AN EMPIRICAL STUDY OF RETURN-VOLUME RELATIONSHIP FOR INDIAN MARKET

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ABSTRACT

Generally there is a common belief that returns and trading activities have a strong positive relationship. This paper analyzes return-volume relationship in Indian context, both in contemporaneous as well as lead-lag. Initial screening of returns and trading activity data shows some idiosyncratic aspect of Indian market although a positive return-activity relationship is acknowledged. This study also documents the dissimilarity in relationship for positive and negative changes in prices. As regards lead-lag relationship, this paper finds strong evidence of volume causing returns than vice-versa.

KEY WORDS

Trading volume, Price change, contemporaneous relationship, lead-lag relationship, systematic irregularities, ARIMA filtering, Haugh test, Granger Sims Causality

OBJECTIVE

The objective of this paper is to study the contemporaneous as well lead-lag relationship between price change and trading volume in Indian stock Market. Paper further analyze whether this relationship has any systematic irregularities on different weekdays as well as for positive and negative change in price.

Although several studies have been done on this issue, but they suffer from some limitations; they either covers a very short period of time or a very limited number of stocks, the data they used to establish this relationship are also really not comparable. Furthermore no such study has been done in Indian context so far[2], except some studies in derivatives segment and one study to test the effect of options expiration on NSE trading and volume.

BACKDROP OF THE PAPER

Generally there is a common belief in the financial markets that there should exist a positive relationship between trading volume and price changes. Wide fluctuation in prices without associated trading volume is considered as speculative move. The rationale behind this assumption is that increased expected terminal value of the asset increases demand function of the investors. Crouch (1970) provided a very clear explanation of why there should be a rise in the trading volume both with a positive and negative change

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in the stock price. He explained that given the initial equilibrium position, any change in demand (increase or decrease) would lead to the price above/below the equilibrium price. This will lead to adjustment transactions in the market, so one should expect a rise in the volume with both rise or fall in the prices.

It is very important to study the relationship between two variables as both are the joint products of a single market mechanism and discussion on one of these variables cannot be complete without a simultaneous discussion of another variable. Karpoff (1987) provides four very important reasons to study the price volume relationship. *First, it provides insight into the structure of the market, because price volume relationship depends on the rate of information flow to the market, how informations are disseminated, extent to which prices convey this information and size of the market. Second, a proper understanding of price volume relationship is also helpful to conduct various event studies and draw inferences. Third, it helps to understand the empirical distribution of speculative prices. And fourth, price-volume relationship has significant implications for research into futures market. Price variability affects the volume of trade in futures contracts. This has bearing on the issue of whether speculation is a stabilizing or destabilizing factor on futures prices. Price volume relationship also indicates the importance of private versus public information in determining investors' demand*[3].

LITERATURE SURVEY

Osborne (1959) made an early attempt to study the price volume relationship, he modeled that variance of stock price change depends on number of transactions. This implies a positive correlation between volume and price change. First serious attempt to study the relationship between price and volume was made by Granger and Morgenstern (1963) using cross-spectral analysis on the SEC composite index and total NYSE volume. They found no relationship between volume and prices. In their later papers Granger, Morgenstern and Godfrey (1964) test the relationship between price and volume of individual stocks and again found no relationship between the two. Although they found that daily volumes are positively correlated with (a) difference between daily high and daily low and (b) squared difference between the daily open and close. But they attributed this correlation to institutional factors, which influences the volume.[4] This led them to conclude that stock price series and series of stock transactions are wholly unrelated. They also inferred that conventional demand and supply theory is useless to study the behaviour of stock market.

Charles Ying (1966) studied S&P 500 index return and total volume of NYSE and found some very interesting results like; large increase in volumes are usually accompanied by large rise or fall in the prices, a large volume is followed by a rise in prices, if volume has been increasing/decreasing for a consecutive five trading days, then there will be a rise/fall in the prices for next four trading days. But findings of Ying has been questioned on the ground that two series under his studies are not comparable.

[3] Adapted from Karpoff (1987) paper.
[4] Institutional factors such as stop-loss, buy-above-market-order etc..

Crouch (1970) demonstrated in his paper that Godfrey, Granger and Morgenstern's inference is not correct. This is because in the short run, supply of the stock is fixed and holds by the investors. Now any change in the stock's price will change investors' perception and motivate them to reshuffle their position. This will affect the demand and supply of the stock. Market maker, who is aware of this change, will quickly change the price. Again here price changes will not be very swift and market maker will continue accepting orders and raising prices. But beyond a point it will be difficult for market maker to provide liquidity in the market and there will be a drastic change in the prices to induce investor community to provide liquidity. So simply there should be some correlation between the transaction volume and change in the security prices. One should expect a rise in the volume with both a positive as well as a negative change in the prices.

