The Dynamic Relationship between Price and Trading Volume: Evidence from Indian Stock Market

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Abstract

This study investigates the nature of relationship between price and trading volume for 50 Indian stocks. Firstly the contemporaneous and asymmetric relation between price and volume are examined. Then we examine the dynamic relation between returns and volume using VAR, Granger causality, variance decomposition (VD) and impulse response function (IRF). Mixture of Distributions Hypothesis (MDH), which tests the GARCH vs. Volume effect, is also studied between the conditional volatility and volume. The results show that there is positive and asymmetric relation between volume and price changes. Further the results of VAR and Granger causality show that there is a bi-directional relation between volume and returns. However, the results of VD imply weak dynamic relation between returns and volume which becomes more evident from the plots of IRF. On MDH, our results are mixed, neither entirely rejecting the MDH nor giving it an unconditional support.

JEL Classification: C22, C32, G12

Keywords: Trading volume, Volatility, Mixture of distributions hypothesis, GARCH, Granger Causality, VAR, Impulse response function, Variance decomposition

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1. Introduction

In financial economics, considerable attention has been given to understand the relationship between returns, volatility and trading volume. As argued by Karpoff (1986, 1987), price-volume relationship is important because this empirical relationship helps in understanding the competing theories of dissemination of information flow into the market. This may also help in event (informational/liquidity) studies by improving the construction of test and its validity. This relationship is also critical in assessing the empirical distribution of returns as many financial models are based on an assumed distribution of return series.

There are numerous empirical studies, which support the positive relationship between price (returns, volatility) and trading volume of a tradable asset (Crouch, 1970; Epps and Epps, 1976; Karpoff, 1986, 1987; Assogbavi et al., 1995; Chen et al, 2001). Various theoretical models have been developed to explain the relationship between price and trading volume. These include sequential arrival of information models (Copeland, 1976; Morse, 1980 and Jennings and Barry, 1983), a mixture of distributions model (Clark, 1973; Epps and Epps, 1976; Tauchen and Pitts, 1983; and Harris, 1986; Lamoureux and Lastrapes, 1990) asymmetric information models (Kyle, 1985; Admati and Pieiderer, 1988), and differences in opinion models (Varian, 1985, 1989; Harris and Raviv, 1993). All these models predict a positive relationship between price and trading volume. In a similar strand of literature, the asymmetric nature of volume response to return (volatility) i.e. the trading volume is higher when price moves up than on the downtick is sought to be explained (Epps 1975; Karpoff 1986, 1987; Assogbavi et al., 1995). The asymmetric nature is explained through heterogeneous expectations and costs involved in short selling. Recently, Henry and McKenzie (2006) examined the relationship between volume and volatility allowing for the impact of short sales in Hong-Kong market and found that the asymmetric bidirectional relationship exists between volatility and volume.

Other than positive contemporaneous relationship between returns and trading volume and asymmetric relationship between level of volume and price changes, some studies also report bidirectional causality between returns and volume (Hiemstra and Jones, 1994; Chen, Firth, and Rui, 2001; Ratner and Leal, 2001). This dynamic relationship between returns and volume is explained by various theoretical models. These include models developed by Blume, Easley, and O'Hara (1994), Wang (1994), He and Wang (1995) and Chordia and Swaminathan (2000). Most of these models assume volume as a proxy for quality and precision of information. It is found that the information content of volume and sequential processing of information may lead to dynamic relationship between returns and trading volume. Blume, Easley, and O'Hara (1994) developed a model in which prices and volume of the past carry information about the value of security and explained that the traders, who include past volume measures in their technical analysis, performed better. Wang (1994) and He and Wang (1995) developed a model based on asymmetric information and showed that the trading volume is related to information flow in the market and investor's private information is revealed through trading volume. Chordia and Swaminathan (2000) also examined the predictability of short-term stock returns based on trading volume and concluded that high volume stocks respond promptly to market-wide information.

Similar to returns and volume, considerable attention has also been given to understand the relationship between volatility and trading volume of an asset by the researchers. Most of the studies report the evidence of ARCH effects in the time series of returns. However, very few of them try to give any theoretical economic explanation of the autoregressive nature of conditional volatility. One of the possible theoretical explanations is the mixture of distributions hypothesis (Clark, 1973; Epps and Epps, 1976; Tauchen and Pitts, 1983; Lamoureux and Lastrapes, 1990). The Mixture of distributions hypothesis (MDH) explains the positive relationship between price volatility and trading volume as they jointly depend on a common factor, information innovation. According to MDH, returns are generated by mixture of distributions and information arrival is the mixing variable. This mixing variable causes momentum in the squared residual of daily returns and hence autoregressive nature of the conditional volatility. As information arrival is unobserved, trading volume has been usually considered as a proxy of information flow into the market. Any unexpected information affects both volatility and volume contemporaneously and, therefore volatility and volume are hypothesized to be positively related.

While a fair amount of empirical evidence on the price (returns, volatility) and volume relationship, asymmetric relationship between volume and price change, and on the mixed distribution hypothesis exists for developed countries, very few empirical studies have been reported from emerging markets and specifically from Indian stock market. This paper reports same empirical evidence on these issues for Indian Stock market. All the 50 stocks of S&P CNX Nifty, a value-weighted stock index of National Stock Exchange (www.nseindia.com), Mumbai, derived from the prices of 50 large capitalization stocks, for the period of 1st January 2000 to 31st December 2008 are analyzed. We find that there is a positive contemporaneous relationship between returns and volume. Further we that find that both unconditional as well as conditional volatilities are positively related with volume. It is also found that the trading volume depends on the direction of price change, with more volume being associated with positive price changes. From the results of the VAR and Granger Causality it can be seen that though bi-directional causation is there but returns cause volume to a greater extent than vice versa. It is interesting to note that even after controlling for high autoregressive nature of volume, we find significant effect of one day lagged returns and volume. However, variance decomposition results show that the effect that returns have on volume is at the most 5 percent only. Similarly volume at most explains 1 percent of returns only. On plotting the impulse response function, it becomes evident that dynamic relation is very weak between returns and volume. We get a mixed result on MDH, with some stocks supporting the MDH hypothesis and others rejecting it. Given the high autoregressive nature of both volume and volatility, it can be said that information is processed sequentially in Indian market.

The remainder of this paper is organized as follows. A brief review of empirical literature is given in section 2. Section 3 explains the sample and basic characteristics of the data. The empirical models of the contemporaneous and dynamic relationship between returns and trading volume, and models of the mixture of distributions hypothesis are explained in section 4. Section 5 discusses the empirical findings and the last section summarizes them and concludes.

2. Literature on Relationship among Trading Volume, Returns and Volatility

There have been number of empirical studies in developed markets which provide evidence on the relationship between trading volume and stock returns. Rogalski (1978) using monthly stock data found positive contemporaneous correlation between returns and trading volume. Using

nonlinear Granger causality test, Hiemstra and Jones (1994) analyzed the bidirectional causality between trading volume and returns for New York Stock Exchange and found support for positive bidirectional causality between them. In an emerging market context, Saatcioglu and Starks (1998) examined the relationship between price changes and volume for six Latin American markets (Argentina, Brazil, Chile, Colombia, Mexico, and Venezuela) found a positive contemporaneous relationship between returns and volume. However, upon employing Granger causality, they failed to find strong evidence on returns leading to volume. Chen et al. (2001) examined casual relationship between returns and volume for nine national markets. The results indicated that for some countries, returns cause volume and volume causes returns. Assogbavi et al. (2007) used vector auto-regression model to analyze dynamic relationship between returns and trading volume using weekly data of individual equities of the Russian Stock Exchange. They found a strong evidence of bi-directional relationship between volume and returns. The relationship between stock return volatility and trading volume has also been analyzed in several studies. Crouch (1970) studied the relationship between daily trading volume and daily absolute changes of market index and individual stocks and found positive correlation between them. Epps (1975) used transactions data and found a positive contemporaneous correlation between trading volume and absolute price changes. Harris (1987) used the number of transactions as a measure of volume and found a positive correlation between changes in volume and changes in squared returns for individual NYSE stocks. Smirlock and Starks (1988) analyzed the causal relationship between trading volume and volatility using individual stock transactions data and found a positive lagged relation between volume and absolute price changes. Moosa and Al-Loughani (1995) examined the dynamic relationship between volatility and volume for four Asian stock markets excluding India and found a strong evidence for bi-directional causality for Malaysia, Singapore, and Thailand. However, Bhagat and Bhatia (1996) found strong one-directional causality running from volatility to trading volume while analyzing the lead-lag relationship between trading volume and volatility using Granger causality test. Brailsford (1996) for the Australian stock market found a positive contemporaneous relationship between absolute returns and volatility.

Several empirical studies have been done investigating MDH. In the U.S. stock market, Andersen (1996), Gallo and Pacini (2000), Kim and Kon (1994), and Lamoureux and Lastrapes (1990, 1994) found support for the MDH. In emerging markets context, Pyun et al. (2000) investigated 15 individual shares of the Korean stock market, Brailsford (1996) analyzed the effect of information arrivals on volatility persistence in the Australian stock market and Lange (1999) for the small Vancouver stock exchange. All of them found support for the mixed distribution hypothesis. Wang et al. (2005) examined the Chinese stock market and investigated the dynamic causal relation between stock return volatility and trading volume. They found support for the MDH as the inclusion of trading volume in the GARCH specification of volatility reduced the persistence of the conditional variance. In general, most of empirical studies in the developed and developing market context have found evidence that the inclusion of trading volume in GARCH models for volatility results in reduction of the estimated persistence or even causes it to vanish. However, Huang and Yang (2001) for the Taiwan Stock Market and Ahmed et al. (2005) for the Kuala Lumpur Stock Exchange found that the persistence in return volatility remains even after volume is included in the conditional variance equation.

The relationship between volume and volatility has also been studied in the market microstructure strand of literature. However, the implications are not always consistent. For example, the model of Admati and Pfleiderer (1988) which assumes three kinds of traders,

informed traders who trade on information, discretionary liquidity traders who can choose the time they want to trade but must satisfy their liquidity demands before the end of the trading day, and non discretionary traders who transact due to the reasons exogenous at a specific time and don't have the flexibility of choosing the trade time, predicts the positive relationship between volatility and trading volume. On the other hand Foster and Viswanathan (1990) model implies that this relationship does not necessarily follow even when they use the same classification of traders as used by Admati and Pfleiderer.

Another very important issue that has been has been addressed by researchers is the measurement of trading volume. Generally, three kinds of measures, namely, number of trades, volume of trade or total dollar value of trades have been used as a proxy of volume. The theoretical models of the past did not support the effect of trade size in the volatility volume relationship. However, recent models consider the effect of trade size on the volume volatility relationship but report contradictory results. On one hand, some models (Grundy and McNichols, 1989; Holthausen and Verrecchia, 1990; Kim and Verrecchia, 1991) show that informed traders prefer to trade large amounts at any given price and hence size is positively related to the quality of information and is therefore correlated with price volatility. On the other hand, some other models (Kyle, 1985; Admati and Pfeiderer, 1988) indicate that a monopolist informed trader may disguise his trading activity by splitting one large trade into several small trades. Thus, trade size may not necessarily convey adverse information.

Given the mixed empirical results between price and trading volume especially in emerging markets context, more empirical research from other emerging financial markets is needed to better understand the price-volume relationship. Very few studies have examined the price-volume relationship in Indian market. This paper represents one such attempt to investigate returns, volatility and trading volume relationship in Indian Stock market.

2. The Sample and its Characteristics

In this study our data set consists of all the stocks of S&P CNX Nifty Index. S&P CNX Nifty is a well diversified 50 stock index accounting for 21 sectors of the Indian economy. Table 1 provides the list of these companies, industry type and the period considered in the analysis. Data has been collected for the period of 1st January 2000 to 31st December 2008. For companies that were listed after 1st January 2000, the data has been taken from the listing date to 31st December 2008. The data set consists of 82674 data points of adjusted daily closing prices and three different measures of daily volume (number of transactions, number of shares traded and total value of shares). The daily adjusted closing prices have been used for estimating daily returns. The percentage return of the stock is defined as $R_t = \ln\left(p_t / p_{t-1}\right) \times 100$, where, R_t is logarithmic daily percentage return at time t and p_{t-1} and p_t are daily price of an asset on two successive days t-1 and t respectively. Table 2 presents the basic statistics relating to the returns and the squared returns of each stock in the sample.

Table 1: List of Constituents of S&P CNX Nifty

This table provides the list of constituents of 50 large capitalization stocks of S&P CNX Nifty, a value-weighted stock index of National Stock Exchange, Mumbai. Their industry type and data period are also presented.

Company Name	Symbol	Industry	Data Period
ABB Ltd.	ABB	ELECTRICAL EQUIPMENT	Jan 2000 to Dec 2008
ACC Ltd.	ACC	CEMENT AND CEMENT PRODUCTS	Jan 2000 to Dec 2008
Ambuja Cements Ltd.	AMBUJA	CEMENT AND CEMENT PRODUCTS	Jan 2000 to Dec 2008
Bharat Heavy Electricals Ltd.	BHEL	ELECTRICAL EQUIPMENT	Jan 2000 to Dec 2008
Bharat Petroleum Corporation Ltd.	BPCL	REFINERIES	Jan 2000 to Dec 2008
Bharti Airtel Ltd.	BHARTI	TELECOMMUNICATION - SERVICES	Feb 2002 to Dec 2008
Cairn India Ltd.	CAIRN	OIL EXPLORATION/PRODUCTION	Jan 2000 to Dec 2008
Cipla Ltd.	CIPLA	PHARMACEUTICALS	Jan 2000 to Dec 2008
DLF Ltd.	DLF	CONSTRUCTION	Jul 2007 to Dec 2008
GAIL (India) Ltd.	GAIL	GAS	Jan 2000 to Dec 2008
Grasim Industries Ltd.	GRASIM	CEMENT AND CEMENT PRODUCTS	Jan 2000 to Dec 2008
HCL Technologies Ltd.	HCL	COMPUTERS - SOFTWARE	Jan 2000 to Dec 2008
HDFC Bank Ltd.	HDFC	BANKS	Jan 2000 to Dec 2008
Hero Honda Motors Ltd.	HONDA	AUTOMOBILES - 2 AND 3 WHEELERS	Jan 2000 to Dec 2008
Hindalco Industries Ltd.	HINDALC	ALUMINIUM	Jan 2000 to Dec 2008
Hindustan Unilever Ltd.	HLL	DIVERSIFIED	Jan 2000 to Dec 2008
Housing Development Finance Corporation Ltd.	HDFCORP	FINANCE - HOUSING	Jan 2000 to Dec 2008
I T C Ltd.	ITC	CIGARETTES	Jan 2000 to Dec 2008
ICICI Bank Ltd.	ICICI	BANKS	Jan 2000 to Dec 2008
Idea Cellular Ltd.	IDEA	TELECOMMUNICATION - SERVICES	Mar 2007 to Dec 2008
Infosys Technologies Ltd.	INFOSYS	COMPUTERS - SOFTWARE	Jan 2000 to Dec 2008
Larsen & Toubro Ltd.	L&T	ENGINEERING	Jan 2000 to Dec 2008
Mahindra & Mahindra Ltd.	M&M	AUTOMOBILES - 4 WHEELERS	Jan 2000 to Dec 2008
Maruti Suzuki India Ltd.	MARUTI	AUTOMOBILES - 4 WHEELERS	Jul 2003 to Dec 2008
NTPC Ltd.	NTPC	POWER	Nov 2004 to Dec 2008
National Aluminium Co. Ltd.	NALCO	ALUMINIUM	Jan 2000 to Dec 2008
Oil & Natural Gas Corporation Ltd.	ONGC	OIL EXPLORATION/PRODUCTION	Jan 2000 to Dec 2008
Power Grid Corporation of India Ltd.	POWER&G	POWER	Oct 2007 to Dec 2008
Punjab National Bank	PNB	BANKS	Apr 2002 to Dec 2008
Ranbaxy Laboratories Ltd.	RANBAXY	PHARMACEUTICALS	Jan 2000 to Dec 2008
Reliance Communications Ltd.	RCOMM	TELECOMMUNICATION - SERVICES	Jul 2006 to Dec 2008
Reliance Industries Ltd.	RELIANC	REFINERIES	Jan 2000 to Dec 2008
Reliance Infrastructure Ltd.	RINFRA	POWER	Jan 2000 to Dec 2008
Reliance Petroleum Ltd.	RPETRO	REFINERIES	May 2006 to Dec 2008
Reliance Power Ltd.	RPOWER	POWER	Feb 2008 to Dec 2008
Satyam Computer Services Ltd.	SATYAM	COMPUTERS - SOFTWARE	Jan 2000 to Dec 2008
Siemens Ltd.	SIEMENS	ELECTRICAL EQUIPMENT	Jan 2000 to Dec 2008
State Bank of India	SBI	BANKS	Jan 2000 to Dec 2008
Steel Authority of India Ltd.	SAIL	STEEL AND STEEL PRODUCTS	Jan 2000 to Dec 2008
Sterlite Industries (India) Ltd.	STERLIT	METALS	Jan 2000 to Dec 2008
Sun Pharmaceutical Industries Ltd.	SUNPHAR	PHARMACEUTICALS	Jan 2000 to Dec 2008
Suzlon Energy Ltd.	SUZLON	ELECTRICAL EQUIPMENT	Oct 2005 to Dec 2008
Tata Communications Ltd.	TATACOM	TELECOMMUNICATION - SERVICES	Jan 2000 to Dec 2008
Tata Consultancy Services Ltd.	TCS	COMPUTERS - SOFTWARE	Aug 2004 to Dec 2008
Tata Motors Ltd.	TATAMOT	AUTOMOBILES - 4 WHEELERS	Jan 2000 to Dec 2008
Tata Power Co. Ltd.	TATAPOW	POWER	Jan 2000 to Dec 2008
Tata Steel Ltd.	TATASTE	STEEL AND STEEL PRODUCTS	Jan 2000 to Dec 2008
Unitech Ltd.	UNITECH	CONSTRUCTION	Jan 2000 to Dec 2008
Wipro Ltd.	WIPRO	COMPUTERS - SOFTWARE	Jan 2000 to Dec 2008
Zee Entertainment Enterprises Ltd.	ZEE	MEDIA & ENTERTAINMENT	Jan 2000 to Dec 2008

Table 2: Sample Summary Statistics of Return and Squared Return

This table provides descriptive statistics for return and squared return of all constituents companies of NIFTY: Symbol; Mean, Standard Deviation, Skewness, and Kurtosis over the period from January 2000 through December 2008.

Company	N	Mean	SD	Skewness	Kurtosis	Mean	SD	Skewness	Kurtosis
		Return				Squared Return			
ABB	2251	0.095	2.428	-0.313	4.311	0.059	0.147	8.875	140.915
ACC	2252	0.026	2.714	-0.368	3.840	0.074	0.178	7.828	95.368
AMBUJA	2251	0.020	2.497	-0.055	2.639	0.062	0.134	4.824	31.722
BHARTI	1720	0.162	2.762	0.355	2.601	0.077	0.165	6.441	63.474
BHEL	2251	0.111	2.927	-0.169	3.706	0.086	0.204	9.717	185.074
BPCL	2251	0.028	3.074	-0.107	3.577	0.094	0.223	8.960	147.877
CIPLA	2251	0.020	2.354	-0.292	4.327	0.055	0.139	6.947	72.852
CAIRN	489	0.046	3.603	-0.633	4.360	0.130	0.325	7.227	70.480
DLF	544	-0.129	5.839	5.194	74.871	0.341	2.964	22.445	515.794
GAIL	2250	0.049	3.007	-1.110	22.117	0.090	0.443	26.301	872.561
GRASIM	2251	0.045	2.571	-0.137	3.482	0.066	0.155	5.805	44.921
HCL	2246	-0.055	3.844	-0.368	3.256	0.148	0.339	5.697	43.596
HDFC	2252	0.077	2.447	0.123	8.382	0.060	0.193	16.891	413.665
HDFCORP	2251	0.101	2.594	0.230	3.489	0.067	0.158	6.740	73.649
HINDALC	2251	-0.016	2.635	-0.404	5.240	0.069	0.187	9.078	125.359
HLL	2252	0.002	2.219	0.048	3.345	0.049	0.114	8.583	139.917
HONDA	2251	0.054	2.518	0.237	2.561	0.063	0.136	6.705	77.248
ICICI	2251	0.079	3.249	-0.033	3.798	0.106	0.254	7.001	80.119
IDEA	449	-0.108	3.479	-0.198	2.453	0.121	0.255	4.409	23.217
INFOSYS	2252	0.006	3.020	-0.616	7.784	0.091	0.285	19.167	590.222
ITC	2251	0.057	2.275	0.005	3.002	0.052	0.116	4.914	30.288
L&T	2227	0.011	3.199	-5.260	108.311	0.102	1.073	42.884	1933.382
M&M	2252	0.009	2.988	-0.178	4.021	0.089	0.219	7.747	98.052
MARUTI	1373	0.084	2.639	-0.005	2.006	0.070	0.139	4.925	33.410
NALCO	2251	0.047	3.290	-0.252	5.295	0.108	0.292	9.618	149.576
NTPC	1034	0.084	2.362	-0.138	4.151	0.056	0.138	7.792	95.744
ONGC	2251	0.069	2.570	0.025	5.201	0.066	0.177	9.780	142.111
PNB	1673	0.158	3.136	-0.121	4.084	0.099	0.242	10.026	157.137
POWER&G	305	-0.062	3.588	-0.515	3.494	0.128	0.300	6.379	53.452
RANBAXY	2251	-0.009	2.535	-0.381	5.377	0.064	0.174	8.995	133.088
RCOMM	702	-0.035	3.756	-0.535	5.178	0.141	0.377	7.459	78.859
RELIANC	2252	0.070	2.546	-0.931	11.762	0.065	0.239	21.938	699.775
RPOWER	216	-0.308	4.024	0.326	1.671	0.162	0.304	5.873	51.373
RINFRA	2251	0.047	3.233	-0.533	8.719	0.105	0.341	11.798	221.447
RPETRO	658	0.003	3.168	-0.733	7.056	0.100	0.301	7.936	79.429
SAIL	2251	0.078	3.671	0.330	4.708	0.135	0.349	7.651	92.106
SATYAM	2252	-0.015	3.672	-0.454	6.004	0.135	0.381	18.550	573.982
SBI	2252	0.077	2.533	-0.290	3.051	0.064	0.144	6.803	75.823
SIEMENS	2251	0.073	2.690	-0.061	4.312	0.072	0.181	7.433	90.187
STERLIT	2131	0.058	6.206	-22.682	825.253	0.385	11.057	46.102	2127.278
SUNPHAR	2251	0.086	2.588	0.121	3.052	0.067	0.151	4.619	27.179
SUZLON	795	-0.100	4.396	-1.827	21.858	0.193	0.944	22.663	584.854
TATACOM	2251	-0.012	3.599	-0.803	13.167	0.129	0.504	26.604	980.581
TATAMOT	2251	-0.012	2.935	-0.379	2.780	0.086	0.188	6.458	67.960
TATAPOW	2252	0.101	2.973	-0.178	5.581	0.088	0.243	8.767	116.384
TATASTE	2252	0.034	2.978	-0.416	3.340	0.089	0.204	6.239	55.549
TCS	1085	-0.003	2.355	-0.186	3.444	0.055	0.129	5.245	36.135
UNITECH	2021	0.237	4.536	-1.778	33.203	0.206	1.213	38.556	1621.010
WIPRO	2252	-0.031	3.581	-0.160	4.276	0.128	0.321	6.197	52.582
ZEE	2252	-0.095	3.916	-0.445	5.088	0.153	0.409	11.943	254.012

The statistics from Table 2 show that most of the stock returns are negatively skewed during the period, although the skewness is not large. The negative skewness implies that there is higher probability of earning negative returns. These stock returns also show higher kurtosis (>3). This implies that the distribution of returns have fat tails compared to the normal distribution. In squared return series, the kurtosis is much higher than three. This implies fat tails in volatility and is an indicator of ARCH effect.

Given the multiple possible measures of trading volume and inconsistent results from previous research, we employ three different measures of trading volume:

- Daily number of equity traded or daily number of transactions (trade);
- Daily number of shares traded (volume);
- Daily total value of shares traded (value).

Table 3 presents the year wise description of average daily measurement of volume of the constituents of NIFTY stocks for each of three measures. Table 4 reports the basic statistics relating to the three measures of trading volume of each stock. For the sample period, the average daily number of transactions of Nifty stocks was around 7025 with around 0.84 million of traded shares. The average value of share traded per day was around Rs. 319.3 million.

Table 3: Year wise description of average daily measurements of trading volume of Nifty stocks

This table provides the yearly estimates of three measures of daily volume i.e, Number of transactions, Number of shares traded and Value of shares for the data period.

Year	N	Number of transactions (Trade)	Number of shares traded (Volume)	Value of shares traded (Value) (Rs. Million)
2000	9113	5608.5	956429.6	525.0
2001	9087	6239.6	923933.9	286.4
2002	9512	4352.1	594220.5	161.2
2003	10000	5238.1	902284.3	217.9
2004	10260	7332.0	1014290.3	333.5
2005	10592	4026.9	596276.1	236.3
2006	11120	6473.6	660513.6	313.2
2007	11833	7596.8	763866.5	348.8
2008	12436	14310.35	1144107	430.8

Table 5 presents the Pearson correlation between the three measures of daily trading volume. The three measures of volume are closely related as would be expected. For most of the companies we found high correlation between all the three measures of volume: the number of shares traded, the value of trades, and number of transactions (more than 0.8). The measures of trading volume have been standardized for further analysis. The stationarity of the returns, squared returns and all three standardized measures of volume is tested using Augmented Dickey-Fuller (1979) test. The results confirm that all series used in our sample are stationary[4].

[4] Results of the Augmented Dickey-Fuller (1979) test on the returns, squared returns, and standardized measures of volume (Number of transactions, Number of shares traded and Value of trades) can be obtained from authors on request.

Table 4: Sample Summary Statistics of Value, Volume and Trade

This table provides basic Summary Statistics of daily trading volume. Daily trading volume is measured in three ways: the daily total value of shares traded (value), the daily number of shares traded (volume) and the daily number of equity trades (trade). The mean, standard deviation, skewness and kurtosis of standardized value of value, volume and trade are presented.

