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THE EMPIRICAL RELATIONSHIP BETWEEN STOCKS RETURNS, TRADING VOLUME AND VOLATILITY: EVIDENCE FROM STOCK MARKET OF UNITED KINGDOM.

Haroon Iqbal
Lecturer (Business Administration)
University of the Punjab Jhelum campus, Pakistan

Tabassum Riaz
Lecturer (Commerce)
University of the Punjab Jhelum campus, Pakistan

Abstract

The purpose of this paper is to inspect the pragmatic association among daily traded volume of stocks, volatility as well as daily stock returns by taking one market index that is FTSE 100 and five individual stocks trading on FTSE 100. FTSE 100 index is under study because it represents about 81% of the market capitalization of the whole London Stock Exchange. The five stocks which are under examination are traded on FTSE 100 belongs to different sectors. The stocks are selected randomly by keeping in mind the fact that one from each sector. The stocks are Royal bank of Scotland (RBS), Vodafone (VOD), Sainsbury (SBRY), British Petroleum (BP) and British American Tobacco (BATS) and their sectors are Banks, Mobile telecommunication, Food and Drug Retailers, Oil and Gas Producers and Tobacco respectively. The data was taken for the period ranging from 7, July 2010 to 7, July 2014. Only one measure of trading volume is used that obtained by taking log of the daily turnover. This study does not use the de-trended trading as done in previous studies. Stationarity tests, OLS estimation, ARCH, GARCH and VAR model was employed in order to investigate undermine relationship. By considering individual stocks both positive and negative contemporary link found between the traded volume of stocks as well as their returns. But indication of negative contemporary link between daily traded volume and returns in case of market index. Evidence have been found that past return causes volume but no evidence that past volume causes returns so this suggests, no feedback association among returns and traded volume by considering market as well as stocks. ARCH effect cannot be reduced by introducing traded volume as an advisory variable in GARCH model so this suggest that traders trading in FTSE 100 cannot find traded volume as an informative variable. This study has also evaluates the linkage among volatility and traded volume separately and also the association among volatility, stock returns and traded volume.

***Keywords*—**Stock returns, Trading Volume, Stock Volatility, FTSE.

Introduction

In this Global World it is crucial for the positive reception of the microstructure of the financial markets to understand the association among volatility, volume and returns. The fluctuation in the stock markets are reflected by the flow of information, if the news is good all the investors will invest this will lead to rise in the trading volume and if the information is bad than investor will not invest, so it becomes necessary to every investor to keep an eye in the trading volume before investing. Traded volume with volatility and returns can affect the decision of investors. There is an extensive research

that has been done on different stock exchanges to understand the association among stock returns, volatility and traded volume. For many years financial economist are engaged in studying the association among volatility stock returns and traded volume. Karpoff (1986) has provided three main reasons for studying the association among volatility, returns and volume. First, association among three variables(volatility, returns and volume) can provide the investors as an important source to understand the financial markets. Second, by using the combination of returns and volume data one can draw the inferences. Third, the relation of volume and returns is crucial to argue over the empirical distribution of speculative prices. The basic purpose of this paper is to use the volume as a descriptive variable in addition to past returns, and inspect the association among volatility, return and volume. The possible hypothesis that this research will carry out are; to check whether stock returns and volatility have any relationship with trading volume, to examine the casual association among volume and returns for both stock exchange and at the individual stock level and does ARCH effect exist in the stock returns? If yes than, is this ARCH effects diminished or reduced by introducing trading volume as an descriptive variable in the GARCH equation.

