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The Technical Investigation of Relationship between Return and Volatility in Indian Stock Market

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Abstract—*This paper examines the technical relationship between return and volatility in stock market by using daily data of the Sensitive Index (SENSEX) of Bombay Stock Exchange (BSE) during the period from March 2012 to March 2016. The technical analysis provides evidence of positive and significant correlation between return and volatility i.e. indicative of both mixture of distribution and sequential arrival hypothesis of information flow. There is a relationship of causality following from volatility and return, which shows the mixture of distributions hypothesis and supports the sequential information arrival hypothesis. This paper supports the proposition that current information is absorbed sequentially and intermediate informational equilibrium is reached before the final equilibrium is found in Indian stock market. These results might be largely attributed to the existence of substantial speculative trading, low level of market depth and price limits observed in Indian market.*

Keywords*: GARCH, Trading Volume, Causal Relationship, Linear Granger causality, ARCH.*

1. INTRODUCTION

Trading volume is positively related to stock return volatility. While there is substantial anecdotal evidence supporting these links, there is little scientific evidence in this area, particularly in India. A major limitation has been the lack of substantial theory linking trading volume directly to stock returns. However, more recently, researchers have examined indirect links through models of information arrival and stock returns. Trading volume and stock price movement changes mainly reflect the available set of relevant information in the market. Unlike stock price and return, however, a revision in investors' expectations always leads to an increase in trading volume which therefore reflects the sum of investors' reactions to news. Various studies reported that there are significant relationship between volume and stock price movement and volatility, due to the fact that trading volume is a source of risk because of the flow of information. There are many reasons why traders pay attention to trading volume. Low volume means that the market is illiquid; this also implies high price fluctuation. On the other hand, high volume usually implies that the market is highly liquid, resulting in low price variability. This also reduces the price effect of large trades. In general, with an increase in volume, broker revenue will increase, and market makers have greater opportunity for profit as a result of higher turnover. Generally it is known that pricing react to the arrival of new information. Investors in the stock markets frequently revise their expected prices of stocks depending on the flow of information. Possible disagreement to informational events can also lead to increased trading. Trading volumes can increase even if investors interpret the information identically but they have divergent prior expectations.

The emergence of informational efficient financial markets is an important facet of any country's economic modernization, with far-reaching implication for its macroeconomic stability and performance. Thus, it is in the interest of the economy to achieve efficiency in the dynamics of the stock markets. Return and volume are two major pillars, around which entire stock market revolves. While return can be interpreted as the evaluation of new information, volume is an indicator to which the investors disagree about this information. Moreover, it is observed from the prior literature1 that stock prices are noisy which can't convey all available information to market dynamics of stock prices and trading volume. Therefore, studying the joint dynamics of stock prices and trading volume is essential to improve the understanding of the microstructure of stock markets. Relatively little attention has been devoted to this relationship in India. Some researchers have made attempts to evaluate return-volume relationship in Indian stock market but these are elementary efforts and moreover, the studies have failed to take the phenomena of volatility persistence/volatility clustering in return-volume relationship. Financial time series behave in such a way that does not conform to the normality distribution. Hence, the volatility observed in the market is a natural application for the autoregressive conditional heteroscedasticity (ARCH). To observe these phenomena, ARCH model and generalized ARCH (GARCH) model is used in many studies. The GARCH specification allows the current conditional variance

to be a function of past conditional variances. Therefore, the current study investigates return, volume and volatility relationship in Indian stock market using EGARCH model.

2. REVIEW OF LITERATURE

Blume, Easley, and O'Hara (1994) have come forward with a model in which traders can learn valuable information about a security by observing both past price and past volume information. In their model, volume provides data on the quality or precision of information about past price movements.

Wang (1994) analyzed dynamic relations between volume and returns based on a model with information asymmetry. His model showed that volume might provide information about expected future returns.

Muradoglu et al. (1999) examined how determinants of volatility and stock returns change with financial crisis in an emerging market such as that of Pakistan. Authors have found that during a financial crisis in an emerging market, risk-return relationship and the factors that determine this relationship change.

Chordia and Swaminathan (2000) found that trading volume is a significant determinant of the lead-lag patterns observed in stock returns. Specifically, returns of portfolios containing high trading volume lead returns of portfolios comprised of low trading volume stocks after controlling for size and that this is not explained by non-synchronous trading or low volume portfolio autocorrelations.

Herbert (1995) and Ciner (2002) found that lagged trading volume contains predictive power for current price volatility. These empirical results provide evidence against the mixture of distributions hypothesis and instead, support the sequential information arrival hypothesis.

Otavio et al., (2006) reported the bidirectional causality between the variables, which implies that that the strong form of market efficiency holds since private information is reflected on stock prices.

