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ABSTRACT

This paper investigates the relationship between stock market returns and volatility in the Indian stock markets using AR(1)-EGARCH(p, q)-in-Mean model. The study considers daily closing prices of two major indexes of Indian stock exchanges, viz., S&P CNX NIFTY and the BSE-SENSEX of National Stock Exchange (NSE) and Bombay Stock Exchange (BSE), respectively for the period from July 1, 1997 to December 31, 2013. The empirical results show positive but insignificant relationship between stock returns and conditional variance in the case of NSE Nifty and BSE SENSEX stock markets. Besides, the analysis reveals that volatility is persistent and there exists leverage effect supporting the work of Nelson (1991) in the Indian stock markets. The present study suggests that the capital market regulators, investors and market participants should employ the asymmetric GARCH-type model that sufficiently captures the stylized characteristics of the return, such as time varying volatility, high persistence and asymmetric volatility responses, in determining the hedging strategy and portfolio management and estimating and forecasting volatility for risk management decision making at Indian Stock Exchange.

Keywords: Stock Market Returns, Weak-From Efficiency, India, AR-EGARCH-M model

JEL classification codes: G12, C15, C22

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1. INTRODUCTION

With Understanding the risk-return trade-off is fundamental to equilibrium asset pricing and has been has been an important topic in financial research. Many theoretical asset pricing models (e.g., Sharpe, 1964; Lintner, 1965; Mossin, 1966; Merton, 1973, 1980) postulates the return of an asset to its own return variance. However, whether such a relationship is positive or negative has been controversial. Many traditional asset-pricing models (e.g., Sharpe, 1964; Merton, 1980) postulate a positive relationship between a stock portfolio's expected return and the conditional variance as a proxy for risk. On the other hand, theoretical works by Black (1976), Cox and Ross (1976), Bekaert and Wu (2000), Whitelaw (2000) and Wu (2001) consistently asserts that stock market volatility should be negatively correlated with stock returns.

Empirical studies pertaining to the relationship between expected returns and conditional volatility also provides ambiguous result. Jensen et al., (1972) reports a linear relationship between risk and return for the New York Stock Exchange (NYSE). Myers and Brealey (1981) show a positive correlation between expected return and risk. French et al., (1987) confirms a significant positive relationship between excess return and risk for the Standard & Poor 500 index of United States. Harvey (1995) indicates that the risk-return relation in emerging stock markets displays different patterns compared to mature stock markets due to high expected returns and risk in emerging markets. Fletcher (1997) exerts a positive risk-return relationship in United Kingdom. Similarly, the literature such as for Japan (Chan et al., 1991 and Hawawini 1991) and France (Hawawini et al., 1983) reports positive correlation between return and risk. Further, the study of Elsas (2003) in Germany signifies that expected return and risk have a positive relationship. Bali and Peng (2006) uses daily data of emerging stock market indices and finds positive risk-return tradeoffs. Guo and Neely (2008) supports a positive risk-return relationship for the nineteen major international stock markets, including the world market. Lanne and Luoto (2008) reveal the existence of relatively robust positive relationship in the case of US stock market. Recently, the studies of Narang and Bhalla (2011), Jiranyakul (2011) and Lahmiri (2013) establishes a positive and significant relationship between expected returns and conditional variance.

However, there was a weak empirical evidence for the positive risk-return relationship reflected in the studies by Fama and French (1992), He and Ng (1994) Miles and Timmermann (1996) and Davis (1994). Glosten, Jagannathan, and

Runkle (1993) use an asymmetric GARCH-M model and find a negative risk-return relationship, which confirms Nelson (1991)'s findings. Besides, the study of Bekaert and Wu (2000), Wu (2001), Brandt and Kang (2004) and Li et al., (2005) reports a negative and often significant relationship.