Literature review

Chen, Firth and Rui, 2001 investigate the dynamic association between volatility, volume and returns. The main purpose of their research is to investigate the dynamic and casual association among three variables by considering the major National stock markets of different countries. Their finding suggest that there is positive association among volume and returns in Hong Kong, Switzerland, Netherland, Japan, and France. But there is no considerable relationship for UK, USA, Canada and Italy. They also argue that the results for UK market contrast with previous studies. Pisedtasalasai, Gunasekarage 2007 also investigate the casual and dynamic relationship among three variables for the markets in South East Asia that are Indonesia, Malaysia, Philippines, Singapore and Thailand. Their findings suggest significant contemporary association among returns and volume. Lee and Oliver Rui 2002 investigate the casual and dynamic association and the sign and magnitude of dynamic effect among three variables for both the domestic and cross country markets. Their finding suggest significant contemporary association among volume and returns after considering Heteroskedasticity. They concluded that trading volume cannot be used as explanatory variables returns. Now let's consider another research done by Nowbusting and Naregadu 2009. They studied the association among three variables considering Stock Exchange of Mauritius (SEM). They find that the coefficients of volume are very small in value and only two are significant at 1% level. Conditional volatility is also persistence as $\alpha + \beta$ is less than one. It has also been noted that difference between $\alpha + \beta$ for unrestricted and restricted equations are very small, which confirms that volume contribution to volatility is almost null. Another finding by them is that stock returns can be predicted using the previous day's returns based in autocorrelation analysis.

Another very impressive research done by Mubarik and Javid 2009. They investigate the association among three variables at firm level as well as at market level by considering Karachi Stock Exchange (KSE) of Pakistan. They suggested that last day return considerably affect the next day market returns. They also suggested that returns and volume do influence each other because of their casual relationship. Their results also suggested that in case of overall market there exist a positive and considerable impact on volatility by the lag of volume. At firm level their results suggest the existence of considerable auto-regressive process of first order. Now let's consider another research done by Brailsford, 1994. This study examines the association among three variables in the Australian market. This study empirically reveals the results that relationship between returns and volume are

significantly positive across all three consideration volume as well as the asymmetry in the relationship is also noteworthy across all three measures of trading volume. Now let's discuss some of the other studies briefly, Hasan Baklaci and Adnan Kasman 2005 have done the research to check association among three variables for 25 individual stocks traded on Istanbul Stock Exchange in Turkey. Their finding suggest considerably association among three variables contemporaneously, after traded volume is integrated in to conditional variance equation of the returns. It has also been noted that persistence in return volatility does not diminished after incorporating trading volume in majority of the stocks. Ngo and Jory (2008) did the study to examine the association among returns and volume in different international stock markets. Their results as are not consistent as there is a great variation in the association among variables across countries. They suggest serial correlation among volume and returns which can be useful to traders.

After studying and analyzing the above literature one can argue that trading volume is very important variable for investors to examine before investing in the stocks. There are different possible hypothesis that this research will carry out during the study. This research will examine its hypothesis both at firm level and at market level. This study will examine whether stock returns and volatility have any relation with trading volume. This study will also test the causal association among volume and returns. Does ARCH effect exist in the stock returns? If yes than, is this ARCH effects diminished or reduced when volume is added in the GARCH equation as a descriptive variable.

The Data and Methodology

This study has taken one market index that is Financial Times Stock Exchange (FTSE) 100. This index is under study because it represents about 81% of the market capitalization of the whole London Stock Exchange. It is the most widely used UK stock market indicator because it comprises of 100 most highly capitalized blue chip companies, representing approximately 81% of the UK market. It is also used as a basis for investment products like derivatives and exchange traded funds. The five stocks which are under examination are traded on FTSE 100 belongs to different sectors. The stocks are selected randomly by keeping in mind the fact that one from each sector. The stocks are Royal bank of Scotland (RBS), Vodafone (VOD), Sainsbury (SBRY), British Petroleum (BP) and British American Tobacco (BATS) and their sectors are Banks, Mobile telecommunication, Food and Drug Retailers, Oil and Gas Producers and Tobacco respectively. Table 1 presents the basic information about the stocks.

The five stocks which are under examination are traded on FTSE 100 belongs to different sectors. The stocks are selected randomly by keeping in mind the fact that one from each sector. The stocks are Royal bank of Scotland (RBS), Vodafone (VOD), Sainsbury (SBRY), British Petroleum (BP) and British American Tobacco (BATS) and their sectors are Banks, Mobile telecommunication, Food and Drug Retailers, Oil and Gas Producers and Tobacco respectively. Table 1 presents the basic information about the stocks.