Floros and Vougas (2007) studied the relationship between trading volume and returns in Greek Stock Index Futures Market and found significant positive contemporaneous relationship between the two in FTSE/ASE-20.

Pathirawasam (2008) conducted a study using stock volume and returns from Colombo Stock Exchange and found that stock returns are positively related to changes in volume, but negatively to past trading volume. Author attributed this negative cause to misspecification and illiquidity issues.

Tripathy(2011) investigated the dynamic causal relationship between stock return and trading volume of Indian stock Market and found bi-directional causality between the two. Also, the results of Johansen's co integration test depicted long-run relationship between volume and returns.

3. RESEARCH METHODOLOGY

The series of stock return is computed from daily closing prices for the Sensitive Index (SENSEX) of Bombay Stock Exchange for a period of 5 years from March, 2012 to March, 2016. The SENSEX index of BSE captures all the events in the most judicial manner. One can identify the booms and busts of the Indian stock market through SENSEX. It represents the period when electronic trading was introduced in the Bombay Stock Exchange. Introduction of automation has affected the movement of the index and volume trades in the market in different ways. This study attempts to evaluate the return–volume relationship after the introduction of electronic trading. The daily stock returns are continuous rates of return, computed as log of ratio of present day's price to previous day's price (i.e. $Rt = \ln (Pt / Pt\text{-}1)$).

Financial time series such as stock prices often exhibit the phenomena of volatility clustering. To observe this phenomena, ARCH model introduced by Engle (1982) and Bollerslev's (1986) generalized ARCH (GARCH) model is used.

The GARCH specification allows the current conditional variance to be a function of past conditional variances, allowing volatility shocks to persist over time (Huson Joher et al., (2005)). In particular, to test whether the positive contemporaneous relationship between trading volume and returns exists, the following GARCH (1,1) model is estimated where volume is included in mean equation.

4. RESULTS AND ANALYSIS:

Table 1: Descriptive Statistics

	Volume	Return	Volatility
Mean	15.76580	0.000521	0.000254
Median	15.76236	0.001205	8.30E-05
Std. Deviation	0.415460	0.014112	0.000634
Skewness	-0.320674	-0.415634	8.452301
Kurtosis	7.431569	6.345230	135.4123
Jarque-Bera	2330.125	1346.248	1745.340
Probability	0.000000	0.000000	0.000000

Table 1 discusses the descriptive statistics to assess the distribution properties of return and volume series. Significant Jarque Bera statistics clearly rejects the hypothesis, which implies that pattern of all variables does not conform to normal distribution, which is the precondition for any market to be efficient in the weak form.

The empirical distribution of the volatility series is positively skewed, indicating a right tail of distribution, which shows asymmetry. On the other side, negative skewness is observed for return and volume, which has led the returns to be asymmetric and non-normal and it can be verified from p value of Jarque-Bera test. This table also reports that returns are asymmetric and highly volatile. Moreover, the excess

kurtosis estimated for trading volume is large, clearly a sign of peaked (leptokurtic) end relative to the normal distribution which may result into positive correlation between volume and return volatility.

Table 2: Correlation Results

Variables	Volume	Return
Return	0.034**(0.076)	1.001
Volatility	0.153*(0.000)	----------

Note: * and ** Correlation is significant at the 0.01 level and 10% level (2-tailed)

Table 2 discusses the correlation results, which clearly shows that volume and return volatility are positively correlated. There might exist a causal relationship between trading volume and return volatility because a latent, exogenous variable, representing the rate of information arrival to the market, affects both volume and stock price variance, causing simultaneous movements. In this study, a weak correlation is detected between return and volume implying that forecasts of one of these variables cannot be improved by knowledge of the other.

Table 3: Unit Root Results

Variables	Augmented Dickey Fuller		P-P Test	
	With constant	With constant and trend	With constant	With constant and trend
Return	-44.34612*	-44.40671*	-44.32561*	-44.42568*
Return Volatility	-16.34210*	-25.02367*	-39.43417*	-38.71252*

*Significant at 1% Significance level

As reported in table 3, Unit root test results shows that trading volume, return and volatility are stationary at levels, on the basis of both the ADF and PP tests.

Table 4: GARCH (1, 1) estimates for Return- Volume

Parameter	Coefficient	P-value
γ	0.001454	0.0165
ω	9.40E-05	0.0000
αi	0.153300	0.0000
βj	0.717160	0.0000
αi+ βj	0.871420	0.0000

Note: * γ is a parameter of volume, which is included in mean equation.

In table 4, coefficient of trading volume is positive and significant (i.e. there exists a positive contemporaneous relationship between trading volume and returns). The significant αi and βj coefficients clearly indicate that conditional variance is predominantly affected by lagged variance, which implies that previous information shock significantly, affect current returns. These evidences imply that Indian stock market is not efficient in weak form. It shows that there is volatility clustering as measured by sum of αi and βj (0.871), which further supports the asymmetry and inefficiency in market after the introduction of automation.