		Mean	SD	Skew	Kurtosis	Mean	SD	Skew	Kurtosis	Mean	SD	Skew	Kurtosis
Company	N	Value				Volume				Trade			
ABB	2005	3.74	6.53	4.26	29.28	35451.45	55731.48	4.89	38.93	1029.04	1471.66	3.42	18.59
ACC	2006	22.99	26.37	3.53	23.53	878988.10	1233818.85	3.39	15.46	5879.72	4602.28	1.75	4.50
AMBUJA	2005	10.35	37.52	20.47	482.80	728747.17	2993375.17	19.75	446.34	2832.16	2661.72	2.86	13.39
BHARTI	1474	23.47	83.35	20.85	534.72	767458.16	3743614.29	23.93	630.59	4492.28	4787.61	2.48	9.58
BHEL	2005	19.67	24.52	2.96	13.70	360201.88	534149.26	4.94	36.66	5365.15	7137.97	3.57	17.51
BPCL	2005	8.33	11.87	4.59	33.34	279488.88	433194.20	5.67	52.85	2537.74	3192.89	4.47	33.82
CIPLA	2005	8.43	10.39	4.76	38.27	222584.94	329762.41	5.96	77.07	3082.61	3180.56	4.99	60.40
CAIRN	243	29.34	38.59	3.85	19.08	1386952.18	1411329.80	2.80	10.02	11166.57	12281.76	3.24	13.97
DLF	298	85.51	57.75	3.04	17.01	1648922.88	1457564.28	2.63	9.46	29083.34	19129.31	1.72	4.39
GAIL	2004	9.41	17.54	4.40	25.07	419829.28	767146.78	4.31	23.53	3191.10	5118.45	3.88	19.80
GRASIM	2005	8.89	9.62	3.41	21.68	134660.54	238392.66	4.77	29.22	1994.68	1744.25	2.51	9.65
HCL	2000	11.30	14.91	3.59	18.32	396505.73	746944.48	6.51	69.23	3916.33	5496.71	4.63	35.03
HDFC	2006	10.42	37.23	17.50	368.86	168999.76	604985.22	17.03	323.05	1804.83	2733.53	4.09	18.92
HDFCORP	2005	18.87	53.38	12.07	191.72	176226.03	515674.58	15.43	301.22	2162.18	3507.99	4.64	26.66
HINDALC	2005	11.03	14.12	3.58	22.45	563649.47	1146765.39	6.94	89.59	3592.06	4957.97	3.60	21.56
HLL	2006	17.86	18.53	3.81	25.05	823898.03	866183.36	4.28	33.37	4556.28	3282.28	2.74	15.23
HONDA	2005	6.74	8.79	4.09	25.64	141002.24	175686.70	3.16	14.63	1877.00	1838.22	2.86	13.22
ICICI	2005	27.75	58.18	8.34	140.64	596030.80	2425773.21	35.45	1485.36	6851.40	13230.94	4.72	31.85
IDEA	203	21.63	24.19	3.07	13.42	2079519.70	2355836.12	3.55	17.20	9713.33	7634.24	2.59	9.87
INFOSYS	2006	119.46	124.47	3.00	11.85	328460.86	219980.48	2.52	11.82	14481.96	9026.58	1.71	5.88
ITC	2005	23.61	25.34	3.29	16.43	681104.58	867784.29	2.77	11.31	5114.87	4193.46	2.20	7.70
L&T	1981	40.07	46.26	2.75	13.02	673051.52	988466.78	3.46	15.36	8760.43	9983.06	2.98	11.96
M&M	2006	10.91	13.49	6.15	94.07	314364.89	393258.30	5.31	48.62	2968.94	2365.46	2.42	9.54
MARUTI	1127	44.74	48.95	2.27	6.04	941812.17	1186215.37	2.17	5.51	10149.56	9754.84	2.02	4.35
NALCO	2005	3.34	4.45	5.39	74.39	190747.27	287505.20	12.64	332.22	1645.60	1860.91	2.50	12.85
NTPC	788	26.59	30.25	2.75	9.88	1774449.62	1878713.66	3.87	27.71	9513.87	9539.89	2.10	5.86
ONGC	2005	25.54	38.74	7.38	119.98	309834.52	451538.81	7.40	124.28	5333.25	5779.40	2.08	7.28
PNB	1427	11.34	12.55	4.55	40.51	418256.72	589642.56	4.28	29.26	4171.15	3949.89	2.81	14.06
POWER&G	59	42.41	78.87	4.30	22.33	3528412.82	6201691.80	4.72	26.89	20179.14	27122.61	3.84	18.66
RANBAXY	2005	23.80	33.18	6.91	89.99	409201.59	598897.49	7.65	101.44	5471.11	6810.49	8.38	125.46
RCOMM	456	97.40	68.69	2.78	12.10	2311692.31	1551220.51	2.25	8.91	28595.06	17815.64	2.64	17.29

		Mean	SD	Skew	Kurtosis	Mean	SD	Skew	Kurtosis	Mean	SD	Skew	Kurtosis
Company	**N**	**Value**				**Volume**				**Trade**			
RELIANC	2006	159.73	149.75	6.70	103.15	2611330.65	2569210.70	4.17	35.53	21326.52	17752.69	3.38	17.89
RPOWER		43.55	71.80	5.13	29.24	1687040.33	4777774.38	6.01	38.41	18220.00	34596.65	5.53	33.02
RINFRA	2005	34.22	76.97	4.32	24.89	427554.55	719914.60	5.25	65.98	8140.61	15658.96	2.94	9.76
RPETRO	412	104.67	160.09	4.59	35.57	6520920.44	7370820.46	3.10	18.53	39399.63	43571.68	2.18	9.42
SAIL	2005	22.62	28.84	2.45	10.70	3803178.49	5196293.87	3.46	19.50	8446.00	9036.99	1.77	6.26
SATYAM	2006	139.13	164.92	2.36	6.52	3576395.12	4044647.85	2.37	9.26	21367.27	17282.18	4.55	49.80
SBI	2006	66.37	57.44	1.26	2.43	1076105.38	978484.62	1.91	5.18	12092.54	11051.33	2.24	7.32
SIEMENS	2005	6.67	13.66	6.62	71.86	69587.82	124093.60	7.98	114.58	1818.98	3120.26	5.48	53.96
STERLIT	1885	19.82	37.44	4.70	32.85	354466.84	550069.40	2.69	9.41	4694.99	6760.16	2.75	11.06
SUNPHAR	2005	3.05	6.72	10.88	168.79	38902.14	80519.61	14.27	327.97	726.75	763.74	3.48	24.06
SUZLON	549	43.12	37.18	2.31	8.21	1777182.89	4357273.51	4.37	21.83	15161.21	19072.08	2.96	11.54
TATACOM	2005	10.33	21.17	5.94	55.14	291456.74	530506.55	5.34	43.99	3156.20	4220.57	3.92	24.94
TATAMOT	2005	30.88	37.74	2.87	13.11	881526.29	954301.10	2.75	11.39	6616.81	5654.44	2.18	6.95
TATAPOW	2006	12.08	19.50	6.53	88.38	365480.22	563410.08	3.87	20.44	3839.11	4629.52	3.18	17.37
TATASTE	2006	62.33	60.79	1.81	5.22	1835355.03	1586852.39	1.88	4.94	15284.43	13244.27	1.67	3.94
TCS	839	33.08	50.02	12.47	201.75	291734.72	432902.45	12.60	212.48	7335.67	5070.67	2.61	12.25
UNITECH	1775	14.94	30.55	3.83	27.95	836164.22	3218366.11	7.57	65.05	6393.04	12930.64	3.09	13.37
WIPRO	2006	45.23	60.64	2.54	7.15	347324.16	318408.38	4.71	52.28	10688.26	9723.47	1.87	4.07
ZEE	2006	66.60	124.68	2.93	8.90	2496313.24	3265417.64	2.59	9.82	12859.34	12288.60	1.48	2.03

Table 5: Pearson Correlation between Measures of Daily Trading Volume

This table presents the Pearson Correlation between Measures of Daily Trading Volume namely Number of Transactions, Traded Quantity and Turnover for the whole period.

Company	Number of Transactions and Traded Quantity	Number of Transactions and Turnover	Traded Quantity and Turnover
ABB	0.75	0.80	0.70
ACC	0.74	0.85	0.72
AMBUJA	0.27	0.29	0.96
BHARTI	0.30	0.39	0.93
BHEL	0.36	0.91	0.35
BPCL	0.95	0.91	0.94
CIPLA	0.81	0.85	0.76
CAIRN	0.89	0.95	0.95
DLF	0.95	0.70	0.75
GAIL	0.94	0.92	0.95
GRASIM	0.82	0.77	0.72
HCL	0.94	0.80	0.86
HDFC	0.14	0.26	0.92
HDFCORP	0.16	0.27	0.84
HINDALC	0.89	0.84	0.80
HLL	0.74	0.77	0.87
HONDA	0.79	0.59	0.86
ICICI	0.33	0.72	0.76
IDEA	0.75	0.78	0.97
INFOSYS	0.83	0.76	0.73
ITC	0.81	0.66	0.58
L&T	0.36	0.83	0.41
M&M	0.79	0.69	0.75
MARUTI	0.96	0.95	0.93
NALCO	0.66	0.81	0.87
NTPC	0.70	0.87	0.83
ONGC	0.74	0.69	0.96
PNB	0.90	0.88	0.82
POWER&G	0.98	0.99	0.99
RANBAXY	0.90	0.81	0.92
RCOMM	0.82	0.72	0.76
RELIANC	0.27	0.62	0.68
RPOWER	0.99	0.97	0.97
RINFRA	0.80	0.87	0.82
RPETRO	0.97	0.94	0.96
SAIL	0.65	0.89	0.77
SATYAM	0.89	0.61	0.63
SBI	0.48	0.84	0.68
SIEMENS	0.86	0.86	0.72
STERLIT	0.91	0.77	0.85
SUNPHAR	0.39	0.39	0.89
SUZLON	0.91	0.70	0.56
TATACOM	0.91	0.89	0.97
TATAMOT	0.82	0.89	0.77
TATAPOW	0.81	0.88	0.71
TATASTE	0.70	0.79	0.84
TCS	0.43	0.37	0.97
UNITECH	0.80	0.81	0.54
WIPRO	0.75	0.85	0.73
ZEE	0.92	0.78	0.75

3. Models for Investigating Empirical Relationships among Volume, Returns and Volatility

The study reported in this paper investigates relationship between trading volume and return, its asymmetric nature, and dynamic relationship using OLS regression and VAR modeling approach. The relationship between volume and unconditional volatility and its asymmetric effect is investigated using OLS regression. We also test the mixed distribution hypothesis (MDH) using GARCH model in which contemporary volume is used as an explanatory variable in the GARCH specification.

3.1 Trading Volume and Returns

The relationship between trading volume and price change and asymmetric nature is generally investigated through estimating contemporaneous correlation between returns and trading volume by using OLS equation as follows:

$$V_t = \alpha + \beta_1 r_t + \beta_2 D_t r_t \qquad [1]$$

where, V_t = standardized trading volume at time t, r_t is the return at time t and D_t=1 when r_t <0 and D_t=0 when $r_t \geq 0$. Three alternative measures of trading volume, daily total value of shares traded (value), daily number of shares traded (volume) and daily number of trades (trade) have been used in the equation as the dependent variable. The parameter β_1 measures the partial correlation between absolute returns and volume irrespective of the direction of return. The parameter β_2 captures the asymmetry in the relationship. A statistically significant negative value of β_2 would indicate that the relation between return and trading volume for negative returns is smaller than for positive returns.

3.2 Causal Relation between Trading Volume and Returns

The dynamic relationship between returns and trading volume is estimated using bivariate VAR model in which returns and trading volume are used as endogenous variables. In this case also three alternative measures of trading volume, daily value of trades, daily number of shares and daily number of transactions have been used.

$$r_t = \alpha_0 + \sum_{i=1}^{5} \alpha_i r_{t-i} + \sum_{j=1}^{5} \beta_j V_{t-j}$$
$$V_t = \gamma_0 + \sum_{i=1}^{5} \gamma_i V_{t-i} + \sum_{j=1}^{5} \delta_j r_{t-j} \qquad [2]$$

The coefficients α_i and β_j represents the effect of lagged returns and lagged volume on the present returns. If β_j =0 then it can be concluded that volume does not cause returns. Similarly, γ_i and δ_j represents the effect of lagged volume and lagged return on the present volume. The significance of the parameters δ_j indicates that the causality runs from returns to volume. If both parameters β and δ are significant then there exists bi-directional causal relation between returns and trading volume. We report both Granger Causality test and VAR parameter estimates to understand the dynamic relationship between volume and returns. We also investigate the

dynamic relationship between returns and volume through impulse response function and variance decomposition techniques.

3.2.1 Impulse Response Function and Variance Decomposition of Returns and Trading Volume

One of the well established methods of VAR analysis is the impulse-response function, which simulates the effects of a shock to one variable in the system on the conditional forecast of another variable (Sims, 1972, 1980; Abdullah and Rangazas, 1988). It explains the impact of an exogenous shock in one variable on the other variables of the system. We use the impulse-response function to analyze the impact of change in prices on volume and vice versa.

Under the VAR representation, the variance decomposition explains the relative impact of one variable on another variable. This analysis measures the percentage of the forecast error of one endogenous variable that is explained by other variables.

3.3 Trading Volume and Unconditional Volatility

The relationship between trading volume and unconditional volatility (measured by either absolute returns or squared returns)[5] and its asymmetric nature is investigated through OLS regression as follows:

$$V_t = \alpha + \beta_1 |r_t| + \beta_2 D_t |r_t| \text{ or,}$$

$$V_t = \alpha + \beta_1 r_t^2 + \beta_2 D_t r_t^2, \qquad [3]$$

where V_t = standardized trading volume at time t, r_t is the return at time t and D_t=1 when r_t <0 and D_t=0 when $r_t \geq 0$. As explained in section 3.1 the parameter β_1 captures the relation between absolute returns/ squared returns and volume and β_2 the asymmetric relationship. The significant and negative value of the parameter β_2 would indicate that the relation between unconditional volatility ($|r_t| / r_t^2$) and volume would be lesser for negative returns than positive returns.

3.4. Trading Volume and Conditional Volatility

The conditional volatility of the returns is measured through GARCH model. Let r_t is the return at time t. The GARCH (1,1) model is given by:

$$r_t = a + \sum_{i=1}^{5} b_i r_{t-i} + \varepsilon_t$$

$$\varepsilon_t \,|\, \psi_{t-1} \sim N(0, \sigma_t^2) \text{ and} \qquad [4]$$

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_J \sigma_{t-j}^2 .$$

The parameters α_i and β_j measure the dependence of current volatility (σ_t^2) on innovation term (ε_{t-i}) and past volatility (σ_{t-j}^2) respectively. The persistence of the conditional volatility is measured by $\alpha_i + \beta_j$. The relationship between conditional volatility and trading volume is

[5] Absolute returns is a more robust measure of unconditional volatility as compared to squared returns

modeled by modifying GARCH equation. The contemporaneous volume is used as explanatory variable in GARCH equation (Lamoureux and Lastrapes, 1990) as given by:

$$r_t = a + \sum_{i=1}^{5} b_i r_{t-i} + \varepsilon_t$$
$$\varepsilon_t \,|\, \psi_{t-1} \sim N(0, \sigma_t^2) \text{ and} \qquad [5]$$
$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_J \sigma_{t-j}^2 + \chi V_t .$$

The significance of the coefficient estimate (χ) of trading volume indicates the influence of trading volume on the conditional volatility.

4. Results and Discussions on Relationship between Volume, Returns and Volatility

In this section of the paper we present empirical results on the relationship between trading volume, returns and volatility (conditional and unconditional). Firstly we report the relationship between trading volume and price changes. Later, we report the relationship between volume and unconditional and conditional volatility.

4.1 Trading Volume and Returns

The results of the OLS regression using equation [1] to explain the relation between volume and price changes and its asymmetric nature are presented in Table 6. The estimates of β_1, which measure the relationship between price changes and volume irrespective of the direction of the price change, are significant and positive at 1% level (except for Idea Cellular Ltd., where the coefficient is significant at 5% level when value is taken as measure of trading volume and Reliance Power, where it is not significant when value and trade is taken as the measure of trading volume) across all three measures of trading volume. The coefficients are higher for most of the companies, when the number of transactions is taken as a measure of trading volume followed by volume of transactions.

The asymmetric behavior of relation between volume and returns is indicated by coefficient β_2. In almost all the cases, β_2 is significant and negative i.e. for most stocks β_2 is negative for at least two out of the three trading volume measures. The negative value of β_2 indicates that the relation between price changes and trading volume is smaller for negative returns than for positive returns. This is consistent with Karpoff (1986, 1987) and Assogbavi et al. (1995) who relate the observed price-volume asymmetry in developed markets to the higher cost of short sales as compared to margin buying. Only Reliance Power does not show asymmetric behavior in two of the measure of volume (value and trade where it is insignificant).

Table 6: Relationship between Standardized Trading Volume and Returns

This table provides the coefficient estimates from regressions of trading volume against the price changes (e returns) and asymmetric coefficient of the OLS equation $V_t = \alpha + \beta_1 r_t + \beta_2 D_t r_t$, where V_t = standardized trading volume at time t, r_t is the return at time t and D_t=1 when r_t <0 and D_t=0 when $r_t \geq 0$. Three measures of trading volume, the daily total dollar value of shares traded (value), the daily number of shares traded (volume) and the daily number of equity trades (trade) are considered. Parameter estimates of all 50 companies are presented.

	Value				Volume				Trade			
Company	**α**	**β₁**	**β₂**	**RSQ**	**α**	**β₁**	**β₂**	**RSQ**	**α**	**β₁**	**β₂**	**RSQ**
ABB	-0.174*	0.126*	-0.201*	0.034	-0.309*	0.209*	-0.359*	0.102	-0.307*	0.203*	-0.358*	0.100
ACC	-0.268*	0.175*	-0.279*	0.078	-0.274*	0.188*	-0.284*	0.086	-0.337*	0.221*	-0.351*	0.124
AMBUJA	-0.058*	0.052*	-0.065*	0.006	-0.051	0.047*	-0.058**	0.005	-0.312*	0.205*	-0.351*	0.100
BHARTI	-0.109*	0.043*	-0.111*	0.011	-0.093*	0.040*	-0.093*	0.008	-0.420*	0.205*	-0.418*	0.158
BHEL	-0.294*	0.155*	-0.282*	0.086	-0.342*	0.186*	-0.326*	0.118	-0.319*	0.157*	-0.306*	0.100
BPCL	-0.248*	0.143*	-0.223*	0.066	-0.266*	0.143*	-0.240*	0.071	-0.273*	0.147*	-0.246*	0.075
CIPLA	-0.362*	0.252*	-0.445*	0.146	-0.266*	0.162*	-0.327*	0.078	-0.382*	0.248*	-0.470*	0.161
CAIRN	-0.262*	0.133*	-0.188*	0.083	-0.251*	0.118*	-0.170*	0.106	-0.305*	0.143*	-0.221*	0.104
DLF	-0.075**	0.027*	-0.024**	0.040	-0.133*	0.037*	-0.059*	0.049	-0.167*	0.042*	-0.083*	0.047
GAIL	-0.197*	0.117*	-0.198*	0.051	-0.207*	0.128*	-0.208*	0.058	-0.229*	0.137*	-0.230*	0.069
GRASIM	-0.230*	0.171*	-0.251*	0.065	-0.239*	0.168*	-0.261*	0.065	-0.351*	0.243*	-0.386*	0.139
HCL	-0.322*	0.139*	-0.233*	0.112	-0.292*	0.120*	-0.215*	0.085	-0.324*	0.129*	-0.238*	0.103
HDFC	-0.089*	0.061*	-0.105*	0.009	-0.061**	0.049*	-0.072*	0.006	-0.336*	0.194*	-0.399*	0.125
HDFCORP	-0.147*	0.074*	-0.162*	0.022	-0.129*	0.072*	-0.141*	0.017	-0.427*	0.220*	-0.469*	0.186
HINDALC	-0.368*	0.242*	-0.405*	0.152	-0.409*	0.253*	-0.451*	0.183	-0.452*	0.267*	-0.497*	0.222
HLL	-0.349*	0.278*	-0.435*	0.133	-0.253*	0.205*	-0.316*	0.072	-0.415*	0.304*	-0.519*	0.171
HONDA	-0.154*	0.105*	-0.168*	0.026	-0.243*	0.163*	-0.266*	0.063	-0.299*	0.181*	-0.329*	0.086
ICICI	-0.238*	0.096*	-0.211*	0.060	-0.130*	0.052*	-0.115*	0.018	-0.325*	0.128*	-0.288*	0.113
IDEA	-0.056	0.037**	-0.020	0.019	-0.109**	0.049*	-0.059**	0.022	-0.147*	0.083*	-0.093*	0.053
INFOSYS	-0.310*	0.156*	-0.297*	0.104	-0.335*	0.163*	-0.321*	0.122	-0.394*	0.195*	-0.377*	0.168
ITC	-0.418*	0.276*	-0.516*	0.174	-0.293*	0.187*	-0.363*	0.085	-0.423*	0.280*	-0.522*	0.178
L&T	-0.330*	0.219*	-0.324*	0.145	-0.267*	0.183*	-0.262*	0.097	-0.313*	0.192*	-0.308*	0.129
M&M	-0.071**	0.072*	-0.067*	0.017	-0.152*	0.118*	-0.143*	0.040	-0.208*	0.147*	-0.196*	0.060
MARUTI	-0.263*	0.162*	-0.264*	0.064	-0.241*	0.146*	-0.236*	0.057	-0.279*	0.167*	-0.280*	0.071
NALCO	-0.226*	0.139*	-0.198*	0.073	-0.224*	0.134*	-0.196*	0.068	-0.324*	0.173*	-0.285*	0.125
NTPC	-0.375*	0.203*	-0.435*	0.213	-0.192*	0.099*	-0.201*	0.111	-0.520*	0.287*	-0.619*	0.328
ONGC	-0.148*	0.093*	-0.165*	0.024	-0.189*	0.119*	-0.209*	0.038	-0.274*	0.168*	-0.304*	0.080
PNB	-0.333*	0.191*	-0.289*	0.127	-0.415*	0.226*	-0.360*	0.185	-0.433*	0.232*	-0.377*	0.196
POWER&G	-0.243*	0.126*	-0.163*	0.091	-0.268*	0.132*	-0.179*	0.118	-0.304*	0.153*	-0.213*	0.122
RANBAXY	-0.334*	0.217*	-0.382*	0.125	-0.380*	0.237*	-0.436*	0.160	-0.380*	0.239*	-0.436*	0.161
RCOMM	-0.237*	0.109*	-0.175*	0.064	-0.378*	0.161*	-0.280*	0.175	-0.459*	0.194*	-0.351*	0.229
RELIANC	-0.355*	0.198*	-0.405*	0.140	-0.331*	0.208*	-0.375*	0.119	-0.445*	0.244*	-0.508*	0.223
RPOWER	-0.036	0.004	-0.023	0.002	-0.053*	0.004*	-0.033*	0.004	-0.060	0.009	-0.038	0.004
RINFRA	-0.330*	0.177*	-0.314*	0.152	-0.401*	0.223*	-0.381*	0.227	-0.372*	0.188*	-0.354*	0.190
RPETRO	-0.404*	0.208*	-0.384*	0.211	-0.483*	0.246*	-0.453*	0.325	-0.465*	0.235*	-0.443*	0.281
SAIL	-0.260*	0.122*	-0.204*	0.083	-0.306*	0.145*	-0.239*	0.116	-0.314*	0.134*	-0.247*	0.111
SATYAM	-0.344*	0.141*	-0.264*	0.116	-0.330*	0.133*	-0.253*	0.107	-0.409*	0.157*	-0.314*	0.164
SBI	-0.323*	0.196*	-0.351*	0.096	-0.322*	0.204*	-0.349*	0.097	-0.361*	0.208*	-0.393*	0.118
SIEMENS	-0.252*	0.149*	-0.269*	0.072	-0.355*	0.173*	-0.382*	0.141	-0.330*	0.167*	-0.356*	0.120
STERLIT	-0.167*	0.101*	-0.121*	0.063	-0.204*	0.112*	-0.149*	0.096	-0.175*	0.097*	-0.128*	0.070
SUNPHAR	-0.130*	0.085*	-0.144*	0.020	-0.128*	0.093*	-0.141*	0.022	-0.371*	0.234*	-0.411*	0.158
SUZLON	-0.331*	0.144*	-0.213*	0.202	-0.371*	0.148*	-0.252*	0.162	-0.452*	0.171*	-0.302*	0.257
TATACOM	-0.139*	0.094*	-0.116*	0.038	-0.146*	0.096*	-0.121*	0.040	-0.177*	0.108*	-0.147*	0.051
TATAMOT	-0.082*	0.060*	-0.077*	0.009	-0.239*	0.152*	-0.223*	0.059	-0.205*	0.119*	-0.192*	0.039
TATAPOW	-0.333*	0.174*	-0.324*	0.123	-0.286*	0.159*	-0.277*	0.093	-0.335*	0.171*	-0.326*	0.124
TATASTE	-0.260*	0.144*	-0.244*	0.066	-0.303*	0.174*	-0.284*	0.091	-0.396*	0.196*	-0.372*	0.149
TCS	-0.099**	0.065*	-0.106*	0.009	-0.158	0.097*	-0.175*	0.025	-0.376*	0.212*	-0.431*	0.190
UNITECH	-0.213*	0.082*	-0.131*	0.049	-0.300*	0.099*	-0.187*	0.092	-0.294*	0.094*	-0.185*	0.089
WIPRO	-0.271*	0.127*	-0.221*	0.085	-0.248*	0.118*	-0.203*	0.072	-0.320*	0.142*	-0.261*	0.117
ZEE	-0.256*	0.105*	-0.186*	0.066	-0.317*	0.139*	-0.231*	0.105	-0.360*	0.155*	-0.262*	0.134

4.2 Causal Relation between Trading Volume and Returns

In order to investigate dynamic relationship between returns and trading volume, we analyze these variables through a bivariate VAR model. We also explore lead-lag relationship between returns and trading volume by using Granger Causality test (Smirlock and Starks, (1988), and Assogbavi et al. (2007). Granger Causality test is a F test which checks the block exogeneity. In equation 2 given earlier, it tests the null hypothesis that return series is not affected by past volume ($\beta_j = 0$) and that the volume is not affected by past returns ($\delta_j = 0$) separately. Results of the test are reported in Table 6.

The results of the Granger causality test indicate mixed results on effect of past returns on trading volume. When the number of transactions is taken as a measure of volume, in case of 23 stocks the null hypothesis that past returns does not cause trading volume ($\delta_j = 0$) is rejected at 1% significance level, and for 7 stocks it is rejected at 5% significance level. On the other hand, the null hypothesis that the past volume does not cause returns ($\beta_j = 0$) is rejected in case of 6 stocks at 1% significance level, and for 4 stocks at 5% significance level. Similar[6] kind of results are found when other two measures of volume, daily number of shares traded and daily value of stocks traded are used to test the dynamic relationship between returns and volume. The Granger causality results show that returns cause volume and that the past trading volume also Granger causes returns albeit in lesser number of stocks. This evidence supports the sequential processing of information hypothesis argued by Smirlock and Starks (1985). They propose that the information arrives sequentially rather than simultaneously in the market. The evidence that volume Granger causes returns for some stocks supports theoretical models which imply that there is information content in volume which predicts future returns. The difference in direction of causality across stocks may be due to nature of the industry, types of investors etc.

The autoregressive coefficient of return and partial coefficient of return on past volume and autoregressive coefficient of volume and volume on past returns are also estimated through bivariate VAR model as explained in equation [2]. In this case also, all the three measures of volume have been considered and the results are reported in Table 8. We find that the all three measures of volume are highly autocorrelated with past volume. These results provide evidence that in Indian market, information is processed sequentially. Even after factoring in high autocorrelation in volume, the partial correlation between volume and past returns are significant and most of the significance is found with only last day return (21 stocks when number of trades, 26 stocks when volume and 25 stocks when value is taken as measure of traded volume). The return series are also autocorrelated up to lag 1 or 2 (in most of the stocks) and the coefficients are small. In some cases, (lesser than dependence of volume on past returns) we find significant partial correlation between returns and past volume and in these cases, most of the significant coefficients are for relation between return and last day volume (7 stocks when number of trades, 4 stocks when volume and 6 stocks when value is taken).

