THE RELATIONSHIP BETWEEN TRADING VOLUME AND STOCK RETURNS IN THE JSE SECURITIES EXCHANGE IN SOUTH AFRICA

Raphael T Mpofu*

Abstract

This study examines the relationship between trading volume and stock returns in the JSE Securities Exchange in South Africa. The study looked at the price and trading returns of the FTSE/JSE index from July 22, 1988 till June 11, 2012. The study revealed that stock returns are positively related to the contemporary change in trading volume. Further, it was found that past returns were not affected significantly by changes in trading volumes. The results present a significant relationship between trading volume and the absolute value of price changes. Autoregressive tests were used to explore whether return causes volume or volume causes return. The results suggest that volume is influenced by a lagged returns effect for the FTSE/JSE index. Therefore, return seems to contribute some information to investors when they make investment decisions.

Keywords: South Africa, FTSE/JSE, Trading Volume, Stock Returns

** Associate Professor, Department of Finance & Risk Management and Banking, University of South Africa, PO Box 392, Pretoria, 0003, South Africa*
Fax: (+27) 12 429-4553
Tel.: (+27) 12 429-4497
E-mail: mpofurt@unisa.ac.za

1. Introduction

Since Eugene Fama (1970) proposed the efficient markets hypotheses, a number of studies have been done in various markets to determine the validity of these hypotheses. The three types of efficiency proposed by Fama were that of the strong-form; semi-strong form and weak-form efficiency. In the weak form efficiency, Fama proposed that it is not possible for investors to profit from historical share price information. With the semi-strong form, he stated that investors could only profit from historical share prices if they had access to all the information required for asset selection reflected all publicly available information. Finally, in the strong-form efficiency, Fama stated that for investors to profit from historical share price movements, all information, including private information, should be incorporated in the share price. The discussion on market efficiency therefore looks at how information is factored in share prices and the hypothesis of market efficiency can be tested by looking at the relationship between share prices and expected returns and for investors to make profitable asset allocations based on that historical information.

Since Fama points out that a market is weak-form efficient if all the information contains in past stock prices fully reflect in current prices (Fama, 1970, 1991), this implies that past share prices cannot be used to predict the future price changes and therefore invalidates the use of technical analysis in asset selection and asset allocation decisions. This however goes against the grain of current investment decisions as a number of investors rely heavily on technical analysts who base their decisions on the movement of historical share prices.

Given the important role of technical analysts in investment decisions as per findings of Karpoff (1987); that volume drives prices; that there are positive relations between the absolute value of daily price changes and daily volume for both market indices and individual stocks (Rutledge, 1984); the role of trading activities in terms of the information it contains about future prices (Gervars, Kaniel and Mingelgrin, 2001), this study sought to determine the existence of the weak-form market efficiency. Literature reveals that most of the studies on volume-price relationships have been based on developed markets. Therefore this study is to empirically test the trading volume-price relationships in the JSE Securities Exchange.

Although there has been extensive research into the empirical and theoretical aspects of the stock price – volume relationship, this research has focused mostly on developed countries financial markets. Since there seems to be no consensus on the relationship, this study sought to seek further insights by investigating the relationship in an emerging market.

This study looked at the price and trading returns of the FTSE/JSE index from July 22, 1988 till June 11, 2012. The subsequent sections look at a summary of related literature, the data collection methods used and a detailed analysis of monthly time-series data covering a period of 24 years. The last section presents the conclusions from the data analysis and the limitations of the study as well as proposals for future research on the volume-return trade-off.

2. Review of Related Literature

The literature on trading volume and share price returns is very extensive. Maury Osborne was the first researcher to publish the hypothesis that price follows a geometric Brownian motion and was responsible for the earliest literature identifying that price deviation is proportional to the square root of time (Osborne 1959). Most of the early studies find positive correlation between the daily price changes and daily volume for both market indices and individual stocks. Karpoff (1986, 1987) provides a theory that links returns with trading volume and leads to an asymmetric relationship between volume and price change. This is supported by studies from Jain and Joh (1988); Epps (1975) and Jennings, Starks and Fellingham (1981).

