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THE DYNAMIC RELATIONSHIP BETWEEN STOCK VOLATILITY AND TRADING VOLUME

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ABSTRACT

The objective of the study is to measure the relationship between trading volume and returns; and change in trading volume and returns of stocks in Pakistan.Various techniques such as Unit root tests and GARCH have been applied on the data to determine the relationship between aforesaid variables. For this purpose, weekly data of Karachi Stock Exchange (KSE-100 index) has been collected and analyzed from January 2000 to March 2012.The GARCH results indicate a significant positive relationship between trading volume and returns; and change in trading volume and returns.This relationship is of great importance to individuals from investment and policy making perspective as trading volume reflects information about market expectations, and its relationship with price can have important implications for trading, speculation, forecasting and hedging activities.

Key Words: Stock returns, Trading volume, Karachi stock exchange, ARCH/GARCH.

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INTRODUCTION

The small and developing economies, like Pakistan, are facing the problem of high volatility and great uncertainty in various areas including financial sector. Volatility adversely effects the functioning of the financial system and hence economic performance. Higher returns encourage the investors to invest and increase the capital inflow, whereas in volatile environments the returns are not certain and hard to predict effecting investment eventually.Risk is the major factor that determines the return. Higher the risk, higher will be the return. The analysis of the current study revolves around the volume and price, also known as volume-return relationship. The objective of this study is to measure the relationship between trading volume and returns in the stock market of Pakistan. Most of the research in order to measure this relationship has been undergone at the international level, but relatively little work has been undertaken in our local market.

The empirical studies show that trading volume and stock returns are interrelated. Risk or volatility can be the result of company-related factors, like projects are not going up to projected expectations, potential growth with expected limits, competition from inside and outside of the country, and changes which are taking place in the management and within the financing patterns. This is unsystematic risk and can be eliminated.The other type of risk is said to be as market risk or systematic risk. It is affected by factors such as fiscal budget, agricultural production, foreign exchange reserves and market sentiments, through which stock prices is pushed up/down within different times. The rate of fluctuation depends upon relationship of stock with the whole market. Investors use this information to assess the efficiency of management team, to decide on buy/hold/sell strategy and to readjust their portfolio of assets (Bundoo, 2000).

This research paper focuses on relationship of Risk-Return-Volume in Karachi Stock Exchange (KSE). The causal as well as contemporaneous relationship has been investigated by using GARCH and Granger causality tests. The main purpose is to impart inside knowledge of the relationship between volume and returns and help the investors and other stakeholders in Pakistan in making investment decisions. This study will open new dimensions of research for future researchers as KSE is the biggest and best performing stock market of the country.

The rest of the article has the following sequence. Section 2 describes a literature review of theory and previous empirical research. Section 3 presents the data and measurement variables. Section 4 is about the results of the methodology, and Section 5 offers some concluding remarks.

LITERATURE REVIEW

The return and volume relationship has been studied and investigated from many different perspectives in the literature. Granger and Morgenstern(1963) had studied the relation between price indexes and aggregate exchange trading volume.Crouch (1970); Westerfield(1977);Rogalski

(1978); and Tauchen and Pitts (1983)had investigated the relationship between contemporaneous price change and trading volume.Epps and Epps(1976) had measured the relationship between the variance of price change and trading volume.Clark (1973); and Harris (1986) had estimated the relationship between squared price changes and trading volume.

Numerous studies have focused on the relationship between trading volume and returns.Karpoff (1987) had given four reasons for the importance of this relationship. First, there is the need to understand the financial market structure. Second, it has great significance for event studies. Third, it is an integral part of speculation. And fourth, it can provide insight into future markets.A study undergone by Jain and Joh (1988) had stated that there exists a significant relationship between returns and trading volume. The data comprised of common stock volume and returns of New York Stock Exchange (NYSE).

To test for causal relationship, Hiemstra and Jones (1994) had used Granger test to find linear and non-linear causal relationship and found bidirectional linear causality between volume and returns in NYSE. Muradoglu, Berument and Metin (1999) had examined how determinants of volatility and stock returns change with financial crisis in an emerging market such as that of Pakistan. They have found that during a financial crisis in an emerging market, risk-return relationship and the factors that determine this relationship change.

Chen, Firth and Rui (2001) had investigated this relationship in nine major stock markets, i.e. U.S., Japan, U.K., France, Canada, Italy, Switzerland, Netherlands and Hong Kong and their results showed significant positive association between trading volume and returns.Gunduz and Hatemi-J (2005) carried out a research to investigate the causality between returns and volume in the emerging markets of Czech Republic, Hungary, Poland, Russia and Turkey. There is no causal relationship between the variables in the Czech Republic. In Hungary and Poland, there is evidence of bidirectional causality between stock prices and volume. Returns cause volume in case of Russia and Turkey i.e. there is a unidirectional causal relationship.

