51643]*	[-2.55109]*	[-2.08246]*
2003	253	0.582863	0.258195	0.13881	0.070605
		(-6.62184)*	(-6.29442)*	(-4.62163)*	(-3.35181)*
		[-4.61281]*	[-4.79579]*	[-3.84639]*	[-2.98214]*
2002	250	0.604759	0.255112	0.129111	0.079421
		(-6.2368)*	(-6.28285)*	(-4.64578)*	(-3.3002)*
		[-3.51943]*	[-3.84282]*	[-3.25193]*	[-2.59612]*
2001	247	0.650283	0.283076	0.146512	0.072258
		(-5.4851)*	(-6.01044)*	(-4.52544)*	(-3.30578)*
		[-3.99108]*	[-4.14958]*	[-3.15622]*	[-2.41931]*
2000	249	0.475565	0.243348	0.120195	0.053483
		(-8.25881)*	(-6.36924)*	(-4.68391)*	(-3.38636)*
		[-5.11186]*	[-4.26181]*	[-3.47543]*	[-2.83753]*
1999	247	0.528213	0.256214	0.140853	0.072116
		(-7.39969)*	(-6.23564)*	(-4.55545)*	(-3.30629)*
		[-4.33897]*	[-4.19523]*	[-3.59202]*	[-2.85497]*
1998	243	0.532231	0.271852	0.118396	0.062353
		-7.27677*	(-6.05471)*	(-4.63636)*	(-3.3138)*
		[-5.03059]*	[-4.51087]*	[-3.717]*	[-2.79988]*
1997	244	0.652202	0.344117	0.163887	0.083336
		(-5.42164)*	(-5.46507)*	(-4.4062)*	(-3.24633)*
		[-2.87113]*	[-3.33196]*	[-3.12483]*	[-2.54221]*
1996	236	0.685171	0.314878	0.174559	0.095441
		(-4.82624)*	(-5.61394)*	(-4.27776)*	(-3.15029)*
		[-3.99483]*	[-4.78261]*	[-3.80272]*	[-2.90842]*
1995	230	0.777805	0.38624	0.200189	0.091087
		(-3.36243)*	(-4.96458)*	(-4.09168)*	(-3.12478)*
		[-2.67466]*	[-3.7023]*	[-3.12906]*	[-2.57859]*
1994	229	0.778879	0.349174	0.205208	0.076107
		(-3.33886)*	(-5.25289)*	(-4.05711)*	(-3.16934)*
		[-2.09425]*	[-3.40314]*	[-2.7286]*	[-2.25267]*
1993	211	0.760321	0.358	0.195224	0.083122
		(-3.47327)*	(-4.97291)*	(-3.94258)*	(-3.01856)*
		[-2.88057]*	[-4.21599]*	[-3.36856]*	[-2.66322]*
1992	175	0.561283	0.276226	0.154074	0.054091
		(-5.78708)*	(-5.10321)*	(-3.77227)*	(-2.83467)*
		[-2.7457]*	[-2.758]*	[-2.39795]*	[-2.0458]*
1991	186	0.533341	0.293381	0.120998	0.057471
		(-6.34725)*	(-5.13732)*	(-4.04177)*	(-2.91246)*
		[-3.54887]*	[-3.39399]*	[-2.85483]*	[-2.1051]*
1990	191	0.533268	0.244162	0.132256	0.049883
		(-6.43346)*	(-5.56893)*	(-4.04357)*	(-2.97532)*
		[-3.11896]*	[-2.88292]*	[-2.40325]*	[-2.03194]*

Note: The different rows values in columns 3, 4, 5, and 6 represent the different test statistic values. The first row represents the variance ratios, Homoscedasticity test statistics Z(n) in the parentheses are in the second row and heteroscedasticity Z*(n) statistics are in the square brackets in the third row. * Variance ratios are significantly different from unity at 0.05 level.
Source: Authors' calculations