Some early studies using daily and weekly stock data conclude that prices and volume are virtually unrelated and that price changes follow a random walk (Granger and Morgenstern, 1963; Godfrey et al, 1964). In contrast, using daily and hourly price changes for both market indices and individual stocks Crouch (1970a, 1970b) finds a positive correlation between volume and the magnitude of returns.

Examining the relation between volume and returns, a positive contemporaneous correlation has been found by Rogalski (1978) using monthly stock and warrant data and by Epps (1975), (1977) using transactions data. To explain such results, Epps proposes a theoretical framework consistent with his findings and supported by Smirlock and Starks (1985) and by Assogbavi, Khoury, and Yourougou (1995).

Granger and Morgenstern conducted an early empirical study based on the New York Stock Exchange (NYSE) composite index from 1939-1961 (Granger and Morgenstern, 1963). While their findings indicated that there is no relation between absolute value of daily price changes and daily volume, subsequent studies did find a relationship between absolute price change and volume change (Crouch, 1970; Epps and Epps, 1976; Haris, 1986). Studies done in the last decade have also found a relation between stock returns and trading volume (Chen, Firth and Rui, 2001; Khan and Rizwan, 2001; Lee and Rui, 2002; Pisedtasalasai and Gunasekarage, 2008). Other authors have included Admati and Pfleiderer (1988), Barclay, Litzenberger and Warner (1990), Barclay and Warner (1993), Brock and Kleidon (1992), Easley and O'Hara (1987), Foster and Viswanathan (1990) and Kyle (1985).

Miller (1977) also looked at the relationship between stock price and volume. He hypotheses that when investors differ in their opinions about the value of a stock, the traders who hold the stock show optimism about its value by driving demand up, hence leading to an increase in the stock price. Miller’s argument is that when investors have mixed beliefs about a stock and face a shortage of that stock, the stock’s price will reflect the opinion of the optimistic investors forcing the price of the stock to rise (Harrison and Kreps, 1978; Mayshar 1983; Morris, 1996). One can conclude from this hypothesis that if there is a wide difference of opinion on the value of a stock among investors, that stock is likely to trade at a premium (Chen, Hong and Stein, 2002). Similarly, Diether, Malloy, and Scherbina (2002) have also shown that a stock that has a higher divergence of opinion is normally followed by a lower future stock return.

In examining the relationship between volume and returns, a positive concomitant correlation has been found by Epps (1975, 1977) using transactions data. Epps proposes a theoretical framework that implies that the ratio of volume to returns should be greater for price increases than for price decreases. This conclusion is also supported in studies by Smirlock and Starks (1985) who employed individual stock transactions data and found a strong positive lagged relation between volume and absolute price changes. Bhagat and Bhatia (1996) found evidence that price changes lead to volume changes but did not find evidence that volume changes lead to price changes. Hiemstra and Jones (1995) found a significant positive relation going in both directions between returns and volume. Tse (1991) in his study of the Tokyo Stock Exchange found significant positive correlation in some series and not in others. He concluded that the relationship between price changes and volumes is weak. Chan and Tse (1993) found that there was implicit positive correlation between price and volume through their residuals.

Volume is a measure of the quantity of shares that change amongst owners of a given stock. The amount of daily volume on a security can fluctuate on any given day depending on the amount of new information available about the company. Of the many different elements affecting trading volume, the one which correlates the most to the fundamental valuation of the security is the new information provided. This information can be a press release or a regular earnings announcement provided by the company, or it can be a third party communication, such as a court ruling or a release by a regulatory agency pertaining to the company. So in considering the price-volume relationship, Karpoff (1987) suggests the following four possible reasons.