A study conducted by Henry and McKenzie (2006)had supported the similar outcomes in Hong Kong but causality was non-linear. Further, Mala and Reddy (2007) studied stock market volatility in Fiji, a developing economy, and found that 7 out of 16 listed firms exhibited volatile traits. It was also found that interest rates have a major impact on stock's volatility.Floros and Vougas (2007) had studied the relationship between trading volume and returns in Greek Stock Index Futures Market and found significant positive contemporaneous relationship between the two in FTSE/ASE-20. However, the results for FTSE/ASE Mid 40 show no evidence of relationship between returns and volume.

Pisedtasalasaiand Gunasekarage (2008) had alsoexamined the causal relationship between returns and volume using VAR and GARCH offive countries, i.e.Indonesia, Malaysia, Philippines, Singapore and Thailand. In four countries except Philippines, a unidirectional causality running from returns to volume was found and no results could be derived in Philippines.Pathirawasam (2008)had conducted a study using stock volume and returns from Colombo Stock Exchange and found that stock returns are positively related to changes in volume, but negatively to past trading volume. He attributed this negative cause to misspecification and illiquidity issues.

Khan and Rizwan (2008) had conducted the same study before using the data of KSE 100 index for the period 2001-2007 and deduced a positive contemporaneous relationship between the trading volume and returns. Furthermore, VAR was used to find a feedback relationship, which implies that there is a bidirectional causal relationship between volume and returns. Tripathy(2011) had investigated the dynamic causal relationship between stock return and trading volume of Indian stock Market and found bi-directional causality between the two. Also, the results of Johansen's co integration test depicted long-run relationship between volume and returns.

Another study was conducted by Darwish (2012) who used GARCH model and found strong relationship between returns and volume in the Palestine stock exchange and deduced bidirectional causal relationship.Similarly,a research of 98 companies listed in Karachi Stock Exchange (KSE) of Pakistan by Rehman, Burhan, Shah and Mushtaq (2012) revealed a strong positive relation between returns and trading volume.In the case of emerging markets, numerous literatures can be found that had discussed this return-volume relationship and how volatility can be understood in this context.

RESEARCH METHODOLOGY AND DATA DESCRIPTION

The sample of data used in this current study comprises weekly stock price index and trading volume of the KSE 100 index. The daily data is converted into weekly basis by taking the average of the whole week stock price index and trading volume. The weekly data is used because of the small market size, thin trading and to avoid the day- of- the week effect (Darwish, 2012). The realization period has covered from January 2000 to April 2012 and has been collected from Bloomberg data base and business recorder data base. From the values of the closing index, the weekly rate of return (R_t) was calculated as:

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

Where P_t is the closing index price on week (t).Thevolume (V_t) can take only positive values.Therefore,besidesthe volume,an estimatedchange inthe volume(ΔV_t)is alsotaken intoaccount to cover both thepositive and negative values i.e. increases in volume as well as the decreases.The changes in trading value (ΔV_t) were calculated as:

$$ChangeinV_t = ln(V_t / V_{t-1}) \quad (2)$$

Where V_t is the raw trading volume. The study examines whether rising price leads to higher volume or vice versa. This is what a contemporaneous relationship depicts. For this purpose, the below mentioned regression equation was tested:

$$R_t = \propto_1 + \beta_1 R_{t-1} + b_1 V_t + \epsilon_{t1} \quad (3)$$

Then another equation that was tested:

$$R_t = \propto_2 + \beta_2 R_{t-1} + b_2 \Delta V_t + \epsilon_{t2} \quad (4)$$

WhereR_t stands for return, V_t is trading volume andΔV_t is the change in trading volume at time t.$R_{t-1}$is included in the equations to account for serial correlation in returns series.

