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Analyzing the Causal Relations between Trading Volume and Stock Returns and between Trading Volume and Return Volatility in Tehran Stock Exchange

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Abstract

Identifying the causal relations between trading volume and stock returns and between trading volume and return volatility plays a vital role in identifying profitable investment opportunities. In this study, the Granger causality test was conducted to analyze the causal relationships between the mentioned variables in Tehran Stock Exchange. Consequently, the Vector Auto Regression (VAR) model was employed to determine the conditional mean equations of returns and volume. Moreover, the bivariate Generalized Autoregressive Conditional Heteroskedasticity (GARCH) model was used to model the conditional variance equation, stating the relationship between volume and return volatility. According to the results, no bilateral causal relationship can be ascertained between returns, volume, and return volatility. In other words, return and return volatility could barely predict volume; therefore, volume cannot be the Granger causality of the other two variables. However, stock returns were found to have an important role in determining the volume. Likewise, return volatility can be used to predict volume accurately. In fact, stock returns and the return volatility were both the Granger causalities of the volume.

Keywords: Stock Returns, Volume of trade, Return Volatility, Causal Relationships, Vector Auto Regression Model, Granger Causality, GARCH.

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Introduction

A stock exchange is an official and organized market for the trading of companies' stocks according to specific rules and regulations. Many factors affect the knowledge and opinions of market operators, and stock returns. Some of these factors are domestic while others are caused by certain variables outside the boundaries of the domestic economy.

Stock returns are the first and the most important factor affecting decisions made by the stock exchange investors. Hence, it is very important to identify the factors affecting the rate of stock returns. For this purpose, researchers have always been trying to figure out how and why stock returns, volume, and return volatility are related, presenting hypotheses in an attempt to explain the relationship between these three variables.

In financial markets, certain models are analyzed to predict the relationships between stock returns, volume, and return volatility for a short time with respect to the rate of market input information, quality of information dissemination and market size [5]. Therefore, clarifying the relationships of the mentioned variables will facilitate the identification of investment methods in financial markets in addition to explaining various viewpoints on such markets. Previous studies have sometimes produced different results, which might be due to the type of the surveyed market in terms of development, modeling methods and model estimation techniques.

In the majority of previous studies, the relationships of returns, volume, and return volatility were estimated separately using the two-stage estimation process. Thus, they may have resulted in inefficient model estimations because all of the three variables would simultaneously originate from the same market. Thus, the mentioned variables were analyzed simultaneously in a one-stage estimation process in this study to better describe their relationships. As a result, more efficient estimations were obtained at a higher level of consistency with financial theories.

Literature Review

Financial researchers and economists have been much interested in the analysis of relationships between volume, stock returns and return volatility since 1952. Most studies of the stock exchanges focused on the stock price and how it changes over time. Yet, most other studies focus on stock returns because of the stochastic and unfavorable features of stock prices, including variability. According to the available information on a company, stock returns reflect the

expectations of investors from the future performance. New information will change their expectations, something which is the main cause of the stock price volatility [21].

The wide range of changes and volatility in the market implies a large amount of information. However, an inverse relationship can also be true. Different financial markets follow different models determining the relationships between volume and return changes in one day. Such a model cannot be explained through asset pricing theories like the capital assets pricing model efficiently [8]. In 1987, Karloff gave four reasons for the importance of the relationship between volume and the stock price:

First, the structures of financial markets should be considered. The available models of financial markets predict the relationships between volume and stock prices by analyzing the amount of market input information, information dissemination method, market size, and trading conditions. Therefore, how volume is related to stock prices clarifies the various viewpoints on financial markets and makes different theories of market structures clearly distinct. It is important to know the relationship between volume and stock prices in event studies using data on these variables to make interpretations.

Regarding the empirical distribution of speculative prices, a major role is assumed by the relationship between volume and stock prices. In the studies of future markets, it is important to analyze the quality of the relationship between volume and stock prices. In fact, price changes will affect the future contract volume [17].

Accordingly, an investigation showed that studies on this subject have been rare in Iran. This study is the first work of research to use Tehran Stock Exchange's total index to analyze the relationships between stock returns, return volatility, and volume.

In 2000, Omid Ghaemi analyzed the relationship between volume and stock prices by studying 24 companies listed on Tehran Stock Exchange from July 23, 1995, to November 24, 1999. The following findings were obtained: 1) there is a positive correlation between the number of times every share was traded and the number of traded shares. 2) There is a significant and direct relationship between the number of times every share is traded per day and the number of traded shares per day with the price change in the same day. 3) Price changes have a significant relationship with the number of transactions and the number of shares traded on the current day [2].