First, it adds insight to the structure of financial markets. The correlations which are found can provide information regarding rate of information flow in the marketplace, the extent that prices reflect public information, the market size, and the existence of short sales and other market constraints. Second, studies that use a combination of price and volume data to draw inferences need to properly understand this relationship (also Beaver, 1968). The third is that understanding the price-volume relationship is vital for one to determine why the distributions of rates of return appear kurtosic. The fourth is that price variability affects trading volume in futures contracts. (See also Karpoff, 1987; Gallant, Rossi, and Tauchen, 1992; and Blume, Easley, and O'Hara, 1994). This interaction determines whether speculation is a stabilizing or destabilizing factor on futures prices.

Given the diversity of viewpoints, this study therefore sought to investigate the relationship between stock price and trading volume in the JSE Securities Exchange, an emerging market. The next section looks at the data and the model used for data analysis, which is then followed by a discussion and interpretation of the results, leading to a conclusion and recommendations.

3. Materials and Methods

3.1. The data

The dataset used in this study consists of daily time series of the FTSE/JSE stock index of all listed firms on the JSE Securities Exchange for the period July 22, 1988 to June 11, 2012. The variables used in the study are all the daily closing prices and trading volume of the FTSE/JSE index.

3.2. Methodology

The price-volume relationship was examined by looking at the relation between changes in stock price to trading volume. The contemporary correlation between changes in volume-return is examined by looking at correlation between the natural logarithms of volume changes (V) and the natural logarithms of absolute value of the stock returns$|\Delta P|$. The variable stock returns will be used throughout the rest of the article. The second hypothesis looked at is the relationship between past trading volume and future stock returns.

The returns were calculated using the following approximation:

$$R_{i,t} = \ln\left(\frac{P_{i,t} - P_{i,t-1}}{P_{i,t-1}}\right) \quad (1)$$

where $P_{i,t}$ is the closing price of the index on day t.

The following formula is used to compute the daily trading volume changes.

$$V_{i,t} = \ln\left(V_{i,t} - V_{i,t-1}\right) \quad (2)$$

where $V_{i,t}$ is the trading volume of the index on day t.

In order to avoid survivorship bias, (if stocks with poor performance are dropped from calculation, it often leads to an overestimation of past returns) all stocks that were traded during the study period were included. Tauchen and Pitts (1983) point out that a price variability-volume study can be very misleading if the volume is strongly trended over the sample period. In line with their recommendations, volume data was tested for stationarity using Said and Dickeys' (1984) augmented Dickey-Fuller (ADF) test. The results confirmed that the volume data are non-stationary for the FTSE/JSE index over the study period and this is consistent with the alternative hypothesis that the volume data are non-stationary. This test for stationarity ensures that the study on the price change-volume relationship on the JSE does not give misleading inferences.

A number of researchers and traders in financial markets hold the view that volume has a strong influence on prices movements. This has been found to be true in studies by Crouch (1970), Clark (1973), Tauchen and Pitts (1983), and Jain and Joh (1988) who concluded that there was a positive correlation between absolute price change and volume. In this study, parametric tests for the price change-volume relationship were done by regressing the price change against the absolute price change against trading volume. The regression equation is:

$$|\Delta P_t| = b_0 + b_1 V_t + u_t \quad (3.1)$$

where
$|\Delta P_t|$ = absolute price change in day t
V_t = trading volume for day t
u_t=error term in the regression model,

$$\Delta V_t = a_0 + a_1 P_t + e_t \quad (3.2)$$

where
ΔV_t= trading volume change in day t.

4. Results and Discussion

4.1. Descriptive analysis

Figure 1 shows the time plots of monthly log returns and monthly log trading volumes of the FTSE/JSE. As expected, the plots show that the basic patterns of log returns are as expected.