ARCH (*q*) Model

The data used is time series and is prone to high and low volatility periods. So the value of the disturbance term can be greater in certain periods as compared to others. The assumption of homoskedasticity is limiting in such cases and to model the behavior of conditional variance, ARCH model is used. The conditional variance is denoted by:

$$\sigma_t^2 = var\,(e_t/e_{t-1}e_{t-2}\ldots,.) = E[(e_t - E(e_t)^2)/e_{t-1}e_{t-2}\ldots.] \quad (5)$$

Since$E(e_t) = 0$, the above equation becomes:

$$\sigma_t^2 = var(e_t/e_{t-1}e_{t-2}\ldots,.) = E[e^2/e_{t-1}e_{t-2}\ldots,.] \quad (6)$$

Ordinary Least Squares (OLS) has been used to estimate an ARCH(q) model. Engle (1982) suggested that the lag length or (q) of ARCH errors can be tested with the help of Lagrange multiplier test as follows:

1. Assess the best fitautoregressive modelAR(q).

$$y_t = a_0 + a_1 y_{t-1} + \ldots. + a_q y_{t-q} + \epsilon_t = a_0 + \sum_{i=1}^{q} a_i\, y_{t-i} + \epsilon_t \quad (7)$$

2. Obtain the squares of the error $\hat{\epsilon}^2$and regress them on a constant and *q* lagged values:

$$\hat{\epsilon}_t^2 = \hat{\alpha}_0 + \sum_{i=1}^{q} \hat{\propto}_i\, \hat{\epsilon}_{t-i}^2 \quad (8)$$

Where*q* is the length of ARCH lags.

3. The t-stat TR^2 has χ^2 distribution with q degrees of freedom in a data of T residuals. If the value of TR^2 is larger than the chi-square value, null hypothesis is rejected and ARCH effect exists. If TR^2 has smaller value than Chi-square, null hypothesis is accepted.

GARCH (*p, q*) Model

Generalized Autoregressive Conditional Hetroskedasticity (GARCH) model was used to investigate about the relationship between trading volume and returns. GARCH includes the lagged conditional variance terms as autoregressive terms, one of the drawbacks of ARCH model. TheGARCH (p, q) model (where p is the order of the GARCH terms $\sigma^2$and q is the order of the ARCH terms (ϵ^2) is given by

$$\sigma_t^2 = \propto_0 + \propto_1 \in_{t-1}^2 + \ldots + \propto_q \in_{t-q}^2 + \beta_1 \sigma_{t-1}^2 + \ldots + \beta_p \sigma_{t-p}^2 = \propto_0 + \sum_{i=1}^{q} \propto_i \in_{t-i}^2 + \sum_{i=1}^{p} \beta_i \sigma_{t-i}^2 \quad (9)$$

ANALYSIS

The descriptive statistics has been estimated in order to analyze the high returns and riskiness through mean and standard deviation respectively. The results are shown in Table 1:

Table-1. Descriptive Statistics of Return, Volume and Change in Volume of KSE-100

Description	R_t	V_t	ΔV_t
Min	-0.175786	10.93311	-3.145537
Max	0.105373	22.20456	8.348282
Mean	0.003447	20.35115	0.001417
Standard Deviation	0.031894	1.167638	0.598212
Skewness	-1.076590	-3.609543	4.055927
Kurtosis	7.187225	23.18188	64.51897
Jarque-Bera	581.9373 0.000000	12059.87 0.000000	101072.6 0.000000

The results of Table 1 show that the KSE-100 index has only positive returns. The riskiness has been determined through standard deviation, which shows that the KSE-100 is less risky. The mean of trading volume and the changes in trading volume is also positive. Theresultsof skewness ofreturnsshowthatthedataseriesexhibitasymmetricandredundantkurtosis. The trading volume shows positiveskewnessandan indication ofGARCHeffects.The JB-stats show that the all series have highly significant results at 1% level and the acceptance of hypothesis that the series are not normally distributed.

Augmented Dickey Fuller (ADF) Unit Root test and Phillips Perron(PP) Unit Root testhas been used to check that the economic variables are stationary. The ADF test includes constant with no trend at level *I(0)* and first difference *I(1)* of variables. The lag differences (*k*) are chosen according to Schwarz Info Criterion (SIC). ADF unit root test is commonly applied to measure the existence of stationary, but it's not very powerful tool for infinite samples, for this Phillips and Perron (1988) have introduced another alternative, Phillips-Peron (PP) unit root test. The PP test includes constant with no trend at level *I(0)*and first difference *I(1)* of variables. The bandwidth (*t*) is chosen according to Bartlett Kernel. The test results had shown in Table 2:

Table-2.ADF Unit Root Test and PP Unit Root Test Statistic

Variable	**ADF Unit Root Test**		**PP Unit Root Test**	
	No trend	*k*	*No trend*	*t*
R_t	-17.892*	0	-17.834*	1
V_t	-4. 847*	1	-6.616*	10
ΔV_t	-34.800*	0	-36.138*	11

Note: ADF Unit Root Test Statistics and PP Test Statistics of Return, Volume and Change in Volume Pakistan from 2000 to 2012
*denotes MacKinnon critical values for rejection of null hypothesis of a unit root and significance at the 1% level.