[6] In case of total number of daily shares traded, 13 stocks at 1% significance level and by 7 stocks at 5% significance level have rejected the null that returns do not cause volume. When the daily value of shares traded is used, 13 stocks at 1% significance level and by 8 stocks at 5% significance level. Granger causality from volume to returns is rejected by 2 stocks at 1% significance level and by 5 stocks at 5% significance level and 7 stocks at 1% significance level and by 4 stocks at 5% significance level when total number of shares traded and total value of shares are considered respectively.

Table 7: Granger Causality Test (Wald Test)

This table provides the F test results of restriction on autoregressive parameters $\beta_j=0$ and $\delta_j=0$ of the bivariate VAR model $r_t = \alpha_0 + \sum_{i=1}^{5} \alpha_i r_{t-i} + \sum_{j=1}^{5} \beta_j V_{t-j}$ and $V_t = \gamma_0 + \sum_{i=1}^{5} \gamma_i V_{t-i} + \sum_{j=1}^{5} \delta_j r_{t-j}$ .where V_t is the standardized trading volume at time t, and r_t is the return at time t. Three measures of trading volume, the daily total dollar value of shares traded (value), the daily number of shares traded (volume) and the daily number of equity trades (trade) are considered. Parameter estimates of all 50 companies are presented.

	Value		Volume		Trade	
Company	**$\beta_i=0$**	**$\delta_i=0$**	**$\beta_i=0$**	**$\delta_i=0$**	**$\beta_i=0$**	**$\delta_i=0$**
ABB	1.98	4.61	8.63	1.36	4.31	3.94
ACC	3.87	23.78*	2.16	21.31*	2.27	13.24**
AMBUJA	3.96	3.55	4.48	3.91	4.85	17.01*
BHARTI	9.14	0.9	7.09	2.44	2.1	5.09
BHEL	8.07	16.38*	1.62	17.88*	8.62	29.27*
BPCL	17.52*	8.98	11.34**	4.1	14.94**	5.28
CIPLA	3.99	23.61*	3.01	5.71	3.05	16.68*
CAIRN	2.38	13.32**	2.09	11.09**	2.21	14.35**
DLF	0.83	1.58	3.35	3.04	3.56	1.77
GAIL	8.4	6.27	4.09	2.92	7.38	6.97
GRASIM	3.97	12.07**	3.73	12.38**	4	4.62
HCL	9.15	3.33	15.02**	40.58*	6.01	43.66*
HDFC	1.05	1.31	1.3	2.77	5.91	7.28
HDFCORP	15.26*	12.93**	5.71	11.91**	6.41	32.47*
HINDALC	13.92**	15.03**	13.2**	47.93*	6.05	24.53*
HLL	2.06	6.22	1.35	9.15	5.42	9.53
HONDA	4.09	7.06	1.25	14.77*	1.67	14.93**
ICICI	12.6**	4.76	3.97	4.52	13.58**	19.7*
IDEA	2.63	3.61	4.08	3.26	1.93	2.47
INFOSYS	15.37*	11.59**	6.62	33.38*	7.5	45.08*
ITC	15.71*	28.12*	4.94	3.58	8.84	5.82
L&T	6.37	11.27**	7.96	9.78	6.95	13.28**
M&M	5.29	5.9	5.53	4.49	2.65	3.62
MARUTI	2.01	7.24	2.15	17.61*	2.35	23.39*
NALCO	5.28	17.01*	1.74	11.58**	5.18	24.06*
NTPC	16.76*	20.98*	5.4	7.15	29.9*	5.44
ONGC	8.18	3.07	5.88	2.74	3.89	11.05
PNB	11.33	12.6	14.99**	10.94	6.71	7.82
POWER&G	8.85	5.32	9.95	2.69	6.87	1.92
RANBAXY	10.42	10.9	7.68	13.8**	7.98	24.68*
RCOMM	6.16	2.31	5.88	5.7	10.64	8.57
RELIANC	8.19	12.04**	4.03	9.19	14.37**	7.91
RPOWER	7.36	0.49	6.22	0.27	6.48	0.9
RINFRA	14.34**	4.37	7	7.38	17.72*	8.07
RPETRO	7.38	23.75*	4.75	13.79**	5.9	13.63**
SAIL	8.14	43.76*	6.1	48.39*	7.6	20.42*
SATYAM	10.16	33.63*	8.52	39.95*	6.43	39.27*
SBI	4.59	21.39*	2.85	17.14*	7.88	17.91*
SIEMENS	5.82	8.65	11.55**	9.6	5.02	15.75*
STERLIT	190.34	78.76	67.15	20.33	63*	17.96*
SUNPHAR	12.59**	6.5	6.53	4.58	12.54**	22.57*
SUZLON	8.61	7.07	27.91*	21.39*	20.81*	18.29*
TATACOM	5.7	5.47	5.63	4.19	5.07	5.18
TATAMOT	0.84	11.11**	4.63	17.94*	2.11	13.8**
TATAPOW	40.51*	79.04*	22.31*	37.94*	25.21*	24.31*
TATASTE	6.12	17.55*	7.44	6.96	3	20.87*
TCS	0.67	0.11	1.24	2.57	1.57	19.06*
UNITECH	5.44	10.73	10.49	92.56*	16.82*	77.95*
WIPRO	10.9	8.91	2.43	6.44	5.16	21.26*
ZEE	15.19*	15.39*	7.61	14.51**	6.89	12.95**

Table 8: Results of Bivariate VAR model

This table provides the parameter coefficient estimates of the bivariate VAR model $r_t = \alpha_0 + \sum_{i=1}^{5} \alpha_i r_{t-i} + \sum_{j=1}^{5} \beta_j V_{t-j}$ and $V_t = \gamma_0 + \sum_{i=1}^{5} \gamma_i V_{t-i} + \sum_{j=1}^{5} \delta_j r_{t-j}$ .where V_t is the standardized trading volume at time t, and r_t is the return at time t. Three measures of trading volume, the daily total dollar value of shares traded (value), the daily number of shares traded (volume) and the daily number of equity trades (trade) are considered. Parameter estimates of all 50 companies are presented.

a) VAR model with returns and number of transactions as volume measure

	$r_t = \alpha_0 + \sum_{i=1}^{5} \alpha_i r_{t-i} + \sum_{j=1}^{5} \beta_j V_{t-j}$											$V_t = \gamma_0 + \sum_{i=1}^{5} \gamma_i V_{t-i} + \sum_{j=1}^{5} \delta_j r_{t-j}$										
Company	**α_0**	**α_1**	**α_2**	**α_3**	**α_4**	**α_5**	**β_1**	**β_2**	**β_3**	**β_4**	**β_5**	**γ_0**	**γ_1**	**γ_2**	**γ_3**	**γ_4**	**γ_5**	**δ_1**	**δ_2**	**δ_3**	**δ_4**	**δ_5**
ABB	0.09	0.06*	0.00	0.00	0.00	-0.01	0.06	0.00	-0.09	-0.07	0.01	0.00	0.64*	0.08*	0.01	0.08*	0.08*	0.00	0.00	-0.01	0.00	0.00
ACC	0.03	0.01	-0.04	0.00	0.03	-0.01	0.09	-0.03	-0.08	-0.04	0.10	0.00	0.48*	0.17*	0.06	0.09*	0.10*	0.01*	-0.01	0.01	0.00	0.00
AMBUJA	0.03	0.02	-0.05*	0.01	0.04	-0.02	0.02	-0.19	0.08	0.07	-0.03	0.00	0.52*	0.10*	0.11*	0.09*	0.05*	0.01*	-0.01	-0.01	0.01	-0.01*
BHARTI	0.18*	-0.01	-0.06*	-0.02	-0.03	0.02	0.02	0.04	-0.05	-0.10	0.02	0.00	0.47*	0.08*	0.08*	0.19*	0.05**	-0.01	0.01	0.00	-0.01	0.00
BHEL	0.12	0.04	-0.07*	-0.01	0.02	-0.02	-0.31**	0.13	0.29	-0.37	0.19	0.00	0.72*	0.09*	0.01	0.05**	0.07*	-0.01*	-0.01*	-0.01*	0.01	0.00
BPCL	0.03	0.08*	0.01	0.01	-0.01	-0.04	-0.35*	0.18	-0.04	0.19	-0.09	0.00	0.57*	0.00	0.09*	0.13*	0.06*	0.01	0.00	0.01	0.00	0.00
CIPLA	0.03	0.08*	-0.01	-0.05*	0.00	0.01	-0.09	0.03	0.01	-0.05	0.01	0.00	0.51*	0.04	0.15*	0.04	0.06*	0.02*	0.00	0.00	0.00	-0.01
CAIRN	0.04	0.03	0.02	-0.07	-0.15*	0.00	-0.06	-0.02	0.35	0.01	-0.36	0.00	0.66*	-0.07	0.21*	0.07	0.03	0.01	-0.01**	0.00	0.00	-0.02*
DLF	-0.16	0.01	-0.05	0.07	-0.01	-0.01	0.32	0.07	-0.34	0.46	-0.61	-0.01	0.29*	0.38*	-0.04	0.18*	0.03	-0.002	-0.004	0.001	-0.003	-0.002
GAIL	0.06	-0.01	-0.07*	0.01	0.01	-0.07*	-0.12	0.35	-0.27	0.09	-0.16	0.001	0.61*	0.06**	0.14*	0.09*	0.06*	0.000	-0.006	-0.004	-0.004	-0.002
GRASIM	0.03	0.06*	-0.03	0.06*	0.02	0.03	-0.04	0.08	-0.04	-0.11	0.16	0.001	0.51*	0.09*	0.08*	0.03	0.20*	0.001	-0.006	-0.003	-0.003	-0.007
HCL	-0.07	0.07*	-0.02	-0.06*	-0.02	-0.10*	-0.26	0.23	-0.28	0.29	-0.02	-0.001	0.60*	0.15*	0.05	-0.04	0.17*	-0.015*	-0.004	0.008*	-0.003	0.002
HDFC	0.09	-0.03	-0.05*	-0.02	-0.05*	-0.03	0.05	-0.19	0.25	-0.16	-0.01	0.004	0.42*	0.16*	0.11*	0.14*	0.13*	0.002	-0.005	-0.002	0.001	-0.007**
HDFCORP	0.13*	0.02	-0.09*	-0.06*	-0.02	-0.09*	-0.03	-0.17	-0.08	0.09	0.08	0.01	0.57*	0.02	0.14*	0.16*	0.07*	-0.01**	0.00	-0.01*	-0.01*	-0.01*
HINDALC	-0.02	0.12*	-0.01	-0.07*	0.02	0.01	-0.01	-0.05	0.14	-0.24**	0.07	0.001	0.57*	0.02	0.20*	0.11*	0.01	-0.004	0.005	-0.014*	0.001	-0.016*
HLL	0.00	0.04	-0.02	-0.03	0.01	-0.06*	0.06	0.04	-0.11	-0.06	0.03	0.00	0.45*	0.10*	0.09*	0.10*	0.07*	-0.01	0.00	-0.01	-0.01	-0.01
HONDA	0.06	0.04	-0.10*	-0.05*	-0.03	0.01	0.03	-0.01	0.05	-0.03	-0.07	0.00	0.59*	0.04	0.10*	0.01	0.09*	0.00	-0.02*	0.00	-0.01	-0.01
ICICI	0.08	0.12*	-0.06*	0.01	-0.03	-0.01	0.32	-0.12	0.13	-0.38	-0.10	0.004	0.63*	0.07*	-0.02	0.10*	0.18*	-0.009*	-0.001	0.005	-0.005	-0.001
IDEA	-0.12	0.10**	0.00	0.01	0.03	0.00	-0.15	-0.11	-0.10	0.19	0.25	-0.03	0.56*	-0.02	0.03	0.04	0.07	0.00	-0.01	0.01	0.01	0.00
INFOSYS	0.01	0.08*	-0.06*	0.00	-0.04	-0.03	-0.05	0.09	-0.25*	0.09	0.04	0.00	0.45*	0.14*	0.11*	0.06*	0.08*	-0.03*	0.00	-0.01	0.00	0.01
ITC	0.05	-0.01	-0.01	0.01	0.01	-0.01	-0.06	-0.06	0.02	-0.12	0.11	0.000	0.52*	0.08*	0.12*	-0.01	0.14*	0.009	-0.001	-0.012	0.000	-0.003
L&T	0.02	0.08*	-0.05**	0.02	0.01	-0.03	-0.15	0.10	0.19	-0.19	-0.08	0.002	0.53*	0.10*	0.08*	0.10*	0.13*	-0.002	-0.004	-0.009*	-0.002	-0.005
M&M	0.00	0.14*	-0.05**	-0.01	0.00	-0.05**	0.03	0.07	-0.08	0.13	-0.13	0.002	0.51*	0.07*	0.10*	0.10*	0.11*	-0.001	0.000	-0.007	-0.003	-0.002

company	α_0	α_1	α_2	α_3	α_4	α_5	β_1	β_2	β_3	β_4	β_5	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	δ_1	δ_2	δ_3	δ_4	δ_5
MARUTI	0.08	0.04	-0.05	0.00	0.01	-0.04	-0.17	0.20	0.00	0.13	-0.15	0.00	0.59*	0.05	0.18*	-0.02	0.15*	-0.02*	0.00	-0.01	0.00	-0.01
NALCO	0.04	0.04	0.01	-0.03	-0.01	0.02	-0.004	0.004	0.053	-0.160	-0.044	0.002	0.57*	0.01	0.15*	0.06*	0.07*	0.015*	0.001	-0.010*	0.000	-0.010*
NTPC	0.09	0.04	-0.08*	-0.03	-0.01	-0.02	-0.71*	0.59*	-0.52*	0.24	0.16	-0.004	0.68*	-0.08**	0.18*	0.00	0.16*	0.012**	-0.002	-0.001	0.007	0.001
ONGC	0.067	0.091*	-0.069*	-0.004	0.019	0.003	-0.02	0.03	-0.04	-0.11	0.04	0.003	0.51*	0.08*	0.13*	0.10*	0.09*	0.009	-0.002	-0.005	0.002	-0.011*
PNB	0.16**	0.02	-0.02	-0.04	0.00	-0.05	0.02	0.22	-0.33	0.13	-0.12	-0.001	0.53*	0.19*	0.01	0.11*	0.04	0.010**	0.003	-0.008	0.002	0.003
POWER&G	-0.09	0.15*	-0.11	-0.05	-0.07	-0.05	-0.24	-0.23	0.70	0.25	0.05	-0.027	0.69*	-0.24	0.28*	0.08	0.08	0.003	-0.001	0.005	0.000	0.006
RANBAXY	-0.01	0.05**	-0.01	0.02	0.01	0.01	-0.21*	0.12	-0.02	0.04	-0.01	0.00	0.59*	0.08*	0.00	0.04	0.10*	0.01	-0.02*	-0.01	0.01	-0.01
RCOMM	-0.06	-0.08**	-0.01	0.04	-0.10*	0.01	0.34	-0.07	0.01	-0.51**	-0.04	-0.005	0.45*	0.09**	0.15*	0.01	0.11*	0.000	-0.005	-0.017*	-0.014	0.001
RELIANC	0.062	0.035	-0.005	-0.037	-0.005	0.003	-0.27*	0.21	0.08	-0.19	0.06	0.002	0.51*	0.02	0.14*	0.14*	0.12*	-0.004	0.005	0.010	-0.004	0.000
RPOWER	-0.39	0.16*	-0.04	0.16**	-0.08	-0.01	0.58	0.07	0.39	-0.49	-0.74	0.111*	0.22*	0.20*	0.11	0.19*	0.61*	0.003	-0.004	-0.001	0.009	0.000
RINFRA	0.05	0.06*	-0.07*	0.03	-0.04**	-0.01	0.00	-0.37	-0.51**	0.80	0.04	0.003	0.61*	0.13*	0.09*	-0.02	0.16*	-0.004	0.001	-0.004	0.003	0.001
RPETRO	0.02	0.12*	-0.03	-0.06	0.00	0.03	0.05	0.05	-0.59**	0.25	0.12	0.000	0.60*	0.01	0.18*	-0.05	0.18*	-0.003	0.014**	0.014	0.006	0.009
SAIL	0.08	0.05*	-0.04	0.01	0.01	0.01	-0.35**	0.03	0.05	-0.03	0.20	0.000	0.58*	0.06*	0.14*	0.02	0.13*	0.011*	0.003	0.006**	-0.002	-0.002
SATYAM	-0.02	0.05**	-0.04	-0.01	0.00	-0.03	0.22	-0.07	-0.10	-0.22	0.12	0.010	0.38*	0.17*	0.04	0.14*	0.24*	-0.011*	-0.001	0.001	-0.011*	-0.013*
SBI	0.075	0.056*	-0.043	-0.001	0.005	-0.046**	-0.23	0.18	-0.03	-0.17	0.21	0.004	0.47*	0.10*	0.16*	0.10*	0.13*	0.000	0.009**	-0.004	-0.006	-0.011*
SIEMENS	0.07	0.05*	-0.02	0.01	0.01	0.04	-0.09	-0.04	0.00	0.02	-0.02	0.00	0.64*	0.03	0.05	0.06**	0.09*	0.01*	0.00	0.01	0.00	-0.01*
STERLIT	0.04	0.07*	-0.01	0.04	0.00	0.02	-0.03	-0.02	0.38	-2.24*	1.27*	0.001	0.62*	0.02	0.13*	0.02	0.15*	0.002	0.004*	-0.001	0.004*	-0.002
SUNPHAR	0.10	0.02	-0.01	0.00	-0.04	-0.03	0.00	-0.16	0.13	0.11	-0.19*	0.00	0.51*	0.05	0.12*	0.00	0.14*	0.02*	-0.01	-0.01	0.00	-0.01
SUZLON	-0.09	0.04	0.01	0.02	0.06	0.03	-0.19	1.42*	-0.65	-0.71	-0.12	0.002	0.59*	-0.01	0.30*	-0.06	0.13*	-0.007**	0.007**	-0.003	-0.001	-0.011*
TATACOM	-0.01	0.08*	-0.04	-0.02	-0.02	-0.03	0.03	0.01	-0.18	0.33**	-0.17	0.000	0.58*	0.05**	0.03	0.11*	0.12*	0.006	0.005	0.002	0.000	0.002
TATAMOT	-0.02	0.10*	-0.04	-0.02	-0.03	0.03	0.11	-0.03	0.09	-0.15	-0.03	0.001	0.54*	0.09*	0.09*	0.08*	0.13*	0.007**	-0.005	0.002	-0.003	-0.009*
TATAPOW	-0.001	0.014*	-0.001	0.006	-0.007**	0.005	-0.30**	0.12	-0.39*	0.66*	-0.18	0.02	0.58*	0.05	0.09*	0.12*	0.09*	0.07*	-0.03	0.02	0.00	0.02
TATASTE	0.003	-0.007	0.013*	-0.001	-0.002	-0.004	-0.04	-0.02	-0.07	-0.05	0.06	-0.01	0.54*	0.09*	0.09*	0.06*	0.17*	0.03	-0.10*	-0.11*	-0.10*	0.04
TCS	-0.01	-0.02*	0.01	-0.02*	0.01	-0.01	0.02	-0.02	-0.07	0.08	-0.10	0.21**	0.52*	0.05	0.07**	-0.01	0.10*	-0.02	0.00	0.03	0.05**	0.05**
UNITECH	0.21**	-0.02	0.00	0.03	0.05**	0.05**	0.14	0.37	-0.57**	-0.50	0.34	0.011	0.51*	0.09*	0.14*	0.08*	0.13*	-0.013*	0.006*	-0.012*	-0.001	-0.003
WIPRO	-0.03	0.05*	0.02	-0.01	0.01	0.00	0.09	0.11	-0.40	0.23	-0.11	0.000	0.51*	0.11*	0.08*	0.09*	0.17*	-0.003	0.002	-0.009*	-0.004	-0.003
ZEE	-0.09	0.05*	-0.01	-0.01	-0.04	-0.02	-0.12	0.04	-0.07	0.10	-0.17	-0.003	0.52*	0.13*	0.09*	0.10*	0.10*	-0.002	-0.003	-0.004	-0.004	-0.007*

b. VAR model with returns and the daily number of shares traded as volume measure

$$r_t = \alpha_0 + \sum_{i=1}^{5} \alpha_i r_{t-i} + \sum_{j=1}^{5} \beta_j V_{t-j}$$

$$V_t = \gamma_0 + \sum_{i=1}^{5} \gamma_i V_{t-i} + \sum_{j=1}^{5} \delta_j r_{t-j}$$

Company	α_0	α_1	α_2	α_3	α_4	α_5	β_1	β_2	β_3	β_4	β_5	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	δ_1	δ_2	δ_3	δ_4	δ_5
ABB	0.09	0.06*	0.00	0.00	0.00	-0.01	0.07	0.00	-0.12	0.03	-0.10	0.001	0.39*	0.15*	0.08*	0.14*	0.00	-0.002	-0.003	-0.003	-0.006	-0.001
ACC	0.03	0.01	-0.04	-0.01	0.03	-0.01	0.12	-0.04	0.02	-0.14	0.06	-0.002	0.42*	0.16*	0.13*	0.10*	0.11*	0.017*	-0.007	0.003	-0.002	-0.003
AMBUJA	0.03	0.02	-0.06*	0.00	0.04	-0.01	0.01	-0.04	0.05	-0.06	-0.06	0.000	0.05*	0.03	0.12*	0.03	0.03	-0.002	-0.007	-0.008	0.012	0.002
BHARTI	0.18*	-0.01	-0.06*	-0.02	-0.03	0.02	-0.04	-0.06	-0.14**	0.08	-0.01	-0.005	0.03	0.02	0.03	0.03	0.02	0.003	0.003	0.011	0.007	0.000
BHEL	0.12	0.04	-0.06*	0.00	0.02	-0.02	0.03	-0.07	0.10	-0.06	-0.05	0.002	0.50*	0.15*	0.09*	0.12*	0.05**	-0.002	-0.015*	-0.007	0.002	-0.004
BPCL	0.03	0.08*	0.01	0.01	-0.01	-0.04	-0.27*	0.09	0.06	0.11	-0.07	0.000	0.52*	0.02	0.09*	0.12*	0.08*	0.009	-0.001	0.003	-0.002	-0.002
CIPLA	0.03	0.08*	-0.01	-0.05*	0.00	0.01	-0.05	-0.04	0.10	-0.04	-0.01	0.000	0.40*	0.13*	0.10*	0.05**	0.09*	0.016**	0.004	-0.002	0.003	0.000
CAIRN	0.05	0.02	0.02	-0.07	-0.15*	0.00	0.23	-0.34	0.37	0.05	-0.25	-0.01	0.58*	-0.11**	0.21*	0.05	0.08	0.01**	-0.01	0.00	0.00	-0.01**
DLF	-0.15	0.01	-0.05	0.07	-0.02	-0.01	0.58	0.15	-0.31	0.52	-0.86	-0.011	0.34*	0.31*	0.00	0.18*	0.03	-0.003	-0.003	0.001	-0.001	-0.004
GAIL	0.06	-0.01	-0.07*	0.01	0.01	-0.07*	0.00	0.12	-0.07	0.05	-0.18	0.001	0.51*	0.11*	0.12*	0.07*	0.10*	-0.001	-0.003	-0.004	-0.004	-0.001
GRASIM	0.03	0.05*	-0.04	0.06*	0.02	0.04	0.17	0.05	-0.09	-0.08	-0.04	0.000	0.48*	0.18*	0.12*	0.00	0.16*	0.003	-0.006	-0.005	-0.009**	-0.006
HCL	-0.07	0.07*	-0.02	-0.06*	-0.02	-0.10*	-0.24	0.28	-0.35**	0.44	-0.08	-0.001	0.49*	0.15*	0.11*	0.02	0.12*	-0.017*	-0.004	0.010*	-0.007**	0.001
HDFC	0.09	-0.02	-0.05*	-0.02	-0.05*	-0.03	-0.04	0.04	-0.02	0.01	0.00	-0.002	0.03	0.01	0.02	0.01	0.02	0.004	0.012	0.008	0.001	-0.001
HDFCORP	0.13*	0.03	-0.09*	-0.06*	-0.02	-0.09*	0.02	-0.06	0.02	0.03	-0.11**	-0.01	0.03	0.02	0.04**	0.03	0.03	0.01	0.00	0.02*	0.00	-0.01
HINDALC	-0.02	0.12*	-0.01	-0.07*	0.02	0.01	0.12	0.04	0.18	-0.25*	-0.11	0.001	0.46*	0.04	0.38*	-0.04	0.03	-0.003	-0.010	-0.028*	-0.004	-0.014*
HLL	0.00	0.04	-0.02	-0.04	0.01	-0.06	-0.01	0.04	0.01	-0.06	0.03	0.00	0.26*	0.15*	0.11*	0.10*	0.11*	0.00	-0.02**	-0.02	0.00	-0.01
HONDA	0.06	0.04	-0.10	-0.05	-0.03	0.01	-0.02	0.07	-0.02	-0.04	0.02	0.00	0.42*	0.08*	0.08*	0.05*	0.08*	0.00	-0.02*	-0.01	-0.01	-0.01
ICICI	0.08	0.12*	-0.06*	0.02	-0.03	-0.01	0.05	0.05	0.00	-0.12	-0.02	0.002	0.08*	0.07*	0.05*	0.05*	0.05*	-0.009	0.002	-0.005	-0.009	0.002
IDEA	-0.12	0.10**	0.00	0.00	0.03	0.01	-0.14	-0.47	0.57	0.13	-0.17	-0.030	0.30*	0.16*	0.11**	-0.05	0.11*	0.001	-0.006	-0.001	0.010	0.002
INFOSYS	0.01	0.08*	-0.06*	-0.01	-0.03	-0.03	-0.02	0.07	-0.21*	0.08	0.02	0.001	0.39*	0.14*	0.08*	0.06*	0.06*	-0.031*	-0.006	-0.004	-0.002	0.005
ITC	0.05	-0.02	-0.01	0.01	0.01	0.00	0.03	-0.08	0.05	-0.10	0.01	-0.001	0.47*	0.15*	0.09*	0.04	0.10*	0.010	0.001	-0.006	-0.002	-0.001
L&T	0.02	0.08*	-0.04	0.02	0.01	-0.03	-0.11	-0.14	0.35*	-0.03	-0.14	-0.001	0.54*	0.10*	0.10*	0.09*	0.09*	0.003	-0.009*	-0.003	0.000	-0.005
M&M	0.00	0.13*	-0.05*	-0.01	0.01	-0.05	0.09	0.13	-0.07	0.01	-0.13	0.000	0.36*	0.12*	0.11*	0.14*	0.12*	0.011**	-0.002	0.000	-0.001	0.000
MARUTI	0.08	0.04	-0.05	-0.01	0.01	-0.04	-0.13	0.14	0.06	0.08	-0.07	-0.001	0.59*	0.03	0.15*	-0.01	0.19*	-0.016*	0.004	-0.002	-0.006	-0.004
NALCO	0.04	0.04	0.01	-0.03	-0.01	0.02	-0.02	0.03	0.03	-0.03	-0.08	0.000	0.27*	0.14*	0.10*	0.09*	0.07*	0.016*	0.002	-0.006	0.002	-0.008
NTPC	0.08	0.02	-0.07*	-0.03	-0.01	-0.02	-0.16	0.04	-0.30	-0.11	0.20	-0.010	0.45*	0.04	0.12*	0.06	0.16*	0.010*	-0.004	0.000	0.004	-0.001
ONGC	0.07	0.09*	-0.07*	0.00	0.02	0.00	0.15**	-0.08	-0.03	-0.05	-0.02	0.001	0.33*	0.12*	0.10*	0.15*	0.08*	0.007	-0.003	-0.002	0.003	-0.008
PNB	0.16**	0.02	-0.03	-0.04	0.00	-0.05	0.15	0.27	-0.48*	0.25	-0.17	-0.003	0.42*	0.27*	0.01	0.17*	0.02	0.011*	0.004	-0.009	0.001	0.003
POWER&G	-0.07	0.14*	-0.11	-0.06	-0.07	-0.06	-0.05	-0.50	1.06**	0.24	0.03	-0.027	0.70*	-0.28*	0.34*	0.04	0.08	0.003	0.001	0.005	0.000	0.006
RANBAXY	-0.01	0.04**	-0.01	0.02	0.01	0.01	-0.18*	0.03	0.00	0.00	0.06	-0.002	0.49*	0.08*	0.02	0.05**	0.11*	0.001	-0.020*	-0.007	0.005	-0.009

