Stock Market Returns and Volatility in an Emerging Market: The Indian Evidence

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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 result shows that volatility is persistent and there is leverage effect supporting the work of Nelson (1991) in the Indian stock markets. Besides, 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. The study results also show that market returns are contributed to the high volatility persistence, implying that Indian stock markets are not weak form efficient signifying that there is systematic way to exploit trading opportunities and acquire excess profits. This provides an opportunity to the traders for predicting the future prices and earning abnormal profits.

Keywords: Stock market efficiency, Volatility, Asymmetric effects, EGARCH model

Introduction

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 mixed finding. Earlier studies by French et al., (1987), Bollerslev, (1986), Chou (1988), Harvey (1989), Scruggs (1998), Ghysels et al., (2005), Guo and Whitelaw (2006) as well as Leon et al., (2007) establishes a positive and significant relationship between expected returns and conditional variance. Besides, the earlier works by Baillie and De Gennaro (1990), Theodossiou and Lee (1995), Choudhry (1996), De Santis and Imrohoroglu (1997), Leon (2007) and Olowe (2009) report a positive but insignificant relationship stock market returns and conditional variance. Furthermore, consistent with the asymmetric volatility argument, several researchers (Campbell, 1987; Turner et al., 1989; Nelson, 1991; Glosten et al., 1993; Bekaert and Wu, 2000; Wu, 2001; Brandt and Kang, 2004; Li et al., 2005) report a negative and often significant relationship.

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 this paper is organized as follows. Section-2 discusses the empirical methodology, Section-3 reports the empirical findings, and finally, Section-4 concludes the paper.

Methodology

In order to capture the asymmetric response of volatility to news, Nelson (1991) proposed EGARCH-M model which allows the conditional volatility to have asymmetric relation with past data1. 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

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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). 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. This model expresses the conditional variance of a given variable as a non-linear function of its own past values of standardised innovations that can react asymmetrically to good and bad news. The AR(1)-EGARCH(p, q)-in-Mean model can be specified as follows:

$$R_t = \beta_0+\beta_1 R_{t-1}+ \xi\sigma_t+\varepsilon_t \qquad (1)$$

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

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 directly shed light on the nature of the relationship between stock market returns and its volatility. The expected volatility is approximated by σ^2_t, the conditional variance of R_t such that:

$$\sigma^2_t = \text{var}(R_t/\psi_{t-1}) \quad (3)$$

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 (2), $ln(\sigma^2_t)$ 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 nonnegative. 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 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 $\frac{\varepsilon_{t-1}}{\sigma_{t-1}}$ shocks.

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 σ_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 andare 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).

The daily closing prices of two major indexes of Indian stock exchanges, viz., S&P CNX NIFTY and the SENSEX indexes of National Stock Exchange (NSE) and Bombay Stock Exchange (BSE), respectively were used for the study. The database was considered from July 1, 1997 to August 31, 2012. The PROWESS online database maintained by the Centre for Monitoring Indian Economy (CMIE) provides information regarding the daily closing values of the NSE S&P CNX NIFTY and the BSE SENSEX indexes. Throughout this paper, stock market returns are defined as continuously compounded or log returns (hereafter returns) at time t, R_t, calculated as follows:

$$R_t = \log(P_t / P_{t-1}) = \log P_t - \log P_{t-1} \qquad (4)$$

where P_t and P_{t-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.

Empirical Findings

To assess the distributional properties of stock market return series of NSE Nifty and BSE SENSEX, descriptive statistics are reported in Table-1. The mean and the standard deviation of NSE Nifty and BSE SENSEX market returns indicates, on average, the positive association between risk and returns in Indian stock markets. 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)

Notes: Figures in the parenthesis ( ) indicates p -value. *- denote the significance at one level.