Table 1: List of Stocks

Company Name	Symbol	Industry	Duration
Royal Bank of Scotland	RBS	Banks	7 July 2010 to 7 July 2014
Vodafone Group	VOD	Mobile Telecommunication	7 July 2010 to 7 July 2014
Sainsbury	SBRY	Food and Drug Retailers	7 July 2010 to 7 July 2014
British Petroleum	BP	Oil and Gas Producer	7 July 2010 to 7 July 2014
British American Tobacco	BATS	Tobacco	7 July 2010 to 7 July 2014

The data comprise of five stocks and one market index for the period of 7 July 2010 to 7 July 2014. The data includes daily closing price of stocks as well as market index and daily trading volume in terms of turnover. The dates are not included on which volume is not available. For market index as well as for each stock the total numbers of observations for closing prices are 1265 and same for the trading volume. So the total number of observations for market index as well as five stocks including both closing prices and trading volume becomes 15180. The study has used day to day data to test the casual and dynamic association among three variables because short horizon data are more suitable.

Daily Returns

The daily rate of returns of the stock markets (can be denoted as ui) is the return from last day(yesterday) to today, if is given as;

$$u_i = \frac{S_i - S_{i-1}}{S_{i-1}}$$

The formula above simply give percentage change is not helpful as continuously compounded return. The reason for this is that it is not be reliable to add together simply percentage change numbers over a period of time but continues compounded returns can be scaled over a long period of time. This is the technique called “time consistent; So for this study the technique used for calculating daily rate of return for all stock market as well as for individual stocks is continues compounded and is given by:

Si represents the today value and

Si-1 represents the yesterday value.

$$u_i = \ln\left(\frac{S_i}{S_{i-1}}\right)$$

Descriptive Statistics of Returns

Table 2 presents the descriptive statistics of market returns. It suggests that most of the market returns are negatively skewed during the period although not large as well. The negativity of skewness clearly suggests likelihood of earning negative returns. Market returns also show higher kurtosis (>3) which suggests that returns have fat tails as compared to normal distribution.

Table 2: Descriptive Statistics of FTSE 100 Returns

Market	Observations	Mean	Standard Deviation	Skewness	Kurtosis
FTSE 100	1264	-0.00000764	0.014515	-0.097886	10.44498

Now let's discuss the descriptive statistics of the stock returns which are under study. Table 3 presents the descriptive statistics of all the five stocks which are under examination. The results suggests that all the stocks have higher probability of negative returns because the skewness is negative is all except for BATS because the BATS returns are positively skewed so have more positive returns that is the value of standard deviation is less than the others. The value of kurtosis for all the stocks is very high as compare to standard (3), so this suggests that the returns have fat tail distribution as compared to normal distribution.

Table 3: Descriptive Statistics of Stocks Returns

Stocks	Observations	Mean	Standard Deviation	Skewness	Kurtosis
RBS	1264	-0.001877	0.052536	-7.623965	160.2739
SBRY	1264	0.000153	0.020014	-1.390404	23.92351
BP	1264	-0.000348	0.019495	-0.089103	9.480707
VOD	1264	0.00000564	0.019876	-0.319025	8.341121
BATS	1264	0.000567	0.016095	0.174264	11.39425

For checking the autocorrelation in the stock returns the study has used the Ljung-Box Statistics which is given below:

$$Q^* = T(T+2)\sum_{j=1}^{P}(T-j)^{-1}\,\hat{\rho}_X^2(j) > X^2_{P;0.05}$$

By taking the null hypothesis as the no autocorrelation in the stock returns, the finding suggests that there is autocorrelation in BP, RBS and VOD at the 5% significance level. In BAT there is no autocorrelation for the first lag as the p-value is 60.5% and for all lags there is significant presence of autocorrelation at 5% level. For SBRY there is significant presence of autocorrelation at the 10% level. So they study suggests that there is presence of autocorrelation in the stock returns under observation.

