Asian Social Science; Vol. 11, No. 24; 2015
ISSN 1911-2017 E-ISSN 1911-2025
Published by Canadian Center of Science and Education

Trading Volume and Stock Returns Volatility: Evidence from Industrial Firms of Oman

Hazem Al Samman[1] & Mohamed Khaled Al-Jafari[2]

[1] College of Commerce and Business, Department of Accounting and Finance, Dhofar University, Dhofar, Sultanate of Oman

[2] College of Business Administration, Department of Accounting and Finance, Prince Mohammad Bin Fahd University, Al Khobar, Kingdom of Saudi Arabia

Correspondence: Mohamed Khaled Al-Jafari, College of Business Administration, Department of Accounting and Finance, Prince Mohammad Bin Fahd University, P. O. Box 1664, Al Khobar 31952, Kingdom of Saudi Arabia. Tel: 966-53-005-2740. E-mail: aljafarimohamedkhaled@yahoo.com

Received: April 28, 2015 Accepted: July 13, 2015 Online Published: August 18, 2015

doi:10.5539/ass.v11n24p139 URL: http://dx.doi.org/10.5539/ass.v11n24p139

Abstract

This study analyzes the relationship between trading volume and stock return volatility for industrial firms listed on Muscat securities market. Several tests were utilized to include: Brailsford model, vector autoregressive model (VAR), and the pairwise Granger causality test. The empirical results provide evidence of a significant positive effect for return volatility on trading volume. Likewise, the VAR model provides evidence of a significant positive effect of trading volume on stock returns. On the other hand, the pairwise Granger causality test reveals that trading volume Granger-cause stock return. The previous findings are inconsistent with the weak-form of the efficient market hypothesis.

Keywords: trading volume, stock return volatility, vector autoregressive model, pairwise Granger causality test, weak-form efficiency, Muscat securities market

1. Introduction

There is a considerable amount of research that investigated the relationship between trading volume and stock returns. In a simple term, trading volume can be referred to as the amount of security or securities (even the entire market) that were bought and sold during a given trading day. Accordingly, many practitioners and academicians in the investment field consider trading volume as an important technical indicator utilized to measure the strength of the market. On the other hand, the efficient market hypothesis assumes that investigating this relationship will not help investors in achieving abnormal rate of return. Fama (1970) states that current stock prices reflect all security market information including the historical sequence of prices, rates of return, and trading volume. Therefore, it will be futile to use any trading rules to make a purchasing or selling decision based on past rate of return, trading volume or any past market data.

Results from previous studies related to this issue are abundant and mixed. However, most of them regardless of the econometrical models they used, found a relation between trading volume and market return such as in Osborne (1959), Ying (1966), Morgan (1976), Epps & Epps (1976), Westerfield (1977), Rutledge (1984), Saatcioglu & Starks (1998), and Mahajan & Singh (2009). On the other hand, a very few studies found some conflicting results about this relationship such as in Granger & Morgenstern (1963), James & Edmister (1983), Rogalski (1978), and Harris & Raviv (1993).

The aims of this paper are two-fold. First, it analyzes the relationship between trading volume, and stock return volatility for industrial companies listed on Muscat stock market. It is worth mentioning that there are a scarcity in the literature regarding the behavior of Omani financial market including the relation between trading volume and stock return volatility. Moreover, Oman is rapidly growing emerging market; therefore, this study will be beneficial to investors by giving them a brief preview to the structure of the Omani stock market if they are interested in entering such an emerging market. In addition, the study concentrates on examining only one sector, the industrial sector, instead of including all sectors. We believe that the characteristics of different sectors may have influence on the results. Therefore, this study limited itself to the industrial sector only to avoid biasness.

The second objective of this study is to derive into a conclusion whether the results of such a relationship are consistent with the weak-form of the efficient market hypothesis.

This study includes the following sections: Section 2 explains briefly the results of previous studies. On the other hand, section 3 describes data and research methodology. Analysis of the empirical results is reported in section 4. Finally, section 5 presents the concluding remarks.

2. Literature Review

There is an extensive empirical research in the literature that investigated the relationship between stock return and trading volume. For instance, early study by Granger and Morgenstern (1963) utilized the spectral analysis on New York stock exchange composite index for the period 1939 till 1961. The findings show no relation between the absolute value of daily price change and the daily volumes. A few years later, contrary results were obtained by Ying (1966) where a strong positive correlation was found between the changes in prices and volume. The study revealed that a small volume is associated with price fall and large volume is associated with a price rise. Later on, Crouch (1970a), Crouch (1970b), Westerfield (1977), and Tauchen and Pitts (1983) all reached the same conclusion of a positive correlation between volume and returns.

