Investigation of Causal Relationship between Stock Prices and Trading Volume using Toda and Yamamoto Procedure

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Abstract

The present study probes the relationship between the stock prices and trading volume. For achieving this purpose, daily data of adjusted closing stock prices, trading volume of 39 individual securities and S&P CNX Nifty from January 1, 1998 to May 31, 2013 have been used. In this study, instead of applying ordinary Granger causality test to investigate the relationship between stock prices and trading volume, Toda and Yamamoto (1995) procedure has been applied for analyzing the data. Lag length chosen by AIC and FPE criterion has been insured by running Lagrange Multiplier (LM) test and causality determined by Toda and Yamamoto test has also been confirmed by using VAR methodology. Although, Toda and Yamamoto and VAR test produced little dissimilar results, nevertheless, the empirical analysis provides sufficient grounds to declare the presence of interaction between stock prices and trading volume.

***Keywords:** Stock Returns, Trading Volume, Causal Relationship, Toda and Yamamoto Procedure, Vector Autoregression*

***JEL Code Classification**: C32, G10, G19*

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1. Introduction

The Indian stock markets exhibit greater volatility compared with many other emerging and developed markets of the world such as China, Russia, Brazil, USA etc. Volatility oscillates the volume of trade in the market which impacts stock price and ultimately the stock returns. Therefore, it becomes imperative to understand the inter-relationship between the trading volume and stock returns which may help investors to identify the future patterns of the stock market for effective decision making. Stock's price-volume relation can also be used for the formation of trading strategies for maintaining the efficiency of the stock markets. Theoretically, low volume makes the market illiquid which causes low price fluctuation whereas high volume usually implies that the market is highly liquid, resulting in high price variability that lessens the price effect of large trades. In general, with an increase in volume, broker revenue increases, and market makers have greater opportunity for profit as a result of higher turnover. Many researches have been performed worldwide on the different stock markets, especially in the USA, to investigate the relationship between stock return/price and trading volume. Karpoff (1987) summarised the importance of understanding this relationship to predict various volume-price/return relations that depend on the level of information and the extent to which market prices/volumes convey this information. Researchers in this field have scrutinized the volume-price/return relationship in a variety of contexts and by employing a range of econometric techniques. Early studies examined the correlation between volume and the price change as well as volume and the absolute value of the price change (Granger and Morgenstern (1963), Godfrey et al., (1964), Crouch (1970)). More recent studies were interested in investigating the causal relationship between these two market variables (Smirlock and Starks, 1988; Chordia and Swaminathan, 2000; Chen et al., 2001). The linear and non-linear causality between the stock prices and trading volume has also received a substantial amount of attention in the literature (Campbell et al., 1993; Martikainen et al., 1994; Hiemstra and Jones, 1994) but most of these researches have focused almost exclusively on the well-developed financial markets, usually the U.S. markets. Taking clue from the earlier studies, this study makes an attempt to empirically investigate the interaction between stock prices and trading volume by using a unique and more refined technique called Toda and Yamamoto procedure. This new and more precise econometric model on more recent data would be helpful in reaching on the conclusion regarding relationship between stock prices and trading volume in the Indian Stock Market.

2. Literature Review

Granger and Morgenstern (1963) were the founding members of conducting empirical analysis of volume-price relationship. They revealed that there is no correlation between prices or absolute price changes and volumes using weekly or daily transaction data for the stock market price index and for individual stocks. Karpoff (1987) proposed a simple model of the price-volume relationship called

"asymmetric volume-price change hypothesis", showing that the relationship is fundamentally different for positive and negative price changes. Smirlock and Starks (1988) empirically examined the lagged relationship between the absolute price changes and volume in the equity markets and investigate the implications of this relationship for the microstructure of these markets. Using Granger causality tests their results indicate that there is a significant causal relationship between absolute price changes and volume at the firm level. Furthermore, relationship is stronger in periods surrounding earning announcements. Blume et al. (1994) also studied and developed a model that links trading volume to stock price behavior. The major implication of their model is that investors who focus on past trading volume can obtain additional profits and perform better return than those who use only price measures. Hiemstra and Jones (1994) used nonlinear Granger causality test to examine the nonlinear causal relation between the percentage changes in the NYSE trading volume and stock returns and found positive nonlinear bidirectional relationship between returns and volume. Bhagat and Bhatia (1996) also employed daily and weekly data to test the causal relationship between volume and return, finding return causes volume but not vice versa. Saatcioglu and Starks (1998) used monthly data taken from the six Latin American stock markets to test the relation between price changes and volume. They found a positive price-volume and a causal relationship from volume to stock price changes but not vice versa. Chordia and Swaminathan (2000) found that past trading volume can be used to predict the future stock price momentum. Ratner and Leal (2001) examined the Latin American and Asian financial markets and found a positive contemporaneous relation between return and volume in these countries except India. At the same time they observed that there exists a bi-directional causal relation between return and volume. In summary, the return and volume are strongly related contemporaneously but there is a little evidence that either can be used to predict the other. Similarly, Llorente et al. (2002) used the simple model to explore the dynamic relation between volume and returns. According to their model, returns generated by hedging-motivated trades reverse themselves, while returns generated by speculation-motivated trades tend to continue themselves. Their empirical results support the predictions of the model on the nature of the dynamic volume-return relation. De Medeiros and Doornik (2006), Zolontoy and Melenberg (2007) and Sabri (2008) also investigated the empirical relationship between stock returns, return volatility and trading volume in the various stock markets and found the support for a contemporaneous as well as dynamic relationship between the stock returns and trading volume. Mahajan and Singh (2009) studied the relationship between return, volume and volatility dynamics by using Indian sensitivity index Sensex and evidenced the presence of sequential arrival of information due to the direction of causality from volatility to volume. Besides this, inclusion of trading volume in the GARCH (1, 1) model slightly brought down the volatility persistence and confirmed its prominent role in the precision and dispersion of information signals. A more recent study by Mehrabanpoor et al.,

(2011) investigated the empirical relationship between the stock indices and volume in the Tehran Stock Exchange. Using monthly indices, value and turnover for the period from 2003 to 2009, they proved that there is positive relationship between exchange turnover value and stock exchange indices in the Tehran Stock Exchange. A Similar study by Tripathy (2011) explored the relationship between trading volume and stock returns using data from the Indian Stock Market during the period from January 2005 to January 2010. By using Bivariate Regression model, VECM Model, VAR, IRF and Johansen's cointegration test, his findings support the existence of significant contemporaneous relationship between return volatility and trading volume indicating that information may flow simultaneously rather than sequentially into the market. Moreover, the study also found that the trading volume is associated with an increase in return volatility and that this relationship is asymmetrical. This implied that daily new information in the market may have a significant impact on price volatility, which indicates that the bad news generates more impact on volatility of the stock return and trading volume. Darwish (2012) studied the causal relationship between return and trading volume in the Palestine Stock Exchange. The author has used weekly trading volume and returns over the period from October 2000 to August 2010 and employed GARCH (1,1) model to test the existence of the positive contemporaneous relationship. The study found that the relationship preserves after taking heteroskedasticity into account. Moreover, the results of the Granger causality test show that there is bidirectional Granger causality between returns and trading volume regardless of the measures of trading volume used.

3. Research Methodology

3.1. Data Source and Time Period

The National Stock Exchange was incorporated in the year 1992 and is a well diversified 50 stock index answering for 22 sectors of the economy. It is used for a variety of purposes such as benchmarking fund portfolios, index based derivatives and index funds and promoted by the leading financial institutions. Due to the NSE's tremendous growth (in terms of turnover as well as number of contracts) and its 'CCR AAR' rating assigned by CRISIL[1], present study uses the historical data of NSE. As far as financial market is concerned, investors immediately react (buying/selling) on arrival of new information and trading volume is the result of buying and selling which eventually impacts the security prices. The main objective of the present study is to identify the interaction between stock prices and trading volume and to accomplish the same, adjusted closing prices and trading volume data of 39 individual securities and S&P CNX Nifty for the period from January 1, 1998 to May 31, 2013 have been taken into account. It is pertinent to mention here that only those securities have been considered wherein trading had started on or

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[1] CNX Nifty. Retrieved from http://www.nseindia.com/products/content/equities/indices/cnx_nifty.htm as on December 28, 2013.

before the year 2005 and the complete dataset have been retrieved from the renowned database CMIE PROWESS. Data collected from the above mentioned sources have been analyzed using the Toda and Yamamoto Procedure. Steps for applying the Toda and Yamamoto procedure are as follows:

The returns of the stock prices are calculated as given in equation (1) below:

$$R_t = ln\,(P_t/P_{t-1}) \tag{1}$$

In Equation (1), $ln\,P_t$ stands for natural logarithm of the present closing price of securities and $ln\,P_{t-1}$ is the natural logarithm of the previous day's closing prices. Trading volume is used to depict the amount of buying and selling that has taken place at particular price. For the present study, instead of considering raw values of trading volumes, their logarithm has been considered to enhance normality in the data by following the equation (2).

$$V_t = ln\,Vol_t \tag{2}$$

In Equation (2), $ln\,Vol_t$ stands for natural logarithm of the shares traded (i.e. volume) at time t.

3.2 Unit Root Test

The present study deals with the time series data that is generally found non-stationary and presence of the same makes hypothesis tests' results undependable. Existence of non stationarity or unit root in the dataset is checked by practicing ADF (Augmented Dickey Fuller) and PP (Phillips-Perron) tests. Appropriate lag length for the above mentioned two tests is determined by following the AIC and SIC criterions.

3.3 Toda and Yamamoto Procedure

This section of the study highlights the econometric technique used to study the causal relationship between the volume and closing prices. Ordinarily, a statistical approach proposed by Clive W Granger (1969) known as Granger causality is used to infer cause and effect relationship between the two (or more) time series. The test uses the following Vector Autoregression (VAR) model: -

$$P_i = \alpha_0 + \sum_{i=1}^{n} \alpha_i\,V_{t-i} + \sum_{j=1}^{n} \beta_j\,P_{t-j} + \mu_{1t} \tag{3}$$

$$V_i = \delta_0 + \sum_{i=1}^{n} \delta_i\,V_{t-i} + \sum_{j=1}^{n} \gamma_j\,P_{t-j} + \mu_{2t} \tag{4}$$

In Equation (3), P_i is the log normal daily closing price series and V_i is the log normal daily traded volume. $\alpha_i, \beta_j,\ \delta_i, \gamma_j$ are the coefficients of the respective variables and μ_{1t} , μ_{2t} are the error terms assumed to be uncorrelated. Causality from volume to closing prices and closing prices to volume is confirmed if the estimated coefficient on the lagged V_i and P_i are found statistically different from zero($i.e. \sum \alpha_i = \sum \gamma_j \neq 0$). The Granger causality test is conventionally run by estimating the Vector Autoregressive (VAR) models but according to Granger

Representation Theorem, first of all cointegration test must be run if the series are I(1) or integrated of the same order as at least unidirectional causality must exist in either way but the same test fails to play eminent role if the series are not I(1) or integrated of different orders such as one is I(N) and the other is different from I(N) say I(N+1) or I(N-1). However, Granger causality test can be conducted in an unrestricted VAR model to test the linear restrictions on the parameters of a model, usually by the help of Wald statistic (or F-statistic) but not advised by Phillips and Toda (1993) as Wald test statistics' distribution do not follow its usual asymptotic chi-square distribution and involves 'nuisance parameters' that you can't observe, and so it is totally non-standard. Besides this, Granger causality test depends critically on the number of lagged terms introduced in the model. Due to the presence of above mentioned limitations, the present study adopts a substitute model to the estimation of an unrestricted VAR, popularly known as Toda and Yamamoto (1995) procedure that guarantees the asymptotic distribution of the Wald statistic (an asymptotic χ^2 -distribution), since the testing procedure is robust to the integration and co-integration properties of the process.