Clark (1973) provides an explanation of positive and linear relationship between price change and volume. "*In Clark's model the daily price change is the sum of a random number of within-day price changes. The variance of the daily price change is thus a random variable with a mean proportional to the mean number of daily transactions. Clark argues that the trading volume is related positively to the number of within day transactions and so the trading volume is related positively to the variability of the price change"*[5].

Epps (1975), using portfolio selection models, developed a theory that ratio of volume to price change on individual transactions in bull market should be more than ratio of volume to price change in bear market. Epps (1977) test its' validity for stock returns, when there exists transaction costs and he found that ratio of volume to price change remains higher for positive change in price even when volumes and price changes are measured over trading days, rather than over individual transactions. Hanna (1978) questioned the finding on Epps paper arguing that results can be attributed to the specificities of the time period of the study (During January 1971 there was a sharp upswing in the prices). He replicated the Epps study in the period with diagrammatically opposite market timing (May 1971, a month with sharp decline in the prices). Hanna study proved that instead of a positive bias in Epps's study there was a negative bias. In uptrends there is generally a tendency that P^+ (positive change in price) will exceed P^- (negative change in price), so overall it will bias the ratio of V^+/ P^+ lower side and that of V^-/P^- upper side. But since Epps study seen a higher positive ratio even in uptrend month also It shows that main variable in this ratio relationship is Volume, which has a tendency to rise in up-market and fall in down market.

Rogalski (1978) used Haugh's Prewhitened methodology to test the causal relationship between trading volume and stock returns and provide support to the hypothesis that price change per se and volumes for individual securities are positively interrelated. Tauchen and Pitts (1983) provides further insights into price-volume relationship. Their discussion is basically focused upon the development of the market. They argued that initially a market is very thin, trading volume starts to increase when more investors become aware of the market viability. So empirical results of other studies that price

[5] Tauchens and Pitts (1983).

variability should increase with the growth in trading volume is unlikely, rather more traders would tend to stabilize the prices.

Comiskey, Walking and Weeks (1984) using yearly data on individual common stocks found that volumes are positively correlated with price variability. Jain and Joh (1988) study the hourly common stock trading volume and returns on the NYSE. They found strong contemporaneous relation between trading volume and returns, lead-lag relationship between trading volumes and returns lagged up to four hours. They also found that this relationship is steeper for positive returns than for negative returns.

Literature also provides very important insight into the behaviour of trading volume and price change. Westerfield (1977) provided evidences that pricing process of stock market evolves at different rates on different days and it is connected with transaction time. He also found that absolute magnitude of daily price changes appear to be varying with the number of transaction per day. Jain and Joh (1988) show that average trading volume is lowest on Monday, increase monotonically up to Wednesday and then declines on Thursday and Friday. While returns on Monday are generally negative (Jain and Joh 1988), while high on Friday.

French (1980) examine the return under two different hypothesis of return generating process; calendar time hypothesis (assuming continuous time, ignoring holidays and market close days) and active trading hypothesis. Calendar time hypothesis exhibits that expected return on Monday is three times higher than expected return on other days of the week. Under the trading time hypothesis (assuming returns are generated only during active trading), expected return is the same for each day of the week. In the same study, return for S & P Composite Index under both the models, average return for the other four days of the week was positive while average return for Monday was significantly negative.

Gibbon and Hess (1981), Keim and Stambaugh (1984) also find the day of the week effect for stock return. Negative return for Monday is not limited to few stocks, rather uniform across individual stocks. Lakonishok and Levi (1982) explained that high return on Friday is due to delay in payment. Payments for purchases made on Friday are made generally ten days after the purchase, while in case of other days this period is generally eight days. So this additional two days motivates buyers to pay slightly higher price to buy. Rogalski (1984) discovered that negative return from Friday close to Monday close occurs during non-trading period (Friday close to Monday open). While average trading day return is same for all the days and January/firm size/ year anomalies do not have any bearing on this weekend effect. Bell and Lewin (1998) argued that weekend negative return could be attributed to institutional factors such as *financing discontinuities associated with the account settlement period, the relative scarcity of funds while finance is held in banks' suspense and transmission accounts on settlement day and firms reluctance to hold money during non-trading periods*[6].

[6] Bell and Lewin (1998)

Pearce (1996) using NYSE data for 1972 to 1994 find strong weekend anomalies for small firms stocks, while for large firm stocks this anomaly is weaker and disappeared after 1986. Kohli and Kothers (2001) identified thus far unknown week-of-the-month anomaly. Using S & P Composite Index's weekly data from July 1962 to June 1990, they observed different weekly returns. Returns during the first week of a month are significantly positive, while return during the other weeks of a month are statistically not different from zero.

In summary, existing literature provides strong evidence about positive relationship between trading volume and price changes. Return volume relationship tends to be relatively high during bull phase and relatively low during bear phase. So far as returns are concerned, they are generally negative on Monday and high on Friday. Returns also shows week-of-the-month anomaly, but January/firm size/ year anomalies do not have any bearing. In case of trading volume, volumes are lowest on Monday and highest on Tuesday and Wednesday.