Studies on the future markets by Cornell (1981), Rutledge (1984) and Grammatikos and Saunders (1986) also revealed a positive relationship between changes in volume and changes in the variability of prices of individual future contract.

On the other hand, Smirlock and Starks (1985) used individual stock data and Granger causality test. The results show a strong positive lagged relation between absolute price changes and volume. Similarly, Jain and Joh (1988) examined the joint characteristics of hourly stock trading volume and returns on New York stock exchange. Their findings show a strong contemporaneous relation between trading volume and return lagged up to four hours. Hiemstra and Jones (1994) investigated the dynamic relation between the daily Dow Jones stock return and the percentage changes in New York stock exchange trading volume. They found a significant bi-directional nonlinear causality between return and volumes. On the other hand, Datar, Naik, and Radcliffe (1998) tested the relation between liquidity and stock returns. They found evidence that liquidity plays a significant role in explaining the cross-sectional variation in stock returns.

Six Latin American stock markets were investigated by Saatcioglue and Starks (1998). Their findings show a unidirectional relationship where trading volume changes lead to price changes. Similar conclusion was reached by Chordia and Swaminathn (2000). They found daily and weekly returns on high volume portfolios lead returns on low volume portfolios.

As for China stock market, Lee and Rui (2000) investigated the contemporaneous and causal relationship between trading volume, stock returns and returns volatility for four Chinese stock exchanges. They found that trading volume does not Granger-cause stock market returns. In addition, US and Hong Kong trading volumes do not Granger-cause either return or volatility in China stock market. On the other hand, a positive correlation between trading volume and the absolute value of stock price change were found by Chen, Firth, and Rui (2001). They tested the dynamic relation between stock returns, trading volume and volatility of stock indexes for nine national markets. They found that returns Granger-cause volume and volume Granger-cause returns for some countries. Similar tests were also conducted by Lee and Rui (2002) on New York, Tokyo, and London stock markets. Their results reveal that trading volume does not Granger-cause stock returns for each of the three markets. In addition, they found a positive relationship between trading volumes and return volatility in the three stock markets. Moreover, the US trading volume exhibited a significant predictive power for Tokyo and London financial markets.

Investigating the emerging stock market of Kuwait, Al-Saad (2004) detected asymmetric relationship between change in price and volume. Similar results were obtained by Kamath and Wang (2006). They examined the daily rate of return and the trading volume for six Asian equity markets. They found a significant contemporaneous relation between volume and returns.

On the other hand, Léon (2007) found that volume has a predictive power of stock returns volatility for the regional stock exchange of the West African Economic and Monetary Union. Similarly, Assogbavi, Schell and Fagnissè (2007) examined the Russian stock exchange. Their findings reveal a strong evidence of bi-directional relation between volume and price change. Moving into the Southeast Asian markets, Pisedtasalasai and Gunasekarage (2007) tested the causal and dynamic relationship among returns, return volatility and trading volume for the equity markets of Indonesia, Malaysia, the Philippines, Singapore, and Thailand. They found a strong asymmetric relationship between stock returns and trading volume. They conclude that returns are

important in predicting their future dynamics as well as those of trading volume. However, trading volume found to have a limited impact on the future of dynamics of stock returns.

Testing Pakistan equity market, Khan and Rizwan (2008) found a positive contemporaneous relationship between trading volume and return preserves after taking heteroskedasticity into account. Besides, Al-Saad and Moosa (2008) tested again the emerging equity market of Kuwait. They found evidence of asymmetry and concluded that trading volumes are higher in a rising market. On the other hand, Sabri (2008) examined eight Arab stock markets and found that volume and prices are significantly integrated and volume volatility represents the most predicted variable of increasing price volatility. However, the correlation between volume and price movements was higher in the stock markets of oil Arab countries.

Using the ARCH and GARCH-M models, Mubarik and Javid (2009) investigated Pakistan stock market. Their results show a significant relationship between trading volume and volatility. Similar results were obtained by Khan and Ahmad (2009) when they investigated Karachi, KSE 100 index. They found that trading volume and stock returns are affected by the arrival of events such as a terrorist attack or the assassination of a political figure.

The Indian stock market was tested by Tripathy (2011) who also found a bi-directional causality between trading volume and stock return. On the other hand, Pathirawasam (2011) investigated the relationship between trading volume and stock returns for 266 stocks listed on Colombo stock exchange. The findings show that stock returns are positively related to trading volume. In addition, past trading volume change is negatively related to stock returns.