company	α_0	α_1	α_2	α_3	α_4	α_5	β_1	β_2	β_3	β_4	β_5	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	δ_1	δ_2	δ_3	δ_4	δ_5
RELIANC	0.062	0.039	-0.004	-0.039	-0.004	0.008	-0.10	0.11	0.04	-0.08	0.02	-0.01	0.41*	0.09*	0.16*	0.16*	-0.01	0.02*	0.00	0.00	-0.01	0.00
RPOWER	-0.40	0.17*	-0.04	0.15	-0.07	-0.01	0.63	0.01	0.30	-0.35	-0.91	0.146*	0.09	0.25*	0.13	0.21*	0.87*	0.001	-0.001	-0.001	0.005	0.001
RINFRA	0.05	0.06*	-0.07*	0.03	-0.04	-0.01	0.12	-0.06	-0.19	0.22	-0.01	0.003	0.33*	0.21*	0.12*	0.09*	0.14*	0.002	-0.007	-0.007	-0.004	0.003
RPETRO	0.02	0.11*	-0.02	-0.06	0.00	0.03	0.19	-0.09	-0.41	0.08	0.15	-0.004	0.54*	0.01	0.16*	-0.05	0.22*	-0.001	0.016**	0.016**	0.007	0.010
SAIL	0.076	0.047**	-0.038	-0.002	0.003	0.008	-0.10	-0.18	0.37**	-0.19	0.12	-0.003	0.55*	0.00	0.17*	0.01	0.18*	0.020*	0.004	0.005	0.006	-0.003
SATYAM	-0.02	0.05**	-0.04	-0.01	0.00	-0.03	0.37*	-0.23	-0.16	-0.15	0.12	0.005	0.44*	0.19*	0.01	0.15*	0.17*	-0.009*	-0.002	0.004	-0.009*	-0.011
SBI	0.07	0.05*	-0.04	0.00	0.01	-0.04**	-0.08	0.01	-0.05	-0.04	0.08	0.00	0.47*	0.11*	0.12*	0.11*	0.07*	0.02*	0.01	-0.01	-0.01	0.00
SIEMENS	0.07	0.05*	-0.02	0.01	0.01	0.04	-0.13	-0.05	0.05	-0.07	-0.02	-0.002	0.46*	0.09*	0.04	0.12*	0.06*	0.015*	-0.004	0.004	0.000	-0.010
STERLIT	0.04	0.06*	-0.01	0.04**	-0.01	0.02	0.13	0.17	0.06	-1.89*	0.90*	0.000	0.46*	0.09*	0.09*	0.14*	0.16*	0.003	0.004**	-0.005*	0.005*	-0.002
SUNPHAR	0.10	0.02	-0.02	0.00	-0.03	-0.03	-0.11	-0.05	0.06	0.00	0.03	0.000	0.15*	0.01	0.06*	0.06*	0.05*	0.014	-0.002	0.001	-0.010	-0.001
SUZLON	-0.10	0.03	0.02	0.03	0.06	0.04	0.34	1.58*	-0.77	-0.95**	-0.27	0.007	0.67*	-0.09**	0.31*	-0.16*	0.25*	-0.005	0.006	-0.006	0.000	-0.011*
TATACOM	-0.01	0.08*	-0.04	-0.02	-0.02	-0.03	-0.01	0.09	-0.19	0.24	-0.06	0.000	0.46*	0.22*	-0.04	0.12*	0.09*	0.007	-0.001	-0.003	0.001	-0.002
TATAMOT	-0.02	0.10*	-0.04	-0.02	-0.03	0.03	0.13	0.06	-0.03	-0.02	-0.16	0.00	0.56*	0.08*	0.07*	0.07*	0.13*	0.01	-0.01	0.00	-0.01	-0.01
TATAPOW	0.09	0.08*	-0.10*	0.00	0.01	0.01	-0.07	0.29**	-0.27**	0.40*	-0.40*	0.00	0.39*	0.20*	0.15*	0.11*	0.08*	0.02*	-0.01	0.01	-0.01	0.00
TATASTE	0.02	0.07*	-0.03	0.02	-0.01	0.02	0.12	0.03	-0.17	0.22	-0.21	-0.001	0.43*	0.12*	0.12*	0.06*	0.18*	-0.002	0.009**	0.003	0.000	-0.005
TCS	-0.01	0.03	-0.10*	-0.11*	-0.10*	0.04	-0.04	-0.07	-0.02	-0.01	0.02	-0.02	0.09*	0.04	0.03	0.03	0.03	-0.01	-0.01	-0.01	-0.01	-0.01
UNITECH	0.21**	-0.01	0.01	0.03	0.05*	0.04	0.39	0.07	-0.41	-0.56	0.55**	0.015	0.57*	0.01	0.33*	-0.09*	0.18*	-0.015*	0.002	-0.009*	0.001	-0.006*
WIPRO	-0.03	0.05*	0.02	-0.02	0.01	0.00	0.09	-0.05	-0.04	0.08	-0.12	0.001	0.38*	0.11*	0.07*	0.10*	0.15*	-0.002	0.001	-0.010**	-0.004	-0.001
ZEE	-0.09	0.05*	-0.01	-0.01	-0.03	-0.02	-0.02	0.03	-0.18	-0.01	-0.06	-0.003	0.40*	0.21*	0.05**	0.16*	0.11*	-0.003	-0.002	-0.005	-0.002	-0.009*

c. VAR model with returns and the daily value of shares traded as volume measure

$$r_t = \alpha_0 + \sum_{i=1}^{5} \alpha_i r_{t-i} + \sum_{j=1}^{5} \beta_j V_{t-j} \qquad V_t = \gamma_0 + \sum_{i=1}^{5} \gamma_i V_{t-i} + \sum_{j=1}^{5} \delta_j r_{t-j}$$

Company	α_0	α_1	α_2	α_3	α_4	α_5	β_1	β_2	β_3	β_4	β_5	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	δ_1	δ_2	δ_3	δ_4	δ_5
ABB	0.090	0.064*	-0.001	0.002	0.001	-0.014	0.02	0.02	-0.07	-0.06	0.04	-0.001	0.36*	0.21*	0.11*	0.13*	0.01	0.009	0.009	-0.001	-0.003	0.001
ACC	0.03	0.02	-0.03	-0.01	0.03	-0.01	-0.04	0.01	0.05	-0.15	0.07	0.00	0.38*	0.15*	0.11*	0.12*	0.11*	0.02*	0.00	0.01	0.00	0.01
AMBUJA	0.03	0.02	-0.06*	0.00	0.04	-0.01	-0.01	-0.05	0.04	-0.06	-0.06	0.000	0.05	0.03	0.06*	0.03	0.03	0.000	-0.003	-0.004	0.014	0.005
BHARTI	0.18*	-0.01	-0.06*	-0.03	-0.03	0.02	-0.07	-0.07	-0.15**	0.04	-0.04	0.001	0.07*	0.06*	0.05**	0.05	0.04	-0.005	0.000	0.003	0.003	-0.004
BHEL	0.12	0.04	-0.07*	-0.01	0.02	-0.02	-0.09	0.05	0.21	-0.29	0.03	0.00	0.58*	0.07*	0.15*	0.06*	0.06*	0.00	-0.01*	-0.01*	0.01	-0.01
BPCL	0.03	0.08*	0.02	0.01	-0.01	-0.04	-0.33*	0.07	0.06	0.10	-0.06	0.000	0.47*	0.06*	0.07*	0.10*	0.09*	0.015	0.000	0.004	0.001	-0.002
CIPLA	0.03	0.08*	0.00	-0.05*	0.00	0.01	-0.05	-0.04	0.08	-0.07	0.01	-0.002	0.42*	0.09*	0.12*	0.08*	0.06*	0.033	0.001	0.004	0.010	-0.004
CAIRN	0.04	0.03	0.02	-0.07	-0.15*	0.00	0.11	-0.30	0.40	-0.01	-0.26	-0.01	0.68*	-0.19*	0.30*	-0.01	0.10**	0.02*	-0.01	0.00	-0.01	-0.01
DLF	-0.16	0.01	-0.04	0.06	-0.01	-0.01	0.20	-0.22	0.07	0.20	-0.38	-0.017	0.24*	0.18*	0.02	0.17*	0.03	0.003	0.000	0.004	0.002	-0.001
GAIL	0.06	-0.01	-0.07*	0.00	0.01	-0.07*	0.03	0.06	0.03	-0.06	-0.22	0.000	0.48*	0.12*	0.13*	0.09*	0.11*	0.008	0.001	-0.003	-0.002	0.000
GRASIM	0.03	0.06*	-0.04	0.06*	0.02	0.04	-0.04	0.14	-0.07	-0.06	0.02	0.00	0.36*	0.15*	0.09*	0.09*	0.14*	0.02*	0.00	-0.01	-0.01	-0.01
HCL	-0.07	0.07*	-0.02	-0.06*	-0.02	-0.10*	-0.12	0.09	-0.25	0.29*	-0.06	-0.005	0.35*	0.19*	0.12*	0.06*	0.10*	-0.003	0.000	0.005	-0.003	-0.002
HDFC	0.09	-0.02	-0.05*	-0.02	-0.05*	-0.03	-0.03	0.02	-0.04	0.00	-0.01	0.000	0.06*	0.05*	0.05*	0.05*	0.06*	0.003	0.008	0.003	0.000	-0.005
HDFCORP	0.13**	0.03	-0.09*	-0.06*	-0.02	-0.08*	-0.01	-0.18*	0.01	0.07	-0.10	0.00	0.11*	0.09*	0.09*	0.05**	0.05*	0.01	0.00	0.02*	0.00	-0.01
HINDALC	-0.02	0.12*	-0.01	-0.06*	0.03	0.01	0.15	-0.16	-0.01	-0.21**	0.10	0.00	0.47*	0.14*	0.14*	0.04	0.05*	0.01	0.00	-0.02*	0.00	-0.01
HLL	0.00	0.04	-0.02	-0.04	0.01	-0.06*	0.03	0.02	-0.02	-0.07	0.04	0.00	0.28*	0.15*	0.11*	0.11*	0.10*	0.01	-0.01	-0.01	0.00	-0.01
HONDA	0.06	0.04	-0.10*	-0.05*	-0.03	0.01	-0.08	0.10	-0.03	-0.05	0.00	0.002	0.36*	0.06*	0.09*	0.06*	0.10*	0.011	-0.013	-0.003	0.000	-0.010
ICICI	0.08	0.12*	-0.06*	0.01	-0.03	-0.01	-0.02	0.12	-0.02	-0.25*	-0.03	0.003	0.27*	0.21*	0.08*	0.09*	0.14*	-0.010	0.003	0.000	-0.005	0.003
IDEA	-0.11	0.10	0.00	0.00	0.03	0.01	-0.03	-0.32	0.46	0.00	-0.18	-0.02	0.35*	0.14*	0.14	-0.07	0.12*	0.01	0.00	0.00	0.01	0.00
INFOSYS	0.01	0.09*	-0.07*	0.00	-0.04	-0.03	-0.14	0.19	-0.41*	0.18	0.04	-0.001	0.47*	0.17*	0.12*	0.06*	0.09*	-0.011*	0.001	0.000	-0.001	0.007
ITC	0.05	-0.02	-0.01	0.01	0.02	0.00	-0.01	-0.10	0.03	-0.16	0.05	-0.01	0.45*	0.06*	0.13*	0.05	0.10*	0.03*	0.01	0.00	0.00	0.01
L&T	0.02	0.08*	-0.05	0.02	0.01	-0.03	-0.02	-0.02	0.12	-0.06	-0.17	-0.001	0.48*	0.10*	0.11*	0.14*	0.06*	0.005	-0.008	-0.004	0.000	-0.008
M&M	0.00	0.14*	-0.05**	-0.01	0.01	-0.05**	0.07	0.09	-0.12	0.02	-0.10	0.000	0.24*	0.16*	0.12*	0.11*	0.15*	0.013**	0.002	0.001	0.002	0.000
MARUTI	0.08	0.04	-0.05	-0.01	0.01	-0.04	-0.14	0.17	0.07	-0.05	-0.06	0.000	0.55*	0.08*	0.15*	-0.03	0.19*	-0.011**	0.006	0.000	-0.002	-0.005
NALCO	0.04	0.04	0.01	-0.02	-0.01	0.03	-0.03	0.05	-0.05	-0.03	-0.11	0.000	0.37*	0.12*	0.09*	0.11*	0.07*	0.019	0.005	-0.003	0.004	-0.006
NTPC	0.09	0.01	-0.08*	-0.03	-0.01	-0.02	-0.21	0.09	-0.36**	-0.08	0.24	-0.01	0.55*	0.02	0.06	0.11*	0.16*	0.03*	0.00	0.01	0.01	0.00
ONGC	0.067	0.089*	-0.069*	-0.003	0.017	0.003	0.14	-0.07	-0.04	-0.10	-0.02	0.001	0.32*	0.11*	0.10*	0.16*	0.08*	0.009	0.002	-0.001	0.003	-0.006
PNB	0.16**	0.02	-0.03	-0.04	0.01	-0.05	0.00	0.20	-0.30*	0.07	-0.14	0.00	0.49*	0.16*	-0.01	0.10*	0.07*	0.02*	0.01	-0.01	0.01	0.00
POWER&G	-0.09	0.15*	-0.10	-0.05	-0.07	-0.06	-0.12	-0.44	1.00	0.22	-0.06	-0.023	0.71*	-0.26*	0.28*	0.07	0.08	0.008	0.001	0.007	0.000	0.009
RANBAXY	-0.01	0.05	-0.01	0.02	0.01	0.01	-0.20*	0.00	0.00	0.05	0.02	0.00	0.48*	0.08*	0.02	0.06*	0.15*	0.01	-0.01*	0.00	0.01	-0.01
RCOMM	-0.06	-0.08**	-0.02	0.03	-0.10*	0.01	0.11	0.12	-0.10	-0.28	-0.14	-0.011	0.45*	0.08	0.12*	-0.03	0.12*	0.010	0.003	-0.005	-0.003	0.003

company	α_0	α_1	α_2	α_3	α_4	α_5	β_1	β_2	β_3	β_4	β_5	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	δ_1	δ_2	δ_3	δ_4	δ_5
RELIANC	0.062	0.036	-0.004	-0.038	-0.004	0.008	-0.15**	0.09	0.00	-0.06	0.00	0.00	0.41*	0.01	0.22*	0.14*	-0.02	0.01**	0.01	0.01**	0.00	0.00
RPOWER	-0.35	0.16**	-0.04	0.16**	-0.08	-0.01	0.56	0.13	0.42	-0.54	-0.56	0.097	0.23*	0.24*	0.04	0.30*	0.46*	0.003	-0.003	-0.006	0.004	0.001
RINFRA	0.05	0.06*	-0.06*	0.03	-0.04	-0.01	0.03	-0.31	-0.26	0.49*	0.06	0.001	0.46*	0.19*	0.09*	0.04	0.16*	0.005	0.000	-0.001	0.001	0.004
RPETRO	0.02	0.12	-0.03	-0.06	0.01	0.03	0.06	0.09	-0.59*	0.25	0.05	0.00	0.52*	0.04	0.23*	-0.11*	0.20*	0.01	0.02	0.02	0.01	0.01
SAIL	0.07	0.05*	-0.03	0.01	0.01	0.01	-0.27	-0.09	0.17	-0.08	0.15	0.00	0.53*	0.03	0.17*	0.01	0.14*	0.02*	0.00	0.01**	0.00	0.00
SATYAM	-0.02	0.04	-0.04	-0.01	0.00	-0.03	0.20	-0.31	-0.29	0.29	-0.02	0.00	0.45*	0.13*	0.09*	0.15*	0.12*	0.01*	0.00	0.01*	-0.01*	0.00
SBI	0.07	0.06*	-0.04	0.00	0.00	-0.04**	-0.17	0.10	-0.01	-0.04	0.05	0.00	0.40*	0.14*	0.14*	0.13*	0.10*	0.01*	0.02*	0.00	0.00	-0.01
SIEMENS	0.07	0.06*	-0.02	0.01	0.01	0.04	-0.10	-0.06	0.07	-0.06	0.00	-0.002	0.67*	-0.04	0.06*	0.05**	0.07*	0.014*	0.000	0.005	0.004	-0.004
STERLIT	0.04	0.05**	-0.02	0.02	0.03	0.02	0.47	0.16	0.07	-3.29*	1.61*	-0.002	0.45*	0.08*	0.18*	0.04	0.19*	0.013*	0.010*	0.002	0.005*	0.000
SUNPHAR	0.10	0.02	-0.01	0.00	-0.03	-0.03	-0.17*	-0.07	0.05	-0.02	0.05	-0.002	0.15*	0.03	0.11*	0.08*	0.11*	0.019*	0.003	0.002	-0.004	0.005
SUZLON	-0.10	0.05	0.00	0.01	0.07	0.04	-0.18	0.51	-0.43	-0.38	0.07	-0.01	0.41*	0.09**	0.13*	0.04	0.05	0.00	0.01**	-0.01	0.00	-0.01
TATACOM	-0.01	0.08**	-0.04	-0.02	-0.02	-0.03	-0.05	0.09	-0.19	0.25	-0.07	0.000	0.44*	0.24*	-0.06*	0.15*	0.08*	0.008**	-0.001	-0.003	0.002	-0.001
TATAMOT	-0.02	0.11*	-0.03	-0.02	-0.03	0.03	-0.03	0.06	0.07	-0.03	-0.05	-0.001	0.49*	0.09*	0.12*	0.10*	0.14*	0.010*	0.000	0.000	-0.003	-0.006
TATAPOW	0.09	0.08*	-0.08*	0.01	0.02	0.00	-0.30*	0.03	-0.21	0.60*	-0.24*	-0.01	0.48*	0.05**	0.01	0.24*	0.12*	0.03*	0.00	0.01*	0.00	0.02*
TATASTE	0.02	0.07*	-0.03	0.02	-0.01	0.02	0.02	0.03	-0.19	0.19	-0.14	0.00	0.40*	0.13*	0.13*	0.08*	0.18*	0.01	0.01*	0.01	0.00	0.00
TCS	0.00	0.03	-0.10*	-0.10*	-0.10*	0.04	-0.01	-0.06	0.00	0.01	0.02	-0.017	0.09*	0.04	0.02	0.02	0.02	-0.003	0.000	-0.001	-0.001	-0.003
UNITECH	0.21**	-0.02	0.00	0.03	0.06*	0.05**	0.07	-0.10	-0.14	-0.11	0.05	0.008	0.42*	0.06*	0.19*	0.07*	0.14*	-0.002	0.000	-0.008*	-0.006**	-0.002
WIPRO	-0.03	0.05*	0.02	-0.01	0.01	0.00	0.19	0.11	-0.43**	0.30	-0.31	0.000	0.50*	0.14*	0.04	0.15*	0.12*	0.005	0.003	-0.004	0.000	-0.002
ZEE	-0.09	0.04	-0.01	-0.01	-0.04	-0.02	0.36	-0.16	-0.29	0.01	-0.21	-0.003	0.40*	0.17*	0.11*	0.19*	0.08*	0.006*	0.003	-0.001	-0.003	-0.005**

4.2.1 Variance Decomposition and Impulse Response Function

In order to further explore the nature of dynamic relationship between returns and trading volume, we carry out impulse response function and variance decomposition analysis in addition to the Granger causality tests and VAR modeling. Such an analysis explains economic significance in addition to statistical significance. The results are reported only for 'volume' as the proxy for trading volume as 'value' and 'trade' show similar results. From the variance decomposition (Table 9), it is evident that any variation in returns is explained by its own lagged returns (>99%) than by the lagged volume. In approximately 8% of the stocks, lagged volume explains more than 1% variation in stock returns. From the results of variance decomposition, volume is found to be highly autoregressive i.e. variation in volume is mainly explained by its lagged volume (>95%) than by the lagged returns. However, it is important to note that the lagged returns are able to explain more than 5% variation in volume in case of 4 stocks, more than 3% variation in case of 5 stocks and more than 1% variation in case of 17 stocks. These results support the findings of Granger causality test that in emerging markets returns to some extent lead to trading.

The impulse response of returns to shocks in returns and volume series is given in Appendix A. It can be seen that for most of the stocks, the returns are not affected by volume shock at any lag. Hence even though we have statistical significance of volume affecting returns at one lag, it is not economically significant. Similar to the result found under VAR, returns are found to be autoregressive but effective only for one day. The impulse response of volume to shocks in returns and volume is presented in Appendix B. As can be seen from the results, the volume is more autoregressive in nature than the returns. For most stocks, the effect of shock to volume is persistent up to many lags (more than 12). The exceptions are BHARTI, HDFC, HDFC Corp., ICICI, SUNPHARMA and TCS where the effect of any shock in volume affects the volume only the next day. It is also interesting to note that for some stocks (HCL, HINDALCO, CAIRN, INFOSYS, RANBAXY, RELIANCE COM., RELIANCE POWER, SUZLON and UNITECH), the effect of return shock at higher lags on volume is negative. This may mean that trading volume responds to positive change in prices contemporaneously. With lag, the excessive volume corrects itself and the volume eventually reduces.

4.3 Trading Volume and Unconditional Volatility

The relationship between unconditional volatility (measured by absolute returns) and trading volume and its asymmetric behavior i.e. stronger relationship between trading volume and volatility when on positive change than on a negative change is estimated through OLS using equation [3]. The results are presented in Table 10. The estimates of β_1, which measure the relationship between volume and unconditional volatility irrespective of the direction of the price change, are significant and positive at 1% level (except for Idea Cellular Ltd., where the coefficient is significant at 5% level and Reliance Power, where it is not significant) across all three measures of trading volume. The coefficients are higher for most of the companies, when the number of transactions is taken as a measure of trading volume.

The asymmetric behavior of relation between volume and unconditional volatility is indicated by coefficient β_2. In most of the cases, β_2 is significant and negative i.e. for most stocks β_2 is

negative for at least two out of the three trading volume measures. The negative value of β_2 indicates that the relation between trading volume and unconditional volatility is smaller for negative returns than for positive returns. However, some of the companies do not show asymmetric behavior for at least two of the trading volume measures. Out of 50 stocks, such companies are 18. These companies are Bharti, Cipla, DLF, HDFC, HDFC Corp., ICICI, Infosys, NTPC, Reliance Infra, Reliance industries, Reliance power, Reliance Petroleum, Satyam, Siemens, Sterlite, Tata Power, TCS and Unitech. The parameter β_2 is not significant at even 5% level. Similar to the findings in case of returns and trading volume relationship, the asymmetric behavior is more prominent when the daily number of transactions is taken as the proxy of daily trading volume. This can be interpreted that the number of transactions may be a better proxy of information than the other two measures. Harris (1987) also argued that the transaction data may be a better proxy of information.

4.4. Trading Volume and Conditional Volatility

In order to investigate the effect of trading volume and conditional volatility, we first model the time series of stock returns using GARCH (1,1) model. The parameter estimates of GARCH (1,1) are presented in Table 11. It is found that for all stocks the conditional volatility is time varying and shows persistence. The persistence of the conditional variance process, which we measure by $\alpha_1+\beta_1$, is high (>0.9) except for DLF and is often close to unity.

Table 9: Proportions of Variation in Returns and Volume due to shock s in Returns and Volume

This table gives the variance decomposition of returns and volume by shocks in returns and volume. In other words, it gives the proportion of variation of returns explained by returns itself and the proportion by volume and vice versa. The lags that are reported are 1, 5, 10, 15 and 20. The proportions are given in percentage form.