The test result shown in Table 2, indicates that the time series data at level *I(0)* is stationary at 1% level of significance at different lags. The deterministic trend means that the time series is now completely predictable and not variable. So, all the times series of the variables are stationary, this implies that all the shocks that would be temporary and their effects would be eliminated over time as the series regress to their long term variance.

Now, the long run coefficients have been estimated of eq. (3) and (4) by using the OLS technique. The results of the long run estimates are reported in Table 3:

Table -3. Cointegrating Vectors Using OLS

Regression Eq.: $R_t = \propto_1 + \beta_1 R_{t-1} + b_1 V_t + \epsilon_{t1}$		
Regressor	*Coefficient*	*T-values*
Constant	-0.0412	-1.9351*
R_{t-1}	0.3109	8.1166*
V_t	0.0021	2.0434*
Regression Eq.: $R_t = \propto_2 + \beta_2 R_{t-1} + b_2 \Delta V_t + \epsilon_{t2}$		
Regressor	*Coefficient*	*T-values*
Constant	0.0022	1.8472*
R_{t-1}	0.3328	8.9059*
ΔV_t	0.0068	3.3607*

*denotes significance at the 10% level.

The previous studies had suggested that the relationship between return and volume, return and change in volume is positive (Khan &Rizwan, 2008; Darwish, 2012). The results that are presented in above Table 3 show that the both coefficient of volume and change in volume are statistically significant and positive. It means that rising market go with the rising volume and vice versa. The results also support the theoretical evidence that the information content of volume has affected the future stock return.

Before estimating the GARCH model in order to analyze the portfolio risk, there is a need to determine whether the series is characterized by the ARCH effect in the portfolio return. Engle (1982) had introduced the concept in which the variance depends on the size of the squared error term lagged one period. The results of ARCH test have shown in Table 4:

Table-4.Heteroskedasticity Test of KSE-100

Regression Eq.: $R_t = \propto_1 + \beta_1 R_{t-1} + b_1 V_t + \epsilon_{t1}$			
F-stat	48.97852	Probability F(5, 3004)	0.0000
Obs*R-squared	45.56961	Probability Chi-square(5)	0.0000
Regression Eq.: $R_t = \propto_2 + \beta_2 R_{t-1} + b_2 \Delta V_t + \epsilon_{t2}$			
F-stat	21.15740	Probability F(5, 3004)	0.0000
Obs*R-squared	20.53109	Probability Chi-square(5)	0.0000

The results of Table 4 shows that the LM stat and p-value of ARCH test reject null hypothesis i.e. there is homokedasticity. Therefore, the ARCH (1) effect is present and also effects in the portfolio return series.

Moreover, the GARCH(1,1) model has been estimated in order to explain the conditional variance and volatility clustering. The results of GARCH test have shown in Table 5 and Table 6 by using eq. (3) and eq. (4):

Table -5.GARCH Model for KSE

Regression Eq.: $R_t = \propto_1 + \beta_1 R_{t-1} + b_1 V_t + \in_{t1}$				
Convergence achieved after 18 iterations				
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.062822	0.004944	-12.70764	0.0000
R_{t-1}	0.303570	0.037206	8.159068	0.0000
V_t	0.003236	0.000258	12.56648	0.0000
Variance Equation				
C	0.000101	2.32E-05	4.336276	0.0000
ARCH(1)	0.265158	0.040180	6.599303	0.0000
GARCH(1)	0.635969	0.047486	13.39289	0.0000

Table-6.GARCH Model for KSE

Regression Eq.: $R_t = \propto_2 + \beta_2 R_{t-1} + b_2 \Delta V_t + \in_{t2}$				
Convergence achieved after 51 iterations				
GARCH = C(4) + C(5)*RESID(-1)^2 + C(6)*GARCH(-1)				
Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	0.002893	0.001008	2.868817	0.0041
R_{t-1}	0.362400	0.038023	9.530986	0.0000
ΔV_t	0.017965	0.001745	10.29600	0.0000
Variance Equation				
C	0.000146	2.08E-05	7.028906	0.0000
ARCH(1)	0.445774	0.043973	10.13738	0.0000
GARCH(1)	0.459343	0.040981	11.20867	0.0000