Drawing on daily data, in 2005, Ziodar analyzed the relationships between volume, stock returns, and return volatility by studying fifteen active companies listed on Tehran Stock Exchange in 2004 (from March 27, 2004, to May 31, 2004). The following findings were obtained: 1) There is a concurrent relationship between volume and the absolute value of price change. 2) There is a concurrent relationship between volume and the price change. 3) There is a feedback relationship between volume and stock returns [6]. Many studies were conducted abroad to analyze the relationships between volume and stock returns. Some of them are reviewed here.

Jissels et al. mentioned the price-volume relationship briefly in their 2000 publication. Four of these cases are relevant to this study: 1) the expected return depends on volume, although it seems that the negative coefficient, expected from the concurrent regression, depends on both the presence and the type of variables simultaneously; 2) there is a positive and significant relationship between return volatility and volume; 3) there is a strong, non-linear relationship between price and volume; 4) it is possible that the conditional variable would considerably undermine the linear volume volatility relationships [14]. Many of the theoretical studies explained the causal relationship between returns and volume. Studies conducted by Campbell [10], Wong [25], and Bloom [9] proposed theoretical models, stating that volume could provide valuable information on the future stock returns. At the same time, there was a positive relationship between previous stock returns and current volume, derived from financial-behavioral models [13, 23].

Interestingly, various theoretical findings were different from the findings of empirical studies on the dynamic relationship between returns and volume. Some empirical studies could predict returns based on volume; however, other studies produced different results [26]. For instance, Li and Swaminatan [19] and Grosis [13] claim that the volume from the past offers valuable information on future stock returns. On the other hand, Griffin [15] found out that the high level of market returns, resulting in an extensive volume, is a global phenomenon that can be observed everywhere. In their studies, Heimstra and Jones [16] and Maliaris and Overtia [20] analyzed the causal relationship between returns and volume, introducing it as a feedback relationship.

The serial information input theory, proposed by Copeland-Jenings [11] and Smirlax and Strax [24], can be used to describe the dynamic relationship between volume and volatility. Many scientific studies pointed out a significant relationship between volume and return volatility. For instance, Smirlax and Strax (1988) stated that there was a significant causal relationship between

volume and return volatility in the stock exchange. Moreover, Lamorex and Lastraps (1990) found out that the available information of volume would improve the prediction of return volatility [18]. Finally, Darat et al. (2003) found conclusive evidence of the causal relationship between volume and volatility using daily data of Dow Jones Industrial Average (DJIA) stocks [12].

Theoretical Foundations

1. Stock Returns

The rate of stock returns is now one of the most important criteria for evaluating the performances of institutions. On its own, this criterion can provide investors with information. It can also be used for the performance evaluation. When the rate of stock returns decreases, companies should be alert because a low rate of stock returns shows inappropriate performance. This criterion contains a great deal of information because the performance evaluation can reflect information on investors when it is based on the market value [2]. In the investment process, the rate of stock returns is an impetus for motivation and also a reward for investors. Total return refers to the set of advantages allocated to shares during the year. Such advantages include the stock price, cash dividends, benefits obtained from the priority of the stock purchase, and benefits obtained from stock dividends or bonus shares. In this study, return refers to the logarithmic return on shares, the calculation of which was based only on price changes.

2. Volume of Trade

Volume of trade means the number of stocks traded in a certain period of time, usually one day. The more the volume increases, the more active shares will be. Volume is an important aspect of technical analysis because it is employed to confirm sampling procedures and models. An increasing or decreasing price change with a relatively high volume is considered a stronger and more stable variation than a similar change with low volume. In other words, if volume is higher than the daily mean volume, it can be a sign of a reversal in the procedure. However, if volume is lower than the daily mean volume, there will be no strong opinions as to the probability of a real reversal in the procedure [3].

3. The Relationship between Volume and Stock Returns

Regarding the relationship between volume and stock returns, researchers are mostly occupied with the causality of such a relationship in stock exchanges.

The U-shape form of price changes and volume during one trading day is a primary reason for justifying the positive relationship between stock returns and volume. Kalev, Liu, and Pham (2002) analyzed return volatility and information input during one trading day (twelve 30-minute intervals) using the number of new events occurring in the market, the absolute value of returns, and volume. They also explained the U-shape issue through the following figures.