3.4. Steps involved in Toda and Yamamoto Procedure

Toda and Yamamoto (1995) procedure includes two steps wherein first step involves the identification of the maximum order of integration for the variables in the model. For this purpose, this study uses the Augmented Dickey fuller (ADF) and Phillips-Perron (PP) tests to identify the maximum order of integration assigned a symbol(ρ_{max}). ρ_{max} is equal to N if both variables in the time series are found $I(N)$ or one of the variables is found $I(N)$ and the other one is found $I(N-1)$. Present study runs ADF and PP tests by taking the lag length suggested by AIC (Akaike Information Criterion). Second step involves the determination of the appropriate maximum lag length for the variables in the VAR, say(k) using the two usual information criterions i.e. AIC (Akaike Information Criterion) and Final Prediction Error (FPE). The motive behind choosing the appropriate lag length is to remove serial correlation. To ensure the absence of serial correlation, present study also applies Lagrange Multiplier (LM) test on the residuals for serial independence by testing (at 10 per cent level of significance) the null hypothesis of "no serial correlation" to scrutinize the authenticity of the optimal lag length chosen by using AIC and FPE criterions and increased/decreased the same; if suggested by the LM test until serial correlation issues are resolved. After the determination of preferred VAR model including optimal lag(k), number of lags chosen at the first step for each of the variable i.e. (ρ_{max}) is further added into each of the VAR equation that results in below mentioned bivariate VAR $(k + \rho_{max})$ model.

$$P_t = \phi + \sum_{i=1}^{k} \alpha_i P_{t-i} + \sum_{i=k+1}^{k+\rho_{max}} \alpha_i P_{t-i} + \sum_{i=1}^{k} \beta_i V_{t-i} + \sum_{i=k+1}^{k+\rho_{max}} \beta_i V_{t-i} + \mu_{1t} \qquad (5)$$

$$V_t = \varphi + \sum_{i=1}^{k} \delta_i V_{t-i} + \sum_{i=k+1}^{k+\rho_{max}} \delta_i V_{t-i} + \sum_{i=1}^{k} \gamma_i P_{t-i} + \sum_{i=k+1}^{k+\rho_{max}} \gamma_i P_{t-i} + \mu_{2t} \qquad (6)$$

Where, P_t is $\log normal\ closing\ price$, V_t is $\log\ normal\ volume$, $\alpha_i, \beta_i, \delta_i$ and γ_i are the model's parameters; ρ_{max} is the maximum order of integration expected to occur; $\mu_{1t} \sim N(0, \sum_{\mu1})$ and $\mu_{2t} \sim N(0, \sum_{\mu2})$ are residuals of the model. By following the above mentioned VAR model, null hypothesis (H_0) of non causality from volume to closing price and closing price to volume expressed as: - $H_0: \beta_i = 0, \forall\ i = 1,2,3\ ....k)$, $\gamma_i = 0, \forall\ i = 1,2,3\ ....k$ are tested using a Modified Wald test (MWALD).

3.5. Vector Autoregression

Previous studies have shown the application of co-integration and VECM model for the determination of relationship between underlying variables' price and trading volume series. Though, it is a sound methodology but can be applied only if both underlying variables are non-stationary and integrated of the same order, absence of which demands the application of VAR (Vector Auto-regression) model. In the present study, closing price series are $I(1)$ whereas trading volume series are found $I(0)$ and due to the difference in their integration, VAR has been applied. For the determination of the cause and effect relationship, bivariate VAR i.e. (inclusion of only two variables) has been applied.

$$R_t = \alpha + \sum_{j=1}^k \beta_j R_{t-j} + \sum_{j=1}^k \gamma_j V_{t-j} + \varepsilon_{1t} \tag{7}$$

$$V_t = \delta + \sum_{j=1}^k \theta_j R_{t-j} + \sum_{j=1}^k \varphi_j V_{t-j} + \varepsilon_{2t} \tag{8}$$

In Equation (7) R_t is the security' return series and V_t is the log normal daily traded volume. α and δ are intercept terms; $\beta_{js}, \gamma_{js}, \theta_{js}, \varphi_{js}$ are the coefficients of respective variables; $\varepsilon_{1t}, \varepsilon_{2t}$ are white noise stochastic error terms and k explains the maximum lag length used for running the model. In the above model, causality from volume (V_t) to return series (R_t) can be witnessed only if some of the coefficients (γ_j) are found significant. Similarly, causality from return series (R_t) to volume (V_t) is confirmed in the presence of significant coefficients (θ_{js}). Lag length for the execution of the model is firstly chosen by following the AIC (Akaike Information Criterion) and Final Prediction Error (FPE) criterions and is further checked by running LM (Lagrange Multiplier) test. It is worthwhile to mention here that $t-test$ is used to scrutinise the significance of independent variables' coefficients.

4. Results and Interpretation

4.1. Descriptive Statistics

Before moving on with the in-depth analysis, it is important to recognise the general characteristics of the data as shown in the Table 1. Results clearly depict that except Indusind Bank, mean return of all the individual securities and S&P CNX Nifty have positive return surrounded with reasonable amount of variation. Around 64 per cent of the individual securities are skewed to the right side whereas rest of the securities (i.e. 36 per cent) and an index are negatively skewed (i.e. skewed to

the left) which adjudge the return series asymmetric and abnormal. Absence of normality has further been inspected by the help of p-values of Jarque-Bera test. The shape of the frequency distribution of the return series is leptokurtic in the present dataset because of the presence of kurtosis values above 3 that indicates the presence of positive correlation between return and volume series. On the other hand, trading volume has relatively higher volatility around its mean values for the complete dataset. Furthermore, 82 per cent of the individual securities and index volume series are negatively skewed and 39 per cent of the individual securities and trading volume have shown platykurtic shape (i.e. kurtosis < 3). As far as JB-test for volume series is concerned, it also confirms the presence of non-normality in the complete dataset due to the rejection of the null hypothesis of normal distribution.

Table 1: Descriptive Statistics

Company		Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability (J-B Test)
ACC	Return	0.000601	0.02621	-0.128115	6.40321	1872.34	0.00000
	Volume	13.43339	1.04344	0.167461	2.96605	18.22188	0.00000
Asian Paints	Return	0.000956	0.01836	0.259259	7.96638	4007.082	0.00000
	Volume	9.617747	1.37343	-0.09255	2.78024	13.27132	0.00013
Axis Bank	Return	0.001231	0.03135	0.457583	7.89613	3728.679	0.00000
	Volume	12.75449	1.70943	-0.36324	2.13822	190.991	0.00000
Bank of Baroda	Return	0.000458	0.02978	0.060242	7.31856	2999.549	0.00000
	Volume	12.77508	1.28529	-0.61336	3.29530	255.926	0.00000
Bharti Airtel	Return	0.000965	0.02656	0.905525	12.95	11860.5	0.00000
	Volume	14.50083	1.18082	-0.67166	3.23318	215.6352	0.00000
Bharat Petroleum	Return	0.000346	0.05885	2.251575	730.482	84018613	0.00000
	Volume	12.66124	1.51514	-1.45569	6.33007	3106.03	0.00000
BHEL	Return	0.000461	0.03596	2.694753	291.914	13255734	0.00000
	Volume	13.37121	0.99249	0.22492	3.42403	60.68456	0.00000
Cipla	Return	0.0008	0.02308	-0.02100	6.74938	2259.501	0.00000
	Volume	13.54549	1.14338	-1.28784	5.42489	2011.67	0.00000
Dr. Reddy	Return	0.000843	0.02468	-0.02801	7.78484	3679.882	0.00000
	Volume	12.4012	0.94633	-0.59666	3.80752	333.7411	0.00000
GAIL	Return	0.000334	0.02601	0.01949	11.7720	12360.22	0.00000
	Volume	12.97749	2.03004	-0.82772	2.83793	444.5271	0.00000
Grasim	Return	0.000547	0.02594	-0.09160	7.7062	3564.814	0.00000
	Volume	11.5859	1.04582	-0.77778	4.87942	956.5398	0.00000
Gujarat Ambuja	Return	0.000596	0.02492	0.082435	5.41873	939.1721	0.00000
	Volume	14.38616	1.06696	-0.43064	3.58308	172.9101	0.00000
HCL Tech	Return	0.00010	0.03423	-0.35525	7.66374	3090.715	0.00000
	Volume	13.91834	0.89234	0.127422	5.37192	790.5694	0.00000
Hero Honda	Return	0.000758	0.02440	0.368415	6.74474	2340.882	0.00000
	Volume	11.67354	2.12878	-1.19735	3.21988	929.6163	0.00000
Hindalco	Return	9.55E-05	0.02733	-0.10158	6.57224	2057.422	0.00000
	Volume	1.44E+01	1.43994	-0.47194	2.69279	158.386	0.00000
HUL	Return	0.000374	0.02062	0.232934	7.19165	2857.772	0.00000
	Volume	13.96108	1.31243	-1.22372	4.05002	1139.836	0.00000