Figure 1. Price-Volume Trend 1988 to 2012

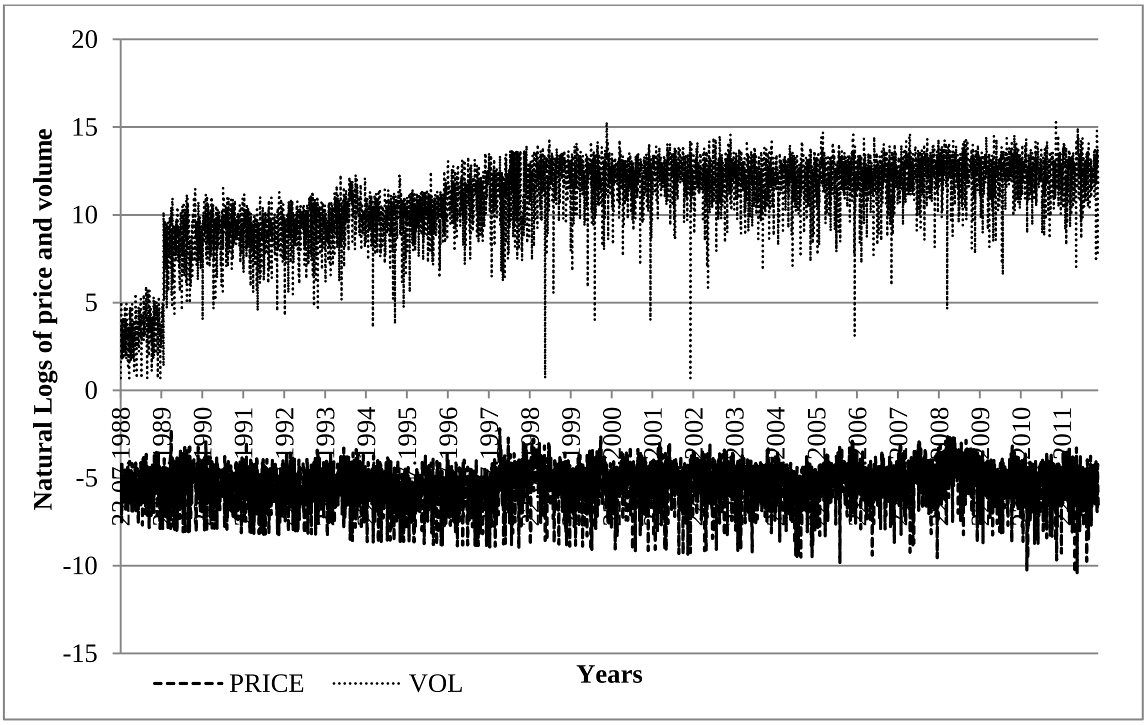

Table 1 provides the summary statistics for the variables in this study. The FTSE/JSE stock market price index shows very low volatile with a standard deviation measure of 0.011 and the trading volume of the stock index shows a very high standard deviation of 2.41. There is also evidence of negative skewness for both stock returns and trading volume at -0.411 and -1.533 respectively. The kurtosis value for stock returns exceeds the normal value of three to four for stock returns at a value of 6.272 but is in line with findings from other research studies. The kurtosis value for trading volume at 2.76 is within the acceptable range for normality. In addition, the low skewness value for trading volume supports a normal distribution of the time series and also supports the apriori condition of a random walk model in the weak or strong form.

Table 1. Descriptive statistics for FTSE/JSE index stock returns and trading volume

Statistics

		PRICE	VOL
N	Valid	5959	5959
	Missing	0	0
Mean		.000554	10.982349
Std. Error of Mean		.0001534	.0311615
Std. Deviation		.0118438	2.4054975
Variance		.000	5.786
Skewness		-.411	-1.533
Std. Error of Skewness		.032	.032
Kurtosis		6.272	2.760
Std. Error of Kurtosis		.063	.063

4.2. Testing for stationarity

The first test that was done was the stationarity test of the time series using the Dickey– Fuller (1979) ADF test. The results are reported in Table 2 and indicate that all series are non-stationary and hence it was concluded that price change and volume change series are non-stationary. The implication of this finding is that testing for causality between price and volume should be based on unrestricted VARs in first differences. The next step, therefore, was to determine whether or not futures prices and volumes were cointegrated. The results of the cointegration tests indicate the absence of cointegration in both cases. Thus, testing for causality will be based on unrestricted VARs, hence the next test will test for white noise or stationarity.