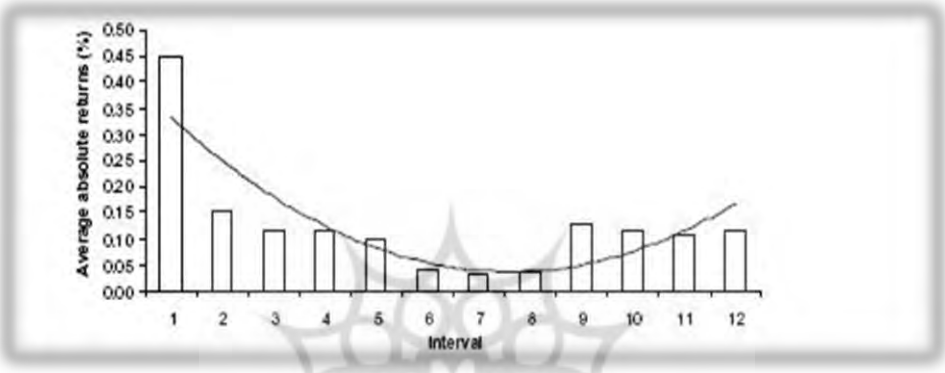

Figure 1. The Histogram for the Absolute Value of Returns during one Trading Day

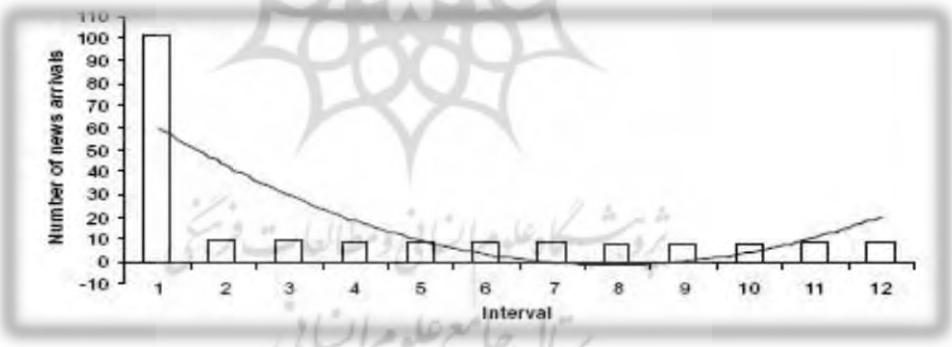

Figure 2. The Histogram for the Number of New Events Occurring during One Trading Day

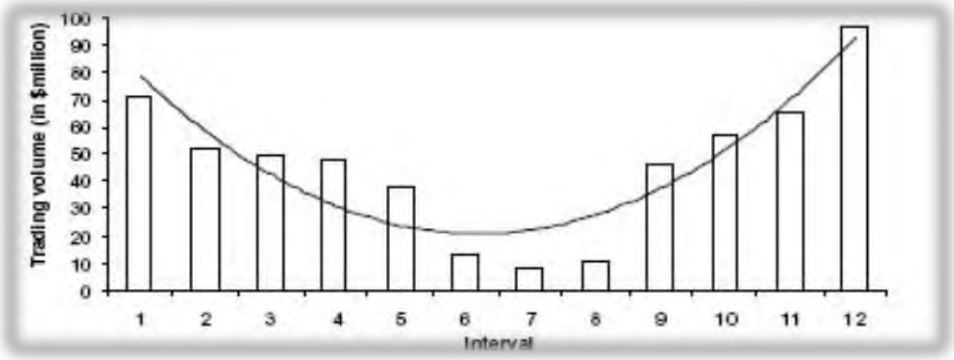

Figure 3. The Histogram for the Volume during One Trading Day [6]

4. Econemtric framework

The vector autoregression (VAR) model is a simple vector model used widely in modeling return on assets. The multivariate time series $r_t$is a first-order vector autoregression model, VAR(1), which follows the next equation.

The VAR model is usually used to predict a system of relevant time series and analyze the dynamic effect of stochastic irregularities on the system. The VAR approach meets the need for structural modeling by modeling each of the endogenous variables in the system in a way that a function of interruptive values of all endogenous variables exists in the system [7].

ARCH models assume conditional variance as a function of previous errors over variable times. Now it is favorable to improve the flexibility of ARCH models over time.

The concept of causality is based on two basic principles: first, a cause occurs before an effect; second, a causal variable includes specific information on the caused variable. Such information cannot be provided by other variables.

This study is aimed at analyzing the relationships between stock returns volume, and return volatility in Tehran Stock Exchange. The total index of Tehran Stock Exchange was employed to calculate stock returns and return volatility. The volume included all of the transactions conducted on one day in Tehran Stock Exchange. The data of all three variables were daily. The Granger causality test was carried out to analyze the causality relationships of variables. It was advisable to increase the number of interruptions in the Granger causality test to achieve valid results and better informational criteria,

based on which more realistic estimative coefficients and an optimal model could be obtained for testing. For this purpose, a larger number of data would be required. Therefore, it was decided to obtain information on stock returns and volume in transactions conducted in Tehran Stock Exchange from 2003 to 2013. There were over 2400 cases.