DATA AND METHDOLOGY

DATA

Daily individual stock data for the period of April 2000 to March 2005 for NSE Nifty Fifty companies are collected from CMIE Prowess database and cross checked from NSE database. Although the composition of Nifty-Fifty keeps on changing time to time, so study includes those fifty companies which were there in the index as on April 1, 2005. Two separate indexes are created to calculate trading activity and price change. Trading activity is measured as the ratio of daily transaction divided by daily market capitalization of individual stock (Because absolute value of transaction do not capture the impact of price change in trading volume when two companies have different market capitalization). For example,

Company	Traded Volume	Market Capitalisation
A	100 Shares	10000 shares
B	500 Shares	100000 shares

So one should naturally look for the ratio of trading volume in terms of market capitalization and not simply the trading volume. Similarly, NSE Nifty Index return is not used in this paper. Because index returns are calculated on weighted basis, so companies with high weights dominates the overall return of the index. For example;

Company	% change in price	Index Weight	Contribution to index return
A	20%	5%	1%
B	10%	15%	1.5%

But in the spot market, individual stock activity is affected by the change in price for that particular stock (20 % and 10% in this example and not by their impact to index or total change in the index). So it makes more sense to take into the consideration these individual return figures (20% ad 10%) and not the index return figures.

Daily series of trading activity is calculated by dividing the turnover of all the companies on a particular day by daily market capitalization of all the companies. Similarly series for price change is generated by natural logarithms difference between total of previous day closing prices for all the securities and total of today's closing prices.

METHODOLOGY

Any study on a time series data should begin with the test of stationary and co-integration. Stationarity shows that there is no trend in the series and mean and variance of the series is constant over time. Literature provides a number of tests to check the stationarity. Some of the important and most widely used tests are Correlogram and Unit-root test (Augmented Dickey-Fuller test and Phillips-Perron test). Correlogram indicates non-stationarity in the series by slowly decaying ACF[7] and PACF. In this paper we used ADF test to check the stationarity, which uses following model;

$$\Delta V_t = a + \delta V_{t-1} + c_i \Sigma_1^m \Delta R_{t-1} + e_t$$

And check whether $\delta = 0$, If $\delta = 0$, then underlying series is non-stationary.

Sometimes in empirical studies one comes across time series, which are although not stationary, but still meaningful results can be drawn from them. In other words we check for Co-integration between the series. Co-integration shows that there exists a long run relationship between the variable, so results obtained are not spurious or sample specific. Again there are a number of test to check the co-integration mainly Engle-Granger two -step procedure, E-G Error Correction Model and Johnson test.

We used two-step procedure to check the co-integration between trading activity and return. Here first we estimate the following regression:

$$\Delta V_t = a + b V_{t-1} + e_t$$

And calculates the estimated value of V_t and obtains the residuals. These residuals are later checked for Stationarity. If residuals are stationary, then underlying series are Co-integrated.

Lead-Lag Relationship

Lead-lag relationship shows the predictive ability of one variable to other. A variable (x) is said to cause another variable (y) if current or past values of it (x) can help to predict the current value of another variable (y), which is not explained by either past value of variable y or other explanatory variables.

[7] Autocorrelation function, denoted as covariance at lag k divided by variances

To study the lead-lag relationship, we used two-step methodology; first filtered the series by using Haugh (1976) procedure and next used Granger-Sims test of causality. Haugh (1976) developed ARIMA filtering technique to control for predictive ability of past values of the variable. In this technique, ARIMA model is build for the series and residuals are obtained. These residuals are called prewhitened residuals (unexplained portion of the series by its own past values). Prewhitened residuals for both the series (in standardized form) are obtained and used for further analysis by Granger-Sims test.

Sims (1972) further worked on Granger (1969) test and developed a new technique of testing causality. Suppose one want to find out causality between x and y, then one should use following regression;

$$Y_t = a + b\, X_t + c_1\, X_{t-1} + \ldots\ldots\ldots + c_k\, X_{t-k} + d_1\, X_{t+1} + \ldots\ldots\ldots + d_k\, X_{t+k} + u_t$$

This regression includes current, lead and lagged values of regressor X. ‘b’ are current coefficients, ‘c’ are lagged coefficients and ‘d’ are lead coefficients. If in this regression only lagging coefficients are significant, then there exist a unidirectional causality from X to Y, if only leading coefficients are significant then unidirectional causality from Y to X, if both leading and lagging coefficients are significant then bi-directional causality and if no coefficients are significant then there exists no causal relationship.