Table 2. Testing for stationarity of price changes and trading volume changes: Estimation Method – VARMAX Least Squares Estimation

Equation	Parameter	Estimate	Standard Error	t Value	Pr > |t|	Variable
VOL	CONST1	1.69588	0.09317	18.20	0.0001	1
	AR1_1_1	0.49585	0.01214	40.84	0.0001	VOL(t-1)
	AR1_1_2	-0.72744	1.59041	-0.46	0.6474	PRICE(t-1)
	AR2_1_1	0.35003	0.01212	28.87	0.0001	VOL(t-2)
	AR2_1_2	-0.77895	1.59031	-0.49	0.6243	PRICE(t-2)
PRICE	CONST2	0.00040	0.00076	0.52	0.6008	1
	AR1_2_1	0.00022	0.00010	2.19	0.0284	VOL(t-1)
	AR1_2_2	0.08530	0.01295	6.58	0.0001	PRICE(t-1)
	AR2_2_1	-0.00021	0.00010	-2.10	0.0355	VOL(t-2)
	AR2_2_2	0.01939	0.01295	1.50	0.1345	PRICE(t-2)

A time series is called a white noise if it is a sequence of independent and identically distributed random variables with finite mean and variance. In particular, if the series is normally distributed, all the ACFs are zero. Based on Table 2, the daily returns of the FTSE/JSE index are close to white noise with ACFs close to zero in both single and second lags. The *p*-values of these test statistics are all close to zero. In finance, price series are commonly believed to be non-stationary, but the log return time series depicted as in equation 2 and used in the calculations in this study shows that the series in stationary. In this case, the log price series is unit-root non-stationary and hence can be treated as an ARIMA process. A Dickey-Fuller test produced the statistics shown in Table 2 above. The t-test statistic for price was 0.52 with a p-value of 0.6, while the t-value for trading volume was 18.20 with a p-value close to zero. Thus, the unit-root hypothesis cannot be rejected at any reasonable significance level. But the parameter estimates were found not significantly different from zero at the 5% level. In summary, for the time period considered, the log series of the index contains a unit root.

4.3. Testing for Autocorrelation

A necessary condition for testing for a contemporaneous relationship between returns and trading volume based on a Vector Autoregressive (VAR) model, it was necessary to first necessary to test for the presence of autocorrelation. The Durbin-Watson test is a widely used method of testing for autocorrelation. The first-order Durbin-Watson test in Table 3 is highly significant with $p < .0001$. Once it was determine that autocorrelation correction was needed, stepwise autoregression was utilised to determine the number of lags required. This resulted in the second-order lags as implemented in the next stages.

Table 3. Testing for Autocorrelation using the Durbin-Watson Test
The AUTOREG Procedure: Ordinary Least Squares Estimates

SSE	34474.4496		DFE		5957	
MSE	5.78722		Root MSE		2.40566	
SBC	27388.2215		AIC		27374.8362	
MAE	1.81181152		AICC		27374.8382	
MAPE	26.9036754		Regress R-Square		0.0000	
			Total R-Square		0.0000	
Durbin-Watson Statistics						
Order	**DW**		**Pr < DW**		**Pr > DW**	
1	0.4686		<.0001		1.0000	
2	0.5370		<.0001		1.0000	
3	0.5327		<.0001		1.0000	
4	0.5293		<.0001		1.0000	
Variable	**Approx DF**	**Variable Estimate**	**Standard Error**	**t Value**	**Pr > |t|**	**Label**
Intercept	1	10.9817	0.0312	352	<.0001	
PRICE	1	1.1102	2.6314	0.42	0.6731	PRICE
NOTE: Pr<DW is the p-value for testing positive autocorrelation, and Pr>DW is the p-value for testing negative autocorrelation.						