Similarly, Al-Jafari and Tliti (2013) empirically tested the banking sector of Amman stock exchange. Their findings show a significant relationship between trading volumes and return volatility. The VECM revealed evidence of long-run causality from return to trading volume. On the other hand, Sun and Li (2015) examined stock returns, volatility and volume in a simultaneous equations model. Their results show that the three variables are interrelated and that intraday skewness has a significant impact on daily returns, volatility and volume.

3. Data and Research Methods

3.1 Data

The research sample consists of monthly trading volume and stock return for 17 industrial companies listed on Muscat securities market from January 2009 till December 2013 for a total of 1020 observations for each variable. The monthly data were collected from the website of Muscat securities market (www.msm.gov.om).

3.2 Methodology

The stock return is calculated as the logarithm of the first difference of closing price at each month as shown in equation1:

$$R_i = ln(\frac{P_t}{P_{t-1}}) \quad (1)$$

As for trading volume, we utilize the natural logarithm of traded shares as commonly used in previous literature and indicated in equation 2.

$$V_t = ln(Vol_t) \quad (2)$$

To examine the relationship, we employ first the unit root test as proposed by Dickey & Fuller (1979), and Phillips & Perron (1988) to check if the times series is stationary. Equation 3 states the general model of the Augmented Dickey-Fuller (ADF) test:

$$\Delta y_t = \beta_1 + \beta_2\, t + \delta y_{t-1} + \sum_{i=1}^{m} \alpha_i\, \Delta\, y_{t-i} + \varepsilon_t \quad (3)$$

On the other hand, the Phillips-Perron test is stated in equation 4:

$$\Delta y_t = a\, y_{t-1} + \beta\, X_t + \varepsilon_t \quad (4)$$

In addition, the study utilizes the model proposed by Brailsford (1996) to investigate the relationship between trading volumes and return volatility as in equation 5:

$$V_t = a_0 + \beta_1 V_{t-1} + \beta_2 V_{t-2} + a_1 R_t^2 + a_2 D_t R_t^2 + \varepsilon_t \quad (5)$$

In general, the presence of cointegration suggests that we should model the data using the vector error correction

model (VECM) rather than using the VAR model. However, if variables are stationary at the level, this means there is no long-run relationship and a short-run relationship may exist. In this case, there will be no need for estimating the cointegration.

It is worth mentioning, the estimation of the VECM will reduce the estimation of the VAR model for a multivariate time series. Therefore, VAR is considered one of the most successful, flexible, and easy to use model for the analysis of multivariate time series. Accordingly, each variable is a linear function of past lags of itself and past lags of the other variables. Afterward, the causality analysis can be conducted to investigate the causality between the variables. The VAR model can be expressed as follows:

$$R_t = a_0 + \sum_{i=1}^{m} \beta_i R_{t-i} + \sum_{j=1}^{n} \beta_j V_{t-j} + \varepsilon_{1t} \quad (6)$$

$$V_t = a_0 + \sum_{i=1}^{m} \beta_i V_{t-i} + \sum_{j=1}^{n} \beta_j R_{t-j} + \varepsilon_{2t} \quad (7)$$

4. Analysis of the Empirical Results

Table 1 shows the descriptive statistics of the natural logarithm of trading volume and stock returns. We can observe that the mean of stock return is 0.0083 with a big difference between the maximum return of 1.26 and the minimum return of -2.087. These results are consistent with the high standard deviation values. Also we can see from the table that the return series does not follow a normal distribution which was tested by using Jarque-Bera test that rejects the null hypothesis of a normal distribution. Furthermore, the results are also consistent with the skewness and the kurtosis statistical values. Similarly, the Jarque-Bera test, the skewness and kurtosis values indicate that trading volume series does not also follow a normal distribution.

Table 1. Descriptive statistics of the variables

	Return	Volume
Mean	0.008341	13.18061
Median	0.000000	14.04375
Maximum	1.263487	18.00831
Minimum	-2.087058	0.000000
Std. Dev.	0.144869	3.441792
Skewness	-4.843385	-2.358183
Kurtosis	90.34868	9.343058
Jarque-Bera	322783.2	2608.477
Probability	0.000000	0.000000

Tables 2 and 3 below show the panel unit root test for stock return and trading volume. According to the results, we reject the null hypothesis that the series has a unit root and conclude that stock return and trading volume are integrated at the level. This means there is no cointegration between trading volume and stock returns and that further analysis for the relationship will be conducted using the VAR model.