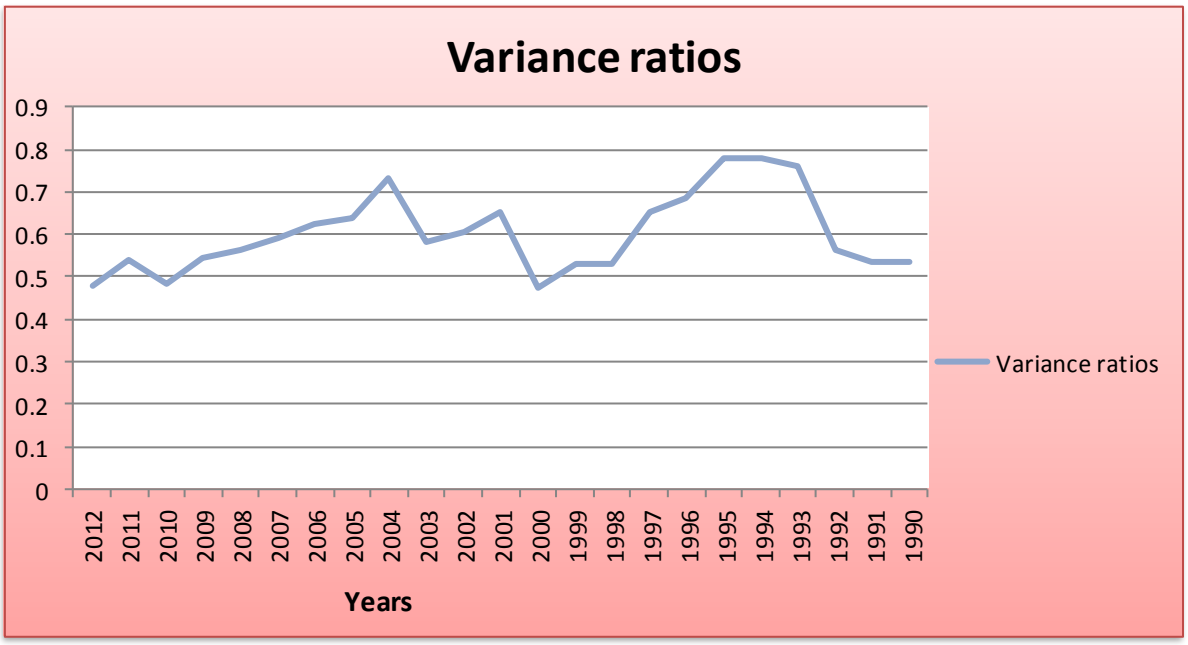

Figure 1 *Shows the Variance Ratios of BSE-100 based companies for 23 years*

TABLE VII *RESULT OF DIFFERENT GARCH MODELS*

Year	GARCH (1, 1) $\alpha+\beta$	GARCH-M σ^2	EGARCH γ	TGARCH γ	PGARCH γ
2012	0.94688	-0.73565*	-0.09190*	0.01485*	0.01873*
2011	0.97189	0.42073*	-0.16349*	0.22753*	0.99937*
2010	0.93554	-0.15831*	-0.23817*	0.30727*	0.99696*
2009	0.99608	-2.71603*	-0.32627*	0.01102*	0.10034*
2008	0.93206	0.12093*	-0.25607*	0.34618*	1.00000*
2007	0.90479	0.32707*	-0.32119*	0.60852*	0.16403*
2006	0.92769	0.08154*	-0.24058*	0.46618*	0.99143*
2005	0.78752	0.33605*	-0.29080*	0.32227*	0.98797*
2004	0.98756	-0.13548*	-0.39246*	0.50184*	0.99897*
2003	0.03520	0.66778*	-0.19772*	0.31790*	0.67672*
2002	0.91068	0.13154*	-0.01084*	0.07402*	-0.09526*
2001	0.94343	-0.04058*	-0.19102*	0.25936*	0.51952*
2000	0.86973	-0.32526*	-0.12828*	0.14399*	0.59152*
1999	0.18488	-0.32748*	-0.06195*	0.08898*	0.06808*
1998	0.88777	0.11659*	-0.09454*	0.18734*	0.72642*
1997	0.11316	-0.15782*	-0.03452*	0.13277*	-0.11619*
1996	0.86403	0.97065*	-0.03628*	0.02673*	-0.04973*
1995	0.79020	0.79516*	-0.14132*	0.21198*	0.66644*
1994	0.97654	0.00771*	-0.00586*	0.01673*	0.02748*
1993	0.93236	0.15998*	-0.01917*	0.00909*	-0.03320*
1992	0.98935	-0.20273*	-0.17858*	0.36574*	-0.90247*