4.4. Testing for contemporaneous relationship

The next analysis involved testing whether trading volume does have a significant impact on stock returns movements on the JSE Securities Exchange. Table 4 presents the contemporaneous relationship between returns and trading volume based on a Vector Autoregressive (VAR) model. The F-statistics and their corresponding level of significance are indicated. The table shows the results for the test of the null hypothesis that returns do not Granger-cause volume and their F-statistics are significant at a 5 per cent level for the FTSE/JSE index. The hypothesis is accepted. This finding implies that past returns and trading volume adds some significant predictive power for future returns and trading volumes in the JSE Securities Exchange. This suggests that trading volumes are influenced by returns or price in the JSE Securities Exchange. The tests revealed that there is a significant correlation between monthly return and trading volume.

Table 4. The AUTOREG Procedure: Dependent Variable – Trading Volume
Ordinary Least Squares Estimates

<table>
<tr><td colspan="2">SSE</td><td>34474.4496</td><td>DFE</td><td colspan="3">5957</td></tr>
<tr><td colspan="2">MSE</td><td>5.78722</td><td>Root MSE</td><td colspan="3">2.40566</td></tr>
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<tr><td colspan="2">MAPE</td><td>26.9036754</td><td>Regression R-Square</td><td colspan="3">0.0000</td></tr>
<tr><td colspan="2">Durbin-Watson</td><td>0.4686</td><td>Total R-Square</td><td colspan="3">0.0000</td></tr>
<tr><td>Variable</td><td>DF</td><td>Estimate</td><td>Standard-Error</td><td>T Value</td><td>Pr > |t|</td><td>Label</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Intercept</td><td>1</td><td>10.9817</td><td>0.0312</td><td>352.00</td><td><.0001</td><td></td></tr>
<tr><td>PRICE</td><td>1</td><td>1.1102</td><td>2.6314</td><td>0.42</td><td>0.6731</td><td>PRICE</td></tr>
<tr><td colspan="7">Estimates of Autocorrelations</td></tr>
<tr><td>Lag</td><td>Covariance</td><td>Correlation</td><td colspan="4">-1 9 8 7 6 5 4 3 2 1 0 1 2 3 4 5 6 7 8 9 1</td></tr>
<tr><td>0</td><td>5.7853</td><td>1.000000</td><td colspan="4">|********************|</td></tr>
<tr><td>1</td><td>4.4209</td><td>0.764167</td><td colspan="4">|*************** |</td></tr>
<tr><td>2</td><td>4.2167</td><td>0.728873</td><td colspan="4">|*************** |</td></tr>
<tr><td colspan="7">Preliminary MSE 2.1149</td></tr>
<tr><td colspan="7">Estimates of Autoregressive Parameters</td></tr>
<tr><td colspan="2">Lag</td><td colspan="2">Coefficient</td><td colspan="2">Standard Error</td><td>t Value</td></tr>
<tr><td colspan="2">1</td><td colspan="2">-0.497987</td><td colspan="2">0.012147</td><td>-41.00</td></tr>
<tr><td colspan="2">2</td><td colspan="2">-0.348328</td><td colspan="2">0.012147</td><td>-28.68</td></tr>
</table>

Table 4 shows the results of Volume being regressed on price with the errors assumed to follow a second-order autoregressive process. The Yule-Walker estimation method was used in conjunction with the maximum likelihood method. The first part of Table 4 shows the Ordinary Least Squares (OLS) results followed by estimates of the autocorrelations calculated from the OLS residuals. The autocorrelations are also displayed graphically.

The Maximum Likelihood Estimates (MLE) are then shown in Table 5, which shows the preliminary Yule-Walker estimates used as starting values for the calculation of the maximum likelihood estimates.