Table 2. ADF-Fisher unit root test

		At level			
		With intercept		With intercept and trend	
		Statistic	Prob.*	Statistic	Prob.*
Return	ADF - Fisher Chi-square	305.923	0.00	247.656	0.00
	ADF - Choi Z-stat	-14.9455	0.00	-12.9572	0.00
Volume	ADF - Fisher Chi-square	120.342	0.00	144.847	0.00
	ADF - Choi Z-stat	-7.15812	0.00	-8.22189	0.00

Note: *, denotes significance at the 1% level.

Table 3. Phillips-Perron Fisher unit root test

		At level			
		With intercept		With intercept and trend	
		Statistic	Prob.*	Statistic	Prob.*
Return	ADF - Fisher Chi-square	571.087	0.00	499.319	0.00
	ADF - Choi Z-stat	-21.7828	0.00	-20.0974	0.00
Volume	ADF - Fisher Chi-square	205.756	0.00	246.769	0.00
	ADF - Choi Z-stat	-10.9537	0.00	-12.574	0.00

Note: *, denotes significance at the 1% level.

Table 4 below shows the results of the relationship between trading volume and return volatility. They indicate a positive effect for return volatility on trading volume at 1 % significant level. The value of adjusted R-squared indicates that 42.5 % of total variation in trading volume is explained by this model. In addition, the F-test is significant and the results are reliable. Therefore, we can conclude that there is a significant relationship between trading volume and stock return.

Table 4. Results of relationship between trading volume and return volatility

Variable	Coefficient	t-Statistic	Prob.
Volume(-1)	0.45652	14.73743	0.0000
Volume(-2)	0.246939	8.02183	0.0000
Return^2	1.124993	2.592124	0.0097
DU*R^2	-4.707915	-3.259609	0.0012
C	3.955634	10.92339	0.0000
F-statistic	178.9618		0.0000
Durbin-Watson stat.	2.128488		
Adjusted R-squared	0.424515		

As shown in Table 5, the results of the VAR estimates considering stock return as an endogenous variable show elasticity of stock return to trading volume of 0.0041 at 5 % significant level. This means that stock return is responding positively to changes in trading volume. Likewise, the value of F-test is significant at the 1 % level. Therefore, we can conclude a significant positive effect of trading volume on stock returns.

Table 5. The results of vector autoregression estimates

	D(Stock Return)	D(Trading Volume)
R(-1)	0.005255	-0.592861
	[0.16441]	[-1.04183]
R(-2)	0.050320	0.053799
	[1.57904]	[0.09482]
V(-1)	4.090000	0.459734***
	[0.02339]	[14.7500]
V(-2)	0.004100**	0.237870***
	[2.37148]	[7.72804]
C	-0.046011**	4.020734***
	[-2.26533]	[11.1188]
R-squared	0.012743	0.419463
Adj. R-squared	0.008633	0.417047
F-statistic	3.100945***	173.5913***

Note: ***, and ** denote significance at 1%, and 5% level respectively.

To test for causality, the pairwise Granger causality test at lag 2 is utilized. The results are listed in Table 6 and it show that we cannot reject the null hypothesis stating stock return does not Granger-cause trading volume. On the other hand, we can reject the null hypothesis stating that trading volume does not Granger-cause the stock return for industrial firms in Oman. Therefore, we can conclude that trading volume Granger-cause stock return.

Table 6. Pairwise Granger causality tests at lag 2

Null Hypothesis	F-Statistic	Prob.
Volume does not Granger cause return	4.69963	0.0093
Return does not Granger cause volume	0.54636	0.5792

5. Conclusion

This study empirically examines the relationship between trading volume and stock return volatility for 17

industrial companies that are listed on Muscat securities market. Therefore, several tests were utilized to examine such a relationship. The results show that stock return and trading volume are integrated at the level. In addition, the study provides evidence of a positive and significant effect of return volatility on trading volume. These results are similar to the findings of Sabri (2008), Mubarik & Javid (2009), Tripathy (2011), Pathirawasam (2011), and Al-Jafari & Tliti (2013). Likewise, the study finds a significant and a positive effect of trading volume on stock returns. Finally, the pairwise Granger causality tests reveal that trading volume Granger-cause stock return. The study concludes that the findings contradict the weak-form of the efficient market hypothesis.