As evident from Table-2, the Ljung-Box test statistics Q(12) and Q2(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). Moreover, Figure-1 and 2 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-1 Residuals Series of S&P CNX Nifty Return

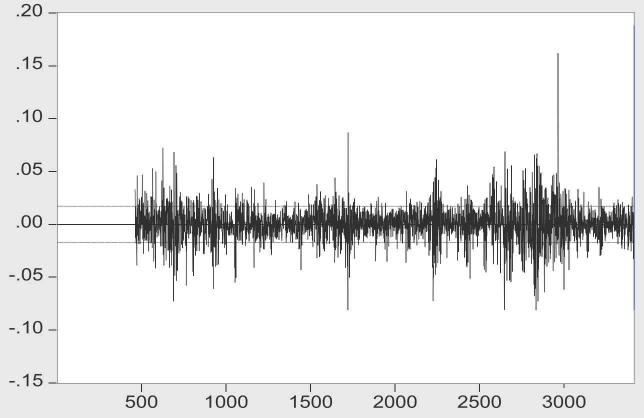
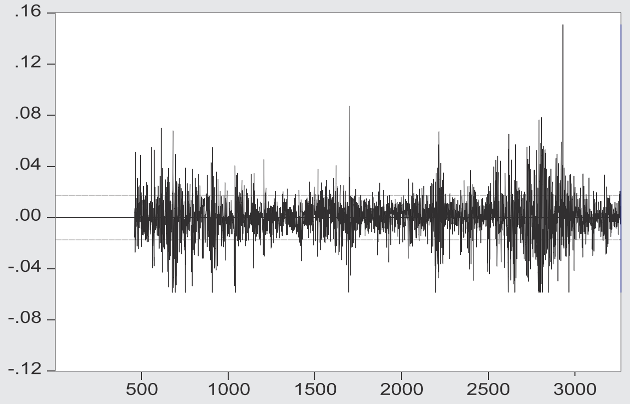


Figure-2 Residuals series of BSE SENSEX



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.

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

Variables	Intercept	With Intercept & trend	Without Intercept & trend
Augmented Dickey-Fuller Test			
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*

Notes: * – 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.

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

$$R_t = \beta_0 + \beta_1 R_{t-1} + \xi\sigma^2_t + \varepsilon_t \qquad \text{.......... (1)}$$

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

β_0	β_1	ξ	α_0	α_1	δ_1	γ_1	Q^2[12]	ARCH-LM[12]
S&P CNX Nifty Return								
0.0006	0.0988	0.1183	-0.6655	0.9458	0.2739	-0.1148	6.4934	0.5261
(1.863)***	(5.524)*	(0.082)	(-13.03)*	(176.70)*	(17.07)*	(-11.47)*		
SENSEX (BSE-30) Return								
0.0007	0.0994	-0.7996	-0.5539	0.9563	0.2461	-0.1056	9.0710	0.7198
(2.193)**	(5.261)*	(-0.554)	(-12.55)*	(209.80)*	(16.49)*	(-11.25)*		

Notes: 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).

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 (1), the coefficient ξ turns out to be positive but statistically insignificant. This implies that stock returns are not affected by volatility trends. In other words, conditional variance lacks predictive power for stock returns. This result is consistent with the findings of French et al. (1987), Baillie and De Gennaro (1990), Chan et al. (1992) and Leon (2007). The present study suggests that investors are not rewarded for the risk they had taken on the Indian stock exchanges. In terms of the conditional variance equation (2), the persistence parameter 1α 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 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).

Besides, the asymmetric coefficient1γ 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.

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 result shows that volatility is persistent and there is leverage effect supporting the work of Nelson (1991) in the Indian stock markets. Besides, 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. The study results also show that market returns are contributed to the high volatility persistence, implying that Indian stock markets are not weak form efficient signifying that there is systematic way to exploit trading opportunities and acquire excess profits. This provides an opportunity to the traders for predicting the future prices and earning abnormal profits. However, the insignificant relationship between risk and return suggests that investors are not rewarded for the risk that they had taken on the Indian stock exchanges. Hence, the present study suggests that there is a need for regulators to evolve policy towards the stability and restoration of investor's confidence through enhancement of transparency and efficiency in the Indian stock markets.

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