Table 1 (cont.): Descriptive Statistics

Company		Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera	Probability (J-B Test)
ICICI Bank	Return	0.000865	0.03115	0.063539	6.77274	2275.8	0.00000
	Volume	13.71558	1.65758	-0.37531	2.27062	174.9935	0.00000
IDFC	Return	0.000372	0.03282	0.309985	7.03337	1280.157	0.00000
	Volume	15.42751	0.76251	-0.90942	4.95464	548.3283	0.00000
Indusind Bank	Return	-0.00277	0.03711	0.999178	9.73320	466.5747	0.00000
	Volume	11.95744	0.83672	-0.49373	2.88373	2.471523	0.00000
Infosys Tech	Return	0.001072	0.02798	-0.51296	11.5818	12005.03	0.00000
	Volume	14.29085	0.94301	-0.51183	4.25157	420.149	0.00000
ITC	Return	0.000723	0.02166	0.054766	6.04103	1489.687	0.00000
	Volume	16.28578	0.99920	0.75991	4.87688	938.0669	0.00000
Jindal Steel	Return	0.001282	0.03400	0.019498	11.0662	9065.918	0.00000
	Volume	11.78362	2.19214	-0.04721	1.95420	153.6762	0.00000
JP Associates	Return	0.001006	0.03992	0.172964	7.44033	3132.469	0.00000
	Volume	15.422	1.389	-0.70896	2.91899	318.6112	0.00000
Kotak Mahindra	Return	0.000873	0.04124	-4.20005	85.7210	1103252	0.00000
	Volume	11.54982	2.11796	-0.26040	1.84202	258.6798	0.00000
Larsen and Toubro	Return	0.000863	0.02703	0.303249	7.33204	3056.726	0.00000
	Volume	14.7004	0.90414	0.286726	3.29346	66.30852	0.00000
Mahindra & Mahindra	Return	0.000464	0.03063	-2.66483	64.4623	611660.2	0.00000
	Volume	13.49617	1.10044	-0.68336	3.61397	360.874	0.00000
Maruti Suzuki	Return	0.000875	0.02377	-0.00664	5.40630	592.8001	0.00000
	Volume	13.72688	0.95220	0.395702	3.16788	67.03209	0.00000
S&P CNX Nifty	Return	0.000445	0.01651	-0.21516	9.65084	7123.691	0.00000
	Volume	18.03868	0.83478	-0.01972	2.35823	66.32009	0.00000
NTPC	Return	0.000267	0.02034	0.02717	7.44369	1720.666	0.00000
	Volume	14.99851	0.80601	-0.29533	4.63866	264.4737	0.00000
ONGC	Return	0.00051	0.02510	0.155092	7.44255	3141.798	0.00000
	Volume	12.77434	2.23025	-0.81586	2.37417	483.9627	0.00000
PNB	Return	0.001089	0.02767	-0.12974	7.76432	2607.668	0.00000
	Volume	13.36897	0.99056	0.017088	3.57124	37.52415	0.00000
Ranbaxy	Return	0.000355	0.02524	-0.13605	8.53593	5246.819	0.00000
	Volume	13.29218	1.43711	-1.43481	5.30049	2310.865	0.00000
Reliance Industries	Return	1.000999	0.02484	0.430889	8.42022	5463.284	0.00000
	Volume	16.06654	0.85134	-0.07198	3.24097	14.29165	0.00000
Reliance Infra	Return	0.000191	0.03169	-0.31334	10.4162	8902.297	0.00000
	Volume	13.09107	1.54479	-0.45784	2.68545	150.6911	0.00000
SBI	Return	0.000549	0.02517	0.006587	5.91134	1362.883	0.00000
	Volume	14.40522	0.92383	-0.99875	4.69098	1101.622	0.00000
SESA GOA	Return	0.000818	0.03474	0.221234	5.44870	970.5851	0.00000
	Volume	12.32814	2.36362	-0.17696	2.06868	155.5925	0.00000
TATA POWER	Return	0.000542	0.02691	-0.03303	8.98691	5760.984	0.00000
	Volume	12.77548	1.40117	-0.21837	2.91127	31.9288	0.00000
TATA STEEL	Return	0.000304	0.02940	-0.19625	5.77837	1264.996	0.00000
	Volume	14.78705	0.97375	-0.64250	3.19000	270.8918	0.00000
TCS	Return	0.00071	0.02224	0.177376	7.59858	1857.831	0.00000
	Volume	14.38541	0.64344	-0.59134	6.89886	1450.417	0.00000
ULTRATECH	Return	0.000852	0.02292	0.240956	5.89415	742.4712	0.00000
	Volume	11.36563	0.97211	-0.31671	4.35986	194.102	0.00000

Source: Authors' Findings

4.2. Unit Root Test

In the initial stage of any time series analysis, the properties of the time series must be examined for the presence of stationarity. In the present paper, this task is accomplished by using two most widely used tests i.e. ADF (Augmented Dickey-Fuller) and PP (Phillips Perron). There are two motives behind running the stationarity test (i) confirmation of stability in the dataset; absence of which might show spurious results and (ii) determination of the maximum order of integration (ρ_{max}) to be added in the Vector Autoregressive (VAR) model for Toda and Yamamoto test. Table 2 reports the results of ADF and PP tests and it is apparent that securities and index' closing prices are integrated of order one while every security' trading volume data is stationary at level. Hence for each and every company, VAR model will add only one extra lag ($\rho_{max} = 1$) for the execution of causality test.

Table 2: Unit Root Test

Company		Closing Prices		Volume		
		With Intercept	With Intercept and Trend	With Intercept	With Intercept and Trend	(ρ_{max})
ACC	I [0] (ADF)	-0.33305	-2.52586	-4.61997	-5.47713	1
	I [1] (ADF)	-10.23022	-10.27504	-	-	
	I [0] (PP)	-0.55117	-2.69165	-32.92096	-37.87977	
	I [1] (PP)	-63.47590	-63.47576	-	-	
Asian Paints	I [0] (ADF)	0.72465	1.34448	-3.75620	-6.66207	1
	I [1] (ADF)	-9.08954	-9.81023	-	-	
	I [0] (PP)	0.24674	1.45856	-56.75569	-61.59747	
	I [1] (PP)	-65.33445	-65.83626	-	-	
Axis Bank	I [0] (ADF)	-0.27759	-2.64472	-2.57631	-5.81136	1
	I [1] (ADF)	-16.56492	-16.58408	-	-	
	I [0] (PP)	-0.34787	-2.77378	-11.92045	-37.20424	
	I [1] (PP)	-57.41353	-57.41772	-	-	
Bank of Baroda	I [0] (ADF)	-0.81480	-2.41119	-3.69692	-4.17558	1
	I [1] (ADF)	-29.88766	-29.89156	-	-	
	I [0] (PP)	-0.74262	-2.27775	-25.35390	-29.99494	
	I [1] (PP)	-58.87344	-58.86812	-	-	
BHARAT PETROLEUM	I [0] (ADF)	-1.67432	-2.67606	-3.86133	-4.68252	1
	I [1] (ADF)	-20.81437	-20.81678	-	-	
	I [0] (PP)	-2.10236	-2.80664	-28.33864	-37.58443	
	I [1] (PP)	-62.74554	-62.73898	-	-	
BHARTI AIRTEL	I [0] (ADF)	-1.59027	-1.31989	-3.12067	-4.05629	1
	I [1] (ADF)	-12.33739	-12.37615	-	-	
	I [0] (PP)	-1.60130	-1.51458	-21.95059	-33.64555	
	I [1] (PP)	-54.64790	-54.68406	-	-	
BHEL	I [0] (ADF)	-1.18464	-1.13720	-3.86836	-5.11915	1
	I [1] (ADF)	-13.16960	-13.18436	-	-	
	I [0] (PP)	-1.15994	-1.16935	-29.58349	-36.54668	
	I [1] (PP)	-56.26061	-56.26268	-	-	

Table 2 (cont.): Unit Root Test

Company		Closing Prices		Volume		
		With Intercept	With Intercept and Trend	With Intercept	With Intercept and Trend	(ρ_{max})
Cipla	I [0] (ADF)	-0.43857	-2.88914	-4.10286	-4.65888	1
	I [1] (ADF)	-11.95947	-11.97556	-	-	
	I [0] (PP)	-0.40157	-3.13159	-37.62442	-47.78385	
	I [1] (PP)	-66.56309	-66.57018	-	-	
Dr. Reddy	I [0] (ADF)	1.15998	-0.94708	-5.44682	-6.27224	1
	I [1] (ADF)	-31.31353	-31.37708	-	-	
	I [0] (PP)	1.20822	-0.92876	-43.91622	-47.94033	
	I [1] (PP)	-67.86950	-67.95019	-	-	
GAIL	I [0] (ADF)	-0.96124	-2.21642	-2.60757	-3.80453	1
	I [1] (ADF)	-31.51293	-31.50911	-	-	
	I [0] (PP)	-0.93568	-2.05984	-14.60382	-26.50465	
	I [1] (PP)	-66.62651	-13.39218	-	-	
Grasim	I [0] (ADF)	-0.68944	-2.51564	-5.23203	-5.31927	1
	I [1] (ADF)	-28.09403	-65.53994	-	-	
	I [0] (PP)	-0.88597	-2.77568	-37.75699	-37.74555	
	I [1] (PP)	-66.19390	-66.18745	-	-	
Gujarat Ambuja	I [0] (ADF)	-1.93765	-2.41699	-4.61516	-4.81059	1
	I [1] (ADF)	-38.48837	-38.47257	-	-	
	I [0] (PP)	-1.93175	-2.40513	-38.48801	-41.12649	
	I [1] (PP)	-38.57890	-38.57741	-	-	
HCL Tech	I [0] (ADF)	-0.65562	-2.99169	-4.86727	-5.23047	1
	I [1] (ADF)	-29.30822	-29.43763	-	-	
	I [0] (PP)	-0.32634	-3.04114	-46.36591	-47.79201	
	I [1] (PP)	-50.80855	-51.55076	-	-	
Hero Honda	I [0] (ADF)	-0.47971	-2.40032	-2.79262	-3.17523	1
	I [1] (ADF)	-30.37252	-30.37474	-	-	
	I [0] (PP)	-0.54474	-2.49801	-12.24628	-23.51247	
	I [1] (PP)	-65.42448	-65.42131	-	-	
Hindalco	I [0] (ADF)	-2.37212	-2.78167	-3.39529	-6.73276	1
	I [1] (ADF)	-39.28929	-39.28868	-	-	
	I [0] (PP)	-2.38866	-2.82505	-23.55892	-51.42953	
	I [1] (PP)	-64.45790	-64.45363	-	-	
HUL	I [0] (ADF)	0.24231	-1.02414	-2.75849	-3.83713	1
	I [1] (ADF)	-31.38803	-31.41447	-	-	
	I [0] (PP)	0.62437	-0.64417	-22.99144	-36.27395	
	I [1] (PP)	-66.35115	-66.40286	-	-	
ICICI Bank	I [0] (ADF)	-1.03168	-3.14866	-3.21961	-4.52781	1
	I [1] (ADF)	-30.61085	-30.60969	-	-	
	I [0] (PP)	-0.92975	-2.99820	-11.49388	-34.69967	
	I [1] (PP)	-55.97047	-55.96485	-	-	
IDFC	I [0] (ADF)	-2.12126	-2.19636	-4.24280	-4.61935	1
	I [1] (ADF)	-41.39331	-41.38535	-	-	
	I [0] (PP)	-2.03526	-2.07685	-27.94030	-29.42369	
	I [1] (PP)	-41.41520	-41.40794	-	-	