Moreover, the empirical results of Cheung and Wong (1992) and Ho et al., (2000) for Hong Kong, Hawawini et al., (1989) for Canada, Ostermark (1991) for Sweden and Finland, Cheunga et al., (1993) for Taiwan and Korea and Hawawini et al., (1988) and Chan and Chui (1996) for United Kingdom confirms no significant relationship between expected return and risk. The study of Sriyalatha (2009) for Colombo Stock Exchange indicates no significant risk-return tradeoff. Theodossiou and Lee (1995) find no risk-return tradeoff in some Asian stock markets. Using a GARCH (1,1) model, De Santis and Imrohoroglu (1997) find no evidence on the positive tradeoff in the Asian stock markets. Chiang and Doong (2001) investigate the relationship between stock returns and conditional variance in the case of Hong Kong, Korea, Malaysia, the Philippines, Singapore, Taiwan, and Thailand and exerts a significant positive relationship in daily data, but the impact of volatility (or risk) on market returns is weak in weekly data and insignificant in monthly data. Shin (2005) estimates GARCH-in-mean models using weekly data to examine the risk-return tradeoff in Latin American, Asian, and European emerging stock markets. The empirical results from the Asian stock markets show a positive but insignificant tradeoff in most cases, including the case of Thailand. For the Indian stock market, Karmakar (2007) finds no relationship between return and risk. Lanne and Saikkonen (2006) show no risk-return tradeoff for the United States. Besides, Guo and Neely (2008) find significant positive relation in Hong Kong, but not in Singapore. Kong et al., (2008) studies the risk-return tradeoff for the Chinese stock markets and reports mixed evidences.

Given the conflicting results cited above, it is primarily an empirical question whether the conditional first and second moments of equity returns are positively related. Besides, the several emerging markets like India are not weak-form efficient and subject to have asymmetric properties in risk-return characteristics. Hence, the usage of asymmetric econometric models in examining risk-return trade-off could provide more precise results, as Exponential GARCH-in-Mean (EGARCH-M) accommodates an asymmetric relationship between stock price returns and volatility changes under the assumption that both the magnitude and sign of volatility was important in determining the risk-return correlation. Thus, the negative and positive sign of the conditional variance allowed the stock price returns to respond asymmetrically (bad and good news) to rises and falls in stock prices.

The purpose of this paper is to investigate the relationship between stock market returns and volatility in the Indian stock markets by employing AR(1)-EGARCH(p, q)-in-Mean model. The rest of the paper is organised as follows: Section 2 discusses the methodology of the study. Section 2 presents empirical findings. Concluding remarks are given in Section 4.

2. METHODOLOGY

The study considers daily closing prices of two major indexes of Indian stock exchanges, viz., S&P CNX NIFTY and the BSE-SENSEX of National Stock Exchange (NSE) and Bombay Stock Exchange (BSE), respectively for the period from July 1, 1997 to December 31, 2013. The necessary information regarding the daily closing values of the NSE S&P CNX NIFTY and BSE SENSEX indexes is collected from the NSE (www.nseindia.com) and BSE (www.bseindia.com) website, respectively. In the present study, the stock market returns are defined as continuously compounded or log returns (hereafter returns) at time t, Rt, calculated as follows:

$$Rt = \log (Pt / Pt\text{-}1) = \log Pt - \log Pt\text{-}1 \qquad (1)$$

where Pt and Pt-1 are the daily closing values of the NSE S&P CNX Nifty and the BSE SENSEX indexes at days t and t−1, respectively.

As a preliminary investigation, the descriptive statistics has been used to examine the distribution properties of stock index return series. Besides, the stationarity conditions of the stock market indices are tested by means of Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests. Both the tests are used to detect the presence of stationarity in the time series data. If the variables in the regression model are not stationary, then it can be shown that the standard assumptions for asymptotic analysis will not be valid. In other words, the usual "t ratios" do not follow a t-distribution and they are inappropriate to undertake hypothesis tests about the regression parameters. Hence, the presence of unit root in a time series is investigated with the help of ADF and PP tests in the study. Moreover, we used the EGARCH-M model of Nelson (1991) to examine the risk-return relation. This model sufficiently captures the asymmetric response of volatility to news and allows the conditional volatility to have asymmetric relation with past data[3]. Statistically, this effect occurs when an unexpected drop in stock price due to bad news increases volatility more than an unexpected increase in price due to good news of similar magnitude. The EGARCH-M model expresses the conditional variance of a given variable as a non-linear function of its own past values of standardized innovations that can react asymmetrically to good and bad news. The AR(1)-EGARCH(p, q)-in-Mean model can be specified as follows:

$$R_t = \beta_0+\beta_1 R_{t-1}+ \xi\sigma^2 t+\varepsilon_t \tag{2}$$

$$\ln(\sigma^2_t) = \alpha_0 + \alpha_1 \ln(\sigma^2_{t-1}) + \delta_1\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right| + \gamma_1 \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \tag{3}$$

where, R_t is the stock market returns of the S&P CNX Nifty and BSE SENSEX Indices at time 't'. R_{t-1} is a proxy for the mean of R_t conditional on past information. β_0 is comparable to the risk-free rate in the Capital Asset Pricing Model. $\xi\sigma^2_t$ is the market risk premium for expected volatility. This is the most relevant parameter for this study, because the sign and significance of the parameter ξ directly shed light on the nature of the relationship between stock market returns and its volatility. The expected volatility is approximated by $\sigma^2 t$, the conditional variance of R_t such that:

$$\sigma^2_t = \text{var}\ (R_t / \psi_{t-1}) \tag{4}$$

where ψ_{t-1} is the information set up to time, t-1 and, var(.) is the variance operator.

In terms of conditional variance equation (3), $\ln(\sigma^2_t)$ is the one-period ahead volatility forecast. This implies that the leverage effect is exponential rather than quadratic and forecast of conditional variance are guaranteed to be non-negative. σ^2_{t-1} denotes the estimation of the variance of the previous time period that stands for the linkage between current and past volatility. In other words, it measures the degree of volatility persistence of conditional variance in the

[3]Two explanations for asymmetric responses have been put forward. The traditional explanation for this phenomenon was the so-called 'leverage effect' whereby a fall in price results in greater financial leverage, leading to an increase in risk premiums (Black, 1976 and Christie, 1982). Moreover, Black (1976) acknowledged that financial leverage alone was not a sufficient explanation to account for the actual size of the observed asymmetries, and an alternative explanation based on market dynamics and the role of noise traders have been expounded (Kyle, 1985 and Sentana and Wadhwani, 1992).

previous period. $\left|\frac{\varepsilon_{t-1}}{\sigma_{t-1}}\right|$: represents information concerning the volatility of the previous time period. It signifies the magnitude impact (size effect) coming from the unexpected shocks. $\frac{\varepsilon_{t-1}}{\sigma_{t-1}}$: indicates information concerning the asymmetry effects. Unlike the GARCH model, the EGARCH model allows for leverage effect. If γ_1 is negative, leverage effect exists. That is an unexpected drop in price (bad news) increases predictable volatility more than an unexpected increase in price (good news) of similar magnitude (Black, 1976; Christie, 1982). If δ_1 is positive, then the conditional volatility tends to rise (fall) when the absolute value of the standardized residuals is larger (smaller). α's, β's, ξ, δ and γ_1 are the constant parameters to be estimated. ε_t represents the innovations distributed as a Generalised error distribution (GED), a special case of which is the normal distribution (Nelson, 1991).

3. RESULTS AND DISCUSSION

To evaluate the distributional properties of stock market return series of NSE Nifty and BSE SENSEX, descriptive statistics are reported in Table 1. For the NSE Nifty and BSE SENSEX, the mean returns are found to be positive, implying a bullish trend over the sample period. The standard deviation of both market returns recorded the least, that ranges from 0.043 and 0.046 percent and it found to be relatively higher in the case of BSE SENSEX. Besides, the skewness values of both market return series are negative, indicating that the asymmetric tail extends more towards negative values than positive ones. This reflects that both the market return series are non-symmetric. The kurtosis values of market return series was much higher than three, indicating that the return distribution is fat-tailed or leptokurtic. The market return series of NSE Nifty and BSE SENSEX are non-normal according to the Jarque-Bera test, which rejects normality at one per cent level.