DESCRIPTIVE STATISTICS

(Diagram One: Graph of Daily Trading Activity and Daily Return)

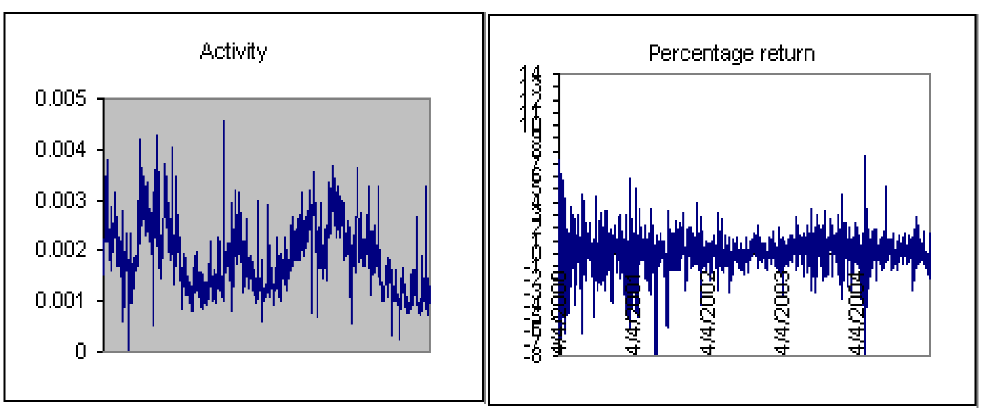


Table one shows mean and standard deviation for trading volume and stock returns for different days of the week. On average 0.244 percentages of shares changes hands on daily basis. Table also shows that contrary to general belief about lowest trading volume on Monday and highest on Tuesday, there is no significant difference among trading volumes on different days. Although trading volumes are lowest on Monday, but almost equal on different days. Similarly in case of return, as per the general belief returns are lowest on Monday but not highest on Friday; rather we observed lowest return on Friday.

Table 1: Mean and Standard Deviation for Trading volume and Return

	Return	**Trading Activity**
Monday	-0.2246	0.00224
	(3.9203)	(0.0014)
Tuesday	0.5933	0.00250
	(7.9048)	(0.0015)
Wednesday	0.1075	0.00251
	(1.4362)	(0.0014)
Thursday	0.0491	0.00249
Friday	(1.3436)	(0.0013)
	0.0061	0.00251
	(1.7121)	(0.0014)
Average	**0.00108**	**0.00244**
	(0.0410)	**(0.0014)**
F- day test	1.438	1.634
	(0.230)	(0.163)
F-1 test	2.150	4.609
	(0.1431)	(0.032)**
F-2 test	$3.06*10^{-5}$	0.258
	(0.995)	(0.611)
F-3 test	0.473	0.0126
	(0.491)	(0.998)

(Note: F- day tests whether means of all the days are statistically equal. F-1 tests whether mean of Monday is equal to mean of other days return, F-2 compares mean of Friday return with mean of other days returns and F-3 tests mean of Friday return with mean of Tuesday, Wednesday and Thursday returns. In case of activity F-2 tests compares mean of Tuesday activity with mean of other days activity and F-3 tests whether there is any difference between mean activity on Tuesday, Wednesday, Thursday and Friday)

We carried out analysis of variance tests to further analyze the weekday anomaly. Results of these tests are also summarized in table one. It shows that there is no statistically significant difference between the return and trading activity on different days. Result also shows that trading activity on Monday is significantly lower than other days. To further check the validity of these results we used following regression:

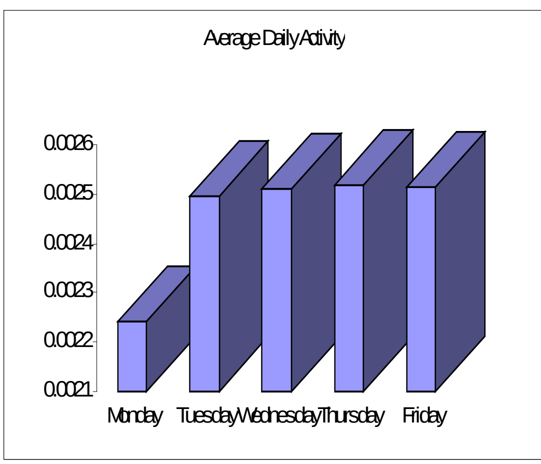
$$Y_t = b_1 D_{1t} + b_2 D_{2t} + b_3 D_{3t} + b_4 D_{4t} + b_5 D_{5t} + e_t$$