The volume of market and the stock is the daily turnover, which has the same duration as of stock returns. The literature studied above has used trading volume in different way. This study is using the trading volume in a different way; it has taken the log of daily turnover which is used for the purpose of analysis. For checking the autocorrelation in the trading volume Ljung-Box Statistics has been used by taking the null hypothesis as the no autocorrelation for market and stock, the finding suggests that there is presence for auto-correlation in the trading volume at the significant level of 1%.

Stationarity Test

Augmented Dickey Fuller (ADF) test has been used for checking the stationarity in the returns as well as in the trading volume. ADF test has been done for market and individual return for both the returns as well as trading volume. The ADF test for returns is given below:

$$\Delta U_i = \alpha_o + \gamma U_{i_{t-1}} + \sum_{i=1}^{n}\beta_i\,\Delta U_{t-i} + \epsilon_t$$

Where Ui represents the returns for both market as well as for stocks; the ADF test is negative, which suggests the rejection of the hypothesis that there is unit root at some level of confidence. The null hypothesis for the test is of no Stationarity and the alternative is of Stationarity

Table:4 ADF Test for Returns

Returns	ADF Test Statistics of 1st Lag
FTSE	-27.5679
RBS	-25.0899
BP	-26.9665
BAT	-29.6083
SBRY	-26.1046
VOD	-28.2496

Table 4 presents the ADF test statistics for the market return as well as for the stocks up to the 1st lag. The test has been done up to 12 lags which show the same results as for the 1st lag. The findings of ADF test suggests that study has to accept the alternative hypothesis that there is stationarity in the stock returns as the test statistics of 1st lag are less than the critical value (-2.8643) which is same up to 12 lags, so null hypothesis will be rejected. ADF test is also applied to the trading volume for checking the stationarity and equation is given below:

$$\Delta V_i = \alpha_o + \gamma V_{i_{t-1}} + \sum_{i=1}^{n} \beta_i \Delta V_{t-i} + \epsilon_t$$

Whereas Vi represents the trading volume. ADF test is tested up to 12 lags on the trading volume of stocks as well as market. They results for the ADF test statistics are presented in table 4.2 up to the 1st lag.

Table 4.1 ADF Test for Trading Volume

Trading Volume	ADF Test Statistics of 1st Lag
FTSE	-11.1098
RBS	-9.5648
BP	-9.8241
BAT	-12.2016
SBRY	-12.0008
VOD	-10.0739

95% Critical Value for ADF statistics is -2.8643

Findings in Table 4.1 suggests that null hypothesis has to be rejected against the alternative that there is stationarity in the trading volume for both market level as well as the firm level as the test statistics are less than the critical value (-2.8643). The above findings also apply up to the ADF test statistics up to the 12 lags.

$$\Delta \sigma_i = \alpha_o + \gamma \sigma_{i_{t-1}} + \sum_{i=1}^{n} \beta_i \Delta \sigma_{t-i} + \epsilon_t$$

The above equation is the ADF test used to test the stationarity of the volatility which has been finding through GARCH model. The results are shown in Table 4.3.

Table 4.2 ADF Test for Conditional Volatility

Trading Volume	ADF Test Statistics of 1st Lag
FTSE	-3.1947
RBS	-10.1899
BP	-3.4858
BAT	-3.3047
SBRY	-10.3133
VOD	-3.7271

95% Critical Value for ADF statistics is -2.8643

Findings presented in Table 4.2 suggest that study has to reject the null hypothesis against the alternative that there is presence of stationarity in conditional variance for market as well as at the individual firm level because the test statistics up to 1st lag are less than the critical value (-2.8643).