References

Al-Jafari, M. K., & Tliti, M. (2013). An empirical investigation of the relationship between stock return and trading volume: Evidence from the Jordanian banking sector. *Journal of Applied Finance & Banking*, *3*(3), 45-64.

Al-Saad, K. (2004). Asymmetry in the price-volume relationship: Evidence from the Kuwait stock market. *Journal of Accounting and Finance, 3*, 53-56.

Al-Saad, K., & Moosa I. A. (2008). Asymmetry in the price-volume relation: Evidence based on individual company stocks traded in an emerging stock market. *Applied Financial Economics Letters, 4*(2), 151-158. http://dx.doi.org/10.1080/17446540600993811

Assogbavi, T., Schell, J., & Fagnissè, S. (2007). Equity price-volume relationship on the Russian stock exchange. *International Business & Economics Research Journal, 6*(9), 107-116.

Brailsford, T. J. (1996). The empirical relationship between trading volume, returns, and volatility. *Accounting & Finance*, *36*(1), 89-111. http://dx.doi.org/10.1111/j.1467-629X.1996.tb00300.x

Chen, G., Firth, M., & Rui, O. (2001). The dynamic relation between stock returns, trading volume, and volatility. *The Financial Review*, *36*(3), 153-174. http://dx.doi.org/10.1111/j.1540-6288.2001.tb00024.x

Chordia, T., & Swaminathan, B. (2000). Trading volume and cross-autocorrelations in stock returns. *Journal of Finance, 55*(2), 913-935. http://dx.doi.org/10.1111/0022-1082.00231

Cornell, B. (1981). The relationship between volume and price variability in futures markets. *Journal of Futures Markets, 1*(3), 303-316. http://dx.doi.org/10.1002/fut.3990010303

Crouch, R. L. (1970a). A nonlinear test of the random walk hypothesis. *American Economic Review, 60*(1), 199-202.

Crouch, R. L. (1970b). The volume of transactions and price changes on the New York Stock Exchange. *Financial Analysts Journal, 26*(4), 104-109. http://dx.doi.org/10.2469/faj.v26.n4.104

Datar, V. T., Naik, N., & Radcliffe, R. (1998). Liquidity and stock returns: An alternative test. *Journal of Financial Markets, 1*(2), 203-219. http://dx.doi.org/10.1016/S1386-4181(97)00004-9

Dickey, D. A., & Fuller, W. (1979). Distribution of the estimators for autoregressive time series with a unit root. *Journal of the American Statistical Association, 74*(366), 427-431. http://dx.doi.org/10.2307/2286348

Epps, T. W., & Epps, M. L. (1976). The stochastic dependence of security price changes and transaction volumes: Implications for the mixture-of-distributions hypothesis. *Econometrica, 44*(2), 305-321. http://dx.doi.org/10.2307/1912726

Fama, E. F. (1970). Efficient capital markets: A review of theory and empirical work. *Journal of Finance*, *25*(2), 383-417. http://dx.doi.org/10.2307/2325486

Grammatikos, T., & Saunders, A. (1986). Futures price variability: A test of maturity and volume effects. *Journal of Business*, *59*(2), 319-330. http://dx.doi.org/10.1086/296330

Granger, C. W., & Morgenstern, O. (1963). Spectral analysis of New York stock market prices. *Kyklos, 16*(1), 1-27. http://dx.doi.org/10.1111/j.1467-6435.1963.tb00270.x

Griffin, J. M., Nardari, F., & Stulz, R. M. (2004). *Stock market trading and market conditions*. NBER Working Papers, No. 10719.

Harris, M., & Raviv, A. (1993). Differences of opinions make a horse race. *The Review of Financial Studies*, *6*(3), 473-506. http://dx.doi.org/10.1093/rfs/6.3.473

Hiemstra, G., & Jones, D. J. (1994). Testing for linear and nonlinear Granger causality in the stock price-volume relation. *The Journal of Finance*, *49*(5), 1639-1663. http://dx.doi.org/10.2307/2329266

Jain, P. C., & Joh, G. (1986). The dependence between hourly prices and trading volume. *The Journal of Financial and Quantitative Analysis*, *23*(3), 269-283. http://dx.doi.org/10.2307/2331067

James, C., & Edmister, R. O. (1983). The relation between common stock returns trading activity and market value. *Journal of Finance*, *38*(4), 1075-1086. http://dx.doi.org/10.2307/2328012

Kamath R., & Wang, Y. (2006). The causality between stock index returns and volumes in the Asian equity markets. *Journal of International Business Research, 5*, 63-74.