Table 2 (cont.): Unit Root Test

Company		Closing Prices		Volume		
		With Intercept	With Intercept and Trend	With Intercept	With Intercept and Trend	(ρ_{max})
Indusind Bank	I [0] (ADF)	2.89119	0.88072	-4.98365	-4.98747	1
	I [1] (ADF)	-10.55558	-10.98172	-	-	
	I [0] (PP)	3.27100	0.99164	-4.91060	-4.90978	
	I [1] (PP)	-60.46323	-60.70997	-	-	
InfosysTech	I [0] (ADF)	-1.05993	-2.91478	-3.93537	-4.29098	1
	I [1] (ADF)	-64.78699	-64.77975	-	-	
	I [0] (PP)	-1.00471	-2.81604	-34.41929	-34.91416	
	I [1] (PP)	-64.83617	-64.82832	-	-	
ITC	I [0] (ADF)	1.41671	2.99933	-3.41548	-4.36533	1
	I [1] (ADF)	-17.25556	-16.60040	-	-	
	I [0] (PP)	1.37018	1.90249	-36.11046	-49.54922	
	I [1] (PP)	-70.01122	-69.44946	-	-	
Jindal Steel	I [0] (ADF)	-1.28368	-1.80517	-2.62181	-4.98319	1
	I [1] (ADF)	-10.74001	-10.74572	-	-	
	I [0] (PP)	-1.15657	-1.45799	-8.93256	-24.19580	
	I [1] (PP)	-53.11038	-53.10498	-	-	
JPAssociates	I [0] (ADF)	-2.23663	-3.15425	-3.13237	-4.71248	1
	I [1] (ADF)	-10.94639	-10.94621	-	-	
	I [0] (PP)	-2.00347	-2.81038	-19.21803	-33.42578	
	I [1] (PP)	-63.37666	-63.37008	-	-	
Kotak Mahindra	I [0] (ADF)	-1.77499	-3.26359	-2.90396	-4.41111	1
	I [1] (ADF)	-58.53411	-58.52705	-	-	
	I [0] (PP)	-1.69189	-3.14656	-11.76395	-36.09748	
	I [1] (PP)	-58.44669	-58.43931	-	-	
Larsen and Toubro	I [0] (ADF)	-1.00748	-2.43811	-3.44027	-4.64434	1
	I [1] (ADF)	-59.77467	-59.76923	-	-	
	I [0] (PP)	-0.92237	-2.30949	-32.47228	-41.88337	
	I [1] (PP)	-59.57256	-59.56594	-	-	
Mahindra nd Mahindra	I [0] (ADF)	-1.03885	-2.76336	-4.48606	-5.23066	1
	I [1] (ADF)	-64.37708	-64.37460	-	-	
	I [0] (PP)	-1.07811	-2.83393	-29.81580	-37.61761	
	I [1] (PP)	-64.35353	-64.35084	-	-	
Maruti Suzuki	I [0] (ADF)	-1.42364	-2.65140	-2.72593	-4.95716	1
	I [1] (ADF)	-47.58588	-47.57624	-	-	
	I [0] (PP)	-1.45857	-2.75581	-23.24196	-34.37161	
	I [1] (PP)	-47.55987	-47.55007	-	-	
S&P CNX Nifty	I [0] (ADF)	-0.48996	-2.54846	-3.39980	-4.55787	1
	I [1] (ADF)	-14.16680	-14.17896	-	-	
	I [0] (PP)	-0.35944	-2.42938	-15.60183	-39.24566	
	I [1] (PP)	-61.95980	-61.95857	-	-	
NTPC	I [0] (ADF)	-2.21096	-1.86367	-4.04148	-3.97930	1
	I [1] (ADF)	-10.73653	-10.80302	-	-	
	I [0] (PP)	-2.35837	-2.14000	-33.19996	-34.11296	
	I [1] (PP)	-45.90858	-45.96830	-	-	

Table 2 (cont.): Unit Root Test

Company		Closing Prices		Volume		
		With Intercept	With Intercept and Trend	With Intercept	With Intercept and Trend	(ρ_{max})
ONGC	I [0] (ADF)	-0.75480	-3.74194	-2.77662	-4.88116	1
	I [1] (ADF)	-13.86177	-13.86606	-	-	
	I [0] (PP)	-0.80467	-3.81501	-7.81874	-25.58082	
	I [1] (PP)	-58.81082	-58.80569	-	-	
PNB	I [0] (ADF)	-1.69380	-2.10722	-3.76647	-4.22621	1
	I [1] (ADF)	-48.67783	-48.68016	-	-	
	I [0] (PP)	-1.65639	-1.97695	-24.12821	-27.58924	
	I [1] (PP)	-48.61780	-48.61959	-	-	
Ranbaxy	I [0] (ADF)	-1.99929	-2.61347	-3.58342	-3.61504	1
	I [1] (ADF)	-63.89288	-63.89017	-	-	
	I [0] (PP)	-2.07186	-2.79318	-22.26048	-28.57323	
	I [1] (PP)	-64.10105	-64.09655	-	-	
Reliance Industries	I [0] (ADF)	-0.99010	-1.91675	-3.63391	-6.59182	1
	I [1] (ADF)	-33.98784	-33.98402	-	-	
	I [0] (PP)	-1.07236	-2.08798	-34.89450	-52.42726	
	I [1] (PP)	-63.31765	-63.30980	-	-	
Reliance Infra	I [0] (ADF)	-2.39579	-2.73665	-3.14288	-4.60125	1
	I [1] (ADF)	-15.54836	-15.55438	-	-	
	I [0] (PP)	-2.29974	-2.63339	-18.45449	-29.91883	
	I [1] (PP)	-62.68646	-62.68165	-	-	
SBI	I [0] (ADF)	-1.10019	-2.82704	-4.45012	-4.45092	1
	I [1] (ADF)	-59.89210	-59.88659	-	-	
	I [0] (PP)	-1.04044	-2.68218	-27.36136	-27.35942	
	I [1] (PP)	-59.57581	-59.56692	-	-	
SESA GOA	I [0] (ADF)	-1.18134	-1.75285	-3.05950	-4.60044	1
	I [1] (ADF)	-11.84122	-11.84134	-	-	
	I [0] (PP)	-1.22601	-1.83809	-6.22703	-21.01804	
	I [1] (PP)	-58.62433	-58.61672	-	-	
TATA POWER	I [0] (ADF)	-1.11317	-2.52919	-2.85224	-3.85068	1
	I [1] (ADF)	-17.65114	-17.64905	-	-	
	I [0] (PP)	-1.13558	-2.40494	-19.99430	-29.91434	
	I [1] (PP)	-64.19872	-64.19054	-	-	
TATA STEEL	I [0] (ADF)	-1.65342	-2.10720	-3.55346	-4.60167	1
	I [1] (ADF)	-31.26160	-31.26047	-	-	
	I [0] (PP)	-1.77550	-2.33723	-24.64568	-33.93580	
	I [1] (PP)	-64.45103	-64.44468	-	-	
TCS	I [0] (ADF)	0.11450	-1.73487	-4.96234	-5.96205	1
	I [1] (ADF)	-33.74925	-33.76686	-	-	
	I [0] (PP)	0.32152	-1.50011	-36.67851	-36.87090	
	I [1] (PP)	-46.12200	-46.17809	-	-	
ULTRATECH	I [0] (ADF)	-0.43948	-1.64111	-5.99773	-8.01508	1
	I [1] (ADF)	-10.44074	-10.46026	-	-	
	I [0] (PP)	-0.09372	-1.31694	-41.01033	-40.31200	
	I [1] (PP)	-44.23274	-44.23741	-	-	

Source: Authors' Findings

ADF and PP tests P-Values: - [(With Intercept) @ 1% (-3.43), @ 5% (-2.86) and @ 10% (-2.56)]

ADF and PP tests P-Values: - [(With Intercept & Trend) @ 1% (-3.96), @ 5% (-3.41) and @ 10% (-3.12)]

4.3. Toda and Yamamoto Granger Causality Results

Following the methodological approach described earlier, appropriate maximum lagged length (k) for the variables in the VAR is chosen as suggested by two usual information criterions i.e. AIC and FPE. However, these criterions might show inappropriate results because it is not possible to find the best model with many datasets. To remove the possibility of any error, Lagrange multiplier (LM) test is also run for testing the hypothesis of "no residual serial correlation" and required adjustments are made in the lagged length to make the VAR model parsimonious. The results of Wald statistics along with their appropriate lag length are shown in Table 3. Results clearly depict that 26 per cent of the individual securities' (i.e. 10 securities) and an index have bilateral causality between price and trading volume series whereas around 36 per cent of the sample securities (i.e. 14 securities) have demonstrated unilateral causality from closing prices series to volume that can be interpreted as securities' price is the major factor impacting the investors' decision to go for trading (buying/selling). On the other hand, unilateral causality from trading volume to closing price has also been registered but only in case of 3 securities (i.e. 8 per cent of the sample size). Besides this 31 per cent of the sample size (i.e. 12 securities) has shown absence of cause and effect relationship between the volume and closing prices.

4.4. Vector Autoregression (VAR) Results

The results of Vector Autoregression (VAR) for the 39 individual securities and an index are displayed in Table 4 (a-g). Significant stock returns' coefficients at first lag in the volume equation evidence the leading role of stock returns in case of around 80 per cent (i.e. 31 securities) of the individual securities which explains the prominent role of stock return over trading volume i.e. investors' buying/selling decision largely depends upon the variation in stock returns. However, 13 per cent of the individual securities (i.e. 5 securities) and an index have shown the deterministic role of trading volume that can be interpreted as investors' buying/selling decision (demand and supply interaction) determines the direction (positive/negative) of stock returns and around 7 per cent (i.e. Reliance infra, NTPC and Tata Steel) didn't find lead-lag relation because both variables are impacting each other either up to the same number of lags or not impacting each other. Besides lead/lag relationship, VAR results can also be used to depict the presence and direction of causality between returns and trading volume that exhibit bilateral causality incase of 29 individual securities' and an index whereas 8 securities (i.e. ACC, Bank of Baroda, Gujarat Ambuja, Hero Honda, Hindalco, ICICI Bank, PNB and Cipla) have shown unilateral causality from stock returns to trading volume but not the vice versa and only one security i.e. Reliance industries has shown the direction of causality from trading volume to return. On the other hand, one security i.e. NTPC has shown the absence of interaction between stock returns and trading volume.

Table 3: Wald Statistics (Toda and Yamamoto Granger Causality Test)

Company	Lags	Stock Price does not cause Trading Volume		Trading Volume does not cause Stock Price	
		Wald Statistics	P-value	Wald Statistics	P-value
ACC¥	3	10.37635**	0.0156	1.726128	0.6311
Asian Paints¥	14	24.24841**	0.0428	17.7869	0.2167
Axis Bank^	6	45.04147*	0.0000	18.1514*	0.0059
Bank of Baroda¥	4	43.90302*	0.0000	4.510166	0.3413
BHARTI AIRTEL	3	5.843096	0.1195	4.763714	0.1899
BHARAT PETRO¥	6	23.94724*	0.0005	5.470955	0.4850
BHEL¥	6	7.222133	0.3008	13.8082**	0.0319
Cipla¥	18	57.80687*	0.0000	11.16491	0.8872
Dr. Reddy	3	4.678754	0.1969	0.763846	0.8581
GAIL¥	4	19.99396*	0.0005	5.606036	0.2306
Grasim¥	6	24.77522*	0.0004	6.714148	0.3481
Gujarat Ambuja¥	4	16.20145*	0.0028	3.379472	0.4964
HCL Tech	13	17.71824	0.1685	12.17618	0.5133
Hero Honda¥	4	30.63701*	0.0000	2.891069	0.5762
Hindalco^	4	13.06944**	0.0109	9.101771***	0.0586
HUL¥	9	7.650568	0.5697	19.56849**	0.0208
ICICI Bank^	4	3801.261*	0.0000	23.91005*	0.0001
IDFC	5	3.292527	0.6550	5.763224	0.3299
Indusind Bank^	6	27.45202*	0.0001	12.93627**	0.0441
Infosys Tech^	7	15.90745**	0.0260	15.22665**	0.0332
ITC¥	6	7.592327	0.2695	13.03128**	0.0425
Jindal Steel¥	9	23.68445*	0.0048	5.429394	0.7954
JP Associates^	3	36.23929*	0.0000	18.60735*	0.0003
Kotak Mahindra¥	5	25.58323*	0.0001	4.555101	0.4725
Larsen and Toubro	4	2.96941	0.5630	5.954726	0.2026
M & M^	4	15.89515*	0.0032	19.70844*	0.0006
Maruti Suzuki	7	6.224529	0.5138	9.945861	0.1917
S&P CNX Nifty^	7	16.96927**	0.0176	16.84263**	0.0184
NTPC	10	4.006959	0.9470	6.368027	0.7835
ONGC^	4	48.6506*	0.0000	15.8905*	0.0032
PNB	4	6.196314	0.1850	3.093524	0.5423
Ranbaxy	9	10.50263	0.3113	10.23135	0.3321
Reliance Industries	3	1.559384	0.6686	5.647862	0.1301
Reliance Infra	7	7.522181	0.3766	7.374879	0.3909
SBI¥	9	17.36138**	0.0433	6.484657	0.6906
SESA GOA^	4	52.0152*	0.0000	37.78407*	0.0000
TATA POWER^	8	18.61591**	0.0171	16.30467**	0.0382
TATA STEEL¥	7	15.1773**	0.0338	10.42101	0.1659
TCS	6	9.684918	0.1386	7.147198	0.3074
ULTRATECH¥	6	33.20262*	0.0000	6.204568	0.4007

Source: Authors' Findings

Note: - (*) [**] {***} testify that values are significant @ (1%), [5%] and {10%} level of significance. (^) testifies the presence of bilateral causality between stock prices and trading volume. (¥) testifies the presence of unilateral causality between stock prices and trading volume.