Volatility

The volatility in market returns as well as in stock returns is calculated through GARCH(1,1) model (Generalized Autoregressive Conditional Heteroskedasticity), GARCH(1,1) model is proposed by Bollerslev in 1986. As it is in practice that variance rates tend to be mean reverting, that is why GARCH(1,1) model is used to calculate conditional variance as:

$$\sigma_n^2 = \omega + \alpha u_{n-1}^2 + \beta \sigma_{n-1}^2$$

It incorporates mean reversion. The model is also used by **Anirut Pisedtasalasai and Abeyratna Gunasekarage (2007).** To make the model more appropriate sum of its weights should be equal to 1 that is + + = 1, for a stable GARCH(1,1) process we require + < 1, if this is not so than the weights applied to the long run variance will be negative because = 1-(+). For calculating the volatility in returns the square root of variance is calculated. Conditional Volatility is much weaker for longer horizon returns in case of time series variation, so employment of complex econometrics techniques such as GARCH model is best fit the data.

Volatility in Market Returns

When GARCH(1,1) model is run on the market returns the resulted outcome is presented in Table 5.1.

Table 5.1 GARCH outcome of Market Returns

Returns	α	β	$\alpha + \beta$
FTSE	0.115994*	0.855235*	0.971229

(*) Significant at 1% level

Results presented in Table 5.1 suggests that GARCH(1,1) is stable as + < 1, so the long run variance is also positive. As + is less than but it is close to one so this suggest that conditional variance is highly persistence. For checking whether the model used for calculating the conditional variance is good or not, the autocorrelation function is checked by making the hypothesis as,

Null Hypothesis = Ho = No Autocorrelation leads to good model
Alternative Hypothesis = H1 = Autocorrelation needs improvement or bad model
The GARCH(1,1) model is tested up to 10 lags which suggest that there is no autocorrelation because the p-value is greater than 1% (0.01) significant level for all the lags so null hypothesis is accepted that there is no autocorrelation so the model is good as it removes all the autocorrelation.

Volatility in Stock Returns
When GARCH(1,1) model is run on the stock returns the resulted outcome is presented in Table 5.2.

Table 5.2 GARCH outcome of Stock Returns

Returns	α	β	$\alpha + \beta$
BAT	0.078212*	0.904171*	0.982383
BP	0.104475*	0.880179*	0.984654
RBS	0.255692*	0.687951*	0.943643
SBRY	0.232755*	0.720887*	0.953642
VOD	0.066608*	0.917284*	0.983892

(*) significant at 1% level

Results presented in Table 5.2 suggests that GARCH(1,1) is stable as $+ < 1$, so the long run variance is also positive. As $+$ is less than but it is close to one so this suggest that conditional variance is highly persistence for all the stocks. For checking whether the model used for calculating the conditional variance is good or not for the stock the same autocorrelation function has been tested with the same hypothesis as for the market returns.
The GARCH(1,1) model is tested up to 10 lags which suggest that there is no autocorrelation because the p-value is greater than 1% (0.01) significant level for all the lags so null hypothesis is accepted that there is no autocorrelation so the model is good as it removes all the autocorrelation in the stock returns.

Models for investigating Empirical Relationships among Returns, Volatility and Trading volume

The study focuses on investigating association among return and trading volume by using the Ordinary Least Square (OLS) Method and Vector Autoregressive (VAR) modeling approach. This study is also focusing on the fact that if trading volume is introduces in GARCH than it can remove the ARCH effect or not.

Return and Trading Volume

The association among returns and trading volume is usually investigated through estimating contemporary correlation between Trading volume and return by using the OLS equation (Brailsford 1996).

$$V_t = \propto + \beta\, U_t \qquad [1]$$

Where V_t is the volume at time t, U_t represents returns at time t. The parameter β measures the partial correlation between volume and returns irrespective of the direction of the returns.

Trading Volume and Conditional Volatility

Conditional volatility of returns for market and the stocks is measured through GARCH model developed by Bollerslev (1986). The association among conditional volatility and volume is modelled by modifying GARCH equation. The volume is used as descriptive variable in GARCH equation (Lamoureux and Lastrapes, 1990) as follows:

$$\sigma_n^2 = \omega + \alpha u_{n-1}^2 + \beta\sigma_{n-1}^2 + \gamma V_t \quad [2]$$

The significance of the coefficient estimate (γ) of trading volume indicates the influence of volume on the conditional volatility. If persistence ($\alpha + \beta$) is reduced than it can be said that volume can remove the ARCH effect if it is used as an explanatory variable in the GARCH.