Proportions of Prediction Error Covariances																				
	Returns					Volume					Returns					Volume				
Lag	**1**	**5**	**10**	**15**	**20**	**1**	**5**	**10**	**15**	**20**	**1**	**5**	**10**	**15**	**20**	**1**	**5**	**10**	**15**	**20**
Company	**Returns**					**Volume**					**Returns**					**Volume**				
ABB	100.0%	99.9%	99.6%	99.6%	99.6%	0.0%	0.1%	0.4%	0.4%	0.4%	1.2%	1.0%	0.9%	0.9%	0.9%	98.8%	99.0%	99.1%	99.1%	99.1%
ACC	100.0%	99.9%	99.9%	99.9%	99.9%	0.0%	0.1%	0.1%	0.1%	0.1%	4.1%	6.0%	6.0%	6.0%	6.0%	95.9%	94.0%	94.0%	94.0%	94.0%
AMBUJA	100.0%	99.9%	99.8%	99.8%	99.8%	0.0%	0.1%	0.2%	0.2%	0.2%	0.2%	0.3%	0.3%	0.3%	0.3%	99.8%	99.7%	99.7%	99.7%	99.7%
BHARTI	100.0%	99.6%	99.6%	99.6%	99.6%	0.0%	0.4%	0.4%	0.4%	0.4%	0.0%	0.2%	0.2%	0.2%	0.2%	100.0%	99.8%	99.8%	99.8%	99.8%
BHEL	100.0%	100.0%	99.9%	99.9%	99.9%	0.0%	0.0%	0.1%	0.1%	0.1%	2.2%	1.6%	1.2%	1.0%	1.0%	97.8%	98.4%	98.8%	99.0%	99.0%
BPCL	100.0%	99.5%	99.5%	99.5%	99.5%	0.0%	0.5%	0.5%	0.5%	0.5%	1.7%	2.5%	2.5%	2.5%	2.5%	98.3%	97.5%	97.5%	97.5%	97.5%
CIPLA	100.0%	99.9%	99.9%	99.9%	99.9%	0.0%	0.1%	0.1%	0.1%	0.1%	0.0%	0.3%	0.3%	0.3%	0.3%	100.0%	99.7%	99.7%	99.7%	99.7%
CAIRN	100.0%	99.7%	99.6%	99.6%	99.6%	0.0%	0.3%	0.4%	0.4%	0.4%	2.9%	4.5%	4.1%	3.9%	3.9%	97.1%	95.5%	95.9%	96.1%	96.1%
DLF	100.0%	99.5%	99.4%	99.4%	99.4%	0.0%	0.5%	0.6%	0.6%	0.6%	2.8%	2.0%	1.7%	1.5%	1.4%	97.2%	98.0%	98.4%	98.5%	98.6%
GAIL	100.0%	99.9%	99.9%	99.9%	99.9%	0.0%	0.1%	0.1%	0.1%	0.2%	1.6%	1.2%	0.9%	0.8%	0.8%	98.4%	98.8%	99.1%	99.2%	99.2%
GRASIM	100.0%	99.8%	99.8%	99.8%	99.8%	0.0%	0.2%	0.2%	0.2%	0.2%	2.5%	2.2%	1.6%	1.3%	1.2%	97.5%	97.8%	98.4%	98.7%	98.8%
HCL	100.0%	99.4%	99.4%	99.4%	99.4%	0.0%	0.6%	0.6%	0.6%	0.6%	0.1%	1.1%	0.9%	0.8%	0.8%	99.9%	98.9%	99.1%	99.2%	99.2%
HDFC	100.0%	99.9%	99.9%	99.9%	99.9%	0.0%	0.1%	0.1%	0.1%	0.1%	0.2%	0.3%	0.3%	0.3%	0.3%	99.8%	99.7%	99.7%	99.7%	99.7%
HDFCORP	100.0%	99.9%	99.8%	99.8%	99.8%	0.0%	0.1%	0.2%	0.2%	0.2%	0.1%	0.6%	0.6%	0.6%	0.6%	99.9%	99.4%	99.4%	99.4%	99.4%
HINDALC	100.0%	99.5%	99.4%	99.4%	99.4%	0.0%	0.5%	0.6%	0.6%	0.6%	0.1%	1.6%	3.5%	4.1%	4.3%	99.9%	98.4%	96.5%	95.9%	95.7%
HLL	100.0%	99.9%	99.9%	99.9%	99.9%	0.0%	0.1%	0.1%	0.1%	0.1%	1.7%	1.6%	1.5%	1.4%	1.4%	98.3%	98.4%	98.6%	98.6%	98.6%
HONDA	100.0%	99.9%	99.9%	99.9%	99.9%	0.0%	0.1%	0.1%	0.1%	0.1%	1.2%	1.3%	1.3%	1.3%	1.3%	98.8%	98.7%	98.7%	98.7%	98.7%
ICICI	100.0%	99.8%	99.8%	99.8%	99.8%	0.0%	0.2%	0.2%	0.2%	0.2%	0.0%	0.2%	0.2%	0.2%	0.2%	100.0%	99.8%	99.8%	99.8%	99.8%
IDEA	100.0%	99.2%	99.1%	99.1%	99.1%	0.0%	0.8%	0.9%	0.9%	0.9%	0.9%	1.3%	1.6%	1.6%	1.6%	99.1%	98.7%	98.4%	98.4%	98.4%
INFOSYS	100.0%	99.7%	99.7%	99.7%	99.7%	0.0%	0.3%	0.3%	0.3%	0.3%	0.0%	2.0%	2.0%	2.0%	2.0%	100.0%	98.0%	98.0%	98.0%	98.0%
ITC	100.0%	99.9%	99.8%	99.8%	99.8%	0.0%	0.1%	0.2%	0.2%	0.2%	0.5%	0.7%	0.6%	0.6%	0.6%	99.5%	99.3%	99.4%	99.4%	99.4%
L&T	100.0%	99.7%	99.6%	99.6%	99.6%	0.0%	0.3%	0.4%	0.4%	0.4%	1.9%	1.6%	1.2%	1.1%	1.0%	98.1%	98.4%	98.8%	98.9%	99.0%
M&M	100.0%	99.8%	99.7%	99.7%	99.7%	0.0%	0.2%	0.3%	0.3%	0.3%	2.7%	3.5%	3.6%	3.6%	3.6%	97.3%	96.5%	96.4%	96.4%	96.4%
MARUTI	100.0%	99.9%	99.9%	99.9%	99.9%	0.0%	0.1%	0.1%	0.1%	0.1%	2.1%	1.3%	0.9%	0.7%	0.7%	97.9%	98.7%	99.1%	99.3%	99.3%
NALCO	100.0%	100.0%	99.9%	99.9%	99.9%	0.0%	0.0%	0.1%	0.1%	0.1%	1.9%	2.7%	2.6%	2.6%	2.6%	98.1%	97.3%	97.4%	97.4%	97.4%

NTPC	100.0%	99.6%	99.6%	99.6%	99.5%	0.0%	0.4%	0.4%	0.4%	0.5%	0.3%	1.2%	1.2%	1.2%	1.2%	99.7%	98.8%	98.8%	98.8%	98.8%
ONGC	100.0%	99.8%	99.7%	99.7%	99.7%	0.0%	0.2%	0.3%	0.3%	0.3%	0.2%	0.4%	0.3%	0.3%	0.3%	99.8%	99.6%	99.7%	99.7%	99.7%
PNB	100.0%	99.2%	99.1%	99.1%	99.1%	0.0%	0.8%	0.9%	0.9%	0.9%	8.4%	10.2%	10.7%	10.8%	10.8%	91.6%	89.8%	89.3%	89.2%	89.2%
POWER&G	100.0%	99.0%	98.8%	98.7%	98.7%	0.0%	1.0%	1.2%	1.3%	1.3%	0.3%	1.3%	2.5%	2.7%	2.9%	99.7%	98.7%	97.5%	97.3%	97.1%
RANBAXY	100.0%	99.7%	99.7%	99.6%	99.6%	0.0%	0.3%	0.4%	0.4%	0.4%	0.4%	0.6%	0.7%	0.7%	0.7%	99.6%	99.4%	99.3%	99.3%	99.3%
RCOMM	100.0%	99.4%	99.3%	99.3%	99.3%	0.0%	0.6%	0.7%	0.7%	0.7%	0.1%	1.1%	1.3%	1.3%	1.3%	99.9%	98.9%	98.7%	98.7%	98.7%
RELIANC	100.0%	99.8%	99.8%	99.8%	99.8%	0.0%	0.2%	0.2%	0.2%	0.2%	0.0%	0.4%	0.4%	0.4%	0.4%	100.0%	99.6%	99.6%	99.6%	99.7%
RPOWER	100.0%	98.6%	96.9%	96.1%	95.6%	0.0%	1.4%	3.1%	3.9%	4.4%	0.3%	0.3%	0.2%	0.1%	0.1%	99.7%	99.7%	99.8%	99.9%	99.9%
RINFRA	100.0%	99.7%	99.7%	99.7%	99.7%	0.0%	0.3%	0.3%	0.3%	0.3%	1.2%	1.0%	0.9%	0.8%	0.7%	98.8%	99.0%	99.1%	99.2%	99.3%
RPETRO	100.0%	99.3%	99.2%	99.2%	99.2%	0.0%	0.7%	0.8%	0.8%	0.8%	0.2%	3.4%	5.5%	6.3%	6.7%	99.8%	96.6%	94.5%	93.7%	93.3%
SAIL	100.0%	99.8%	99.7%	99.7%	99.7%	0.0%	0.2%	0.3%	0.3%	0.3%	5.6%	13.0%	14.5%	15.2%	15.6%	94.4%	87.0%	85.5%	84.8%	84.4%
SATYAM	100.0%	99.6%	99.6%	99.6%	99.6%	0.0%	0.4%	0.4%	0.4%	0.4%	0.0%	0.7%	1.9%	2.3%	2.4%	100.0%	99.3%	98.1%	97.7%	97.6%
SBI	100.0%	99.9%	99.9%	99.9%	99.9%	0.0%	0.1%	0.1%	0.1%	0.1%	1.5%	3.1%	3.0%	2.9%	2.9%	98.5%	96.9%	97.0%	97.1%	97.1%
SIEMENS	100.0%	99.7%	99.5%	99.4%	99.4%	0.0%	0.3%	0.5%	0.6%	0.6%	0.1%	0.5%	0.4%	0.4%	0.4%	99.9%	99.5%	99.6%	99.6%	99.6%
STERLIT	100.0%	97.7%	97.5%	97.3%	97.2%	0.0%	2.3%	2.5%	2.7%	2.8%	0.4%	1.3%	1.4%	1.4%	1.4%	99.6%	98.7%	98.6%	98.6%	98.6%
SUNPHAR	100.0%	99.7%	99.7%	99.7%	99.7%	0.0%	0.3%	0.3%	0.3%	0.3%	0.5%	0.8%	0.8%	0.8%	0.8%	99.5%	99.2%	99.2%	99.2%	99.2%
SUZLON	100.0%	96.7%	96.7%	96.6%	96.6%	0.0%	3.3%	3.3%	3.4%	3.4%	0.0%	0.3%	1.9%	2.4%	2.8%	100.0%	99.7%	98.1%	97.6%	97.2%
TATACOM	100.0%	99.8%	99.8%	99.8%	99.8%	0.0%	0.2%	0.2%	0.2%	0.2%	2.5%	3.1%	3.0%	3.0%	3.0%	97.5%	96.9%	97.0%	97.0%	97.0%
TATAMOT	100.0%	99.9%	99.8%	99.8%	99.8%	0.0%	0.1%	0.2%	0.2%	0.2%	2.3%	3.2%	2.6%	2.3%	2.2%	97.7%	96.8%	97.4%	97.7%	97.8%
TATAPOW	100.0%	99.4%	99.2%	99.2%	99.2%	0.0%	0.6%	0.8%	0.8%	0.8%	1.7%	4.1%	4.4%	4.5%	4.5%	98.3%	95.9%	95.6%	95.5%	95.5%
TATASTE	100.0%	99.7%	99.7%	99.7%	99.7%	0.0%	0.3%	0.3%	0.3%	0.3%	1.3%	1.8%	1.8%	1.8%	1.8%	98.7%	98.2%	98.2%	98.2%	98.2%
TCS	100.0%	99.9%	99.9%	99.9%	99.9%	0.0%	0.1%	0.1%	0.1%	0.1%	0.0%	0.2%	0.3%	0.3%	0.3%	100.0%	99.8%	99.7%	99.7%	99.7%
UNITECH	100.0%	99.6%	99.5%	99.5%	99.5%	0.0%	0.5%	0.5%	0.5%	0.5%	0.0%	3.7%	6.5%	7.8%	8.6%	100.0%	96.3%	93.5%	92.2%	91.4%
WIPRO	100.0%	99.9%	99.9%	99.9%	99.9%	0.0%	0.1%	0.1%	0.1%	0.1%	0.4%	0.5%	0.4%	0.4%	0.4%	99.6%	99.5%	99.6%	99.6%	99.6%
ZEE	100.0%	99.9%	99.9%	99.8%	99.8%	0.0%	0.1%	0.1%	0.2%	0.2%	3.7%	2.9%	2.2%	1.8%	1.7%	96.3%	97.1%	97.8%	98.2%	98.4%

Table 10: Relationship between Standardized Trading Volume and Unconditional Volatility[7]

This table provides the coefficient estimates from regressions of trading volume against unconditional volatility and asymmetric coefficient of the OLS equation $V_t = \alpha + \beta_1 |r_t| + \beta_2 D_t |r_t|$, where V_t = standardized trading volume at time t, r_t is the return at time t and D_t=1 when r_t <0 and D_t=0 when $r_t \geq 0$. Three measures of trading volume, the daily total dollar value of shares traded (value), the daily number of shares traded (volume) and the daily number of equity trades (trade) are considered. Parameter estimates of all 50 companies are presented.

	Value				Volume				Trade			
Company	**α**	**β_1**	**β_2**	**RSQ**	**α**	**β_1**	**β_2**	**RSQ**	**α**	**β_1**	**β_2**	**RSQ**
ABB	-0.17*	0.13*	-0.05*	0.034	-0.31*	0.21*	-0.06*	0.102	-0.307*	0.203*	-0.047*	0.100
ACC	-0.27*	0.17*	-0.07*	0.078	-0.27*	0.19*	-0.09*	0.086	-0.337*	0.221*	-0.092*	0.124
AMBUJA	-0.06	0.05*	-0.04**	0.006	-0.05	0.05*	-0.04**	0.005	-0.312*	0.205*	-0.060*	0.100
BHARTI	-0.11*	0.04*	0.03	0.011	-0.09*	0.04*	0.01	0.008	-0.420*	0.205*	0.008	0.158
BHEL	-0.29*	0.15*	-0.03**	0.086	-0.34*	0.19*	-0.05*	0.118	-0.319*	0.157*	-0.007	0.100
BPCL	-0.25*	0.14*	-0.06*	0.066	-0.27*	0.14*	-0.05*	0.071	-0.273*	0.147*	-0.048*	0.075
CIPLA	-0.36*	0.25*	-0.06*	0.146	-0.27*	0.16*	0.00	0.078	-0.382*	0.248*	-0.026	0.161
CAIRN	-0.26*	0.13*	-0.08*	0.083	-0.25*	0.12*	-0.07*	0.106	-0.305*	0.143*	-0.065*	0.104
DLF	-0.07**	0.03*	-0.03*	0.040	-0.13*	0.04*	-0.02	0.049	-0.167*	0.042*	-0.002	0.047
GAIL	-0.20*	0.12*	-0.04*	0.051	-0.21*	0.13*	-0.05*	0.058	-0.229*	0.137*	-0.044*	0.069
GRASIM	-0.23*	0.17*	-0.09*	0.065	-0.24*	0.17*	-0.07*	0.065	-0.351*	0.243*	-0.100*	0.139
HCL	-0.32*	0.14*	-0.05*	0.112	-0.29*	0.12*	-0.03**	0.085	-0.324*	0.129*	-0.020	0.103
HDFC	-0.09*	0.06*	-0.02	0.009	-0.06**	0.05*	-0.03	0.006	-0.336*	0.194*	0.011	0.125
HDFCORP	-0.15*	0.07*	0.01	0.022	-0.13*	0.07*	0.00	0.017	-0.427*	0.220*	0.029**	0.186
HINDALC	-0.37*	0.24*	-0.08*	0.152	-0.41*	0.25*	-0.06*	0.183	-0.452*	0.267*	-0.036**	0.222
HLL	-0.35*	0.28*	-0.12*	0.133	-0.25*	0.21*	-0.09*	0.072	-0.415*	0.304*	-0.089*	0.171
HONDA	-0.15*	0.10*	-0.04**	0.026	-0.24*	0.16*	-0.06*	0.063	-0.299*	0.181*	-0.032**	0.086
ICICI	-0.24*	0.10*	0.02	0.060	-0.13*	0.05*	0.01	0.018	-0.325*	0.128*	0.032*	0.113
IDEA	-0.06	0.04**	-0.05*	0.019	-0.11**	0.05*	-0.04**	0.022	-0.147*	0.083*	-0.073*	0.053
INFOSYS	-0.31*	0.16*	-0.02	0.104	-0.33*	0.16*	0.00	0.122	-0.394*	0.195*	-0.013	0.168
ITC	-0.42*	0.28*	-0.04**	0.174	-0.29*	0.19*	-0.01	0.085	-0.423*	0.280*	-0.039**	0.178
L&T	-0.33*	0.22*	-0.11*	0.145	-0.27*	0.18*	-0.10*	0.097	-0.313*	0.192*	-0.075*	0.129
M&M	-0.07**	0.07*	-0.08*	0.017	-0.15*	0.12*	-0.09*	0.040	-0.208*	0.147*	-0.098*	0.060
MARUTI	-0.26*	0.16*	-0.06*	0.064	-0.24*	0.15*	-0.06*	0.057	-0.279*	0.167*	-0.055*	0.071
NALCO	-0.23*	0.14*	-0.08*	0.073	-0.22*	0.13*	-0.07*	0.068	-0.324*	0.173*	-0.060*	0.125
NTPC	-0.37*	0.20*	0.03	0.213	-0.19*	0.10*	0.00	0.111	-0.520*	0.287*	0.044**	0.328
ONGC	-0.15*	0.09*	-0.02	0.024	-0.19*	0.12*	-0.03	0.038	-0.274*	0.168*	-0.031**	0.080
PNB	-0.33*	0.19*	-0.09*	0.127	-0.41*	0.23*	-0.09*	0.185	-0.433*	0.232*	-0.086*	0.196
POWER&G	-0.24*	0.13*	-0.09*	0.091	-0.27*	0.13*	-0.09*	0.118	-0.304*	0.153*	-0.093*	0.122
RANBAXY	-0.33*	0.22*	-0.05*	0.125	-0.38*	0.24*	-0.04**	0.160	-0.380*	0.239*	-0.042*	0.161
RCOMM	-0.24*	0.11*	-0.04**	0.064	-0.38*	0.16*	-0.04**	0.175	-0.459*	0.194*	-0.038**	0.229
RELIANC	-0.35*	0.20*	0.01	0.140	-0.33*	0.21*	-0.04*	0.119	-0.445*	0.244*	0.019	0.223
RPOWER	-0.04*	0.00*	0.02*	0.002	-0.05	0.00	0.02	0.004	-0.060	0.009	0.019	0.004
RINFRA	-0.33*	0.18*	-0.04*	0.152	-0.40*	0.22*	-0.06*	0.227	-0.372*	0.188*	-0.023	0.190
RPETRO	-0.40*	0.21*	-0.03	0.211	-0.48*	0.25*	-0.04**	0.325	-0.465*	0.235*	-0.026	0.281
SAIL	-0.26*	0.12*	-0.04*	0.083	-0.31*	0.15*	-0.05*	0.116	-0.314*	0.134*	-0.020	0.111
SATYAM	-0.34*	0.14*	-0.02	0.116	-0.33*	0.13*	-0.01	0.107	-0.409*	0.157*	0.000	0.164
SBI	-0.32*	0.20*	-0.04**	0.096	-0.32*	0.20*	-0.06*	0.097	-0.361*	0.208*	-0.024	0.118
SIEMENS	-0.25*	0.15*	-0.03	0.072	-0.35*	0.17*	0.04**	0.141	-0.330*	0.167*	0.023	0.120
STERLIT	-0.17*	0.10*	-0.08*	0.063	-0.20*	0.11*	-0.07*	0.096	-0.175*	0.097*	-0.065*	0.070
SUNPHAR	-0.13*	0.09*	-0.03	0.020	-0.13*	0.09*	-0.04*	0.022	-0.371*	0.234*	-0.056*	0.158
SUZLON	-0.33*	0.14*	-0.07*	0.202	-0.37*	0.15*	-0.04*	0.162	-0.452*	0.171*	-0.040*	0.257
TATACOM	-0.14*	0.09*	-0.07*	0.038	-0.15*	0.10*	-0.07*	0.040	-0.177*	0.108*	-0.068*	0.051
TATAMOT	-0.08*	0.06*	-0.04*	0.009	-0.24*	0.15*	-0.08*	0.059	-0.205*	0.119*	-0.046*	0.039
TATAPOW	-0.33*	0.17*	-0.02	0.123	-0.29*	0.16*	-0.04*	0.093	-0.335*	0.171*	-0.016	0.124
TATASTE	-0.26*	0.14*	-0.04*	0.066	-0.30*	0.17*	-0.06*	0.091	-0.396*	0.196*	-0.019	0.149
TCS	-0.10**	0.06*	-0.02	0.009	-0.16*	0.10*	-0.02	0.025	-0.376*	0.212*	0.007	0.190
UNITECH	-0.21*	0.08*	-0.03*	0.049	-0.30*	0.10*	-0.01	0.092	-0.294*	0.094*	-0.004	0.089
WIPRO	-0.27*	0.13*	-0.03*	0.085	-0.25*	0.12*	-0.03*	0.072	-0.320*	0.142*	-0.023**	0.117
ZEE	-0.26*	0.11*	-0.03**	0.066	-0.32*	0.14*	-0.05*	0.105	-0.360*	0.155*	-0.049*	0.134

*(**) represents significance of the parameter at 1 %(5%) significance level.

[7] The results of the relationship between trading volume and squared returns are given in the appendix B.

Table 11: GARCH parameters estimate

This table provides the GARCH (1,1) parameters estimate for returns of the equation $r_t = a + \sum_{i=1}^{5} b_i r_{t-i} + \varepsilon_t$ where, $\varepsilon_t \mid \psi_{t-1} \sim N(0, \sigma_t^2)$ and $\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_J \sigma_{t-j}^2$. r_t is the return at time t.

Company	α	α1	β_1	α1+ β1
ABB	0.824*	0.214*	0.651*	0.865
ACC	0.197*	0.136*	0.847*	0.982
AMBUJA	0.145*	0.112*	0.868*	0.980
BHARTI	0.297*	0.090*	0.873*	0.963
BHEL	0.238*	0.128*	0.849*	0.977
BPCL	0.201*	0.069*	0.911*	0.980
CIPLA	0.333*	0.104*	0.836*	0.941
CAIRN	0.609*	0.179*	0.774*	0.952
DLF	33.821*	0.000	0.000	0.000
GAIL	0.190*	0.131*	0.860*	0.991
GRASIM	0.116*	0.104*	0.881*	0.986
HCL	0.144*	0.093*	0.900*	0.993
HDFC	0.437*	0.251*	0.699*	0.950
HDFCORP	0.243*	0.126*	0.839*	0.965
HINDALC	0.278*	0.140*	0.821*	0.961
HLL	0.342*	0.107*	0.823*	0.930
HONDA	0.660*	0.177*	0.727*	0.905
ICICI	0.216*	0.101*	0.879*	0.980
IDEA	0.573*	0.150*	0.805*	0.954
INFOSYS	0.131*	0.109*	0.885*	0.994
ITC	0.282*	0.118*	0.827*	0.944
L&T	1.850*	0.106*	0.729*	0.835
M&M	0.314*	0.134*	0.831*	0.965
MARUTI	0.199*	0.109*	0.865*	0.974
NALCO	0.340*	0.151*	0.828*	0.980
NTPC	0.171*	0.124*	0.845*	0.969
ONGC	0.112*	0.098*	0.891*	0.990
PNB	0.242*	0.130*	0.851*	0.982
POWER&G	1.011**	0.400*	0.582*	0.982
RANBAXY	0.338*	0.148*	0.802*	0.950
RCOMM	0.400*	0.132*	0.845*	0.977
RELIANC	0.848*	0.312*	0.572*	0.884
RPOWER	2.887	0.227*	0.594*	0.821
RINFRA	0.264*	0.155*	0.827*	0.982
RPETRO	0.058*	0.091*	0.911*	1.002
SAIL	0.748*	0.191*	0.767*	0.957
SATYAM	0.055*	0.062*	0.937*	0.999
SBI	0.160*	0.093*	0.884*	0.977
SIEMENS	0.630*	0.234*	0.697*	0.931
STERLIT	3.955*	1.884*	0.119*	2.003
SUNPHAR	0.132*	0.112*	0.871*	0.983
SUZLON	0.862*	0.120*	0.834*	0.954
TATACOM	0.404*	0.057*	0.915*	0.972
TATAMOT	0.249*	0.104*	0.867*	0.971
TATAPOW	0.173*	0.111*	0.873*	0.983
TATASTE	0.448*	0.156*	0.793*	0.949
TCS	0.217*	0.149*	0.810*	0.959
UNITECH	2.189*	0.197*	0.691*	0.888
WIPRO	0.325*	0.151*	0.832*	0.982
ZEE	0.928*	0.143*	0.802*	0.945

*(**) indicates significance at 1%(5%) level.

In most of the cases, the autoregressive parameter of conditional volatility is higher than the return innovations (except for STERLITE). The mixed distribution hypothesis or the relationship between conditional volatility and trading volume is then estimated by modifying GARCH equation as explained in equation [5]. The MDH model predicts that if trading volume is a proxy of information and if daily volume is serially correlated then the parameter χ will be significant and positive, and $(\alpha_1 + \beta_1)$ will become either small or statistically insignificant. The persistence of variance as measured by $(\alpha_1 + \beta_1)$ should become negligible if accounting for the uneven flow of information (V) explains the presence of ARCH effect in the data. The contemporaneous trading volume (V) is assumed as the proxy of information[8]. The parameter estimates of equation [5] are presented in Table 12. In most cases, the inclusion of trading volume as an explanatory variable in the conditional variance equation results in a substantial reduction of volatility persistence in daily returns. Hence, a serially correlated news arrival process proxied by trading volume is a source of ARCH effect as indicated by our results. We find that around 80% of the companies have trading volume as significant explanatory variable (across all three measures) of conditional volatility.

In approximately 34% of the stocks, the GARCH parameters become statistically insignificant and in case of another 44%, the persistence reduces dramatically when volume is used as an explanatory variable in the conditional volatility equation. In 18 stocks, the explanatory power of GARCH is not reduced by the inclusion of trading volume as explanatory variable. When value is used, the GARCH effect becomes insignificant in 16% cases only and when trade is used, 54% stocks show insignificant GARCH effect. However, in all stocks the volume parameter is positive and significant at 1% significant level. This result supports strong relationship between contemporaneous trading volume and conditional volatility. However, our results provide mixed results, neither entirely rejecting the MDH nor giving it an unconditional support. Similar results have been reported by Ane and Ureche-Rangau (2008). Ane and Ureche-Rangau (2008) analyzed the temporal dependence of volatility and volume on 50 LSE stocks and found mixed results. They found that in some stocks the effect of volume is very strong, in some moderate and in some cases it has negligible effect. They tried to explain these differences by understanding the long term behavior of volume and volatility and found that the stocks for which the trading volume has negligible explanatory power as compared to the ARCH effect, have highest difference in the fractional differencing parameter of volume and volatility. It is possible that these two variables do share common short-term movements, but they may have fundamentally different long-term behavior.

Our results, which support MDH over ARCH effect for most of the stocks, are in line with the findings of Lamoureax and Lastrapes (1990), Kim & Kon, (1994), Gallo & Pacini, (2000), and Omran & McKenzie (2000) in developed markets and Pyun, Lee, and Nam (2000) and Bohl and Henke (2003) in emerging market. Pyun, Lee, and Nam (2000) studied 15 individual shares of the Korean stock market and found that all stocks show high statistically significant positive correlation with contemporaneous volume. They found that as the volume is used in GARCH equation as an exogenous variable, the return volatility persistence reduces dramatically. Bohl and Henke (2003) investigated 20 Polish stocks and found that in majority of cases volatility persistence tends to disappear when trading volume is included in the conditional variance equation.

[8] In most of the stocks and across all three measures of trading volume, we found very high autocorrelation. This fact validates one of the assumptions of MDH.

Table 11: GARCH parameters estimate with trading volatility as one of the exogenous variable of the GARCH equation

This table provides the GARCH (1,1) parameters estimate for returns of the equation

$r_t = a + \sum_{i=1}^{5} b_i r_{t-i} + \varepsilon_t$ where, $\varepsilon_t \,|\, \psi_{t-1} \sim N(0, \sigma_t^2)$ and $\sigma_t^2 = \alpha_0 + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^{p} \beta_J \sigma_{t-j}^2 + \chi V_t$. r_t is the return at time t and V_t is standardized trading volume at time t. Three measures of trading volume, the daily total dollar value of shares traded (value), the daily number of shares traded (volume) and the daily number of equity trades (trade) are considered.