Sushil BAJAJ & Vibha DUA

Table 4a: Vector Autoregression Model Results

	ACC		Bharti Airtel		Dr. Reddy		JP Associates		Reliance Industries	
	RETURN	**VOLUME**	**RETURN**	**VOLUME**	**RETURN**	**VOLUME**	**RETURN**	**VOLUME**	**RETURN**	**VOLUME**
C	-0.001728	1.277452*	0.013514**	1.263407*	0.01458**	2.108566*	0.011837	0.988641*	0.966451*	2.100871*
	[-0.29526]	[10.4797]	[2.05476]	[8.57369]	[2.48119]	[14.2007]	[1.56684]	[8.82290]	[37.1014]	[4.33897]
RETURN(-1)	0.038803**	2.858943*	-0.019226	-0.831633***	0.006893	2.976251*	0.082376*	2.777091*	0.054302*	0.109558
	[2.40710]	[8.51714]	[-1.00826]	[-1.94650]	[0.42768]	[7.30808]	[5.06021]	[11.5016]	[3.57003]	[0.38750]
RETURN(-2)	-0.04311*	0.592695***	-0.072725*	0.037066	-0.034054**	0.590327	-0.01656	1.03527*	-0.025478**	-0.20614
	[-2.65162]	[1.75078]	[-3.82696]	[0.08705]	[-2.10011]	[1.44073]	[-0.99845]	[4.20936]	[-1.67365]	[-0.72851]
RETURN(-3)	0.006436	-0.059095	-0.029443	-1.30372*	-0.007142	0.296256	0.007366	-0.276092	-0.011496	-0.393242
	[0.39601]	[-0.17461]	[-1.54995]	[-3.06301]	[-0.44052]	[0.72314]	[0.44780]	[-1.13167]	[-0.75606]	[-1.39143]
VOLUME(-1)	0.001044	0.455989*	0.00103	0.538319*	-0.000225	0.479373*	-0.00014	0.526038*	0.001872**	0.490798*
	[1.38362]	[29.0115]	[1.24028]	[28.9293]	[-0.35791]	[30.2252]	[-0.13061]	[33.1618]	[2.34073]	[33.0243]
VOLUME(-2)	-0.000457	0.228873*	0.000119	0.153176*	0.000181	0.170664*	0.001554	0.199315*	-0.00007	0.197492*
	[-0.56092]	[13.4941]	[0.12714]	[7.28354]	[0.26174]	[9.79221]	[1.29972]	[11.2368]	[-0.08069]	[12.0782]
VOLUME(-3)	-0.000414	0.219922*	-0.002008**	0.221543*	-0.00106***	0.179747*	-0.00212**	0.210442*	-0.00073	0.211453*
	[-0.54990]	[14.0363]	[-2.41795]	[11.9052]	[-1.69568]	[11.3615]	[-1.99032]	[13.3080]	[-0.91340]	[14.2287]
F-Values	**2.260.321**	**1.704.059**	**436.737**	**1.376.176**	**189.854**	**8.342.732**	**5.304.617**	**2.854.044**	**4.378.562**	**1.748.982**

Source: Authors' Findings

Note: - (*) testifies that values are significant at 1 per cent level (critical value: 2.58); (**) testifies that values are significant at 5 per cent level

 (critical value: 1.96); (***) testifies that values are significant at 10 per cent level of significance (critical value 1.65)

Investigation of Causal Relationship between Stock Prices and Trading Volume using...

Table 4b: Vector Autoregression Model Results

	Bank of Baroda		GAIL		Gujarat Ambuja		Hero Honda		Hindalco	
	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME
C	-0.003471	0.908451*	-0.001924	0.445772*	-0.005938	1.578406*	0.000935	0.314759*	0.000314	0.768444*
	[-0.67469]	[8.56473]	[-0.68395]	[5.75521]	[-0.97485]	[10.4097]	[0.41651]	[5.04290]	[0.06730]	[7.14795]
RETURN(-1)	0.099714*	2.813667*	0.002569	2.247389*	0.000169	3.000706*	0.049921*	2.539546*	0.089207*	1.608267*
	[6.17873]	[8.45606]	[0.15917]	[5.05639]	[0.01046]	[7.45390]	[3.09496]	[5.66332]	[5.52812]	[4.32080]
RETURN(-2)	-0.025506	1.682172*	-0.044504*	1.692313*	-0.055255*	1.272152*	-0.05739*	0.835093***	0.007549	0.879317**
	[-1.55985]	[4.98966]	[-2.74893]	[3.79555]	[-3.39248]	[3.13781]	[-3.54794]	[1.85718]	[0.46538]	[2.35002]
RETURN(-3)	-0.015998	-0.27779	-0.003636	0.577203	0.00003	-0.71087***	-0.07251*	-1.496342*	-0.04607*	-0.055227
	[-0.97598]	[-0.82197]	[-0.22435]	[1.29314]	[0.00198]	[-1.75097]	[-4.48039]	[-3.32564]	[-2.83963]	[-0.14759]
RETURN(-4)	-0.021464	-0.871507**	0.008244	0.083634	0.014207	-0.556175	-0.00961	-1.538193*	-0.01017	-0.752651**
	[-1.31789]	[-2.59536]	[0.50928]	[0.18760]	[0.87164]	[-1.37088]	[-0.59222]	[-3.41134]	[-0.62943]	[-2.01992]
VOLUME(-1)	0.000303	0.510804*	-0.000111	0.422269*	0.0002	0.407419*	0.00006	0.443259*	0.000287	0.422186*
	[0.39359]	[32.1391]	[-0.19148]	[26.5150]	[0.31111]	[25.4141]	[0.10287]	[27.9090]	[0.41643]	[26.5172]
VOLUME(-2)	0.000226	0.138753*	-0.000522	0.20592*	0.000476	0.205698*	0.000472	0.216211*	0.000159	0.217158*
	[0.26177]	[7.79438]	[-0.84173]	[12.0548]	[0.69042]	[11.9842]	[0.76207]	[12.5435]	[0.21427]	[12.6602]
VOLUME(-3)	-0.00009	0.116979*	0.001219**	0.177547*	0.000302	0.146518*	-0.00023	0.151257*	0.000268	0.149062*
	[-0.10304]	[6.58811]	[1.96605]	[10.3946]	[0.43817]	[8.53929]	[-0.36999]	[8.77300]	[0.36030]	[8.69260]
VOLUME(-4)	-0.000134	0.162282*	-0.000412	0.159946*	-0.000523	0.130627*	-0.00031	0.162481*	-0.00073	0.158235*
	[-0.17537]	[10.2779]	[-0.71279]	[10.0516]	[-0.81655]	[8.19899]	[-0.54606]	[10.2695]	[-1.06025]	[9.96303]
F-Values	5.434.045	1.646.514	1.587.804	3.383.359	1.885.944	9.319.657	5.701.048	4295.27	5.152.705	2.042.428

Table 4c: Vector Autoregression Model Results

	ICICI BANK		Larsen & Toubro		Mahindra & Mahindra		ONGC		PNB	
	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME
C	0.003009	0.481285*	0.007079	1.398381*	-0.008156	1.161322*	-0.00088	0.281571*	-0.010467	1.191055*
	[0.69523]	[5.92678]	[0.90904]	[9.71360]	[-1.23511]	[9.45388]	[-0.36315]	[4.64411]	[-1.33054]	[7.87175]
RETURN(-1)	0.105152*	1.915685*	0.074933*	2.334378*	0.112808*	2.338871*	0.066395*	1.88395*	0.045545**	0.882889**
	[6.49797]	[6.30911]	[4.63551]	[7.81186]	[6.98727]	[7.78784]	[4.08027]	[4.61438]	[2.35584]	[2.37438]
RETURN(-2)	-0.038236**	0.255822	-0.04569*	0.081247	-0.03155***	0.525442***	-0.03846**	0.714843***	-0.015968	0.03734
	[-2.34068]	[0.83463]	[-2.80298]	[0.26966]	[-1.92926]	[1.72701]	[-2.35555]	[1.74520]	[-0.82586]	[0.10041]
RETURN(-3)	0.00007	-0.381814	0.049494*	-0.145147	-0.017405	-0.723697**	0.000741	-0.647167	-0.03216***	-0.233317
	[0.00418]	[-1.24599]	[3.03626]	[-0.48167]	[-1.06355]	[-2.37731]	[0.04554]	[-1.58411]	[-1.66571]	[-0.62827]
RETURN(-4)	-0.023426	-0.359169	0.00921	-0.428949	-0.005052	-0.56494***	0.016404	0.789229***	0.009608	-0.171791
	[-1.44378]	[-1.17972]	[0.56660]	[-1.42759]	[-0.31096]	[-1.86924]	[1.01036]	[1.93739]	[0.50058]	[-0.46537]
VOLUME(-1)	0.000653	0.543984*	-0.00047	0.4730*	0.000106	0.481377*	0.00238	0.472313*	-0.000216	0.495057*
	[0.77017]	[34.1836]	[-0.54515]	[29.5262]	[0.12284]	[30.1273]	[3.71679]	[29.3978]	[-0.21818]	[26.0222]
VOLUME(-2)	0.00021	0.1588*	0.002363**	0.164982*	0.00181***	0.174964*	-0.00109	0.190504*	0.001634	0.14654*
	[0.21772]	[8.76099]	[2.47761]	[9.35838]	[1.90575]	[9.90181]	[-1.55067]	[10.8241]	[1.48112]	[6.90669]
VOLUME(-3)	-0.000614	0.081674*	-0.0004	0.131377*	0.000308	0.113393*	-0.00054	0.157156*	-0.000937	0.093146*
	[-0.63584]	[4.50532]	[-0.42014]	[7.44617]	[0.32424]	[6.41415]	[-0.77550]	[8.92750]	[-0.85012]	[4.39214]
VOLUME(-4)	-0.000408	0.180461*	-0.00192**	0.135394*	-0.00158***	0.144292*	-0.00064	0.158116*	0.00038	0.176116*
	[-0.48190]	[11.3636]	[-2.21901]	[8.47363]	[-1.86151]	[9.09556]	[-1.00176]	[9.84298]	[0.38561]	[9.28983]
F-Values	6.152.269	3.409.274	6.122.636	1.106.679	7.504.632	1.327.325	4.627.757	5.512.638	1.635.338	8.520.377

Investigation of Causal Relationship between Stock Prices and Trading Volume using...