Khan, K., & Ahmad, M. S. (2009). Trading volume and stock return: The impact of events in Pakistan on KSE 100 indexes. *International Review of Business Research Papers, 5*(5), 373-383.

Khan, S. U., & Rizwan, F. (2008). Trading volume and stock returns: Evidence from Pakistan's stock market. *International Review of Business Research Papers, 4*(2), 151-162.

Lee, B.-S., & Rui, O. (2002). The dynamic relationship between stock return and trading volume: Domestic and cross-country evidence. *Journal of Banking and Finance*, *26*(1), 51-78. http://dx.doi.org/10.1016/S0378-4266(00)00173-4

Lee, C., & Rui, O. M. (2000). Does trading volume contain information to predict stock returns? Evidence from China's stock markets. *Review of Quantitative Finance and Accounting, 14*(4), 341-360. http://dx.doi.org/10.1023/A:1008319826042

Léon, N. (2007). An empirical study of the relation between stock return volatility and trading volume in the BRVM. *African Journal of Business Management, 1*(7), 176- 184.

Mahajan, S. & Singh, B. (2009). The empirical investigation of relationship between return, volume, and volatility dynamics in Indian stock market. *Eurasian Journal of Business and Economics, 2*(4), 113-137.

Morgan, I. G. (1976). Stock price and heteroscedasticity. *Journal of Business, 49*(4), 496-508. http://dx.doi.org/10.1086/295881

Mubarik, F., & Javid, Y. A. (2009). Relationship between stock return, trading volume and volatility: Evidence from Pakistani stock market. *Asia Pacific Journal of Finance and Banking Research, 3*(3), 1-17.

Osborne, M. F. M. (1959). Brownian motion in the stock market. *Operations Research, 7*(2), 145-173. http://dx.doi.org/10.1287/opre.7.2.145

Pathirawasam, C. (2011). The relationship between trading volume and stock returns. *Journal of Competiveness*, 3, 41-49.

Phillips, P. C. B., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika, 75*(2), 335-346. http://dx.doi.org/10.1093/biomet/75.2.335

Pisedtasalasai, A., & Gunasekarage, A. (2007). Causal and dynamic relationships among stock returns, return volatility and trading volume: Evidence from emerging markets in South-East Asia. *Asia-Pacific Finance Markets, 14*(4), 277-297. http://dx.doi.org/10.1007/s10690-008-9063-3

Rogalski, R. J. (1978). The dependence of prices and volume. *The Review of Economics and Statistics*, *60*(2), 268-274. http://dx.doi.org/10.2307/1924980

Rutledge, D. J. S. (1984). Trading volume and price variability: New evidence on the price effects of speculation, in selected writings on futures markets: Research directions in commodity markets, 1970-1980, A. E. Peck, ed. Chicago: Chicago Board of Trade, 237-251.

Saatcioglu, K., & Starks, L. T. (1998). The stock price–volume relationship in emerging stock markets: The case of Latin America. *International Journal of Forecasting*, *14*(2), 215-225. http://dx.doi.org/10.1016/S0169-2070(98)00028-4

Sabri, N. (2008). The impact of trading volume on stock price volatility in the Arab economy. *Journal of Derivatives & Hedge Funds*, *14*(3-4), 285-298. http://dx.doi.org/10.1057/jdhf.2008.22

Smirlock, M., & Starks, L. (1985). A further examination of stock price changes and transactions volume. *Journal of Financial Research*, *8*(3), 217-225. http://dx.doi.org/10.1111/j.1475-6803.1985.tb00404.x

Sun, M. Y., & Li, J. F. (2015). A simultaneous equations model of returns, volatility, and volume with intraday trading dynamics. *Accounting and Finance Research*, *4*(2), 50-59. http://dx.doi.org/10.5430/afr.v4n2p50

Tauchen, G., & Pitts, M. (1983). The price variability-volume relationship on speculative markets. *Econometrica, 51*(2), 485-505. http://dx.doi.org/10.2307/1912002

Tripathy, N. (2011). The relation between price changes and trading volume: A study in Indian stock market. *Interdisciplinary Journal of Research in Business, 1*(7), 81-95.

Westerfield, R. (1977). The distribution of common stock price changes: An application of transactions time and subordinated stochastic models. *The Journal of Financial and Quantitative Analysis, 12*(5), 743-765. http://dx.doi.org/10.2307/2330254

Ying, C. C. (1966). Stock market prices and volumes of sales. *Econometrica*, *34*(3), 676-686. http://dx.doi.org/10.2307/1909776