Casual Relationship between Return and Trading Volume

The relationship between returns and trading volume is estimated using the bivariate VAR model in which returns and trading volume are used as endogenous variables. The model is as follows:

$$u_t = \propto_0 + \sum_{i=1}^{5} \propto_i u_{t-i} + \sum_{j=1}^{5} \beta_j V_{t-j} \quad [3]$$

$$V_t = \gamma_0 + \sum_{i=1}^{5} \gamma_i V_{t-i} + \sum_{j=1}^{5} \delta_j u_{t-j} \quad [4]$$

The coefficient α_i and β_j represents the effect of lagged returns and lagged volume respectively. If $\beta_j=0$ than it can be concluded that volume does not cause returns. Similarly, if γ_i and δ_j represents the effect of lagged volume and lagged returns on the present volume. The significance of parameter δ_j indicates that the causality runs from returns to volume. If both the parameters β and δ are significant then there exists bi-directional causal association among returns and trading volume.

Relationship Between Trading Volume and Volatility

This study also has checked the association among trading volume and stock volatility in the GARCH model by including trading volume as an explanatory variable. In this section study will check the direct association among volatility and volume by using OLS equation estimation.

$$V_t = \propto + \beta\, \sigma_t \quad [5]$$

In equation [5] V_t represents the volume and σ_t represents volatility. The value of the coefficient β will tell that what sort of relationship exit between trading volume and volatility.

Relationship between Trading Volume, Volatility and Stock Return

This part of paper is using OLS equation estimation to explore the direct association among volume, volatility and stock returns by taking trading volume as a dependent variable. The equation used for this analysis is given below:

$$V_t = \propto + \beta\, \sigma_t + \gamma u_t \quad [6]$$

The coefficient β and γ will explain the relationship of volatility and return with trading volume respectively. If the coefficients are positive than there exist a positive relationship if it's negative than there exist a negative relationship, significance of test statistics are also important consideration for the above relationship.

Results and Discussion

In this section of this paper we present empirical results on the association among volume, returns and conditional volatility. Firstly the relationship between trading volume and returns is reported than the study reported the association among volume and conditional volatility.

Volume and Return

The results of the OLS regression using equation [1] to explain the association among volume and returns are presented in Table 6.

Table 6: Association among Trading Volume and Returns

Description	α	β
FTSE	14.1465*	-1.6317**
RBS	11.3163*	-0.77081**
BP	11.0235*	-2.0924*
BAT	8.6518*	0.33069
SBRY	9.1218*	1.1145
VOD	12.2471	-0.19177

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

The estimates of β presented in Table 6 examines the association among returns and volume not considering the direction of the returns. Results in Table 6 suggest that negative contemporary association among volume and returns for FTSE, RBS and BP which has the parameter significant at 5% level for FTSE, RBS and significant at 1% level for BP. The parameter β for BAT as well as SBRY shows positive contemporaneous relationship but its insignificant both at 1% level as well as 5% level. For VOD the parameter β is negative and also insignificant so this suggests that there exist a negative contemporary association among volume and returns of VOD but it is insignificant at 1% as well as 5% level.

Casual Association among Volume and Return

In order to investigate the association among returns and volume, the study has analyzed these variables through VAR model. The study has also explored the lead lag association among returns and volume by using Granger Causality (Smirlock and Starks, (1988), and Assogbavi et al. (1992). In equation [3] null hypothesis is tested that past volume does not cause returns (β_j=0) and in equation [4] null hypothesis is tested that the past returns does not cause volume (δ_j=0) separately. Results for the test are presented in Table 7.