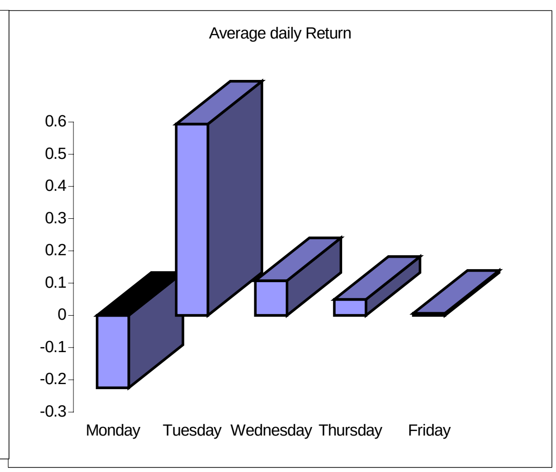
Where Y_t is the variable under study (i.e. daily return or daily trading activity) for period t, while dummy variables indicates the day of the week and e_t is the disturbance term. The coefficient of this equation shows the mean value of variable (return or activity), if mean value is same for all the days then estimated values of all the coefficient will be same and F-statistics will be insignificant. Result of this regression is reported in Table two, which shows that there is no difference in the return for different weekdays, but trading activity is not same across the different weekdays.

Table 2: Output of Regression Equation for week days Effect on Volume and Return

Return				
Day	Coefficient	S.E.	T-Statistics	p-value
Monday	- 0.22465	0.140185024	-1.6025314	0.109292
Tuesday	0.10308	0.140466238	0.7338451	0.463182
Wednesday	0.107512	0.139905493	0.7684609	0.442359
Thursday	0.049116	0.138803857	0.3538541	0.723508
Friday	0.006119	0.142189815	0.0430316	0.965683
Adj. R-Square	0.00096			
F-Value	0.7612			
Trading Volume				
Monday	0.00224	0.000093	24.102	0.000013
Tuesday	0.002502	0.000093	26.867	0.000095
Wednesday	0.002512	0.000092	27.075	0.000027
Thursday	0.002492	0.000092	27.077	.0.00027
Friday	0.002516	0.000094	26.681	0.000023
Adj. R-Square	0.00125			
F-Value	1.3073			

(Diagram Two: Average Daily Trading Activity and Average Daily Return)





RESULT DISCUSSION

Graphical test and ADF tests shows that two series under study are stationary. To further check, whether both the series are co-integrated or not, we performed Engle-Granger two stage procedure, which shows that both the series are co-integrated. This means using these series would not yield any spurious results (Exhibit). A further analysis of relationship between trading volume and return need to specify which variable is dependant and which is independent. Since existing literature do not provide any insight on this issue, further theoretically also we cannot distinguish whether return will influence trading volume or trading volume will influence return. So we conduct Granger Causality test. Granger test shows a bi-directional causality between return and trading volume (Exhibit). Initially Activity Granger Cause Return up to 60lags, while Return Granger Cause Activity from 30^{th} lag to 230 lags.

Contemporaneous Relationship Between Volume and Return

To study the contemporaneous relationship between trading volume and stock return, we use the qualitative variable approach, which uses dummies for all the qualitative factors. A similar type of methodology was used by Jain and Joh (1988) in his paper. Here we use following regression;

$$V_t = a + b\,R_t + c\,D_1R_t + d\,D_2 + e\,D_3 + f\,D_4 + g\,D_5 + h\,D_6R_t + ì\,D_7R_t + j\,D_8R_t + k\,D_9R_t + e_t$$

Here V_t and R_t show trading volume and return respectively for time t.
Dummy D_1 = 0 if hour t return is positive, 1 otherwise.
Dummy D_2 to D_5 for Different weekdays, Tuesday to Friday. Takes 0 and 1
Dummy D_6 to D_9 is included to check the interaction effect.

This regression was run in three stages; first, to check only impact of positive and negative return; second, to check the impact of weekdays also and in third stage, interactive dummies were also introduced. Results of these regressions are shown in table Three.

Table 3 : Test of Contemporaneous Relationship b/w Return and Trading Activity

Independent Variable	**Model One**	**Model Two**	**Model Three**
Intercept	0.002255 (42.940)	0.00201 (20.431)	0.00187 (18.795)
R_t	0.000268 (5.7024)	0.00027(5.7720)	0.00059(8.833)
D (negative return)	-0.000338 (-6.011)	-0.00034(-6.145)	-0.00061(-8.900)
D (Tuesday)		0.00028 (2.230)	0.00029(2.342)
D (Wednesday)		0.00030 (2.326)	0.00033(2.592)
D (Thursday)		0.00028 (2.224)	0.00029(2.358)
D (Friday)		0.00028 (2.184)	0.00027(2.099)
R_t D (Tuesday)			-0.00024(-3.512)
R_t D (Wednesday)			-0.00032(-4.384)
R_t D (Thursday)			-0.00031(-4.174)
R_t D (Friday)			-0.00036(-5.792)
Adj. R Square	0.0267	0.0300	0.0636

Note: Two values shown are estimated coefficients and t-statistics.

Model one shows a significant positive relationship between trading activity and daily return. For one percent increase in daily return, trading activity (ratio of traded volume to market capitalization) increases on an average by 0.02 percent. It also shows that this relationship is different for positive and negative returns. Relationship is more steep for positive return (slope coefficient 0.000268) than for negative return.