Table 1. *Descriptive Statistics*

	S&P CNX Nifty	SENSEX (BSE-30)
Mean	0.00043	0.00046
Std. Deviation	0.01726	0.01756
Skewness	-0.22848	-0.10584

Kurtosis	9.27793	8.16175
Jarque-Bera	5634.4*	3628.5*
	(0.000)	(0.000)

Source: Author's own computation.
Note: Figures in the parenthesis ( ) indicates p-value. *- denote the significance at one level.

Further, the study employed Quantile-Quantile (QQ) plots to assess whether the data in a single series follow a specified theoretical distribution; e.g. whether the data are normally distributed (Chambers, et al., 1983; Cleveland, 1994). If the two distributions are the same, the QQ plot should lie on a straight line. If the QQ-plot does not lie on a straight line, the two distributions differ along some dimension. The pattern of deviation from linearity provides an indication of the nature of the mismatch. Figures 1 and 2 clearly validates that the distribution of the stock market returns series show a strong departure from normality.

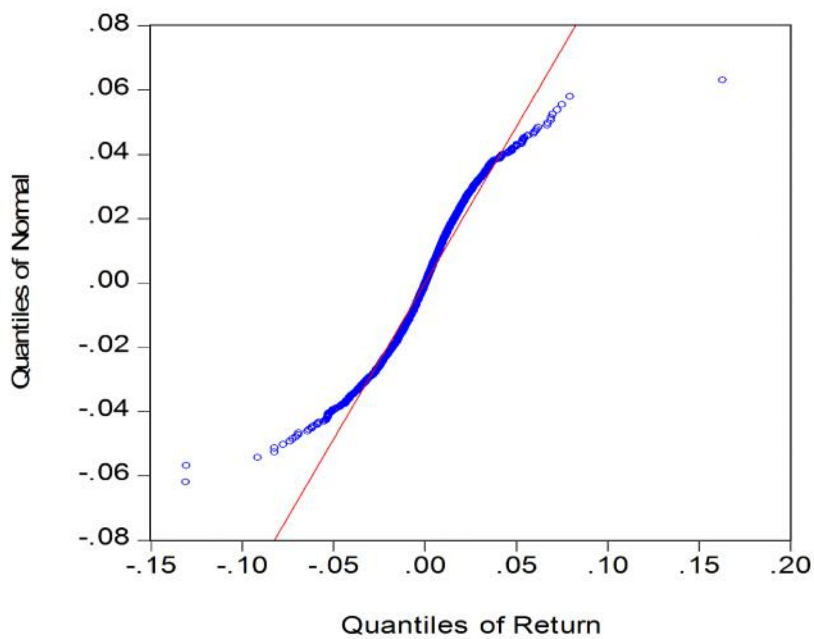

Figure 1. *Quantile-Quantile (QQ) Plot of S&P CNX NIFTY Return Series*

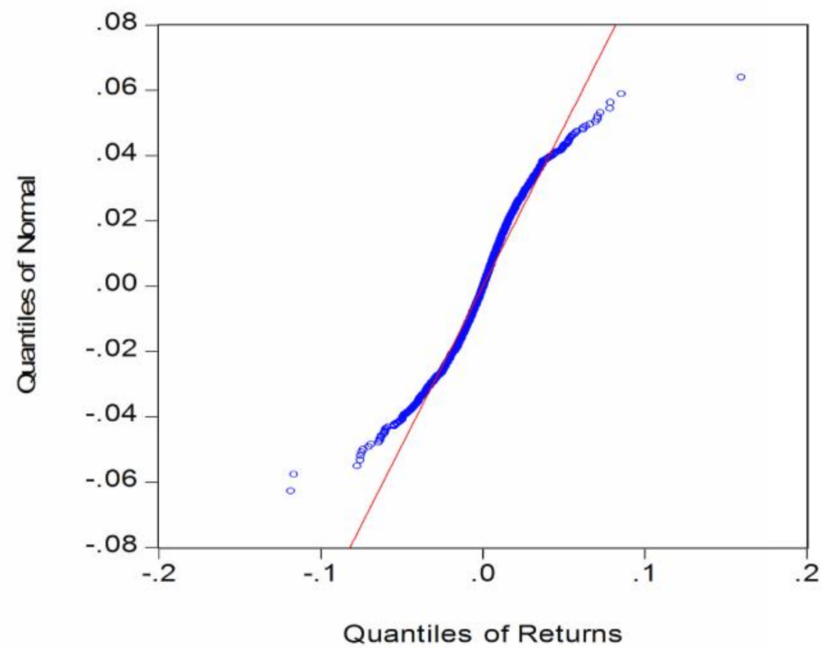

Figure 2. *Quantile-Quantile (QQ) Plot of BSE SENSEX Return Series*

As evident from Table 2, the Ljung-Box test statistics Q(12) and $Q^2(12)$ for the return and squared returns series of NSE Nifty and BSE SENSEX confirms the presence of autocorrelation. We can also observe that the both stock market return shows evidence of ARCH effects judging from the significant ARCH-LM test statistics, proposed by Engle (1982).