Table 5: GARCH (1,1) estimates for Volume-Volatility Relationship

Parameter	Coefficient	P-value
ω	-0000256	0.0000
αi	0.153015	0.0000
βj	0.756650	0.0000
γi	1.65E-05	0.0000
αi+ βj	0.827	--------

Note: * γi is a parameter of volume, which is included in variance equation.

In table 5 parameters αi and βj are positive and significant where trading volume is included in the variance equation of GARCH model. The coefficient on the volume γi is significant and indicates positive impact on volatility. The study shows a small decline in the persistence of volatility when trading volume is included in the variance equation, since the sum (αi+ βj) falls to 0.82 in the table 5 as compared to sum of αi and βj (0.87) in table 4 where volume is not included in variance equation of GARCH model. It means small degree of persistence is absorbed by the volume series. Therefore, our results for Indian stock market show weak support for the MDH model.

Table 6: EGARCH (1, 1) Estimates for Volume-Volatility Relationship

Parameter	Coefficient	P-value
γ1	-3.432011	0.0000
γ2	0.894012	0.0000
γ3	-0.162419	0.0000
γ4	0.991256	0.0000
γ5	0.052418	0.0000

Note:*γ5 is parameter of volume included in variance equation

The presence of leverage effect can be seen in table 6, which implies that every price change responds asymmetrically to the positive and negative news in the market. Coefficient γ0 (which is a parameter of volume) shows a positive impact of volume on return. The parameter γ2 is statistically significant, which supports the previous evidences of asymmetric distribution of returns in descriptive statistics and significant γ3 indicates mean reverting behavior of returns because the value of γ3 is negative, which implies that every price change responds asymmetrically to the positive and negative news in the market (table 6). Coefficient γ4 (which is a parameter of lagged conditional volatility) is significant in both cases of EGARCH (1, 1) which implies that Indian market is informational inefficient.

Table 7 Linear Granger Causality Test Results

Null Hypothesis	F-Statistic	P-value
Trading Volume does not cause Return	1.45569	0.34246
Return does not cause Trading Volume	4.65278*	0.00712
Trading Volume does not cause Volatility	1.67349	0.45249
Volatility does not cause Trading Volume	6.34710*	7.8E-09

Note: * Significant at 1% level

In table 7, Granger causality results provide very important information regarding the direction of information transmission. Causality has been observed from return to volume and volatility to volume; however volume causes neither of these. It can be inferred that returns contain significant information for volume. Moreover, preceding return volatility can be seen as some evidence that new information arrival might follow a sequential rather than a simultaneous process. It shows that the strong form of market efficiency does not hold since some private information exists that is not reflected in stock prices.

5. CONCLUSION

This paper examines the empirical relationship between return, volatility and volume dynamics of stock market by using daily data for the Sensitive Index (SENSEX) of Bombay Stock Exchange, India's premier stock exchange. A main issue has been whether information about trading volume is useful in improving the forecasts of return and return volatility in dynamic context. The empirical analysis provides evidence of positive and significant correlation between volume and return volatility that is indicative of both mixture of distribution and sequential arrival hypothesis of information flow. Positive correlation between volatility and trading volume arises because trading by informed traders reveals private information to markets and affects prices. It shows that the informed traders trade only when they receive private information, and that their trading carries information and affects prices.

Using GARCH (1,1), the research paper documents small decline in persistence of variance over time with the inclusion of trading volume as a proxy for information arrivals in the equation of conditional volatility. Moreover, ARCH and GARCH effects remain significant as observed which highlights the inefficiency in the market. This finding leaves the possibility that there may be other variables besides volume, which contribute, to the heteroscedasticity in returns. We can attribute this finding to low level of market depth in India. The study has used the EGARCH (1, 1) or exponential GARCH (1, 1) model, which allows for asymmetric shocks to volatility. It indicates the presence of leverage effect and positive impact of volume on volatility. The differential cost of taking long and short positions is main reason for information asymmetry (leverage effect).

This paper records the evidence of a significant relationship of causality following from volatility to trading volume, which contradicts the mixture of distributions hypothesis and supports the sequential information arrival hypothesis. This implies that the strong form of market efficiency does not hold since some private information exists that is not reflected in stock prices. This study also detects one-way causality from return to volume that is indicative of noise trading model of return volume interaction in this market. In nutshell, it can be stated that volume provides information on the precision and dispersion of information signals, rather than serving as a proxy for the information signal itself. Moreover, new information is absorbed sequentially and the intermediate informational equilibrium is reached before the final equilibrium is found in Indian stock market.

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