Model two shows that this relationship is different for different weekdays. On Monday activity will be equal to 'a + b*return', while on other days it is 'a + c/d/e/f + b*return (as the case may be)' and since all the c to f coefficients are positive and statistically significant it shows that relationship is weakest on Monday but almost constant for different days. Diagrammatically it is shown in Figure in Appendix.

Model three captures the interaction effect also. Unlike the previous model where we assumed that slope coefficient of the regression remains constant and any changes in the relationship can be attribute to intercept term only, here we modeled to further break down this difference. Whether the weekdays difference is only due to the differing intercept or slope coefficient also changes on different days. Results of this regression show that different days have different types of volume-return relationship.

Lead-Lag Relationship

To test the lead-lag relationship we used the standardized variables[8]. This transformation was done to control for systematic irregularities. To filter the series, alternative ARIMA models were developed and tried to obtain the residuals. Next we run the following regression:

$$PV_t = a + b\, PR_t + c\, D_0R_t + d_1\, PR_{t-1} + \ldots\ldots + d_k\, PR_{t-k} + e_1\, PR_{t+1} + \ldots\ldots + e_k\, PR_{t+k} + f_1\, D_1PR_{t-1} + \ldots\ldots + f_k\, D_kPR_{t-k} + g_1\, D_1PR_{t+1} + \ldots\ldots + g_k\, D_kPR_{t+k} + u_t$$

Here PV_t and PR_t are prewhitened volume and returns, PR_{t+k} and PR_{t+k} refers to lagged and leaded values of prewhitened series. Dummies show the positive and negative return for time t and takes value '0' for positive return and '1' for negative return. This model was tested for different values of residuals (obtained from different ARIMA filtering) and for different length of lead and leg values (tried for 5, 10 and 15 length). Summary results of this regression is shown in next Table, entire results are provided in table in Annexure

Independent Variable	Coefficient	t-Statistics	P-Value
Intercept	-0.035862	-2.3757	0.0177
$PreReturn_t$	0.068202	3.3209	0.0009
$DumPreReturn_t$	-0.106226	-3.7960	0.0450
$PreReturn_{t-1}$	0.054319	2.7398	0.0062
$DumPreReturn_{t-1}$	-0.064138	-2.1003	0.0359
$DumPreReturn_{t-2}$	-0.092820	-3.5607	0.0004

[8] To obtain the standardized series, we subtract mean from individual values and divided them by standard deviation of the series.

$DumPreReturn_{t-3}$	-0.047875	-1.8307	0.0674
$PreReturn_{t+1}$	0.035607	1.7897	0.0738
$PreReturn_{t+2}$	0.037988	2.0069	0.0450

Results in table can be interpreted this way; Highly significant 'PreReturn' coefficient confirms the old expectations developed by various studies in the past that when new informations arises in the market, price process evolves very fast and it causes significant activity in the market. Results once again confirms our previous results that trading activity is more for positive change in prices then for negative changes. Results also indicate that prewhitened returns cause prewhitened activity for one lag, but prewhitened activity causes prewhitened return up to two lead. In other words, results are contrary to general belief that return causes activity. We find more strong causal evidence from volume to return. It reinforces Walk Street saying that "It takes volume to make prices move".

CONCLUSION

This paper provides that a strong positive contemporaneous as well as lead-lag relationship between trading volume and stock return exist in Indian market. Although this relationship is not same, it shoes certain systematic irregularities like on Monday this relationship is slightly week and it is steeper for positive returns. Again this relationship is not the way it is generally assumed. In Indian market Volume is a leading variable, which causes returns. An analysis of data also revels that in Indian market no significant difference is there in trading volume for different weekdays, except that volumes are slightly lower on Monday. Similarly on an average Monday shows the negative return, while Friday is the lowest return day.

FURTHER SCOPE

This paper has enormous potential to look into various characteristics of Indian market. One can simply study the same return-volume relationship for other systematic irregularities like week-of-the-month effect, month effect or year effect. One can also check for seasonal impact or look into Sector wise effect also.

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ANNEXTURES

Exhibit One: Engle-Granger Two stage test for Co-integration

Engle-Granger Two Stage test for Co-Integration

ADF Test Statistic	-3.264529	1% Critical Value*	-3.4384
		5% Critical Value	-2.8643
		10% Critical Value	-2.5683

*MacKinnon critical values for rejection of hypothesis of a unit root.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(RESID01)
Method: Least Squares
Date: 04/11/05 Time: 00:15
Sample(adjusted): 6 1254
Included observations: 1249 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
RESID01(-1)	-0.037558	0.011505	-3.264529	0.0011
D(RESID01(-1))	-0.478536	0.029155	-16.41348	0.0000
D(RESID01(-2))	-0.241296	0.031252	-7.720883	0.0000
D(RESID01(-3))	-0.219300	0.030974	-7.080112	0.0000
D(RESID01(-4))	-0.145320	0.027971	-5.195475	0.0000
C	-2.65E-06	1.61E-05	-0.164580	0.8693