Table 4d: Vector Autoregression Model Results

	Sesa Goa		IDFC		Kotak Mahindra		Axis Bank		Bharat Petroleum	
	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME
C	-0.001502	0.252287*	-0.006661	2.767222*	0.00210	0.307044*	0.005861	0.330915*	-0.007343	0.704821*
	[-0.48943]	[4.45935]	[-0.35004]	[8.78848]	[0.55395]	[4.77939]	[1.43441]	[4.42183]	[-0.81872]	[6.34364]
RETURN(-1)	0.072013*	1.594722*	0.02288	1.22022*	0.09040*	1.980981*	0.02339	3.286887*	0.006763	0.656779*
	[4.32844]	[5.19976]	[0.97781]	[3.15163]	[5.58131]	[7.29663]	[1.40222]	[10.7589]	[0.41453]	[3.24955]
RETURN(-2)	-0.03170***	0.492807	-0.06743*	0.419611	0.00340	1.017933*	-0.043963**	1.740177*	0.002323	0.066993
	[-1.90178]	[1.60339]	[-2.87563]	[1.08149]	[0.20688]	[3.70731]	[-2.59382]	[5.60595]	[0.14223]	[0.33115]
RETURN(-3)	-0.008069	-1.319797*	-0.01433	-0.179125	0.0305***	0.069341	-0.022821	0.546918***	0.041664***	-0.622237*
	[-0.48847]	[-4.33437]	[-0.60976]	[-0.46065]	[1.86167]	[0.25232]	[-1.34395]	[1.75859]	[2.55168]	[-3.07618]
RETURN(-4)	0.02541	-0.48417	-0.04089***	-0.438656	0.00180	0.129685	-0.017494	0.222668	0.011128	0.241127
	[1.55085]	[-1.60300]	[-1.74356]	[-1.13042]	[0.10879]	[0.47202]	[-1.03005]	[0.71585]	[0.68070]	[1.19062]
RETURN(-5)	-	-	-0.014561	-0.151106	-0.00580	-0.390398	-0.007223	-0.153067	-0.022283	-0.195285
	-	-	[-0.62127]	[-0.38964]	[-0.35261]	[-1.42765]	[-0.42810]	[-0.49537]	[-1.36435]	[-0.96520]
RETURN(-6)	-	-	-	-	-	-	-0.044059**	-0.56235***	-0.003361	-0.155168
	-	-	-	-	-	-	[-2.62043]	[-1.82621]	[-0.20594]	[-0.76740]
VOLUME(-1)	0.005129*	0.567219*	-0.001451	0.464422*	0.00010	0.47998*	0.002155**	0.470754*	0.001662	0.397465*
	[5.75121]	[34.5009]	[-1.03233]	[19.9688]	[0.05310]	[29.8771]	[2.36575]	[28.2178]	[1.26231]	[24.3612]
VOLUME(-2)	-0.002845*	0.152024*	0.001234	0.102082*	-0.0010	0.181185*	-0.002477**	0.150092*	-0.00250***	0.141816*
	[-2.79554]	[8.10282]	[0.79589]	[3.97941]	[-0.91365]	[10.1824]	[-2.47320]	[8.18299]	[-1.78719]	[8.16471]
VOLUME(-3)	-0.001398	0.097156*	-0.001404	0.099724*	-0.0009	0.101743*	0.00238**	0.084706*	0.000575	0.108961*
	[-1.37265]	[5.17468]	[-0.90521]	[3.88622]	[-0.80427]	[5.66859]	[2.36343]	[4.59281]	[0.40881]	[6.24847]
VOLUME(-4)	-0.000703	0.163256*	-0.000666	0.044888***	-0.00050	0.086273*	-0.001379	0.103568*	0.001443	0.109156*
	[-0.78932]	[9.94692]	[-0.42962]	[1.75023]	[-0.46747]	[4.85360]	[-1.36904]	[5.61384]	[1.02389]	[6.25108]
VOLUME(-5)	-	-	0.002746**	0.10956*	0.00220**	0.124251*	0.000292	0.117569*	-0.000363	0.117237*
	-	-	[1.96019]	[4.72652]	[2.25779]	[7.74860]	[0.29141]	[6.40490]	[-0.25817]	[6.73246]
VOLUME(-6)	-	-	-	-	-	-	-0.001324	0.047064*	-0.000207	0.069960*
	-	-	-	-	-	-	[-1.45607]	[2.82598]	[-0.15808]	[4.30671]
F-Values	8.369.753	5.996.783	1.880.673	1.798.872	42.164	3.205.257	2.630.845	2.378.758	1.158.392	1.001.369

Table 4e: Vector Autoregression Model Results

	BHEL		Grasim		Indusind Bank		ITC		TCS	
	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME
C	0.00826	0.919597*	-0.011898**	1.095159*	0.043122	347.618	0.00508	1.258013*	-0.00778	3.551281*
	[0.94084]	[7.20047]	[-2.20462]	[8.66129]	[0.49401]	[1.52035]	[0.78199]	[7.64934]	[-0.52229]	[10.0960]
RETURN(-1)	0.04126**	-0.042137	0.096263*	2.567182*	-0.058601	-1.370.854	-0.013945	2.397839*	0.004252	-1.17645**
	[2.53844]	[-0.17814]	[5.95955]	[6.78332]	[-0.38956]	[-0.34791]	[-0.86249]	[5.85808]	[0.19379]	[-2.27004]
RETURN(-2)	-0.0375**	-0.197961	-0.034696**	1.294753*	0.048301	7.306669**	-0.02943**	0.496554	-0.07727*	0.209161
	[-2.30258]	[-0.83623]	[-2.12851]	[3.39012]	[0.34572]	[1.99661]	[-1.81242]	[1.20783]	[-3.51775]	[0.40317]
RETURN(-3)	-0.0248	-0.628385*	0.069023*	0.547817	0.22492	6.314425***	-0.021082	-0.2240	-0.07439*	-0.407751
	[-1.52867]	[-2.65759]	[4.22836]	[1.43233]	[1.59112]	[1.70534]	[-1.29780]	[-0.54467]	[-3.38002]	[-0.78444]
RETURN(-4)	-0.0002	0.003658	0.008674	-0.73861***	0.039209	-6.87907***	0.023148	-0.291666	-0.04328**	-0.473923
	[-0.01203]	[0.01546]	[0.53166]	[-1.93219]	[0.28442]	[-1.90507]	[1.42451]	[-0.70897]	[-1.96647]	[-0.91169]
RETURN(-5)	0.00041	-0.073755	0.040779**	0.155989	0.217998	8.205986**	-0.001348	-0.548454	0.002241	-0.735831
	[0.02500]	[-0.31183]	[2.50145]	[0.40839]	[1.54600]	[2.22173]	[-0.08297]	[-1.33335]	[0.10208]	[-1.41924]
RETURN(-6)	-0.02880***	-0.292823	-0.02071	-0.897989**	-0.214174	-3.064.568	-0.007601	0.661635	-0.00575	-0.347015
	[-1.77446]	[-1.23917]	[-1.27587]	[-2.36118]	[-1.46940]	[-0.80269]	[-0.46788]	[1.60870]	[-0.26189]	[-0.66936]
VOLUME(-1)	0.00058	0.477232*	0.000598	0.419343*	0.004135	0.432312*	-0.000793	0.40378*	0.001794***	0.361949*
	[0.52236]	[29.4586]	[0.87030]	[26.0302]	[0.71162]	[2.84029]	[-1.24552]	[25.0623]	[1.93277]	[16.5108]
VOLUME(-2)	0.00003	0.091354*	0.00008	0.096187*	0.000115	0.039008	0.000754	0.144603*	-0.002**	0.117774*
	[0.02140]	[5.10244]	[0.10896]	[5.53877]	[0.01894]	[0.24473]	[1.10536]	[8.37869]	[-2.03343]	[5.06389]
VOLUME(-3)	0.00202	0.087432*	-0.000306	0.090703*	-0.0134**	-0.220767	-0.000763	0.090683*	0.000563	0.079863*
	[1.64180]	[4.88846]	[-0.41428]	[5.23463]	[-2.35174]	[-1.47918]	[-1.11263]	[5.22667]	[0.56904]	[3.41611]
VOLUME(-4)	-0.0040*	0.101323*	-0.00128***	0.111336*	0.000844	0.230745	-0.000282	0.09149*	0.000572	0.067888*
	[-3.26545]	[5.66503]	[-1.74149]	[6.42896]	[0.13831]	[1.44419]	[-0.41133]	[5.26899]	[0.57801]	[2.90302]
VOLUME(-5)	-0.00050	0.086676*	0.001446***	0.123284*	0.00663	0.075975	0.002007*	0.12558*	-0.00096	0.081257*
	[-0.41186]	[4.83330]	[1.95626]	[7.11700]	[1.12410]	[0.49178]	[2.94252]	[7.27126]	[-0.97170]	[3.49139]
VOLUME(-6)	0.00132	0.087377*	0.000537	0.064661*	-0.001741	0.148814	-0.00118***	0.066357*	0.000631	0.044425**
	[1.18037]	[5.38769]	[0.78645]	[4.04245]	[-0.30827]	[1.00595]	[-1.86938]	[4.12803]	[0.67989]	[2.02541]
F-Values	260.956	8.273.011	6.386.239	625.693	1.467.092	2.778.519	1.691.059	7.183.415	2.932.152	9.008.137