Table 2. *Results of Portmanteau Ljung-Box Test Statistics and Langrange Multiplier Test*

Parameters	S&P CNX Nifty Return	BSE-30 SENSEX Return
LB-Q[12]	30.024*	35.760*
	(0.003)	(0.000)
LB2-Q[12]	643.25*	721.96*
	(0.000)	(0.000)
ARCH-LM[12]	28.405*	28.578*
	(0.000)	(0.000)

Source: Author's own computation.
Note: Figures in the parenthesis ( ) indicates p-value. *- denote the

significance at one level. Q[12] and Q2[12] represents Portmanteau Ljung-Box (1978) Q-statistics for the return and squared return series respectively. They test for existence of autocorrelation in return and squared return series for 12 lags respectively. LJung-Box Q test statistic tests the null hypothesis of absence of autocorrelation. ARCH-LM[12] is a Lagrange multiplier test for ARCH effects up to order 12 in the residuals (Engle, 1982).

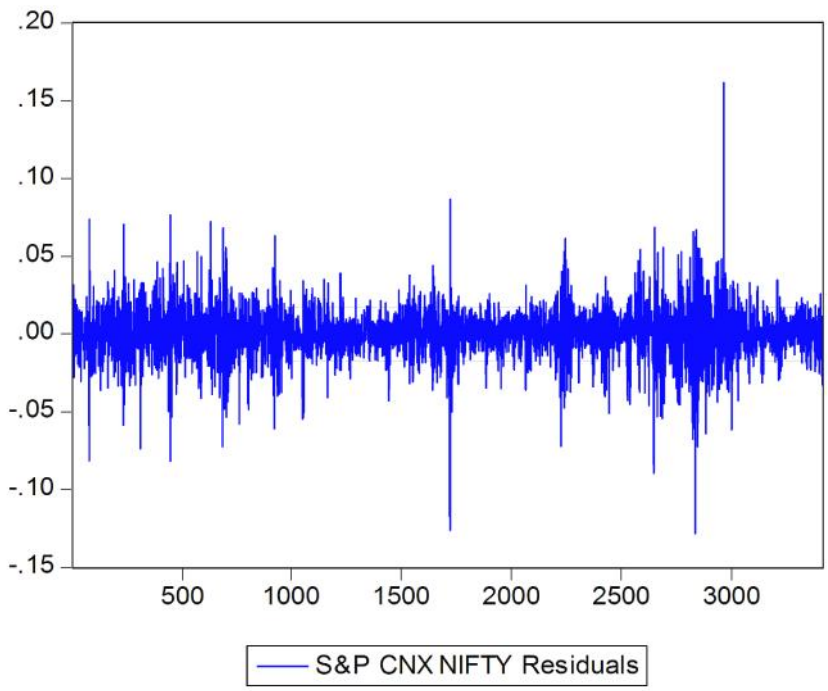

Figure 3. *Residuals Series of S&P CNX Nifty Return*

Moreover, Figure 3 and 4 represents the graphs of residual series of S&P CNX Nifty and BSE SENSEX return for the study period, respectively. The graphs confirm the presence of volatility clustering, implying that volatility changes over time and it tends to cluster with periods with low volatility and periods with high volatility.