Company	Value					Volume					Trade				
	α		β_1	β1	X	α		β_1	β1	χ	α		β_1	β1	X
ABB	1.131*	0.258*	0.560*	0.818	0.34*	5.015*	0.209*	0.000	0.209	5.80*	5.208*	0.229*	0.000	0.229	5.52*
ACC	0.573*	0.161*	0.771*	0.932	0.47*	3.569*	0.253*	0.310*	0.564	3.38*	6.235*	0.196*	0.001	0.197	5.04*
AMBUJA	0.174*	0.117*	0.858*	0.975	0.11	0.171*	0.116*	0.859*	0.975	0.10**	4.429*	0.297*	0.068**	0.365	4.05*
BHARTI	1.949*	0.215*	0.555*	0.770	2.67*	8.439*	0.153*	0.000	0.153	33.59*	6.581*	0.144*	0.000	0.144	4.92*
BHEL	5.237*	0.333*	0.151*	0.485	4.95*	8.495*	0.176*	0.000	0.176	11.84*	8.650*	0.216*	0.000	0.216	11.73*
BPCL	2.329*	0.255*	0.511*	0.766	1.36*	6.127*	0.282*	0.088**	0.370	4.41*	6.304*	0.293*	0.068	0.361	4.617*
CIPLA	4.364*	0.215*	0.054*	0.269	5.29*	4.389*	0.281*	0.047*	0.327	4.85*	4.254*	0.230*	0.032*	0.262	4.65*
CAIRN	4.744*	0.384*	0.305*	0.689	5.86*	5.877*	0.381*	0.222*	0.603	7.95*	10.46*	0.310*	0.000	0.310	13.35*
DLF	32.67*	0.000	0.002	0.002	0.00	33.84*	0.000	0.000	0.000	1.25	33.83*	0.000	0.000	0.000	0.00
GAIL	5.781*	0.351*	0.165*	0.516	6.17*	0.349*	0.145*	0.830*	0.975	0.30*	0.575*	0.162*	0.790*	0.953	0.55*
GRASIM	0.230*	0.120*	0.847*	0.967	0.16*	0.548*	0.170*	0.761*	0.932	0.66*	4.381*	0.271*	0.116*	0.387	4.09*
HCL	4.797*	0.415*	0.325*	0.740	5.41*	1.152*	0.189*	0.746*	0.935	1.64*	2.689*	0.263*	0.583*	0.846	3.29*
HDFC	1.248*	0.295*	0.550*	0.845	2.85*	5.877*	0.230*	0.013	0.242	18.85*	5.530*	0.191*	0.000	0.191	8.33*
HDFCORP	4.139*	0.230*	0.269*	0.499	9.41*	6.219*	0.139*	0.089*	0.228	15.85*	6.288*	0.108*	0.000	0.108	9.95*
HINDALC	3.928*	0.296*	0.150*	0.445	3.86*	0.807*	0.183*	0.700*	0.883	0.64*	5.123*	0.279*	0.040	0.319	5.61*
HLL	4.301*	0.149*	0.025	0.173	4.38*	1.983*	0.259*	0.348*	0.608	1.25*	3.867*	0.157*	0.005	0.162	3.05*
HONDA	0.790*	0.197*	0.689*	0.886	0.21*	1.032*	0.204*	0.645*	0.849	0.49*	4.888*	0.245*	0.000	0.245	2.94*
ICICI	0.283*	0.094*	0.879*	0.973	0.20*	0.335*	0.099*	0.869*	0.968	0.64*	0.323*	0.099*	0.870*	0.969	0.21*
IDEA	0.468*	0.216*	0.761*	0.978	0.34	0.684*	0.180*	0.771*	0.951	0.56	0.605*	0.170*	0.786*	0.955	0.20
INFOSYS	5.538*	0.301*	0.146*	0.447	6.20*	5.281*	0.184*	0.172*	0.356	4.47*	4.844*	0.203*	0.149*	0.353	3.50*
ITC	3.418*	0.231*	0.135*	0.366	3.60*	2.694*	0.297*	0.236*	0.533	2.38*	3.765*	0.249*	0.018	0.267	3.11*
L&T	12.75*	0.044*	0.000	0.044	14.71*	9.298*	0.067*	0.013	0.081	3.50*	11.06*	0.000	0.000	0.000	9.25*
M&M	0.340*	0.143*	0.819*	0.961	0.05	0.453*	0.148*	0.799*	0.947	0.19*	0.464*	0.154*	0.793*	0.947	0.12*
MARUTI	0.256*	0.117*	0.849*	0.966	0.08	0.239*	0.112*	0.856*	0.969	0.05	6.340*	0.119*	0.000	0.119	3.91*
NALCO	0.490*	0.222*	0.764*	0.985	0.20*	0.551*	0.206*	0.765*	0.972	0.37*	0.760*	0.216*	0.738*	0.954	0.41*
NTPC	5.180*	0.102*	0.000	0.102	6.76*	5.347*	0.090*	0.000	0.090	10.41*	5.267*	0.021	0.000	0.021	5.90*
ONGC	0.134*	0.108*	0.879*	0.988	0.06*	0.148*	0.111*	0.875*	0.986	0.07*	0.141*	0.107*	0.880*	0.987	0.03*
PNB	1.142*	0.224*	0.669*	0.893	0.86*	8.464*	0.206*	0.000	0.206	9.31*	7.709*	0.202*	0.000	0.202	6.35*
POWER&G	1.508*	0.488*	0.497*	0.985	1.57	2.412*	0.474*	0.466*	0.939	4.20**	10.65*	0.319*	0.000	0.319	14.61*
RANBAXY	5.352*	0.225*	0.011	0.236	7.33*	5.601*	0.141*	0.000	0.141	7.82*	5.129*	0.166*	0.000	0.166	6.52*
RCOMM	9.976*	0.243*	0.085*	0.328	8.42*	9.449*	0.074**	0.155**	0.229	8.33*	9.652*	0.394*	0.001	0.395	7.55*
RELIANC	3.673*	0.334*	0.063*	0.397	3.03*	2.385*	0.381*	0.267*	0.648	1.97*	4.427*	0.262*	0.000	0.262	4.14*
RPOWER	2.698	0.225*	0.609*	0.834	0.95	3.087	0.230*	0.580*	0.810	0.86	2.984	0.221*	0.597*	0.817	1.12
RINFRA	4.509*	0.306*	0.337*	0.642	7.42*	8.659*	0.206*	0.000	0.206	12.70*	11.10*	0.251*	0.000	0.251	19.43*
RPETRO	6.956*	0.269*	0.090	0.359	9.87*	8.566*	0.065	0.007	0.072	10.27*	10.09*	0.077	0.000	0.077	11.24*
SAIL	1.106*	0.215*	0.717*	0.933	0.46*	10.783*	0.290*	0.000	0.290	11.65*	1.832*	0.239*	0.640*	0.879	0.83*
SATYAM	5.890*	0.313*	0.301*	0.614	5.66*	1.930*	0.226*	0.648*	0.875	1.59*	6.960*	0.286*	0.186*	0.472	5.73*
SBI	4.804*	0.223*	0.024	0.247	2.47*	0.336*	0.113*	0.837*	0.950	0.15*	5.186*	0.210*	0.000	0.210	3.53*

SIEMENS	1.904*	0.314*	0.450*	0.764	1.72*	5.764*	0.231*	0.017	0.248	7.14*	5.321*	0.291*	0.038	0.328	5.92*
STERLIT	14.15*	0.673*	0.003	0.676	10.97*	22.911*	0.256*	0.000	0.256	32.01*	14.81*	0.143*	0.418*	0.562	20.40*
SUNPHAR	0.744*	0.257*	0.646*	0.903	0.83*	1.188*	0.298*	0.545	0.843	1.70*	3.996*	0.329*	0.082*	0.411	3.78*
SUZLON	14.69*	0.17*	0.009	0.184	16.3*	25.286*	0.084**	0.000	0.084	51.98*	18.54*	0.058	0.002	0.059	24.74*
TATACOM	9.35*	0.35*	0.09*	0.448	11.0*	6.530*	0.426*	0.203*	0.629	6.60*	7.564*	0.432*	0.169*	0.602	8.57*
TATAMOT	0.26*	0.10*	0.86*	0.969	0.00	0.286*	0.107*	0.859*	0.966	0.04	0.249*	0.104*	0.867*	0.971	0.00
TATAPOW	1.29*	0.21*	0.64*	0.856	0.7*	0.308*	0.114*	0.853*	0.967	0.20*	5.378*	0.274*	0.104*	0.378	4.20*
TATASTE	0.95*	0.207*	0.682*	0.889	0.36*	1.543*	0.245*	0.576*	0.821	0.73*	1.522*	0.234*	0.589*	0.823	0.67*
TCS	0.211*	0.154*	0.808*	0.961	0.01	3.699*	0.274*	0.107*	0.382	6.27*	3.950*	0.126*	0.052	0.178	3.74*
UNITECH	11.1*	0.292*	0.144**	0.436	5.19*	6.035*	0.228*	0.470*	0.698	6.29*	4.071*	0.233*	0.556*	0.790	1.57*
WIPRO	5.632*	0.366*	0.311*	0.677	7.08*	3.615*	0.397*	0.366*	0.763	3.72*	4.652*	0.375*	0.312*	0.687	4.60*
ZEE	7.99*	0.30*	0.247*	0.547	8.42*	11.543*	0.281*	0.031	0.313	10.79*	12.02*	0.259*	0.000	0.259	9.96*

*indicates significance at the 1% level.

In line with such empirical evidence in other emerging markets, our result partially supports the implications of the MDH which provides, to a large extent, a valid theoretical explanation for behavior of volatility. However, our results are mixed as opposed to the findings of Sharma et al. (1996), Chen et al. (2001) and Argo and Nieto (2005) who found that the total trading volume is unable to eliminate the ARCH effect.

5. Conclusions

Understanding the relationship between returns, volatility and trading volume in financial markets is important for traders, researchers and policy makers. The distribution of returns has implications for various financial models and risk management practices. The dynamic relationship between returns and trading volume helps in understanding the market clearing process and frictions in the market. Also, ability of trading volume to forecast volatility helps agents like traders, with a very short-term investment horizon and portfolio managers that may have a medium- to long-term investment horizon. In emerging markets generally and in Indian stock market context specifically, very few empirical studies has been reported on relationship between returns/volatility and trading volume.

Using 50 Indian stocks, we analyze the returns and volume relationship, focusing on the contemporaneous relation between absolute returns and trading volume, the asymmetric behavior of trading volume in response to price changes and dynamic (lead-lag) relationship between returns and trading volume.

Our findings indicate evidence of positive contemporaneous correlation between price changes and trading volume in Indian stock markets. All the stocks, except Reliance Power, show asymmetric behavior which is in line with the findings of Assogbavi et al. (1995) and Brailsford (1996). Investigation of dynamic relationship between returns and trading volume shows very interesting results. We find evidence that in Indian market, past returns Granger cause trading volume, which can be easily conceived in an emerging market (Assogbavi, 2007) where the state of development of the market possibly does not allow instantaneous information dissemination. These results are further supported by the variance decomposition. However, in most of the cases the relationship lacks economic significance even though it is statistically significant. The results of impulse response analysis indicate that both returns and volume are mostly affected by their own lag and that the volume is more autoregressive than returns i.e. any shock in either returns or volume does not affect the return series beyond one lag.

In case of unconditional volatility and trading volume, we find positive contemporaneous relationship between trading volume and unconditional volatility. However, the results on asymmetric relationship are mixed. In most of the cases, an asymmetric relationship exists and the relationship is stronger when prices move up than when prices go down. In other stocks, we do not find such asymmetric relationship. The results of relation between trading volume and conditional volatility support strong contemporaneous relationship between trading volume and conditional volatility. However, our results are mixed from the point of supporting MDH. They do not entirely reject the MDH but do not also give it an unconditional support. In more than 70-80% of the stocks, ARCH effect is either reduced or becomes insignificant when trading volume is included in GARCH equation. It indicates that the trading volume is a better proxy of information than the volatility itself. However, for some stocks, the GARCH parameters do not

show any reduction when volume is added in variance equation. Similar mixed results have been found for LSE stocks by Ane and Ureche-Rangau (2008). Our results also indicate that in Indian stock markets, the daily number of transactions may be a better proxy of information than the total number of shares traded or the total value of shares traded.

References

Abdullah, D.A. & Rangazas, P.C. (1988). Money and the Business Cycle: Another Look. *Review of Economics and Statistics*, 70, 680-85.

Admati, A.R. & Pfleiderer, P. (1988). A Theory of Intraday Trading Patterns: Volume and Price Variability. *Review of Financial Studies*, 1,3-40.

Ahmed, H. J., Hassan, A. & Nasir, A. (2005). The relationship between trading volume, volatility and stock market returns: A test of Mixed Distribution Hypothesis for a Pre and Post crisis on Kuala Lumpur Stock Exchange. *Investment Management and Financial Innovations*, 3, 146-158.

Andersen, T. (1996). Return volatility and trading volume: An information flow interpretation of stochastic volatility. *Journal of Finance*, 51, 169–204.

Ane, T. & Ureche-Rangau, L. (2008). Does trading volume really explain stock returns volatility?. *Journal of International Financial Markets, Institutions, and Money*, 18, 216–235.

Argo, V. & Nieto, L. (2005). Heteroskedasticity in the returns of the main world stock exchange indices: volume versus GARCH effects. *Journal of International Financial Markets, Institutions, and Money*, 15, 271–384.

Assogbavi, T., Khoury, N., & Yourougou, P. (1995). Short interest and the asymmetry of the price-volume relationship in the Canadian Stock market. *Journal of Banking & Finance* 19 1341-1358.

Assogbavi, T., Schell, C. & Fagnisse, S. (2007). Equity price-volume relationship on the Russian Stock Exchange. *International Business & Economics Research Journal*, Vol. 6, 9, 107-116.

Bhagat, S., & Bhatia. S. (1996). "Trading Volume and Price Variability: Evidence on Lead-Lag Relations for Granger-Causality Tests. Working paper, University of Colorado at Boulder.

Bohl, M. T., & Henke, H. (2003). Trading volume and stock market volatility: The Polish case. *International Review of Financial Analysis*, 12, 513–525

Blume, L., Easley, D., & O'Hara, M. (1994). Market statistics and technical analysis: The role of volume. *Journal of Finance,* 491, 153-182.

Brailsford, T. (1996). The empirical relationship between trading volume, returns, and volatility. *Accounting and Finance*, 35, 89–111.

Chen, G. M., Firth, M., & Rui, O. M. (2001). Dynamic relation between stock returns, trading volume, and volatility. *Financial Review,* 36, 153–73.

Chordia, T. & Swaminathan, B. (2000). Trading volume and cross-autocorrelations in stock returns. *Journal of Finance,* 55,913-935.

Clark, P.K. (1973). A subordinated stochastic process model with finite variance for speculative prices. *Econometrica,* 41, 135-55.

Copeland, T. E. (1976). A model of asset trading under the assumption of sequential information arrival. *Journal of Finance* 31, 1149-1168.

Crouch, R. L., (1970). The volume of transactions and price changes on the New York Stock Exchange. *Financial Analysts Journal,* 26, 104-109.

Epps, T. W. (1975). Security price changes and transaction volumes: Theory and Evidence. *American Economic Review*, 65, 586-597.

Epps, T., & Epps, M. (1976). The stochastic dependence of security price changes and transaction volumes: Implications for the mixture-of-distributions hypothesis", *Econometrica*, 44, 305-321.

Foster, F.D. & Viswanathan, S. (1990). A Theory of Interday Variations in Volume, Variance and Trading Costs in Securities Markets. *Review of Financial Studies*, 3, 593-624.

Gallo, G., & Pacini, B. (2000). "The effects of trading activity on market volatility", *European Journal of Finance*, 6, 163–175.

Grundy, B., & McNichols, M. (1989). Trade and revelation of information through prices and direct disclosure. *Review of Financial Studies*, 2, 495-526.

Harris, L. (1986). Cross-security tests of the mixture of distributions hypothesis. *Journal* of *Financial and Quantitative Analysis,* 21, 39-46.

Harris, L., (1987). Transaction Data Tests of the Mixture of Distributions Hypothesis. *Journal of Financial and Quantitative Analysis*, 22, 127-141.

Harris, M., & Raviv, A. (1993). Differences of opinion make a horse race. *Review of Financial Studies*, 6, 473–506.

He, H., & Wang, J. (1995). Differential information and dynamic behaviour of stock trading volume. *Review of Financial Studies,* 8,919–72.

Henry & McKenzie (2006). The Impact of Short Selling on the Price-Volume Relationship: Evidence from Hong Kong. *Journal of Business*, 79, 671-691.

Hiemstra, C., & Jones, J. D. (1994). Testing for linear and non-linear Granger causality in the stock price–volume relationship. *Journal of Finance,* 49,1639–64.

Houthausen, R. W. & Verrecchia. (1990). The effect of informedness and consensus on price and volume behavior. *Accounting Review*, 65, 191-208.

Huang, B. N., & Yang, C. W. (2001). An empirical investigation of trading volume and return volatility of the Taiwan Stock Market. *Global Finance Journal*, 12, 55-77.

Jennings, R.H. & Barry, C. (1983). Information dissemination and portfolio choice. *Journal of Financial and Quantitative Analysis,* 18, 1-19.

Karpoff, J.M. (1986). A theory of trading volume. *Journal of Finance,* 41, 1069-1088.

Karpoff, J.M., (1987). The relation between price changes and trading volume: A survey. *Journal* of *Financial and Quantitative Analysis,* 22, 109-126

Kim, D., & Kon, S. (1994). Alternative models for the conditional heteroscedasticity of stock returns. *Journal of Business*, 67, 563–588.

Kim, O., & Verrecchia, R. (1991). Market reactions to anticipated announcements. *Journal of Financial Economics*, 30, 273-310.

Kyle, A. (1985). Continuous auctions and insider trading. *Econometrica*, 53, 1315-1335.

Lamoureux, C.G. & W.D. Lastrapes (1990). Heteroskedasticity in stock return data: Volume versus GARCH effects. *Journal of Finance,* 45, 221-229.

Lamoureux, C.G. & W.D. Lastrapes (1994). Endogenous trading volume and momentum in stock-return volatility. *Journal of Business & Economic Statistics,* 12, 253-260.

Lange, S. (1999). Modeling asset market volatility in a small market: Accounting for non-synchronous trading effects. *Journal of International Financial Markets, Institutions, and Money*, 9, 1–18.

Moosa, I. A., & Al-Loughani, N. E. (1995). Testing the price-volume relation in emerging Asian stock markets. *Journal of Asian Economics*, 6, 407-422.

Morse, D. (1980). Asymmetrical information in securities markets and trading volume. *Journal of Financial and Quantitative Analysis,* 15, 1129-1 148.

Omran, M., & McKenzie, E. (2000). Heteroscedasticity in stock returns data revisited: Volume versus GARCH Effects. *Applied Financial Economics*, 10, 553–560.

Pyun, C., Lee, S., & Nam, K. (2000). Volatility and information flows in emerging equity market: A case of the Korean stock exchange. *International Review of Financial Analysis*, 9, 405–420.

Ratner, M., & Leal, R. P. C. (2001). Stock returns and trading volume: Evidence from the emerging markets of Latin America and Asia. *Journal of Emerging Markets,* 6, 5–22.

Rogalski, R.J. (1978). The dependence of prices and volume. *Review of Economics and Statistics,* 60, 268-274.

Saatcioglu, K., & Starks, L. T. (1998). The stock price-volume relationship in emerging stock markets: The case of Latin America. *International Journal of Forecasting*, 14, 215–225.

Sharma, J.L., Mougoue, M., & Kamath, R. (1996). Heteroscedasticity in stock market indicator return data: volume versus GARCH effects. *Applied Financial Economics*, 6, 337–342.

Sims, C. (1972). Money, Income, and Causality. *American Economic Review*, 62, 540-52.

Sims, C. (1980). Macroeconomics and Reality. *Econometrica*, 48, 1-48.

Smirlock, M., & Starks, L. (1985). A further examination of stock price changes and transaction volume. *Journal of Financial Research,* 8, 217-225.

Smirlock, M., & Starks, L.T. (1988). An empirical analysis of the stock price-volume relationship. *Journal of Banking & Finance,* 12, 31-41.

Tauchen, G. E. & M. Pitts (1983). The price variability-volume relationship on speculative markets. *Econometrica,* 51, 485-505.

Varian, H. (1985). Divergence of opinion in complete markets: a note. *Journal of Finance*, 40, 309-317.

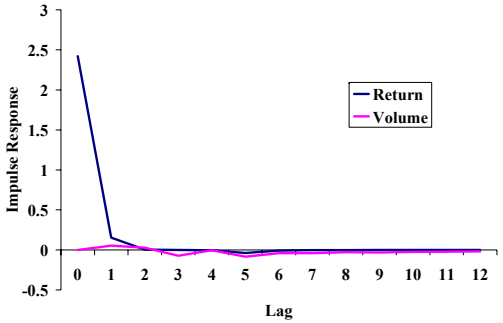
Varian, H. (1989). Differences of opinion in financial markets. In: Stone, C. (Ed.), Financial risk: theory, evidence and implications. *Proceedings of the Eleventh Annual Economic Policy Conference of the Federal Reserve Bank of St. Louis. Kluwer*, Boston, pp. 3-37.

Wang, J. (1994). A model of competitive stock trading volume. *Journal* of *Political Economy,* 102, 127- 168.

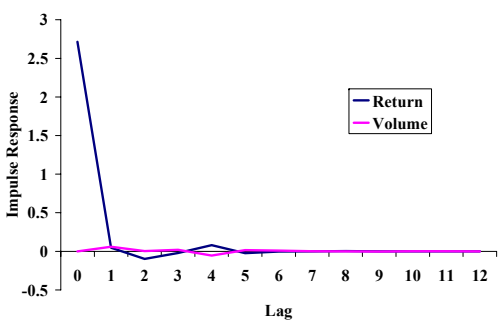
Wang, P. (2005). Stock return volatility and trading volume: Evidence from the Chinese Stock Market. *Journal of Chinese Economic and Business Studies*, 3, 39-54.

Appendix A

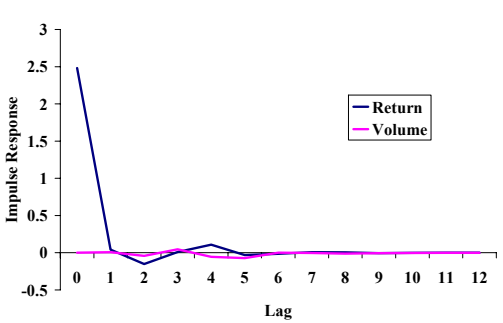
Impulse Response Function of Return (ABB)



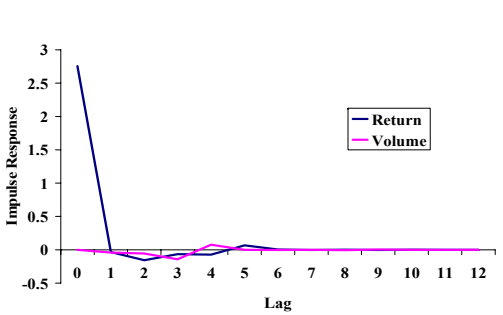
Impulse Response Function of Return (ACC)



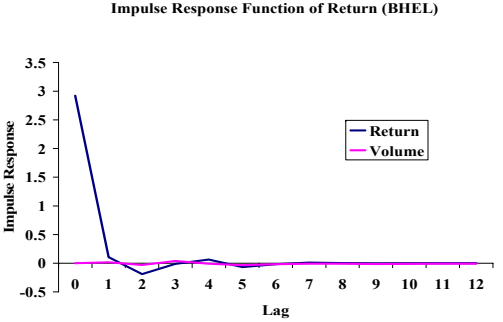
Impulse Response Function of Return (AMBUJA)



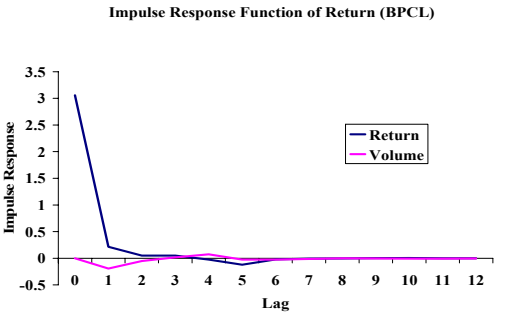
Impulse Response Function of Return (BHARTI)



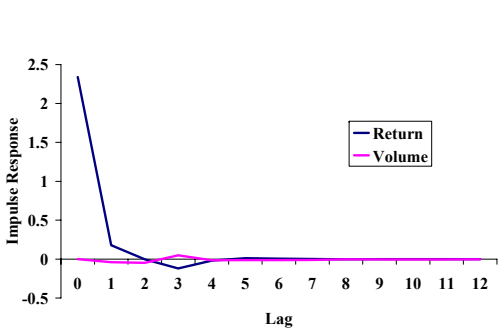
Impulse Response Function of Return (BHEL)



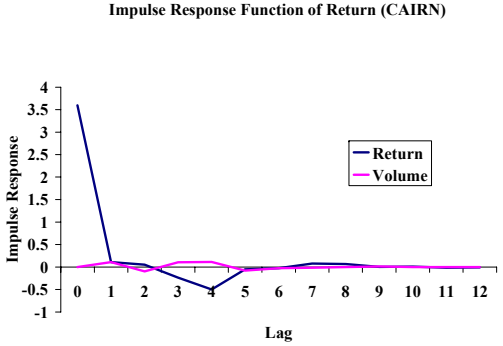
Impulse Response Function of Return (BPCL)



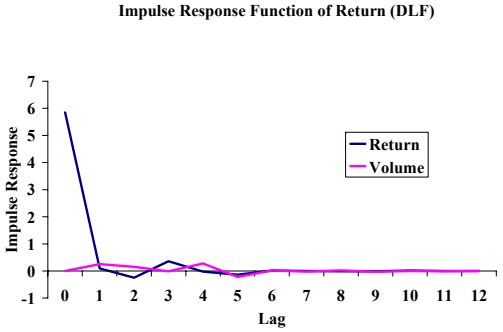
Impulse Response Function of Return (CIPLA)



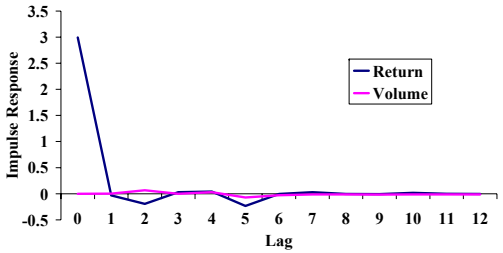
Impulse Response Function of Return (CAIRN)



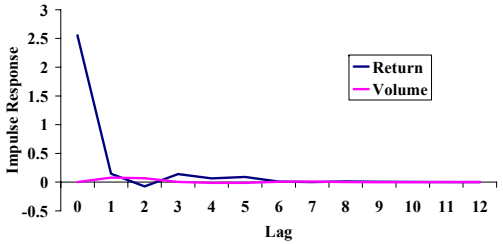
Impulse Response Function of Return (DLF)



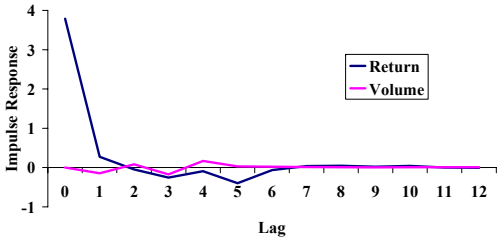
Impulse Response Function of Return (GAIL)