1991	*0.90934*	*-0.36094**	*-0.15228**	*0.14294**	*0.05734**
1990	*0.95498*	*-0.21775**	*-0.02129**	*0.05467**	*0.14451**

Note: $\alpha + \beta$ are the estimated ARCH and GARCH coefficients;σ^2,estimated risk premium coefficients and γ, estimated coefficients of leverage effect. * indicates significant at 5% level.
Source: Authors' calculations

7 CONCLUSION

The objective of the study is to examine the RWH in Indian stock market. We examined the behavior of the daily returns of BSE-100 stocks by applying Runs test, ADF test, PP test, Autocorrelation Test, variance ratio test, GARCH (1, 1) GARCH-M (1, 1), EGARCH (1, 1) TGARCH (1, 1) and PGARCH (1, 1) models. The empirical evidences show that the Jarque-Bera's statistics shows the non-normality of returns for all periods except for 2011, 1999 and 1998. The ADF and PP tests found no-unit root component in the series and both violate the basic assumption of RWH. In the case of autocorrelation test, we found mixed evidences and the results are consistent with those of Sharma and Mahendru (2009). The variance ratio test results are consistent with that of Lakshmi and Roy (2012)but they differ from the results of Fama and French (1988), Lo and MacKinlay (1988) Poterba and Summers (1988). The volatility clustering is observed in GARCH (1, 1) model and the coefficients are statistically significant and this shows that market is inefficient. Further, the positive and negative risk premium is observed during the study (GARCH-M). The leverage effect is examined and EGARCH, TGARCH and PGARCH models showed that there is leverage effect. In particular, our results led to conclude that the Indian stock market is not efficient market as implied in Vaidyanathan and Gali (1994) and Mall et al. (2011). Rather, Indian stock market exhibits the pattern of somewhat mixed evidence, which indicates lack of efficiency. The differences appear partly due to the use of daily data of BSE-100 companies and not the market indices as in the case of most Indian literature. Further, the RWH is tested before by Chaudhuri (1991) who examined RWH from January 1988 to April 1990, Poshakwale (2002) from 1 January, 1990 to 30 November, 1998 by taking the highly traded Indian stocks as sample and found that Indian market is inefficient. Our study extended the analysis of RWH by covering the time period from 1 January 1990 to 31 December 2012 and found mixed evidences which shows that lack of efficiency and leads to conclude that the Indian market is inefficient even for the extended time period. Some conceivable explanations can be provided for the rejection of the RWH for the Indian stock market. The factors such as market imperfections, infrequent trading of few stocks, the changing regulations and practices introduced by regulating authorities etc. affect the speedy processing of information and behavior of stock prices in Indian stock market. Our results are useful as a piece of information to the regulatory authorities, speculators and the individual and institutional investors of Indian stock market. The results show the true picture of the market and the investors' response to the stock prices in emerging markets like India which is going through various phases of financial, economic and regulatory reforms. This study has the global impact as Indian firms are integrated with global capital markets. As the Indian economy has been growing at a fast rate, this type of opportunity in the Indian market will attract more global investors to invest in Indian capital market. Further, the study shows the arbitrage opportunities in Indian capital market which generate excess return may be a factor for attractiveness to global investors. This study gives insight into Indian capital market and offers attractive investment opportunities for both domestic and global investors.

8 ACKNOWLEDGMENT

The authors are grateful to the anonymous referees of the journal for their extremely useful suggestions to improve the quality of the paper. Usual disclaimers apply

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