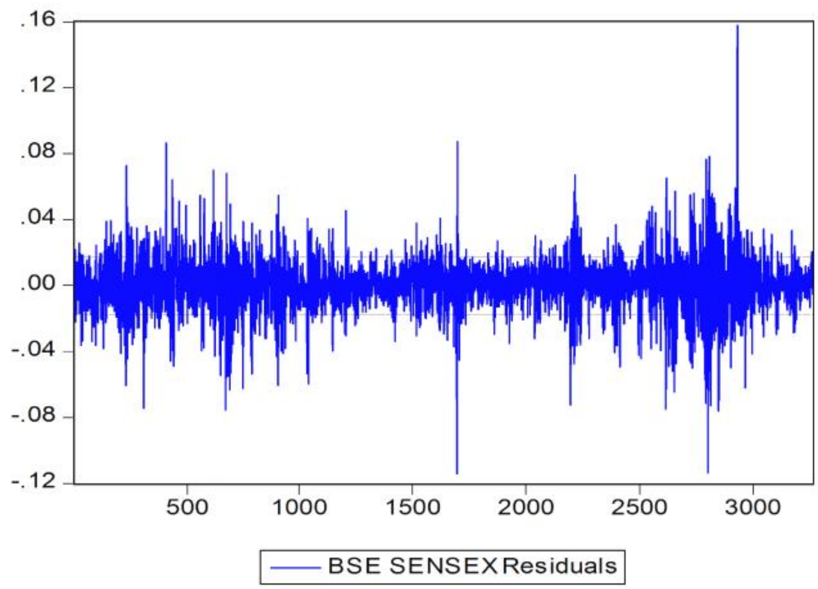

Figure 4. *Residuals series of BSE SENSEX Return*

The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were employed to test the stationarity of both market return series and the results are presented in Table 3. Both unit root tests strongly reject the hypothesis of non-stationarity in the case of two market return series. However, despite the unit root test results that the market return series should be considered stationary, returns display a degree of time dependence. By and large, the return series of NSE Nifty and BSE SENSEX seem to be best described by an unconditional leptokurtic distribution and volatility clustering, and possesses significant ARCH effects. Thus, the EGARCH-M model is capable with generalised error distribution (GED) is deemed fit for modeling the conditional variance. Further, the EGARCH-M model is capable of capturing, at least partially, the leptokurtosis of a non-conditional return distribution of an economic element as well as the valuable information about the dependence in the squared values of return (Engle and Ng, 1993).

Table 3. *Unit Root Test Results of S&P CNX Nifty & BSE-30 SENSEX Returns*

Augmented Dickey-Fuller Test			
Variables	Intercept	With Intercept & trend	Without Intercept & trend
NIFTY	-25.448*	-25.462*	-25.401*
SENSEX	-27.931*	-27.949*	-27.894*
Phillips-Perron Test			
NIFTY	-53.291*	-53.303*	-53.272*
SENSEX	-53.046*	-53.049*	-52.970*

Source: Author's own computation.
Note: * – indicates significance at one per cent level. Optimal lag length is determined by the Schwarz Information Criterion (SC) and Newey-West Criterion for the Augmented Dickey-Fuller (ADF) Test and Phillips-Perron (PP) Test respectively.