Table 7: Bivariate VAR Model Outcome of Causal association among Returns and Volume

$$u_t = \propto_0 + \sum_{i=1}^{5} \propto_i u_{t-i} + \sum_{j=1}^{5} \beta_j V_{t-j}$$

Des	$\propto_0$	$\propto_1$	$\propto_2$	$\propto_3$	$\propto_4$	$\propto_5$	β_1	β_2	β_3	β_4	β_5
FTSE	0.01	-.070**	-0.07**	-.072**	.10*	-.07*	-.001	-.001	.002	-.000	-.0002
RBS	.01	.15*	-.09*	.09*	.016	-.050	-.005	-.000	-.000	.003	.000
BAT	.000	-.03	-.16*	-.11*	-.000	-.05**	-.000	-.001	.002	.000	.000
BP	.011	-.06**	-.05	-.039	.12*	.05**	.001	-.001	.0008	-.000	-.001
SBRY	.001	-.07**	-.007	-.305	.017	.079*	.000	-.001	.002**	-.000	-.0009
VOD	-.01	-.07*	-.09*	-.08*	.037	-.05**	.000	-.000	.001	-.000	-.000

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

The results presented in Table 7 suggest that study has to accept the null that past volume does not cause returns for both at market level as well as at firm level. It also suggest that past returns support the present returns both at 1% and 5% significance level for both the market as well as stocks. For SBRY the analyses suggest that there is hint to accept the alternative hypothesis that past volume does cause returns. Whereas the evidence found by as **Gong-Meng Chen, Michael Firth and Oliver M-Rui (2001)** indicates stronger evidence of returns causing volume than the volume causing returns. The findings of this study contradict with the finding of **Anirut Pisedtasalasai and Abeyratna Gunasekarage (2007).**

The results presented in Table 7.1 suggest that study have to reject the null hypothesis and have to accept the alternative that causality runs from past returns to volume for market as well as stocks level at 1% and 5% significance level. For SBRY there exist a bidirectional association among volume and stock returns, but for all other stocks as well as market there is no bidirectional association found among volume and returns. The findings of this study contradict with the finding of **Anirut Pisedtasalasai and Abeyratna Gunasekarage (2007)** and **Bong-Soo Lee and Oliver M. Rui (2002).**

Table 7.1: VAR Model Outcome of Causal association among with Returns and Volume

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

Des	γ_0	γ_1	γ_2	γ_3	γ_4	γ_5	δ_1	δ_2	δ_3	δ_4	δ_5
FTSE	2.77*	.48*	.12*	.098*	-.013	.10*	-1.5*	-1.0**	-.82	-.78	-.51
RBS	1.54*	.52*	.13*	.06**	.07**	.053	-.66*	.10	-.10	-.05	.015
BAT	1.94*	..35*	.16*	.15*	.014	.08*	-.68	-1.3	-1.3	-2.4*	-1.29
BP	1.7*	.44*	.17*	.11*	-.01	.11*	-.64	-1.83*	-.722	-.39	-1.01
SBRY	1.88*	.39*	.14*	.14*	.02	.07*	-.95	-1.95*	.029	-.43	-.69
VOD	1.48*	.46*	.08*	.15*	-.007	.18*	-1.01	-1.81*	-.13	-1.2**	.037

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

Conditional Volatility and Volume

To investigate the effect of volume and conditional volatility, the study first model the time series of all the stock returns as well as market returns by means of GARCH (1,1) model which is modified by adding trading volume as explanatory variable presented is equation [2]. The results are presented in Table 8.