R-squared	0.223940	Mean dependent var	-1.25E-06
Adjusted R-squared	0.220818	S.D. dependent var	0.000645
S.E. of regression	0.000570	Akaike info criterion	-12.09821
Sum squared resid	0.000403	Schwarz criterion	-12.07357
Log likelihood	7561.335	F-statistic	71.73602
Durbin-Watson stat	2.004859	Prob(F-statistic)	0.000000

Exhibit Two: Granger Causality Test

Pairwise Granger Causality Test
Date: 04/13/05 Time: 10:34
Sample: 1 1300
Lags: 65

Null Hypothesis:	lag	F-Statistics	Probability
RETURN does not Granger Cause ACTIVITY	2	2.1557	0.07191
	29	1.4931	0.04547
	30	1.6047	0.02111
	31	1.5497	0.02838
	60	1.5047	0.00889
	90	1.3758	0.01509
	120	1.3271	0.01515
	230	1.2025	0.04458
ACTIVITY does not Granger Cause RETURN	2	4.0062	0.01844
	3	2.2838	0.07733
	30	1.7378	0.00839
	35	1.7202	0.00600
	40	1.5789	0.01301
	45	1.4928	0.02030
	50	1.6088	0.00519
	60	1.3897	0.02889

Exhibit: Systematic Weekdays Irregularities in Activity-Return Relationship

(Note: Thick lines in this diagram show Monday positive and negative return period. Lines for other days are almost identical and have been overlapping)