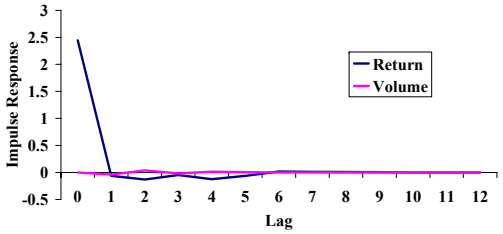
Impulse Response Function of Return (GRASIM)



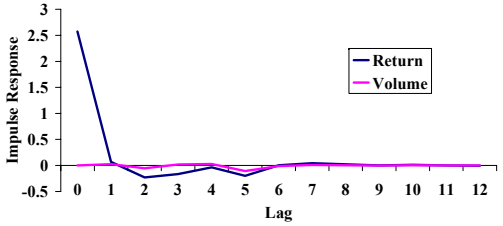
Impulse Response Function of Return (HCL)



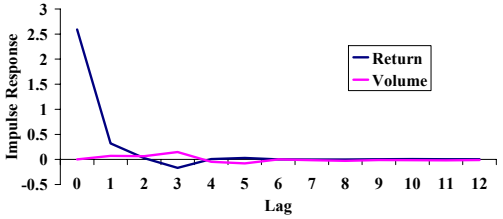
Impulse Response Function of Return (HDFC)



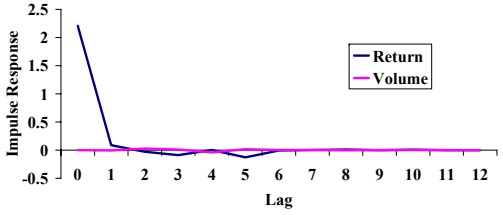
Impulse Response Function of Return (HDFCORP)



Impulse Response Function of Return (HINDALCO)



Impulse Response Function of Return (HLL)



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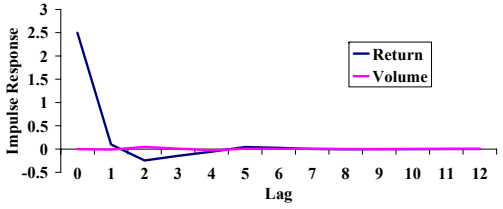
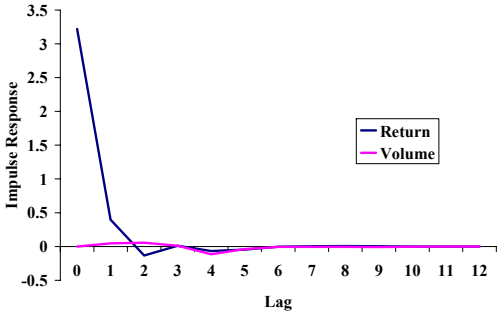
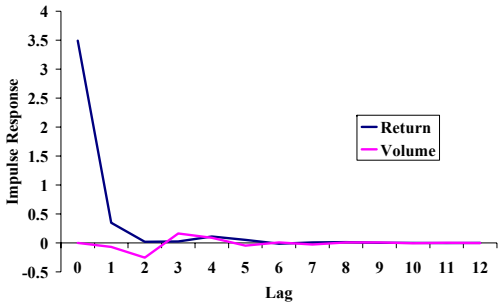


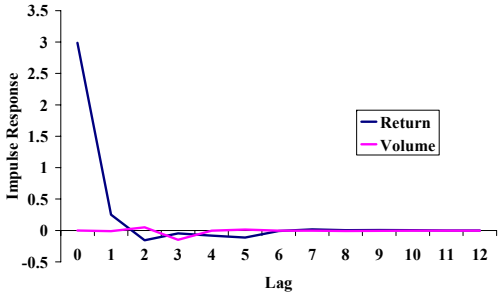
Impulse Response Function of Return (ICICI)



Impulse Response Function of Return (IDEA)



Impulse Response Function of Return (INFOSYS)



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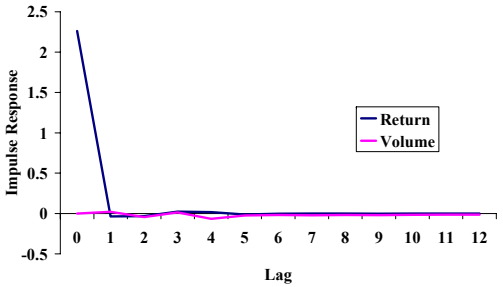
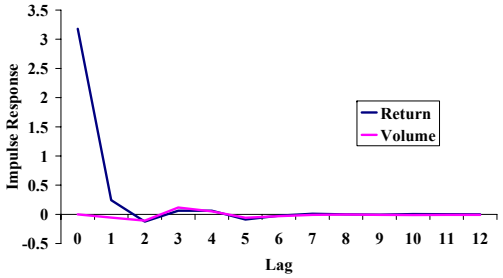
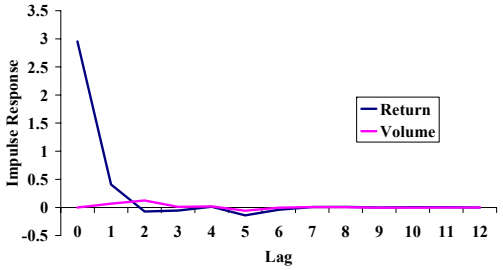


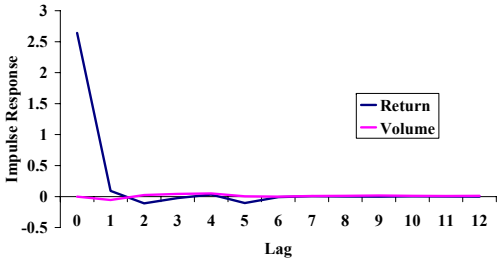
Impulse Response Function of Return (L&T)



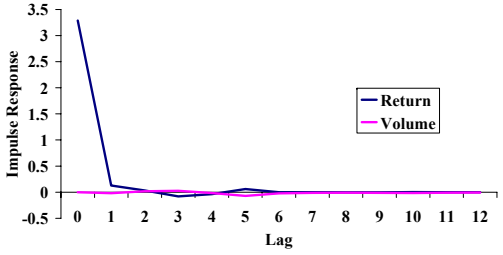
Impulse Response Function of Return (M&M)



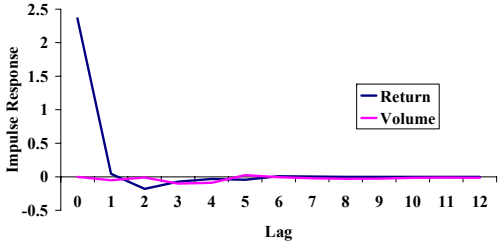
Impulse Response Function of Return (MARUTI)



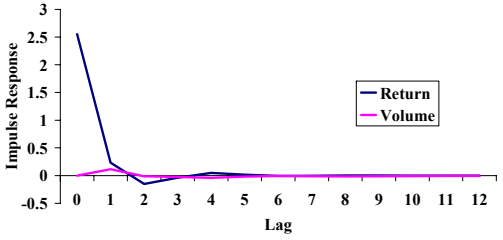
Impulse Response Function of Return (NALCO)



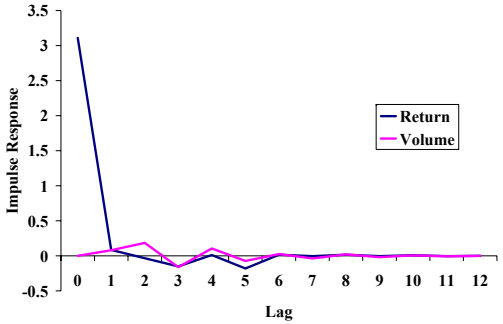
Impulse Response Function of Return (NTPC)



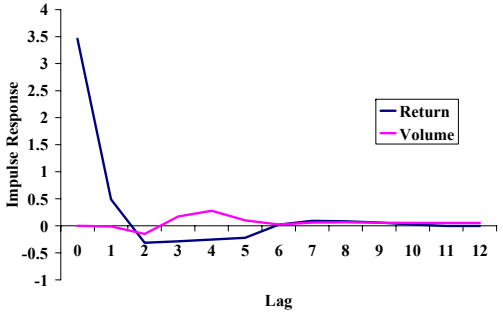
Impulse Response Function of Return (ONGC)



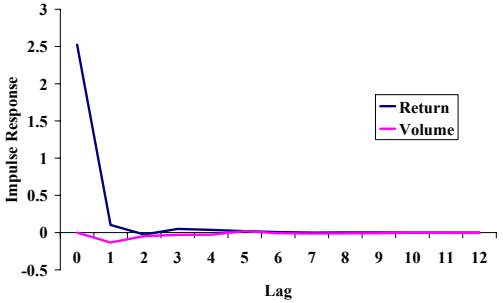
Impulse Response Function of Return (PNB)



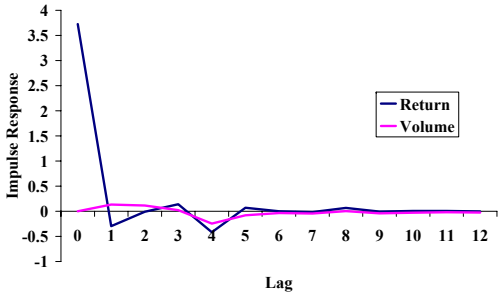
Impulse Response Function of Return (Power Grid)



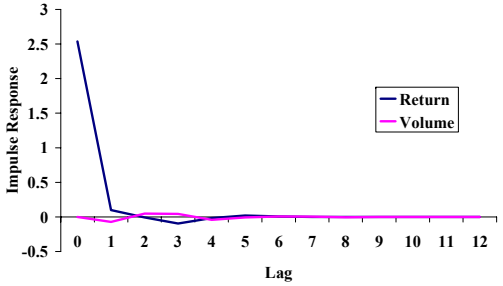
Impulse Response Function of Return (RANBAXY)



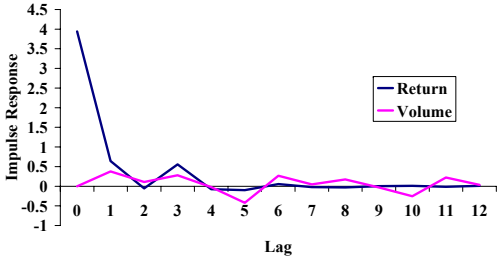
Impulse Response Function of Return (RCOMM)



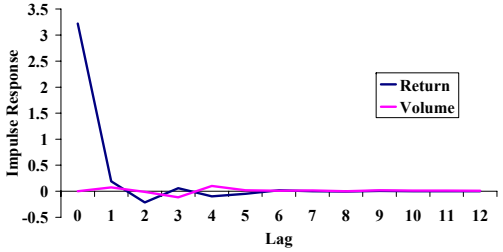
Impulse Response Function of Return (RELIANCE)



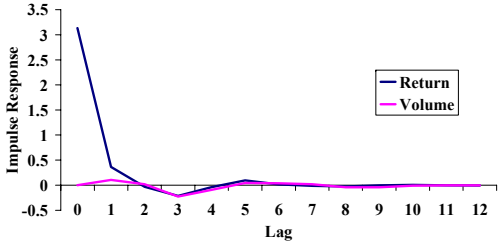
Impulse Response Function of Return (RELIANCE POWER)



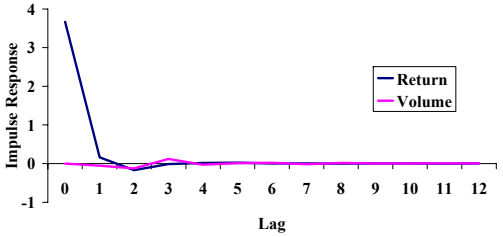
Impulse Response Function of Return (RELIANCE INFRA)



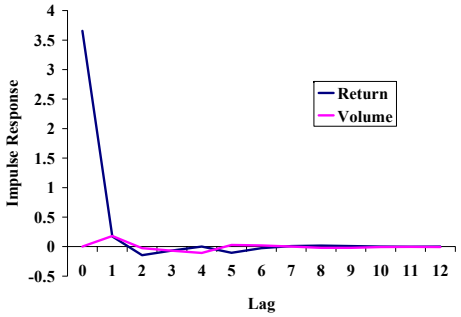
Impulse Response Function of Return (RELIANCE PETRO)



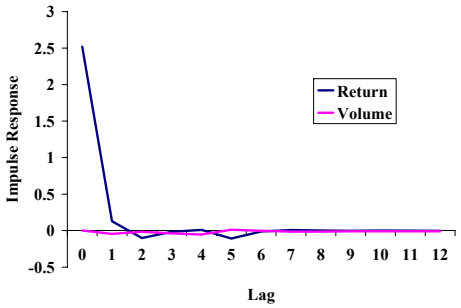
Impulse Response Function of Return (SAIL)



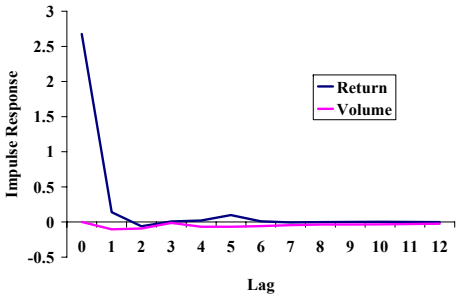
Impulse Response Function of Return (SATYAM)



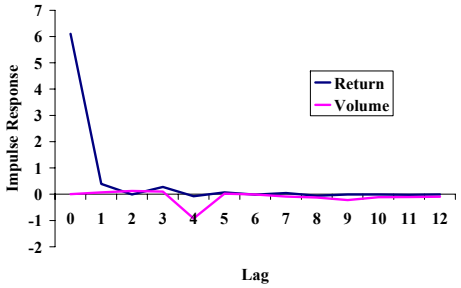
Impulse Response Function of Return (SBI)



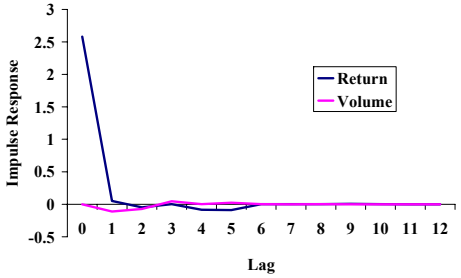
Impulse Response Function of Return (SIEMENS)



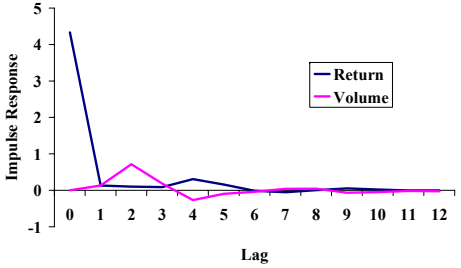
Impulse Response Function of Return (STERLITE)



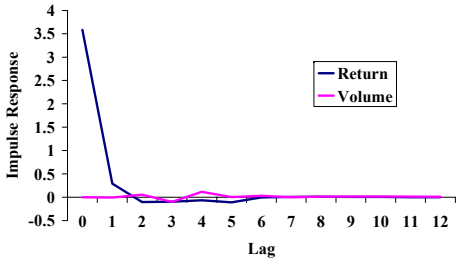
Impulse Response Function of Return (SUN PHARMA)



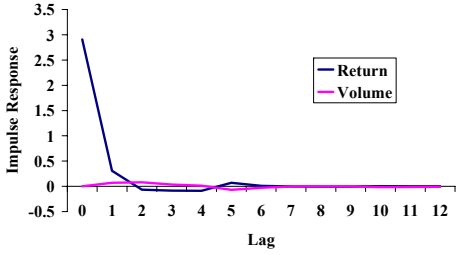
Impulse Response Function of Return (SUZLON)



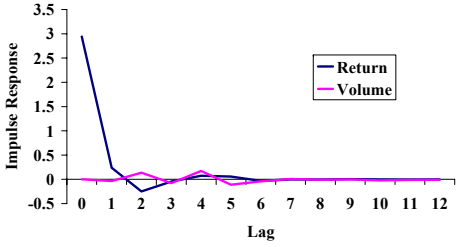
Impulse Response Function of Return (TATACOMM)



Impulse Response Function of Return (TATA MOTORS)



Impulse Response Function of Return (TATA POWER)



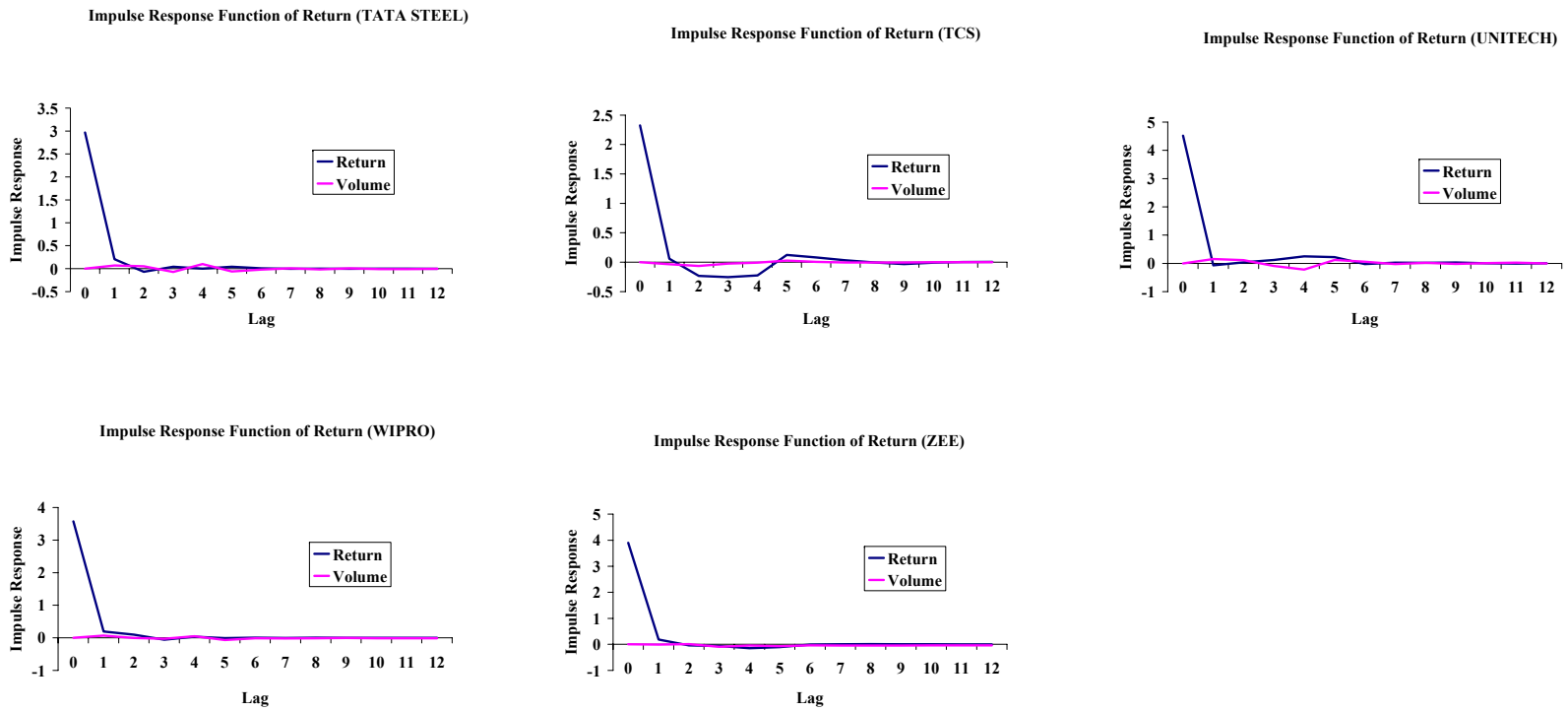
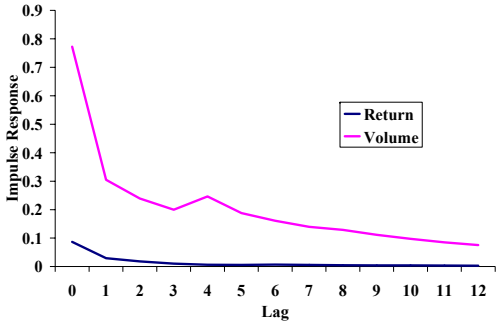


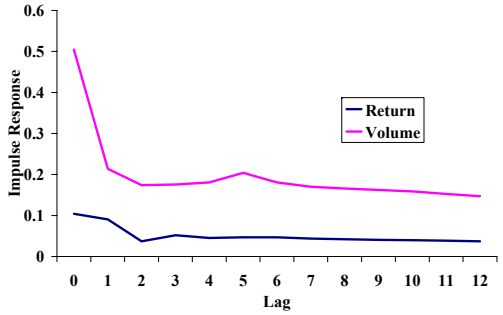
Figure 1: Impulse Response Function of Returns to Shock in Returns and Volume of all the 50 Stocks

Appendix B

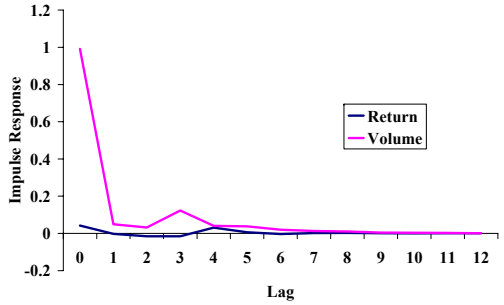
Impulse Response Function of Volume (ABB)



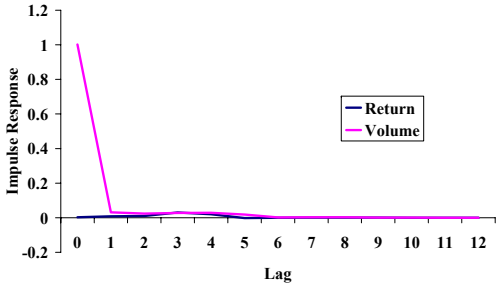
Impulse Response Function of Volume (ACC)



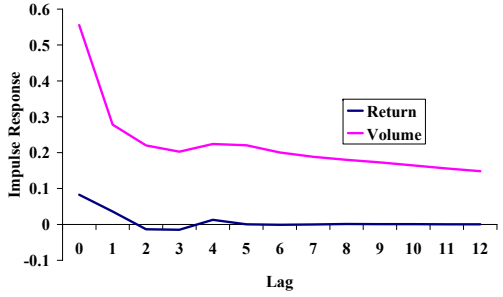
Impulse Response Function of Volume (AMBUJA)



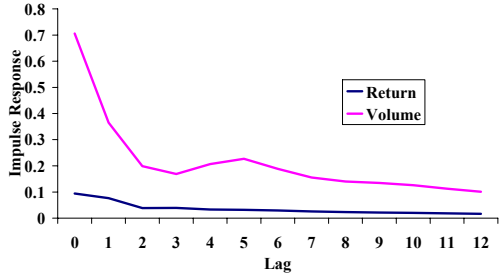
Impulse Response Function of Volume (BHARTI)



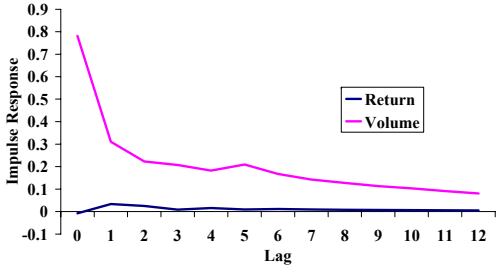
Impulse Response Function of Volume (BHEL)



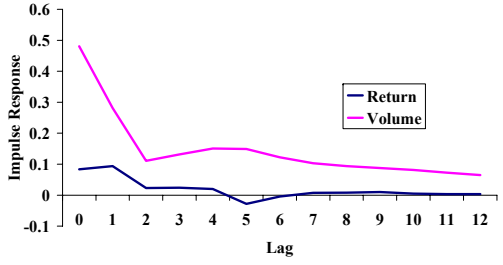
Impulse Response Function of Volume (BPCL)



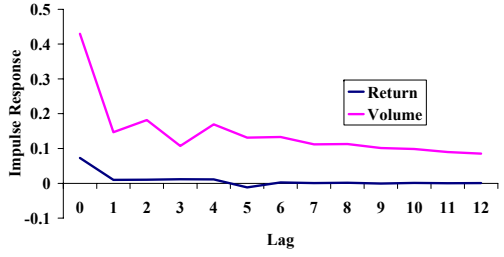
Impulse Response Function of Volume (CIPLA)



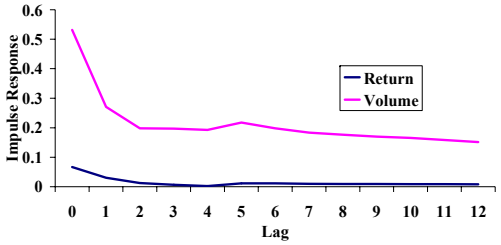
Impulse Response Function of Volume (CAIRN)



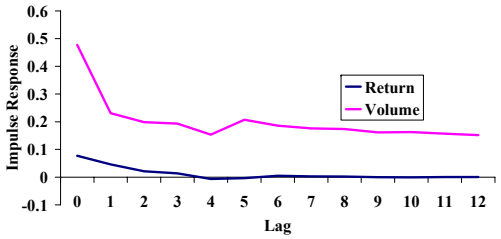
Impulse Response Function of Volume (DLF)



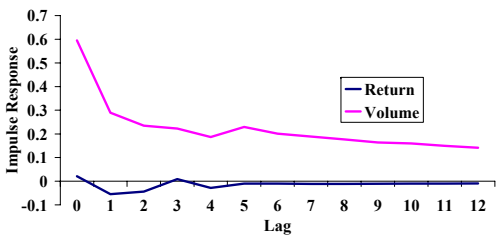
Impulse Response Function of Volume (GAIL)



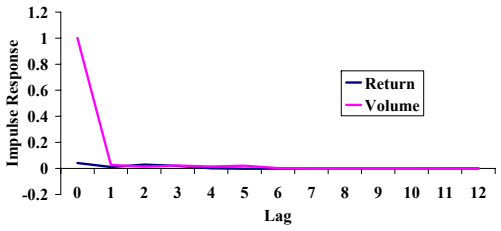
Impulse Response Function of Volume (GRASIM)



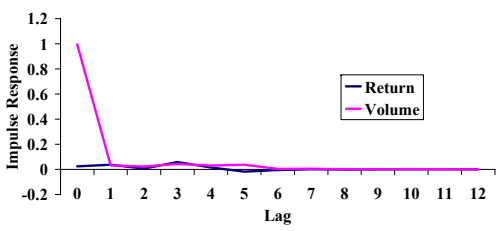
Impulse Response Function of Volume (HCL)



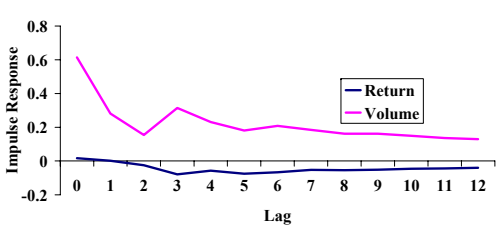
Impulse Response Function of Volume (HDFC)



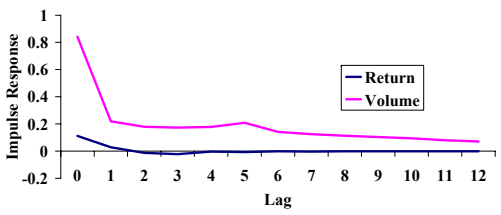
Impulse Response Function of Volume (HDFCORP)