Table 8 GARCH outcome of Stock Returns with Trading Volume

$$\sigma_n^2 = \omega + \alpha u_{n-1}^2 + \beta \sigma_{n-1}^2 + \gamma V_t$$

Returns	α	β	$\alpha + \beta$	γ
FTSE	0.117155*	0.882870*	1.000025	-.0000013
BAT	0.081287*	0.900215*	0.981502	-.00000614
BP	0.104129*	0.879095*	0.983224	-.00000257
RBS	0.271022*	0.763836*	1.034858	.0000196*
SBRY	0.359647*	0.637040*	0.996687	.0000214*
VOD	0.073156*	0.904622*	0.977778	.00000582*

(*) significant at 1% level

The results presented in Table 8 suggest that trading volume shows significant effect at 1% significant level in case of RBS, SBRY and VOD. But in case of BP, BAT and FTSE, coefficient of trading volume is not significant at 1% or at 5% significance level. But if the value of α+β is considered it clearly shows that volatility is highly persistence closer to 1 and in some cases more than one, so this recommend that volume is unable to remove the ARCH effect in the case of market as well as stocks. These findings are supported by the findings of **Bong-Soo Lee and Oliver M. Rui (2002)** and **Fauzia Mubarik** and **Attiya Y. Javid (2009).**

Relationship Between Trading Volume and Volatility

The results which are obtained through by running the equation 5 are presented in Table 9 which suggests the relationship between trading volume and volatility.

Table 9: Relationship between Trading Volume and Volatility

Description	A	β
FTSE	14.14550*	4.502397
RBS	11.28216*	10.55398*
BP	10.96709*	154.1768*
BAT	8.558136*	376.3400*
SBRY	9.071181*	95.77201*
VOD	12.23065*	41.15051

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

Result of equation 5 presented in Table 9 suggests that α is significant and positive for market as well as for individual stocks. But coefficient β is positive for market as well as individual stock but it insignificant at 1% as well as 5% level for market index which suggest that there is no considerable association among volume and volatility at market level. For individual stocks the value of coefficient β is significant at 1% level for all except VOD which is insignificant even at 5% level. This suggests that in case of RBS, BP, BAT, and SBRY volume and volatility have positive and significant relationship with each other.

Association among Volume, Volatility and Return

The results of the equation 6 are presented in Table 10 which explains the association among volume, volatility and returns for market as well as individual stocks.

Table 10: Association among Volume and Volatility and Stock Returns

Description	α	B	γ
FTSE	14.14554*	4.234252	-1.631263**
RBS	11.28036*	10.61941*	-0.846742*
BP	10.96610*	154.8376*	-2.125647*
BAT	8.557981*	376.2841*	0.297813**
SBRY	9.070572*	96.55422*	1.270557**
VOD	12.23052*	41.46702	-0.209140

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

Results presented in Table 10 suggest that trading volume has negative significant (at 5% level) relationship with returns and insignificant relationship with volatility for market index. For individual stocks RBS, BP; volume has significant and positive association with volatility and significant negative relationship with stock returns. For BAT and SBRY volume has positive significant association among volatility and stock returns. For VOD volume has positive insignificant association with volatility and negative insignificant relationship with returns.

Conclusion

This study suggest that at market level there is positive contemporary association among returns and trading volume but for stocks the study suggest positive contemporaneous relationship in two stocks and negative contemporaneous relationship in three stocks among volume and returns. Study suggests that past volume does not cause returns but there is evidence found that past returns cause volume, this suggest that there is no bidirectional association found among volume and returns for market and individual stock. These results are supported by the finding of **Anirut Pisedtasalasai and Abeyratna Gunasekarage (2007)** and **Bong-Soo Lee and Oliver M. Rui (2002).**

The study has used trading volume as an descriptive variable in the GARCH model to check whether the ARCH effect can be removed or not. The findings propose that volume is unable to remove the ARCH affect. The study has also find that there is significant relation among trading volume and volatility at stock level but insignificant interaction at the market. The study has also find the direct association among volume and volatility by means of OLS estimation which suggest that there is no

considerable association in case of market but for individual stock there exist a positive considerable association among trading volume and volatility.
This paper has also combine all the three variable in OLS estimation to check their relationship which suggests that negative significance association among volume and returns. In case of individual stocks there is mix results in some cases positive significant relationship in all three and in some there exist negative significant relationship and for one of the stock there in exist no relation between three variables. This paper suggest traders investing in FTSE 100 to not use trading volume as a proxy of information.

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