Accordingly, four hypotheses were tested in this study:

1) The volume of previous transactions is the Granger cause of the current stock returns.
2) The previous stock returns can be the Granger cause of the current volume.
3) The previous volume is able to predict return volatility.
4) The previous return volatility is able to predict volume.

Model Formulation

1. Conditional Mean Equation

The following models were used to analyze the causality relationships between stock returns and volume in addition to the relationships between current volume and previous return volatility:

$$R_{\mathrm{t}} = \alpha_{R.0} + \Sigma_{a=1}^{A}\beta_{R.a}\, R_{t-a} + \Sigma_{b=1}^{B}\gamma_{R.b}\, V_{t-b} + \varepsilon_{R.t} \quad (1)$$

$$V_{\mathrm{t}} = \alpha_{V.0} + \Sigma_{c=1}^{C}\beta_{V.C}\, R_{t-c} + \Sigma_{d=1}^{D}\gamma_{V.d} V_{t-d} + \Sigma_{e=1}^{E}\varphi_{V.e}\varepsilon_{R.t-e}^{2} + \varepsilon_{V.t} \quad (2)$$

Where R_{t} and V_{t} refer to stock returns and volume at the time of t. The Akaike information criterion (AIC) was used to determine the length of the interruption in the above equations. The squared interruptive error expressions of the first equation were used as a volatility scale in the second equation. Although the features of the first and second equations do not completely match the vector autoregressive equations with the same independent variables on the right, the analysis logic of causality relationships in these equations is the same as the Granger causality test. For instance, the coefficients of $\gamma_{R,b}$ state the relationship between current return stocks and previous volume in the first equation. The rejection of the first null hypothesis ($\gamma_{R,b} = 0$ for all values of b) shows that volume was the Granger causality of stock returns.

2. The Conditional Variance-Covariance Model

The dual GARCH model with constant correlation, introduced by Bollersley in 1990, was used for modeling the second moment of stock returns and analyzing the causality relationship between current return volatility and previous volume. The features of GJR GARCH model were used to state the conditional variance model. The dual GJR GARCH model of stock return volatility and volume can be stated as:

$$\sigma^2_{\mathrm{R.t}} = \omega_R + \Sigma_{n=1}^{N}\delta_{n.p}\,\sigma^2_{\mathrm{R.t-n}} + \Sigma_{o=1}^{O}K_{R.o}\left(\varepsilon_{R,t-o}\right)^2 + S^{-}_{R.t-1}(\varepsilon_{R.t-1})^2 + \Sigma_{l=1}^{L}V_{t-1}\theta_{R.l} \quad (3)$$

In the above equation, $\sigma^2_{R,t}$ is the conditional variance of stock returns at t. The virtual variable $S^{-}_{R,t-1}$ receives 1 if $\varepsilon_{R,t-1} < 0$; otherwise, it receives zero. In this step, the previous volume was considered in the above equation to analyze the causality relationship between stock returns and volume. Therefore, $\theta_{R,l}$ can be used as a parameter to determine the effects of the previous volume on current volatility. Moreover, the GARCH model with constant correlation posed the following constraint on the covariance between stock returns and volume:

$$\sigma_{\mathrm{RV.t}} = \sigma_{\mathrm{VR.t}} = p_{RV}\,\sigma_{\mathrm{R.t}}\sigma_{\mathrm{v.t}} \quad (4)$$

Research Findings

1. Results of Testing the First Hypothesis

Table 1 shows the estimated results of the conditional mean return equation. The parent test was used to analyze the causality relationship between stock returns and volume. This test checks the null hypothesis based on $\gamma_{\mathrm{R.b}} = 0$ for all values of b. Obtained from the chi-squared distribution with a degree of freedom equaling the number of interruptions, the parent distribution statistic follows the AIC. According to Table 1, the null hypothesis was not rejected at all reliance levels, something which means volume could not be the Granger cause of stock returns. In other words, the previous volume of the market had a very limited role in predicting market returns. This finding is consistent with the research results of Pisedtasalasai and Gunasekarage, who studied the relationships between return and volume in developing markets.