The diagnostic statistics and parameter estimates in Table 5 have the same form as the OLS output shown in Table 4, but the values shown are for the autoregressive error model. The MSE for the autoregressive model is 2.103 compared to an OLS MSE value of 5.787 and hence a much improved model which is closer to zero. The total R^2 statistic calculated from the autoregressive model residuals is 0.6367, reflecting the improved fit from the use of past residuals to help predict the next value of trading volume. The t-value of 88.17 is also significant.

The regression results in Table 5 indicate that contemporaneous return explains a relatively large portion of trading volume in the JSE Securities Exchange FTSE/JSE index as evidenced by the high R-square of 0.63. The Durbin-Watson statistic given in Table 5 has a value of 2.1855, and, given that the Durbin-Watson statistics has a range from 0 to 4 with a midpoint of 2, the value obtained here confirms that the model is good.

Table 5. The AUTOREG Procedure: Dependent Variable – Trading Volume
Maximum Likelihood Estimates

SSE		12524.1337	DFE	5955		
MSE		2.10313	Root MSE	1.45022		
SBC		21372.9088	AIC	21346.1382		
MAE		1.07760286	AICC	21346.1449		
MAPE		13.2054636	Regression R-Square	0.0001		
Durbin-Watson		2.1855	Total R-Square	0.6367		
Variable	**DF**	**Estimate**	**Standard-Error**	**T Value**	**Pr > |t|**	**Label**
Intercept	1	10.9707	0.1244	88.17	<.0001	
PRICE	1	0.7638	1.3938	0.55	0.5837	PRICE
AR1	1	-0.4981	0.0121	-41.06	<.0001	
AR2	1	-0.3511	0.0121	-28.92	<.0001	
Autoregressive parameters assumed given						
Variable	**DF**	**Estimate**	**Standard-Error**	**T Value**	**Pr > |t|**	**Label**
Intercept	1	10.9707	0.1244	88.17	<.0001	
PRICE	1	0.7638	1.3938	0.55	0.5837	PRICE

The parameter estimates in Table 4 show the MLE estimates of the regression coefficients and includes two additional rows for the estimates of the autoregressive parameters, labelled AR1 and AR2. The estimated model is:

$$Vol_t = 10.9707 + 0.7638 Price + v_t \qquad (4)$$

where
$v_t = 0.4981_{v_{t-1}} + 0.3511_{v_{t-2}} + e_t$
$Est.Var(e_t) = 2.1031$

The signs of the autoregressive parameters shown in the above equation for v_t are the reverse of the estimates shown in Table 5. The estimates of the regression coefficients with the standard errors are recalculated on the assumption that the autoregressive parameter estimates are equal to the true values. Trading volume on the other hand seems to explain a relatively small portion of returns in the FTSE/JSE index as evidenced by the low R-square of 0.008. This indicates that the effect of stock returns on trading volume is stronger than the effect of trading volumes on stock returns.

5. Conclusion and recommendations

This article investigated the relationship between stock returns and trading volume for the FTSE/JSE stock index. Using daily data, price return was regressed on trading volume and significant relationship was found. The statistical evidence indicated that there is a positive correlation between trading volume and stock returns. In addition, it was also found that stock returns tend to lead trading volumes, but not vice-versa. This result indicates that while South Africa is an emerging market, it exhibits similar behavioural facets as other developed markets like the United States as shown by the studies highlighted earlier

The Autoregressive model was estimated for testing the casual relationship between stock return and trading volume variables. The result implies that there is feedback prevailing in the JSE Securities Exchange. Therefore, the evidence indicates a stronger stock return causing volume than volume causing returns. The findings suggest that there is a positive association between return variance and lagged trading volume for the JSE. The results of the causality test show that the relationship between trading volume and stock return is statistically significant. While this result is consistent with findings from earlier studies, it is recommended that further studies are conducted on individual stock behaviours so as to enhance a better understanding of the JSE Securities Exchange.

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