Table 4f: Vector Autoregression Model Results

	Ultra tech		Infosys tech		Maruti Suzuki		S&P CNX Nifty		Reliance Infra	
	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME
C	-0.00732	3.318444*	0.028221*	1.011097*	-0.01211	0.924864*	-0.002931	0.446089*	-0.000574	0.459367*
	[-0.85670]	[10.7729]	[3.63634]	[7.17971]	[-1.53814]	[5.51639]	[-0.48707]	[4.14955]	[-0.12394]	[5.09969]
RETURN(-1)	0.02069	1.092.942	0.085857*	0.237806	0.033771***	-0.684521	0.063829*	0.782118*	0.037235**	0.65331**
	[0.93697]	[1.37297]	[5.31344]	[0.81103]	[1.65920]	[-1.57933]	[3.95161]	[2.71075]	[2.29329]	[2.07018]
RETURN(-2)	-0.029112	3.153472*	-0.055051*	-1.031703*	-0.016098	-0.056407	-0.046584*	0.285139	-0.048184*	-0.072476
	[-1.32138]	[3.97042]	[-3.39787]	[-3.50922]	[-0.79048]	[-0.13007]	[-2.87866]	[0.98644]	[-2.96474]	[-0.22943]
RETURN(-3)	0.026963	2.513122*	-0.010626	0.220153	-0.024557	-0.029994	0.001289	0.106867	0.014345	-0.144734
	[1.22047]	[3.15547]	[-0.65408]	[0.74679]	[-1.20609]	[-0.06918]	[0.07964]	[0.36953]	[0.88231]	[-0.45799]
RETURN(-4)	-0.025108	-0.049637	-0.026228	-0.49634***	0.010949	0.231663	0.007575	0.004064	-0.023146	-0.146329
	[-1.13284]	[-0.06212]	[-1.61431]	[-1.68350]	[0.53798]	[0.53452]	[0.46800]	[0.01406]	[-1.42396]	[-0.46316]
RETURN(-5)	0.060474*	-1.355.551	-0.009261	-0.189344	-0.026539	-0.629512	-0.012079	0.572589**	-0.010458	0.046382
	[2.72911]	[-1.69691]	[-0.57009]	[-0.64231]	[-1.30406]	[-1.45260]	[-0.74625]	[1.98043]	[-0.64370]	[0.14687]
RETURN(-6)	-0.010287	0.439491	-0.038971**	0.166572	-0.019112	0.359472	-0.043697*	-0.172556	-0.006650	0.230427
	[-0.46325]	[0.54899]	[-2.40113]	[0.56557]	[-0.93888]	[0.82928]	[-2.70243]	[-0.59744]	[-0.41030]	[0.73147]
RETURN(-7)	-	-	-0.02933***	-0.055741	0.005741	-0.115947	0.012508	-0.085032	0.006597	-0.331074
	-	-	[-1.80996]	[-0.18950]	[0.28253]	[-0.26794]	[0.77427]	[-0.29469]	[0.40732]	[-1.05162]
VOLUME(-1)	-0.000153	0.276347*	-0.000507	0.424976*	0.000782	0.453863*	0.002403*	0.389475*	0.001770**	0.465685*
	[-0.24998]	[12.5173]	[-0.57070]	[26.3374]	[0.82045]	[22.3556]	[2.65851]	[24.1257]	[2.12066]	[28.7119]
VOLUME(-2)	-0.000174	0.175432*	-0.002107**	0.093634*	-0.000311	0.095114*	-0.001268	0.154505*	-0.000988	0.132276*
	[-0.27613]	[7.72245]	[-2.18128]	[5.34091]	[-0.29709]	[4.26665]	[-1.30677]	[8.91329]	[-1.07545]	[7.40493]
VOLUME(-3)	-0.000557	0.086578*	0.002459**	0.099263*	0.001454	0.097802*	0.001572	0.098896*	-0.000272	0.101724*
	[-0.87110]	[3.75836]	[2.53985]	[5.65000]	[1.39062]	[4.39116]	[1.61454]	[5.68535]	[-0.29473]	[5.67681]
VOLUME(-4)	-0.00002	0.020749	-0.001041	0.165359*	-0.000943	0.095276*	-0.000423	0.116581*	0.000371	0.076634*
	[-0.02685]	[0.90258]	[-1.08214]	[9.47203]	[-0.90154]	[4.27839]	[-0.43458]	[6.71263]	[0.40122]	[4.26925]
VOLUME(-5)	0.001252**	0.121742*	-0.000375	0.061913*	-0.000494	0.097126*	-0.001238	0.127037*	-0.000757	0.101914*
	[1.99470]	[5.37870]	[-0.38690]	[3.51835]	[-0.47208]	[4.35991]	[-1.27133]	[7.30208]	[-0.82114]	[5.68847]
VOLUME(-6)	0.000366	0.026681	-0.000522	0.026697	0.001921***	0.012204	0.000756	0.035092**	0.000548	0.042862**
	[0.60149]	[1.21513]	[-0.54008]	[1.52349]	[1.83656]	[0.54779]	[0.77876]	[2.02307]	[0.59668]	[2.39928]
VOLUME(-7)	-	-	0.000202	0.057558*	-0.001465	0.081086*	-0.00161***	0.053699*	-0.000611	0.043935*
	-	-	[0.22783]	[3.57433]	[-1.53882]	[3.99950]	[-1.78436]	[3.32405]	[-0.73226]	[2.70992]
F-Values	1.471.046	6.777.792	5.070.115	680.543	1.175.827	4.395.776	3.172.081	1.943.485	1.642.663	1460.77

Table 4g: Vector Autoregression Model Results

	Tata Steel		Tata Power		HUL		Jindal Steel		Ranbaxy	
	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME
C	-0.004745	0.699394*	-0.000888	0.43767*	0.003857	0.484258*	0.007831**	0.228434*	0.000288	0.535755*
	[-0.60270]	[5.86765]	[-0.20869]	[4.82401]	[1.00199]	[4.58111]	[2.35186]	[3.37775]	[0.07207]	[5.45979]
RETURN(-1)	0.051821*	0.46566***	0.054405*	1.241393*	0.007729	3.435070*	0.126781*	1.333398*	0.08351*	0.877368*
	[3.18395]	[1.88961]	[3.34019]	[3.57529]	[0.47764]	[7.73047]	[7.15378]	[3.70432]	[5.31180]	[2.27596]
RETURN(-2)	-0.001955	0.666863*	-0.069689*	-0.063755	-0.026835	-0.241438	-0.02905	0.607225***	-0.00745	0.390027
	[-0.11992]	[2.70176]	[-4.26879]	[-0.18320]	[-1.64786]	[-0.53991]	[-1.62532]	[1.67280]	[-0.47227]	[1.00806]
RETURN(-3)	0.019232	0.144513	-0.012505	0.258481	-0.02949***	0.069645	0.003468	0.350774	0.021312	-0.034737
	[1.17950]	[0.58535]	[-0.76430]	[0.74109]	[-1.81155]	[0.15578]	[0.19401]	[0.96611]	[1.35121]	[-0.08982]
RETURN(-4)	-0.013699	0.083152	0.022022	0.531029	-0.008105	-0.183140	-0.01968	0.304024	0.002704	-0.094488
	[-0.84042]	[0.33690]	[1.34862]	[1.52554]	[-0.49796]	[-0.40973]	[-1.10151]	[0.83783]	[0.17151]	[-0.24437]
RETURN(-5)	0.014838	-0.163029	0.01372	-0.044633	-0.04681*	-0.27421	0.007407	-0.234172	0.009234	-0.197595
	[0.91100]	[-0.66106]	[0.84038]	[-0.12824]	[-2.87849]	[-0.61405]	[0.41528]	[-0.64637]	[0.58557]	[-0.51100]
RETURN(-6)	-0.017963	-0.029544	-0.01118	-0.139495	-0.032196**	-0.395896	-0.01866	-0.45580	-0.025610	-0.191758
	[-1.10561]	[-0.12010]	[-0.68580]	[-0.40141]	[-1.97780]	[-0.88564]	[-1.04754]	[-1.26016]	[-1.62464]	[-0.49605]
RETURN(-7)	0.005678	-0.173846	0.003056	-0.036216	-0.033053**	-0.665123	0.01638	0.125388	0.007159	-0.615306
	[0.35065]	[-0.70901]	[0.18823]	[-0.10463]	[-2.03128]	[-1.48854]	[0.92112]	[0.34716]	[0.45348]	[-1.58947]
RETURN(-8)	-	-	-0.016759	-0.115483	-0.014812	-0.201298	-0.00501	-0.139305	0.011006	-0.325134
	-	-	[-1.03671]	[-0.33513]	[-0.91184]	[-0.45127]	[-0.28311]	[-0.38724]	[0.69720]	[-0.83994]
RETURN(-9)	-	-	-	-	0.010961	-0.920882**	-0.01086	-0.124194	0.01840	-0.333887
	-	-	-	-	[0.67551]	[-2.06680]	[-0.62428]	[-0.35159]	[1.17062]	[-0.86630]
VOLUME(-1)	0.002772*	0.461206*	0.001902**	0.43311*	0.000919	0.416198*	0.001529***	0.475741*	0.000362	0.457363*
	[2.58404]	[28.3990]	[2.49075]	[26.6090]	[1.56421]	[25.7913]	[1.75404]	[26.8731]	[0.56509]	[29.1358]
VOLUME(-2)	-0.001433***	0.106311*	-0.00009	0.127496*	-0.001002	0.121963*	-0.00044	0.131236*	-0.00020	0.107082*
	[-1.85563]	[5.95469]	[-0.10880]	[7.19746]	[-1.57529]	[6.98174]	[-0.45473]	[6.70961]	[-0.28084]	[6.21217]
VOLUME(-3)	-0.00008	0.080496*	-0.000633	0.086683*	-0.000313	0.102021*	0.000664	0.114007*	0.00003	0.073009*
	[-0.07025]	[4.49865]	[-0.75732]	[4.86850]	[-0.48981]	[5.80745]	[0.68555]	[5.79261]	[0.04635]	[4.21819]
VOLUME(-4)	-0.000384	0.112193*	0.000898	0.114798*	0.000748	0.070349*	-0.00056	0.062623*	-0.00049	0.112068*
	[-0.32574]	[6.28771]	[1.07411]	[6.44125]	[1.16472]	[3.98686]	[-0.57302]	[3.16820]	[-0.68629]	[6.46828]
VOLUME(-5)	-0.001637	0.087161*	-0.002161*	0.070723*	0.000248	0.081964*	-0.00057	0.075324*	-0.0008	0.03264**
	[-1.38562]	[4.87129]	[-2.58395]	[3.96695]	[0.38663]	[4.64751]	[-0.58801]	[3.81395]	[-1.13115]	[1.87493]
VOLUME(-6)	0.000892	0.036479**	0.001388***	0.066687*	-0.000202	0.004933	-0.00073	-0.002395	0.001656**	0.051233*
	[0.75586]	[2.04175]	[1.65920]	[3.74016]	[-0.31484]	[0.27941]	[-0.74743]	[-0.12133]	[2.34303]	[2.95677]
VOLUME(-7)	0.00097	0.068903*	-0.000843	0.025234	0.000789	0.050943*	-0.00030	0.039330**	-0.00160**	0.018102
	[0.90418]	[4.24348]	[-1.01323]	[1.42224]	[1.23255]	[2.89808]	[-0.30798]	[2.00237]	[-2.26330]	[1.04489]
VOLUME(-8)	-	-	-0.000348	0.041083**	-0.00113***	0.047227*	0.000301	0.035171***	0.000870	0.055103*
	-	-	[-0.45587]	[2.52179]	[-1.77856]	[2.70176]	[0.31314]	[1.80198]	[1.23668]	[3.19358]
VOLUME(-9)	-	-	-	-	-0.000299	0.069804*	-0.00046	0.049767*	0.000165	0.053414*
	-	-	-	-	[-0.51079]	[4.34467]	[-0.53350]	[2.81584]	[0.25835]	[3.40867]
F-Values	1.922.659	1.043.636	3.101.471	1.208.741	1.795.127	9.356.316	4.092.028	1.711.442	2.483.098	9.766.111