Table 1. The Estimation Results of the Conditional Mean Return Equation

Analyzing the Granger Cause of Volume for Return (Equation 7)			
Variable	$\gamma_{R.b}$		
Length of Interrupt	1		
Parent Test Statistic	0.038004		
Freedom Degree of Distribution	1		
Reliance	99%	Reliance	90%
The Value of Chi-Squared	6.635	The Value of Chi-Squared	2.706
Result	Volume ⇏ return	Result	Volume ⇏ return

2. Results of Testing the Second Hypothesis

Table 2 shows the estimated results of the conditional mean volume equation. The parent test with a freedom degree of 4 (the number of optimal interruptions) was conducted to check if the market return was the Granger cause of volume or not. This test checked the null hypothesis based on $\beta_{V,C} = 0$ for all values of c. According to Table 2, the parent test statistic was located in the rejection area at all three distribution levels; therefore, the null hypothesis was rejected. It means that the previous returns of the market included valuable information for the prediction of volume. In other words, the previous return of the market was the Granger cause of volume. This finding is consistent with the results of previous studies conducted in developing markets.

Table 2. The Estimation Results of the Conditional Mean Volume (Return-Volume)

Analyzing the Granger Cause of Return for Volume (Equation 8)			
Variable	$\beta_{V.C}$		
Length of Interrupt	4		
Parent Test Statistic	21.27283		
Freedom Degree of Distribution	4		
Reliance	99%	Reliance	90%
The Value of Chi-Squared	13.277	The Value of Chi-Squared	7.779
Result	return ⟹ volume	Result	return ⟹ volume

3. Results of Testing the Third Hypothesis

Table 3 indicates the estimated results of the conditional mean volume equation for the squared coefficients of remainders, which were regarded as rates of return volatility in the conditional mean volume model. Accordingly, the null hypothesis was rejected at reliance levels of 90% and 95% based on $\varphi_{V.e} = 0$ for all values of e. However, the null hypothesis was confirmed at a reliance level of 99%. Therefore, the previous volatility was the Granger cause of volume. In other words, it could be a factor affecting in the prediction of volume, although such a relationship was not possible at a reliance level of 95%.

Table 3. The Estimation Results of the Conditional Mean Volume (Volatility-Volume)

Analyzing the Granger Cause of Return Volatility for Volume (Equation 8)			
Variable	$\varphi_{V.e}$		
Length of Interrupt	2		
Parent Test Statistic	9.074979		
Freedom Degree of Distribution	2		
Reliance	99%	Reliance	90%
The Value of Chi-Squared	9.21	The Value of Chi-Squared	4.605
Result	Volatility ⟹ Volume	Result	Volatility ⟹ Volume

4. Results of Testing the Fourth Hypothesis

Table 4 shows the estimated results of the conditional variance equation, which was modeled using the dual GARCH model with constant correlation. The estimated value of previous volume coefficient was not significant in the conditional variance equation of return volatility (θ). Therefore, the previous volume did not have a significant impact on the current and future values of return volatility. It could not be a determinative parameter in the prediction of return volatility. In other words, volume was not the Granger cause of return volatility.

Table 4. The Estimation Results of the Conditional Variance Equation

Analyzing the Granger Cause of Volume for Stock Returns (Equation 9)	
Variable	$\theta_{R,l}$
Length of Interrupt	1
Estimated Value θ	0.001058
Standard Error	0.014471
Result	Volume ⇏ Return Volatility

According to the results of the above tests, the return was the Granger cause of volume. However, an inverse relationship was not true. In other words, the market returns provided investors with important information so that they could predict volume. This finding is consistent with the financial-behavioral theories. In fact, increased returns would attract more investors, something which would in turn increase volume. Another research finding was the relationship between volume and return volatility. Such a relationship stated that return volatility was the Granger cause of volume. However, an inverse relationship was not true. In other words, increasing the return volatility of speculators would result in appropriate openings for gaining profits, something which would increase volume.

Discussion and Conclusion

Many of the researchers have always been concerned with the relationships between return, volume, and return volatility because knowing how the mentioned variables are related can play a key role in identifying profitable investment opportunities. In this study, drawing on methods including VAR and GARCH the relationships between the research's three variables were modeled properly. Given the fact that these three variables are affected concurrently by the market, the abovementioned models were estimated simultaneously. Such a strategy resulted in a more accurate and efficient estimate of the modeled parameters; therefore, more reliable results were produced. Finally, the Granger causality test was conducted to analyze the causal relationships between variables. According to the results, there were no bilateral causality relationships between return, volume, and return volatility. In other words, volume could barely predict return and return volatility;

therefore, it could not be the Granger cause of the other two variables. Meanwhile, stock returns play a significant role in determining volume. Return volatility was also able to predict volume very well. In fact, stock returns and return volatility were the Granger causes of volume.

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