Table 4 reports the results of AR(1)-EGARCH(1, 1)-in-Mean estimates for NSE Nifty and BSE SENSEX stock markets. In the mean equation (2), the coefficient ξ turns out to be positive but statistically insignificant, implying investors are not rewarded for the risk they had taken on the Indian stock exchanges. This result is consistent with the findings of French et al. (1987), Baillie and De Gennaro (1990), Chan et al. (1992) and Leon (2007). In terms of the conditional variance equation (3), the persistence parameter α_1 was 0.9458 and 0.9563 for the NSE and BSE stock markets, respectively. This suggests that the degree of persistence is high and very close to one. In other words, once volatility increases, it is likely to remain high and takes longer time to dissipate. The positive and statistically significant coefficient α_1 in the case of both stock markets confirms that the ARCH effects are very pronounced implying the presence of volatility clustering. Conditional volatility tends to rise (fall) when the absolute value of the standardized residuals is larger (smaller) (Leon, 2007).

Table 4. *Results of Estimated AR(1)-EGARCH(1,1)-Mean Model*

S&P CNX Nifty Return								
$\beta 0$	$\beta 1$	ξ	α_0	α_1	δ_1	γ_1	$Q^2[12]$	ARCH-LM[12]
0.0006 (1.863)***	0.0988 (5.524)*	0.1183 (0.082)	-0.6655 (-13.03)*	0.9458 (176.70)*	0.2739 (17.07)*	-0.1148 (-11.47)*	6.4934	0.5261

SENSEX (BSE-30) Return								
0.0007 (2.193)**	0.0994 (5.261)*	-0.7996 (-0.554)	-0.5539 (-12.55)*	0.9563 (209.80)*	0.2461 (16.49)*	-0.1056 (-11.25)*	9.0710	0.7198

Source: Author's own computation.

Note: Figures in parenthesis are z-statistics, *, ** and ***- denotes the significance at one, five and ten percent level, respectively. Q(12) and $Q^2(12)$ represents the Ljung-Box Q-statistics for the model squared standardized residuals using 12 lags. ARCH-LM[12] is a Lagrange multiplier test for ARCH effects up to order 12 in the residuals (Engle, 1982).

Besides, the asymmetric coefficient γ_1 in the case of both Indian stock markets was found to be negative and statistically significant at one per cent level, implying the presence of asymmetric effects. This suggest that there is a larger impact on volatility due to the noise traders in the Indian stock markets during market downward movement than market upward movement under the same magnitude of innovation, i.e. the volatility of negative innovations is larger than that of positive innovations.

In addition, Table 4 shows the results of the diagnostic checks on the estimated AR(1)-EGARCH(1, 1)-in-Mean estimates for NSE Nifty and BSE SENSEX stock markets. The Ljung-Box $Q^2(12)$ statistics of the squared standardized residuals are found to be insignificant, confirming the absence of ARCH in the variance equations. The ARCH-LM test statistics further showed that the standardized residuals did not exhibit additional ARCH effect. This shows that the variance equations are well specified in the case of both estimates. In other words, the AR(1)-EGARCH (1,1)-M process generally provides a good approximation of the data generating process for stock returns under consideration.

4. CONCLUSION

This paper investigates the relationship between stock market returns and volatility in the Indian stock markets by employing AR(1)-EGARCH(p, q)-in-Mean model. The study reveals positive but insignificant relationship between stock return and risk for NSE Nifty and BSE SENSEX stock markets. This is in accordance with the findings of Choudhry (1996), Chiang and Doong (2001), Shin (2005) and Karmakar (2007) for the emerging stock markets. Besides, the study result shows that volatility is persistent and there exists leverage effect supporting the work of Nelson (1991) in the Indian stock markets. The present study suggests that the capital market regulators, investors and market participants should employ the asymmetric GARCH-type model that sufficiently captures the stylized characteristics of the return, such as time varying volatility, high persistence and asymmetric volatility responses, in determining the hedging strategy and portfolio management and estimating and forecasting volatility for risk management decision making at Indian Stock Exchange.

The Exponential Generalized Autoregressive Conditional Heteroskedasticity model employed in our study sufficiently captures only the short-run dependency of the conditional variances. It is generally accepted that financial time series of practical interest exhibit strong dependence, i.e., long memory. The advantage of modelling long memory better suit the needs of medium-to-long term prediction which is crucial in derivative pricing models. Hence, there exists scope to extend our study by examining long memory properties in the conditional variance using nonlinear long memory models.

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