In Table 5 and Table 6, the coefficients of both the squared of residual (ARCH (1)) and of the conditional variance (GARCH (1)) are highly statistically significant at 1%, level. In the variance equation, the intercept coefficient is very small (but significant) and similarly the coefficient of the ARCH (1) is equal to 0.2 and 0.4 respectively. It has been expected, that in a typical GARCH model for financial data the coefficient of GARCH is statistically significant, as shown in Table 5 and Table 6, which depicts that the shocks to the conditional variance are consistent and that major changes in the conditional variance are followed by other great changes and small changes are followed by other minor changes. The coefficient of GARCH in the conditional variance equation of volume is greater than the change volume. Thisindicates thata minor marketshockleads torelativelylarge changesin futurevolatility. Moreoverthe coefficientsof volume andchanges in volume are positive and statisticallysignificant by using GARH *(1, 1)* model.

Economically speaking, long run equilibrium relationship exists among the variables, because they are integrated at same order. The cointegration relationship between variables is shown in Table 7:

Table-7. Cointegration Test Statistic

Regression Eq.: $R_t = \propto_1 + \beta_1 R_{t-1} + b_1 V_t + \in_{t1}$				
Hypothesized no. of CE	**Eigen Value**	**Trace statistics**	**Critical Value**	**Prob****
None* r=0	0.169559	142.4487	15.49471	0.0001
At Most* 1 r≤1	0.041244	26.32438	3.841466	0.0000
Regression Eq.: $R_t = \propto_2 + \beta_2 R_{t-1} + b_2 \Delta V_t + \in_{t2}$				
Hypothesized no. of CE	**Eigen Value**	**Trace statistics**	**Critical Value**	**Prob****
None* r=0	0.185365	232.0921	15.49471	0.0001
At Most* 1 r≤1	0.153235	103.9579	3.841466	0.0000

* denotes rejection of hypothesis at the 5% significance level.
** MacKinnon-Haug-Michelis (1999) p-values.

Table 7 reported that long run equilibrium exists among the variables. The trace statistics indicates that there are two cointegrating vectors at the 1% significance level. The Granger Causality test has been used to verify the direction of causality among the variables of Pakistan. It measures the two ways causality means the cause and effect relationship between two or more variables. The results are shown in Table 8:

Table-8. Granger Causality Results

Regression Eq.: $R_t = \propto_1 + \beta_1 R_{t-1} + b_1 V_t + \epsilon_{t1}$			
Null Hypothesis	**Obs.**	**F-Stat**	**Prob****
V does not Granger cause R	628	4.48848	0.01160
R does not Granger cause V	628	7.13636	0.00086
Regression Eq.: $R_t = \propto_2 + \beta_2 R_{t-1} + b_2 \Delta V_t + \epsilon_{t2}$			
Null Hypothesis	**Obs.**	**F-Stat**	**Prob****
ΔV does not Granger cause R	628	1.54314	0.21453
R does not Granger cause ΔV	628	0.18118	0.83433

The test results show that there is bidirectional causality between volume and return, i.e. the volume had two way effects on the return of Pakistan. But there is no causal relationship between change in volume and return.

CONCLUSION

This paper empirically examines the dynamic relationship between stock returns and volume in the context of Pakistan's market. A sample of listed companies on Karachi Stock Exchange (KSE) was taken for the period from January 2000 to March 2012. It has found a significant positive relationship between returns and volume, indicating that rising market goes with rising volume and vice versa. This finding depicts that information content of volume affects future stock return.

It has also been the existence of bi-directional granger causality between volume and return, i.e. the volume had two way effects on the return of Pakistan. But there is no causal relationship between change in volume and return. The explanation of this finding with regard to literature is that volume which is affected by market information, leads to price changes. And higher capital gains that depict positive price changes, lead to increase in volume, encouraging buying or long transactions of traders.

The results for the positive contemporaneous relationship are similar to the previous studies conductedby Jain and Joh (1988) in NYSE, Chen, Firth and Rui (2001) in nine major stock markets, Floros and Vougas (2007) in Greek stock market, Darwish (2012) for Palestine Stock Exchange, Khan and Rizwan (2008) and Rehman, Burhan, Shah and Mushtaq (2012) for KSE in Pakistan. In case of causal relationship, our results are in line with those of Hiemstra and Jones (1994) for NYSE, Gunduz and Hatemi-J (2005) for Hungary and Poland, and Tripathy(2011) for Indian Stock Market.

These results suggest that regulators like speculators and hedgers can use past information of stock price and trading volume to foresee future trends in stock price and use it for sale and purchase decisions. Future research might be conducted by including KSE 30 index and all-share index as additional variables.

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