Table 4h: Vector Autoregression Model Results

	CIPLA		SBI		NTPC		HCL-TECH		Asian Paints	
	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME	RETURN	VOLUME
C	0.0149*	0.5947*	0.0021	0.7066*	0.0096	1.8222*	-0.0161	1.2640*	0.0005	0.8668*
	[2.80065]	[4.07704]	[0.30615]	[5.67395]	[0.89697]	[6.03852]	[-1.35224]	[5.92465]	[0.19048]	[6.15290]
RETURN(-1)	0.0674*	2.6790*	0.0830*	0.9029*	-0.0033	0.1333	0.0575*	1.7357*	-0.0242	8.1703*
	[4.15322]	[6.03718]	[5.09857]	[3.11486]	[-0.15132]	[0.21519]	[3.30333]	[5.54570]	[-1.49360]	[9.85864]
RETURN(-2)	-0.0063	1.8764*	-0.0137	0.4259	-0.0368***	0.3549	-0.0310***	-0.6657**	-0.0266	1.9598**
	[-0.38425]	[4.20129]	[-0.83889]	[1.46526]	[-1.66688]	[0.57257]	[-1.77209]	[-2.11856]	[-1.62529]	[2.33691]
RETURN(-3)	-0.0375**	0.5122	0.0122	0.1660	-0.0469**	0.0026	-0.0562*	0.0095	-0.0018	0.6005
	[-2.28949]	[1.14456]	[0.74548]	[0.57140]	[-2.12423]	[0.00422]	[-3.20847]	[0.03029]	[-0.11135]	[0.71557]
RETURN(-4)	-0.0018	0.3786	0.0191	-0.1890	-0.0167	0.0968	-0.0215	0.0327	-0.0065	2.4138*
	[-0.10882]	[0.84524]	[1.17223]	[-0.65178]	[-0.75555]	[0.15627]	[-1.22590]	[0.10376]	[-0.39394]	[2.87649]
RETURN(-5)	-0.02150	0.2775	-0.0492*	0.0217	-0.0117	-0.0165	-0.0726*	-0.4878	0.0129	0.6317
	[-1.31274]	[0.61970]	[-3.02325]	[0.07492]	[-0.53061]	[-0.02670]	[-4.14627]	[-1.55114]	[0.78585]	[0.75281]
RETURN(-6)	-0.04260*	-0.1254	-0.0587*	-0.1973	-0.0729*	0.1629	-0.0579*	0.0537	-0.0239	-1.4521***
	[-2.59972]	[-0.27993]	[-3.60806]	[-0.68048]	[-3.31094]	[0.26370]	[-3.30654]	[0.17052]	[-1.45744]	[-1.73069]
RETURN(-7)	-0.00210	-0.0590	0.0233	0.2942	0.0326	0.7441	0.0378**	-0.0134	-0.0166	-0.5084
	[-0.12887]	[-0.13176]	[1.42782]	[1.01166]	[1.47865]	[1.20158]	[2.15261]	[-0.04243]	[-1.01532]	[-0.60611]
RETURN(-8)	-0.00640	-0.7762***	0.0565*	0.4113	0.0355	0.1831	0.0175	-0.5018	0.0040	10.738
	[-0.39148]	[-1.73320]	[3.46384]	[1.41644]	[1.60878]	[0.29605]	[0.99894]	[-1.59424]	[0.24255]	[1.28055]
RETURN(-9)	-0.01450	-0.3913	0.0122	-0.0558	-0.0114	0.3788	-0.0142	-0.2955	-0.0176	0.9795
	[-0.88225]	[-0.87370]	[0.75124]	[-0.19348]	[-0.51774]	[0.61373]	[-0.81272]	[-0.94101]	[-1.07265]	[1.16887]
RETURN(-10)	0.0169	-0.1450	-	-	0.0008	0.6602	-0.0021	0.0593	0.0455*	0.4197
	[1.03085]	[-0.32381]	-	-	[0.03705]	[1.07006]	[-0.11985]	[0.18901]	[2.77985]	[0.50092]
RETURN(-11)	-0.01710	-0.3015	-	-	-	-	0.0187	-0.8038**	-0.0044	0.0785
	[-1.04154]	[-0.67310]	-	-	-	-	[1.06916]	[-2.56417]	[-0.27005]	[0.09360]
RETURN(-12)	0.0260	-0.6078	-	-	-	-	-0.0515*	-0.3754	0.0036	0.3408
	[1.58715]	[-1.35726]	-	-	-	-	[-2.95131]	[-1.19679]	[0.21900]	[0.40679]
RETURN(-13)	0.00540	1.8614*	-	-	-	-	0.0027	0.1759	-0.0497*	-0.5693
	[0.33173]	[4.15710]	-	-	-	-	[0.15769]	[0.56155]	[-3.03857]	[-0.68044]
RETURN(-14)	0.02840***	0.4330	-	-	-	-	-	-	-0.0006	-10.944
	[1.73442]	[0.96591]	-	-	-	-	-	-	[-0.03467]	[-1.30749]
RETURN(-15)	-0.0103	-0.0886	-	-	-	-	-	-	-	-
	[-0.62773]	[-0.19766]	-	-	-	-	-	-	-	-
RETURN(-16)	-0.01280	0.6395	-	-	-	-	-	-	-	-
	[-0.78367]	[1.42765]	-	-	-	-	-	-	-	-
RETURN(-17)	0.04770*	-0.1623	-	-	-	-	-	-	-	-
	[2.91230]	[-0.36248]	-	-	-	-	-	-	-	-
RETURN(-18)	0.00910	-0.1510	-	-	-	-	-	-	-	-
	[0.55998]	[-0.33830]	-	-	-	-	-	-	-	-

Table 4h (cont.): Vector Autoregression Model Results

	CIPLA		SBI		NTPC		HCL-TECH		Asian Paints	
VOLUME(-1)	-0.0006	0.3687*	-0.0002	0.4230*	0.0001	0.3465*	-0.0014	0.3356*	0.0006***	0.2795*
	[-0.94833]	[22.7255]	[-0.22153]	[26.0271]	[0.08560]	[15.7276]	[-1.47149]	[19.2595]	[1.75995]	[17.2699]
VOLUME(-2)	-0.0001	0.0839*	-0.0011	0.1309*	-0.0009	0.1264*	-0.0004	0.1310*	-0.0002	0.1462*
	[-0.13829]	[4.85525]	[-1.08931]	[7.42321]	[-1.08483]	[5.42498]	[-0.36800]	[7.12674]	[-0.60876]	[8.70277]
VOLUME(-3)	-0.0004	0.1168*	0.0009	0.1132*	-0.0006	0.1045*	0.0000	0.0380**	-0.0003	0.0633*
	[-0.61423]	[6.74197]	[0.93123]	[6.37188]	[-0.71799]	[4.45363]	[-0.01036]	[2.05247]	[-0.86510]	[3.73582]
VOLUME(-4)	0.0003	0.0401**	0.0003	0.0950*	-0.0006	0.0757*	-0.0009	0.0602*	0.0002	0.0625*
	[0.50571]	[2.30164]	[0.27383]	[5.32506]	[-0.76168]	[3.21286]	[-0.86744]	[3.25697]	[0.67697]	[3.68239]
VOLUME(-5)	-0.0004	0.04310**	0.0008	0.0289	0.0011	0.0531**	0.0005	0.0960*	0.0002	0.0696*
	[-0.66511]	[2.47322]	[0.82805]	[1.61288]	[1.36570]	[2.24671]	[0.44064]	[5.18386]	[0.52984]	[4.09031]
VOLUME(-6)	0.0002	0.0290***	0.0003	0.0389	0.0003	0.0338	0.0007	0.0338***	-0.0005	0.0413**
	[0.26156]	[1.66949]	[-0.04109]	[1.60590]	[0.32287]	[1.64750]	[0.72142]	[1.82184]	[-1.44655]	[2.42712]
VOLUME(-7)	0.0004	0.0263	-0.0017***	0.0230	0.0006	0.0153	-0.0012	0.0193	0.0006***	0.0293***
	[0.60473]	[1.52036]	[-1.67523]	[1.29244]	[0.73034]	[0.64911]	[-1.12215]	[1.03768]	[1.89683]	[1.72282]
VOLUME(-8)	0.0002	0.0231	0.0001	0.0507*	-0.0009	0.0338	0.0023*	0.0597*	-0.0005	0.0346**
	[0.34129]	[1.33366]	[0.12769]	[2.86787]	[-1.10725]	[1.43944]	[2.22275]	[3.21711]	[-1.59131]	[2.03037]
VOLUME(-9)	0.0000	0.0384**	0.0007	0.0575*	0.0005	0.0411***	0.0009	0.0382**	-0.0001	0.0406**
	[-0.01948]	[2.21982]	[0.78766]	[3.53881]	[0.64598]	[1.76399]	[0.84766]	[2.06334]	[-0.35467]	[2.38540]
VOLUME(-10)	0.0005	0.0654*	-	-	-0.0002	0.0429***	-0.0006	0.0512*	0.0000	0.0216
	[0.72958]	[3.78250]	-	-	[-0.24467]	[1.94591]	[-0.56137]	[2.76816]	[0.08181]	[1.26850]
VOLUME(-11)	-0.0004	0.0031	-	-	-	-	0.0004	0.0144	-0.0003	0.0282***
	[-0.62137]	[0.18083]	-	-	-	-	[0.35525]	[0.77700]	[-0.79914]	[1.66443]
VOLUME(-12)	-0.0007	0.0093	-	-	-	-	0.0004	0.0227	0.0009*	0.0381**
	[-1.12954]	[0.53933]	-	-	-	-	[0.37677]	[1.23673]	[2.69347]	[2.25305]
VOLUME(-13)	-0.0005	-0.0029	-	-	-	-	0.0005	0.0093	-0.0002	0.0292***
	[-0.85023]	[-0.16937]	-	-	-	-	[0.50028]	[0.53685]	[-0.56425]	[1.73754]
VOLUME(-14)	0.0004	0.0209	-	-	-	-	-	-	-0.0004	0.0251
	[0.60473]	[1.20611]	-	-	-	-	-	-	[-1.22782]	[1.56068]
VOLUME(-15)	-0.0001	0.0322***	-	-	-	-	-	-	-	-
	[-0.12307]	[1.86117]	-	-	-	-	-	-	-	-
VOLUME(-16)	-0.0002	0.0212	-	-	-	-	-	-	-	-
	[-0.26283]	[1.23027]	-	-	-	-	-	-	-	-
VOLUME(-17)	0.0004	-0.0015	-	-	-	-	-	-	-	-
	[0.66786]	[-0.08738]	-	-	-	-	-	-	-	-
VOLUME(-18)	0.0000	0.0390**	-	-	-	-	-	-	-	-
	[-0.04749]	[2.43128]	-	-	-	-	-	-	-	-
F-Values	**18.245**	**2.364.495**	**40.870**	**7.064.991**	**15.941**	**1.042.958**	**34.957**	**1.495.894**	**16.136**	**1.555.215**

It is relevant to mention here that results shown by the VAR modeling are marginally different from the results shown by Toda and Yamamoto Granger Causality tests. The possible reason behind the dissimilar results could be the different theoretical background of the two methodologies. Although results are little different, nevertheless presence of interaction between return and trading volume and significant role of stock returns cannot be denied.

5. Concluding Remarks

Monitoring stock prices and trading volume simultaneously can be very prolific for the dynamics of price discovery process. Previous studies (irrespective of their sample size or economy i.e. developing/developed) have already shown how indispensable is the study of above mentioned variables to know the future movements of financial markets. Taking clue from this, present study investigates the empirical relationship between stock returns and trading volume by using daily data of 39 individual securities and S&P CNX Nifty from January 1, 1998 to May 31, 2013. All possible precautions have been considered during the analysis of data, such as (i) instead of applying ordinary Granger causality test; Toda and Yamamoto (1995) test has been used (ii) lag length chosen by AIC and FPE criterion has further been insured by running Lagrange Multiplier (LM) test (iii) Causality determined by Toda and Yamamoto test has also been confirmed by using the VAR model.

Though results shown by Toda and Yamamoto and VAR test were little dissimilar, the empirical analysis provides sufficient grounds to declare the presence of interaction (either unilateral/bilateral) between stock returns and trading volume. However, some securities have shown independent movement in the stock returns and trading volume without communicating each other. As far as lead/lag relationship is concerned, around 80 per cent (i.e. 31 securities) of the individual securities have declared stock return 'a motivating force' behind investments. However, 13 per cent of the individual securities (i.e. 5 securities) and an index have shown the deterministic role of trading volume over stock returns. The policy implications of our findings are straightforward i.e. steps must be taken to stabilize the stock prices so that investors' decisions can be made more rationalized.

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