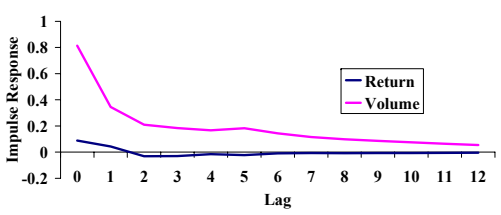
Impulse Response Function of Volume (HINDALCO)



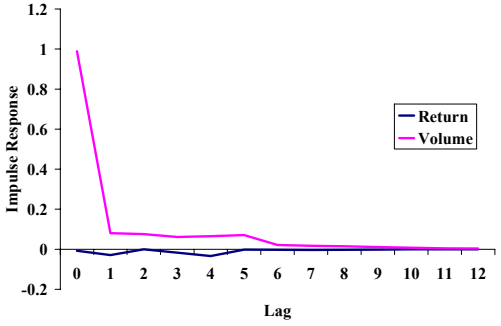
Impulse Response Function of Volume (HLL)



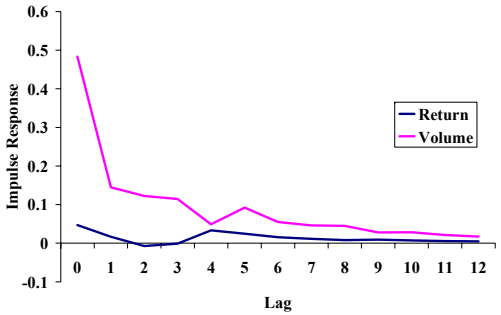
Impulse Response Function of Volume (HONDA)



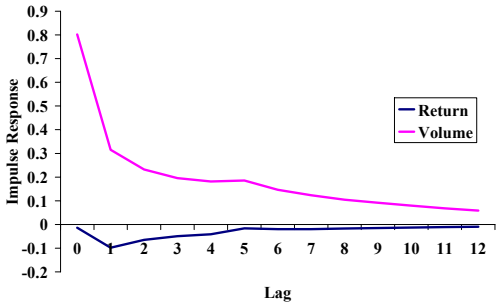
Impulse Response Function of Volume (ICICI)



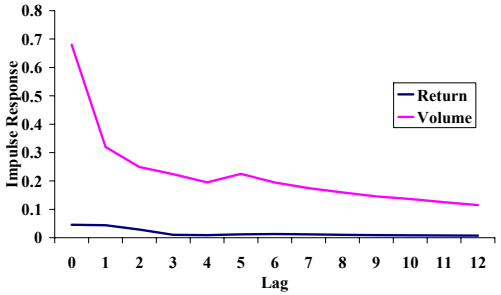
Impulse Response Function of Volume (IDEA)



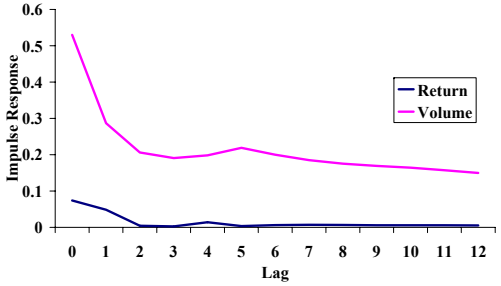
Impulse Response Function of Volume (INFOSYS)



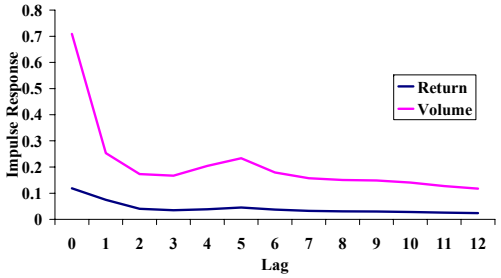
Impulse Response Function of Volume (ITC)



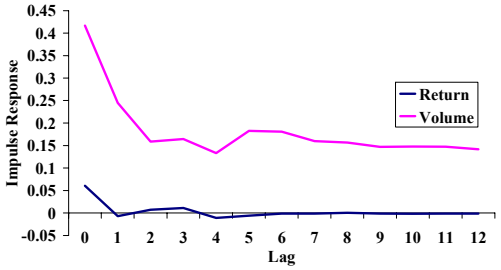
Impulse Response Function of Volume (L&T)



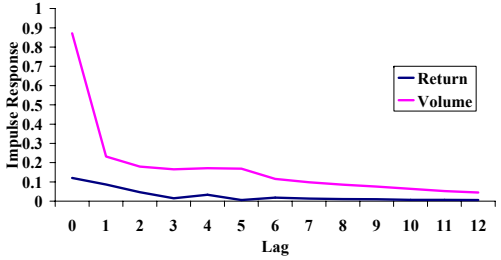
Impulse Response Function of Volume (M&M)



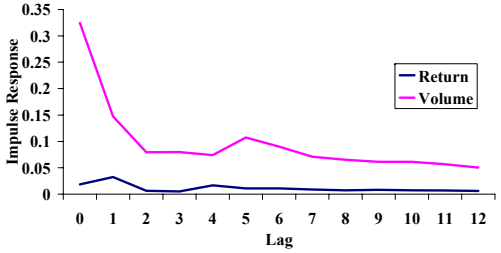
Impulse Response Function of Volume (MARUTI)



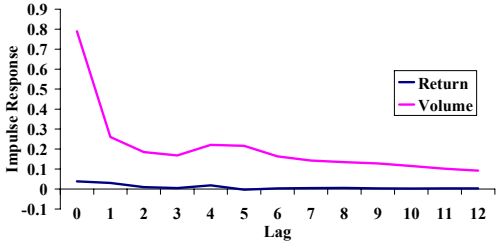
Impulse Response Function of Volume (NALCO)



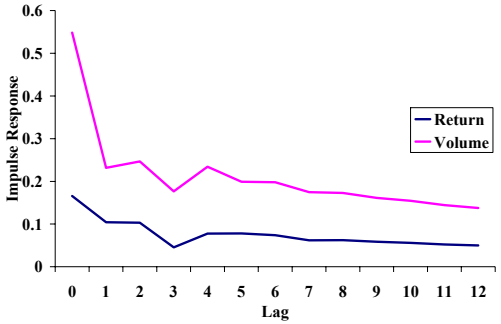
Impulse Response Function of Volume (NTPC)



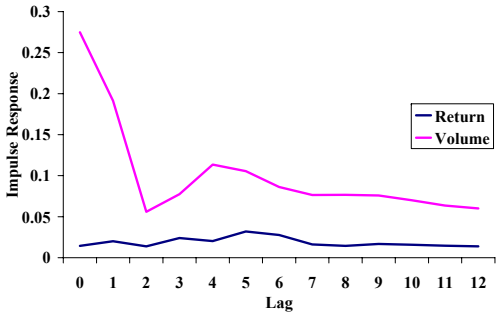
Impulse Response Function of Volume (ONGC)



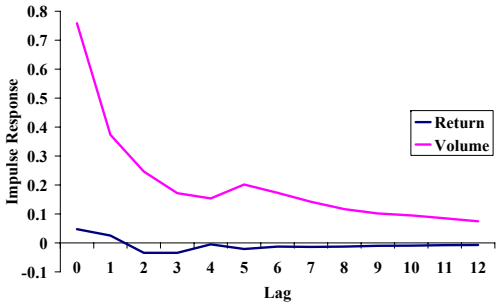
Impulse Response Function of Volume (PNB)



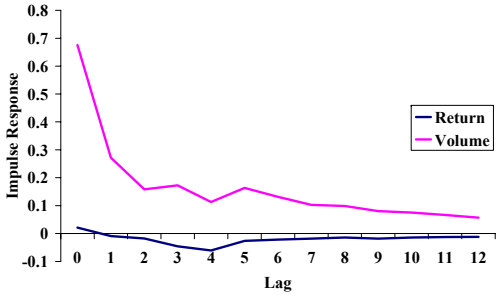
Impulse Response Function of Volume (Power Grid)



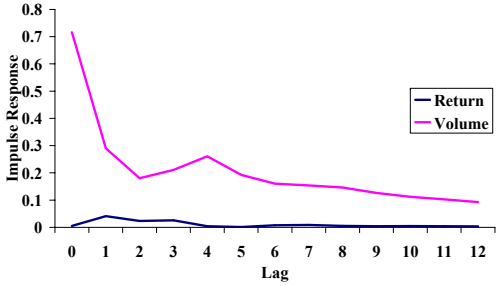
Impulse Response Function of Volume (RANBAXY)



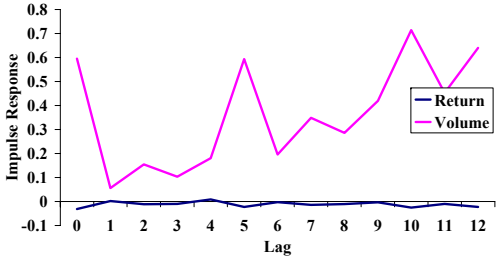
Impulse Response Function of Volume (RCOMM)



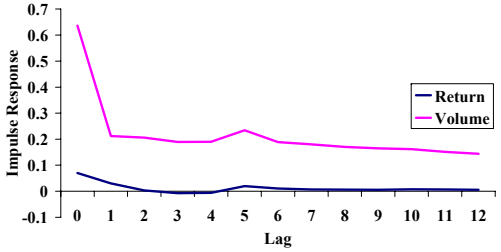
Impulse Response Function of Volume (RELIANCE)



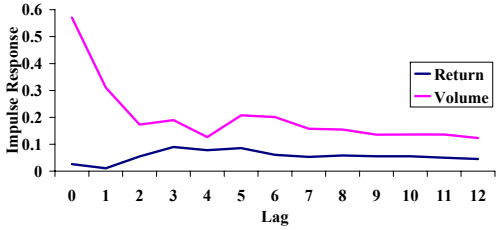
Impulse Response Function of Volume (RELIANCE POWER)



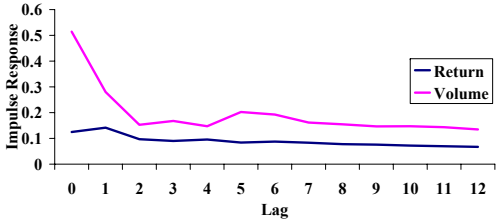
Impulse Response Function of Volume (RELIANCE INFRA)



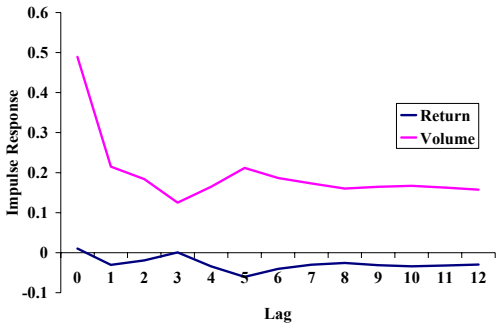
Impulse Response Function of Volume (RELIANCE PETRO)



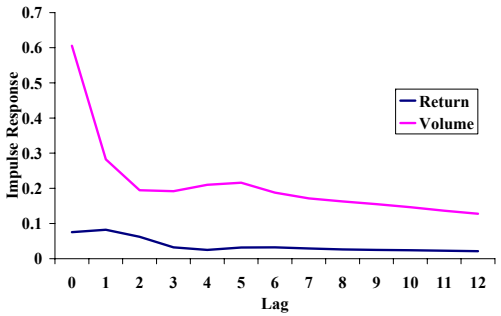
Impulse Response Function of Volume (SAIL)



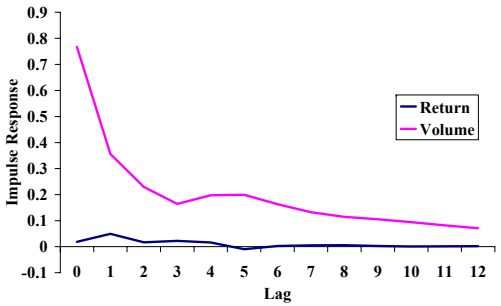
Impulse Response Function of Volume (SATYAM)



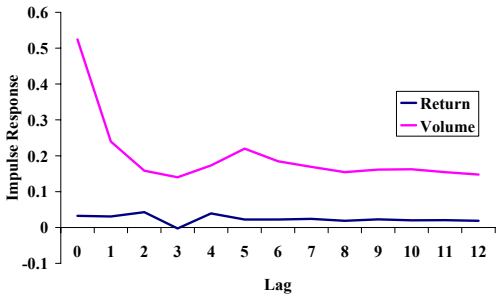
Impulse Response Function of Volume (SBI)



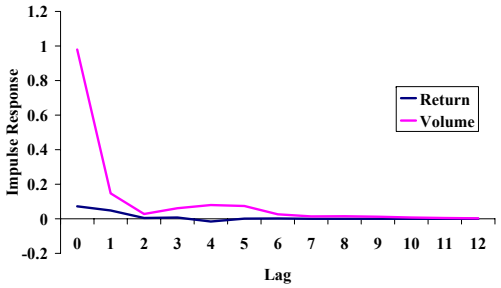
Impulse Response Function of Volume (SIEMENS)



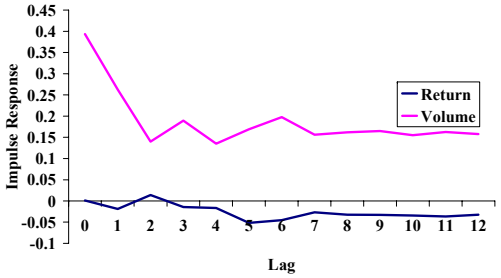
Impulse Response Function of Volume (STERLITE)



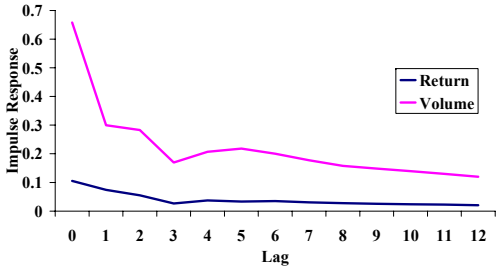
Impulse Response Function of Volume (SUN PHARMA)



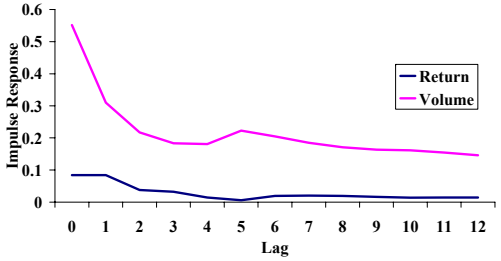
Impulse Response Function of Volume (SUZLON)



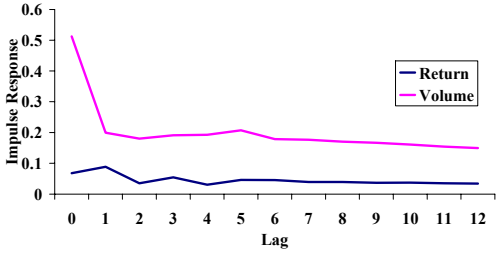
Impulse Response Function of Volume (TATACOMM)



Impulse Response Function of Volume (TATA MOTORS)



Impulse Response Function of Volume (TATA POWER)



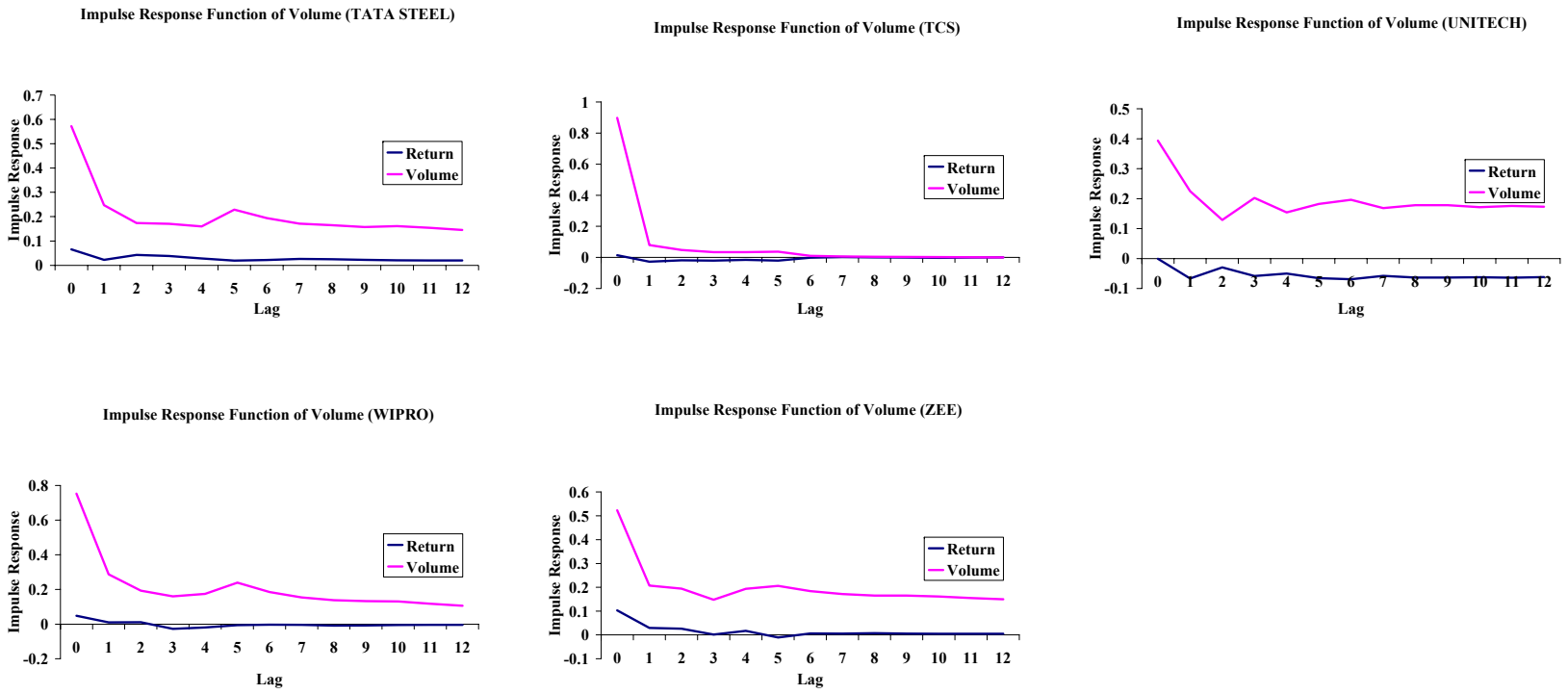


Figure 2: Impulse Response Function of Volume to Shock in Returns and Volume of all the 50 Stocks

Appendix B

Table: Relationship between Standardized Trading Volume and Unconditional Volatility

This table provides the coefficient estimates from regressions of trading volume against unconditional volatility and asymmetric coefficient of the OLS equation $V_t = \alpha + \beta_1 r_t^2 + \beta_2 D_t r_t^2$, where V_t = standardized trading volume at time t, r_t is the return at time t and D_t=1 when r_t <0 and D_t=0 when $r_t \geq 0$. Three measures of trading volume, the daily total dollar value of shares traded (value), the daily number of shares traded (volume) and the daily number of equity trades (trade) are considered. Parameter estimates of all 50 companies are presented.

	Value				Volume				Trade			
Company	**α**	**β_1**	**β_2**	**RSQ**	**α**	**β_1**	**β_2**	**RSQ**	**α**	**β_1**	**β_2**	**RSQ**
ABB	-0.06*	1.38*	-0.78*	0.019	-0.12*	2.77*	-1.42*	0.083	-0.11*	2.48*	-1.15*	0.071
ACC	-0.10*	2.01*	-1.32*	0.053	-0.11*	2.34*	-1.74*	0.067	-0.12*	2.48*	-1.64*	0.081
AMBUJA	-0.02	0.50**	-0.38	0.002	-0.02	0.46**	-0.33	0.002	-0.12*	2.28*	-0.74*	0.067
BHARTI	-0.04	0.33	0.41	0.007	-0.04	0.44**	0.10	0.006	-0.17*	1.83*	0.86*	0.125
BHEL	-0.09*	1.45*	-0.72*	0.049	-0.12*	1.87*	-0.97*	0.080	-0.10*	1.44*	-0.52*	0.056
BPCL	-0.12*	1.65*	-0.75*	0.080	-0.13*	1.62*	-0.44*	0.095	-0.13*	1.58*	-0.44*	0.089
CIPLA	-0.15*	3.43*	-1.36*	0.135	-0.11*	1.85*	0.39	0.087	-0.15*	2.85*	-0.28	0.138
CAIRN	-0.10*	1.20*	-1.02*	0.056	-0.10*	0.99*	-0.79*	0.065	-0.12*	1.25*	-0.90*	0.068
DLF	-0.03	0.00	-0.02	0.000	-0.04	0.00	0.11	0.004	-0.04	0.00	0.18	0.006
GAIL	-0.04*	0.78*	-0.56*	0.033	-0.05**	0.98*	-0.76*	0.048	-0.06*	1.02*	-0.77*	0.053
GRASIM	-0.07*	1.62*	-1.10*	0.034	-0.08*	1.69*	-0.95*	0.040	-0.12*	2.44*	-1.28*	0.085
HCL	-0.14*	1.16*	-0.45*	0.099	-0.14*	1.03*	-0.19	0.095	-0.15*	1.08*	-0.16	0.108
HDFC	-0.02	0.37**	-0.16	0.003	-0.01	0.35**	-0.23	0.003	-0.07*	1.21*	-0.08	0.051
HDFCORP	-0.06*	0.76*	0.26	0.019	-0.05**	0.70*	0.04	0.013	-0.18*	2.43*	0.52**	0.175
HINDALC	-0.14*	2.59*	-1.00*	0.140	-0.21*	3.75*	-1.42*	0.295	-0.19*	3.04*	-0.61*	0.246
HLL	-0.14*	4.09*	-2.64*	0.120	-0.09*	2.75*	-1.80*	0.054	-0.14*	3.82*	-1.82*	0.118
HONDA	-0.05*	0.98*	-0.35	0.014	-0.09*	1.84*	-0.78*	0.048	-0.11*	1.65*	0.07	0.051
ICICI	-0.10*	0.82*	0.20	0.056	-0.06**	0.49*	0.09	0.019	-0.15*	1.17*	0.48*	0.136
IDEA	-0.04	0.23	-0.37	0.005	-0.07**	0.38**	-0.25	0.011	-0.08*	0.63*	-0.44	0.025
INFOSYS	-0.10*	1.55*	-0.89*	0.070	-0.10*	1.48*	-0.63*	0.085	-0.12*	1.77*	-0.82*	-0.12
ITC	-0.18*	3.70*	-0.49	0.161	-0.11*	2.25*	-0.37	0.058	-0.16*	3.35*	-0.68**	-0.16
L&T	-0.12*	3.08*	-3.05*	0.116	-0.10*	2.48*	-2.46*	0.075	-0.10*	2.60*	-2.57*	-0.10
M&M	-0.01	0.37**	-0.55*	0.004	-0.04	0.76*	-0.70*	0.014	-0.06*	1.06*	-0.81*	0.028
MARUTI	-0.11*	2.03*	-1.04*	0.053	-0.10*	1.85*	-1.01*	0.048	-0.12*	2.13*	-0.96*	0.062
NALCO	-0.07*	1.04*	-0.80*	0.038	-0.07*	1.07*	-0.80*	0.041	-0.10*	1.28*	-0.66*	0.073
NTPC	-0.16*	2.47*	0.15	0.194	-0.09*	1.15*	0.01	0.096	-0.21*	3.52*	0.22	0.299
ONGC	-0.04	0.59*	0.14	0.014	-0.06**	0.89*	0.05	0.026	-0.08*	1.11*	0.16*	0.044
PNB	-0.14*	2.04*	-1.44*	0.113	-0.18*	2.58*	-1.70*	0.187	-0.17*	2.37*	-1.44*	0.164
POWER&G	-0.16	2.00	-1.82	0.139	-0.18*	2.07*	-1.83*	0.179	-0.19*	2.28*	-1.93*	0.168
RANBAXY	-0.13*	2.69*	-1.38*	0.110	-0.15*	3.05*	-1.30*	0.158	-0.15*	3.14*	-1.39*	0.162
RCOMM	-0.08**	0.68	-0.39	0.030	-0.14*	1.14*	-0.52*	0.113	-0.16*	1.42*	-0.58*	0.160
RELIANC	-0.11*	1.93*	-0.43**	0.144	-0.11*	2.38*	-1.19*	0.123	-0.13*	2.49*	-0.87*	0.184
RPOWER	-0.02	0.02	0.19	0.002	-0.02	-0.01	0.30	0.003	-0.03	0.06	0.22	0.003
RINFRA	-0.11*	1.40*	-0.75*	0.102	-0.12*	1.74*	-1.07*	0.141	-0.12*	1.47*	-0.69*	0.124
RPETRO	-0.17*	2.08*	-0.77*	0.215	-0.20*	2.43*	-1.04*	0.294	-0.18*	2.28*	-0.94*	0.238
SAIL	-0.09*	0.75*	-0.10	0.062	-0.12*	0.98*	-0.21	0.102	-0.11*	0.75*	0.17	0.082

SATYAM	-0.11*	1.23*	-0.75*	0.077	-0.12*	1.20*	-0.53*	0.098	-0.16*	1.34*	-0.32*	0.174
SBI	-0.12*	2.29*	-0.80*	0.069	-0.13*	2.48*	-1.04*	0.074	-0.14*	2.62*	-0.79*	0.096
SIEMENS	-0.10*	1.68*	-0.56*	0.064	-0.16*	1.75*	0.79*	0.166	-0.14*	1.78*	0.25	0.122
STERLIT	-0.07*	0.89*	-0.88*	0.045	-0.07*	0.94*	-0.94*	0.057	-0.06*	0.83*	-0.83*	0.041
SUNPHAR	-0.05**	0.80*	-0.25	0.011	-0.05**	0.87*	-0.42	0.012	-0.15*	2.43*	-0.54**	0.110
SUZLON	-0.12*	1.14*	-1.02*	0.162	-0.13*	1.29*	-1.04*	0.164	-0.15*	1.37*	-1.06*	0.221
TATACOM	-0.05**	0.76*	-0.73*	0.026	-0.05**	0.75*	-0.67*	0.026	-0.06*	0.82*	-0.70*	0.032
TATAMOT	-0.03	0.60*	-0.57*	0.005	-0.10*	1.83*	-1.32*	0.046	-0.08*	1.33*	-0.66*	0.031
TATAPOW	-0.13*	1.72*	-0.48*	0.128	-0.09*	1.25*	-0.43*	0.063	-0.11*	1.42*	-0.26	0.097
TATASTE	-0.09*	1.41*	-0.68*	0.042	-0.12*	1.90*	-1.01*	0.072	-0.17*	2.29*	-0.63*	0.149
TCS	-0.05	0.68**	-0.05	0.008	-0.08**	1.25*	-0.11	0.028	-0.16*	2.38*	0.48	0.173
UNITECH	-0.06**	0.48*	-0.42*	0.034	-0.09	0.75	-0.59	0.104	-0.09*	0.73*	-0.59*	0.093
WIPRO	-0.10*	0.95*	-0.39*	0.059	-0.09	0.88	-0.36	0.051	-0.12*	1.08*	-0.32*	0.087
ZEE	-0.08*	0.74*	-0.47*	0.035	-0.11	1.15	-0.81	0.075	-0.11*	1.19*	-0.81*	0.083