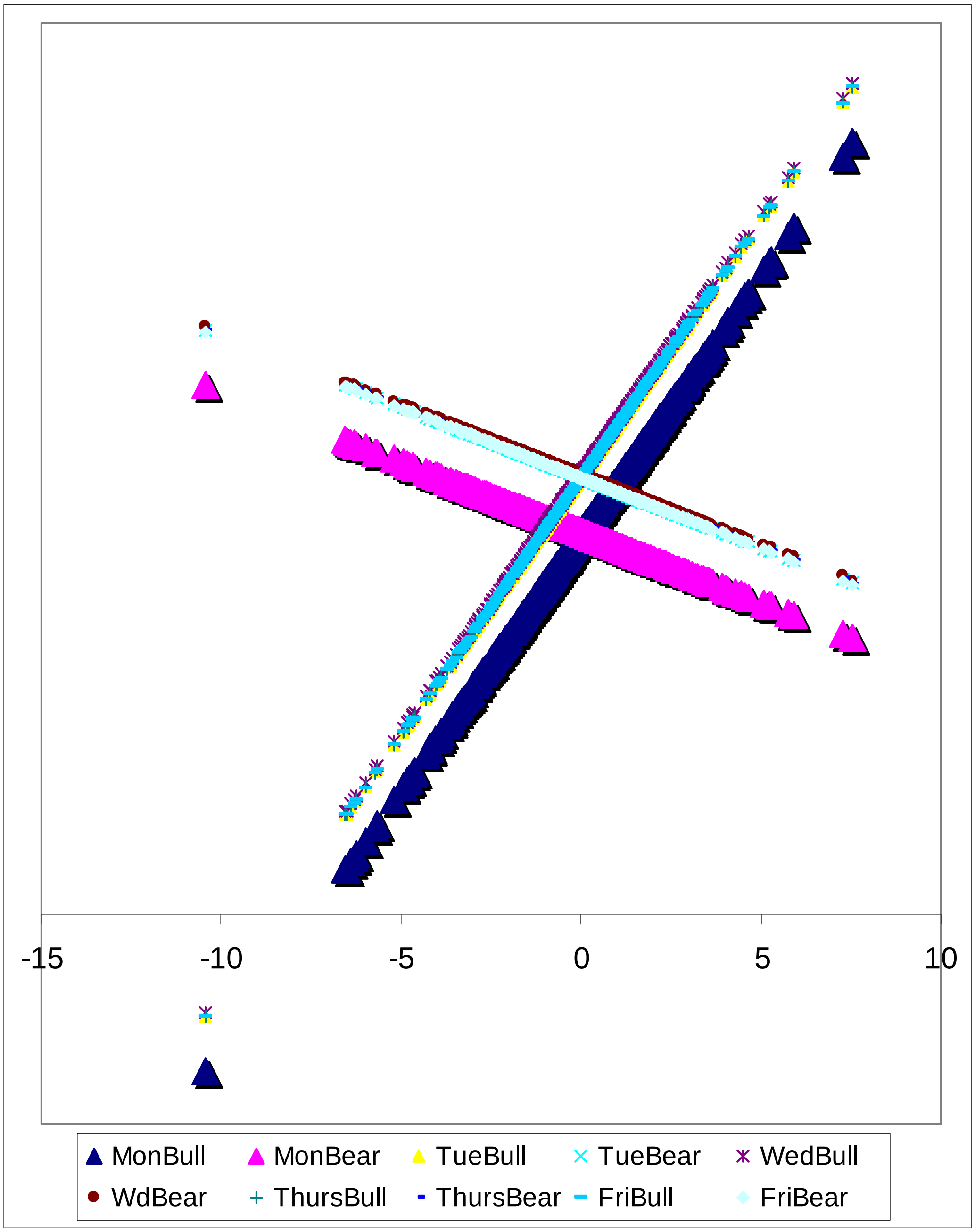

Exhibit : Lead-Lag Relationship between Trading Activity and Stock Return

Dependent Variable: VA
Method: Least Squares
Date: 04/13/05 Time: 06:55
Sample(adjusted): 1 1224
Included observations: 1224 after adjusting endpoints

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.035862	0.015095	-2.375705	0.0177
PR_t	0.068202	0.020537	3.320933	0.0009
PR_{t-1}	0.054319	0.019825	2.739896	0.0062
PR_{t-2}	0.022941	0.018164	1.262996	0.2068
PR_{t-3}	0.031348	0.018507	1.693856	0.0906
PR_{t-4}	-0.003978	0.018064	-0.220195	0.8258
PR_{t-5}	0.021094	0.017554	1.201666	0.2297
PR_{t-6}	0.008355	0.017850	0.468101	0.6398
PR_{t-7}	0.005714	0.018666	0.306092	0.7596
PR_{t-8}	-0.003225	0.018801	-0.171511	0.8639
PR_{t-9}	0.020454	0.018261	1.120096	0.2629
PR_{t-10}	0.032568	0.018361	1.773742	0.0764
PR_{t+1}	0.035607	0.019896	1.789692	0.0738
PR_{t+2}	0.037988	0.018929	2.006923	0.0450
PR_{t+3}	0.008100	0.019483	0.415751	0.6777
PR_{t+4}	0.007879	0.019190	0.410583	0.6815
PR_{t+5}	-0.040249	0.018772	-2.144068	0.0322
PR_{t+6}	0.008468	0.019759	0.428535	0.6683
PR_{t+7}	0.013199	0.018239	0.723683	0.4694
PR_{t+8}	-0.030009	0.018347	-1.635593	0.1022
PR_{t+9}	0.022024	0.018394	1.197330	0.2314
PR_{t+10}	-0.000789	0.018557	-0.042522	0.9661
$DUMPR_t$	-0.106226	0.027983	-3.796096	0.0002
$DUMPR_{t-1}$	-0.064138	0.030537	-2.100350	0.0359
$DUMPR_{t-2}$	-0.092820	0.026067	-3.560755	0.0004
$DUMPR_{t-3}$	-0.047875	0.026150	-1.830770	0.0674
$DUMPR_{t-4}$	-0.037042	0.026023	-1.423430	0.1549
$DUMPR_{t-5}$	-0.008552	0.026232	-0.326011	0.7445
$DUMPR_{t-6}$	0.008077	0.026121	0.309219	0.7572
$DUMPR_{t-7}$	-0.025321	0.026033	-0.972650	0.3309
$DUMPR_{t-8}$	0.002660	0.025852	0.102908	0.9181
$DUMPR_{t-9}$	-0.036688	0.025745	-1.425051	0.1544
$DUMPR_{t-10}$	-0.034230	0.025896	-1.321814	0.1865
$DUMPR_{t+1}$	-0.037562	0.026275	-1.429558	0.1531
$DUMPR_{t+2}$	-0.031020	0.026351	-1.177171	0.2394
$DUMPR_{t+3}$	-0.046582	0.026377	-1.765975	0.0777
$DUMPR_{t+4}$	-0.012150	0.026400	-0.460216	0.6454
$DUMPR_{t+5}$	0.053013	0.026368	2.010513	0.0446
$DUMPR_{t+6}$	-0.025690	0.026642	-0.964278	0.3351
$DUMPR_{t+7}$	-0.012013	0.026504	-0.453260	0.6504
$DUMPR_{t+8}$	0.018994	0.026520	0.716195	0.4740
$DUMPR_{t+9}$	-0.029414	0.026912	-1.092966	0.2746
$DUMPR_{t+10}$	0.005505	0.026775	0.205616	0.8371

R-squared	0.064390	Mean dependent var	-0.000616
Adjusted R-squared	0.031116	S.D. dependent var	0.431633
S.E. of regression	0.424864	Akaike info criterion	1.160405
Sum squared resid	213.1819	Schwarz criterion	1.339919
Log likelihood	-667.1678	F-statistic	1.935181
Durbin-Watson stat	2.812677	Prob(F-statistic)	0.000376