

INVESTIGATING CAUSAL RELATIONS BETWEEN PRICE CHANGES AND TRADING VOLUME CHANGES IN THE TURKISH MARKET

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***ABSTRACT:** This empirical investigation examines the causal relations between daily price changes and trading volume changes on the nascent stock exchange of Istanbul, Turkey. The most recent 40-month period from January 2003 through April 2006 is the focus of this study. The long held view that rising markets tend to be accompanied by rising volume and declining markets tend to be accompanied by falling volume is robustly supported by the evidence uncovered for the Istanbul Stock Exchange. Moreover, the evidence strongly indicates that the volume – return relation is asymmetric, depending on the direction of the underlying market. The findings of this study also support the notion that it takes trading volume to make the market index move. The tests of the Granger causality between daily index returns and daily volume changes provide an overwhelming evidence of a bi-directional feedback.*

INTRODUCTION

The studies of relations between security prices and trading volume can be traced back to the late 1950s. Karpoff's (1987) survey of literature of the previous 25+ years on this subject provided a thorough review. Karpoff outlined four critical reasons why the price – volume (P-V) relations should be investigated. According to Karpoff, the first and the foremost reason for studying these relations is that they can help understand the underlying structure of any speculative market. Accordingly, various aspects of the relations between price changes and volume have continued to be examined for numerous financial markets around the world. Moreover, it is one of the research topics in finance, which has captured the interests of both, academicians as well as practitioners.

Two of the P-V relations often investigated are connected to the commonly mentioned postulates on the Wall Street. Specifically, the seasoned investors generally believe that price increases supported by relatively high trading volume is a sign of a bullish sentiment and price declines accompanied by relatively high volume is an indicator of a bearish sentiment. Yet, another frequently quoted saying on the Wall Street refers to trading volume as the fuel for stock prices (see Stickel and Verrecchia, 1994). Attempting to gather empirical support for such adages from equity markets provides partial motivation for some of the studies of P-V relations. By and large, such studies have focused on developed financial markets. Only a handful of published empirical studies of P-V relations in the developing markets exist. This paucity provides further impetus for the present study. Even though the origin of an organized form of securities market in Turkey can be found during the 19th century, the present day Istanbul Stock Exchange (ISE) commenced stock trading only in January, 1986. This relative youth of the ISE provides further inspiration for this study.

The central objective of this paper is to investigate econometric relations between stock market returns on the Istanbul Stock Exchange National – 100 Index of Turkey (hereon referred to as ISE100 Index) and

the trading volume on the ISE. To meet this goal, the study utilizes the daily data of the ISE over the most recent 40-month period ending in April, 2006. The specific goals of this paper are as follows:

1. To determine if the rising markets are in fact accompanied by rising volume and vice versa;
2. To determine if the empirical evidence of the ISE indicates an asymmetric P-V relationship with respect to the opposite directions of the market;
3. To determine if the evidence backs the notion that it takes trading volume to bring about market index movements; and
4. To ascertain the existence of and the direction of the Granger causality between returns and volume.

A brief review of the relevant literature is covered in the next section. In the following section, the data, the definitions of the variables, some background information on the ISE, and the methodologies utilized in this study are described. The empirical findings of this investigation are presented in the fourth section. A summary of the paper makes up the final section.

LITERATURE REVIEW

The body of noteworthy literature on the relations between security prices and volume is sizable. Depending on the underlying data and the investigation period, researchers have often reached conflicting conclusions for different markets. For example, while Ying (1966) found that volume had led price changes by about four business days, Gordon (1968) discovered that volume had led the market index price by several months in the U.S. For a student of P-V relations, Karpoff's contributions (1986, 1987) are significant. His review of the pioneering studies on the subject at hand and a synthesis of the findings have provided considerable ammunition for those wishing to perform empirical research in this area. Many of the P-V relation studies from the last 10-15 years are founded on the influential studies by Granger and Morganstern (1963), Crouch (1970), Clark (1973), Copeland (1974), Morgan (1976), Epps and Epps (1976), Westerfield (1977), Rogalski (1978), Jennings, et. al (1981), Touchen and Pitts (1983), Smirlock and Starks (1985, 1988), Wood, et. al (1985), Engle and Bollerslev (1986), and Galant, et. al (1992).

Crouch (1970) found a positive correlation between absolute values of price changes and trading volume for both, market indices as well as individual stocks. In a study of transactions data of NYSE stocks, Wood, et. al (1985) also found a positive correlation between volume and the magnitude of price changes. A positive correlation between price changes and volume was found by Westerfield (1977), Rogalski (1978) and Touchen and Pitts (1983), among others. In a 1994 study, Stickel and Verrecchia studied the P-V relation on the U. S. exchange at earnings announcements. Their findings indicated that large price changes supported by weak volume tend to reverse but large price increases supported by hefty volume tend to be followed by further price increases (1994). The four models emerging from the P-V relation studies to rationalize a positive correlation between the magnitudes of price changes and trading volume of speculative assets have been presented by Chen, et. al (2001) in a capsule form. The four models are: the SAI model (sequential arrival of information), the MD model (mixture of distributions), the REAP model (rational expectation asset pricing), and the DO model (differences of opinion).

To determine the presence of and the direction of a causal relation between return and volume, the Granger causality method (Granger, 1969) has been the technique of choice. Studies by Rogalski (1978), Jain and Joh (1988), Campbell, et. al (1993), Martikainen, et. al (1994), Hiemstra and Jones (1995), Saatcioglu and Starks (1998), Chen, et. al (2001) and, Kamath and Wang (2006) are some examples of inquiries which have relied on the Granger causality methodology. Martikainen, et. al (1994) study of the Finnish stock market found a bi-directional feedback between stock returns and volume. Chen, et. al (2001) focused on the P-V relation in nine developed national equity markets such as the U.S., U.K., and

Japan. In all nine markets, they found evidence of a positive contemporaneous relation between volume and the magnitude of price changes. In terms of the Granger causality, they reported that returns were found to cause volume and to a much smaller extent, volumes were found to cause returns. For the markets of Hong Kong, the Netherlands and Switzerland, they found evidence of a significant bi-directional feedback. The Jain and Joh study (1988) examined the hourly returns and volume on the NYSE. While they detected a significantly positive correlation between volume and absolute returns, they noted differences in this relation for positive and negative returns.

Six Latin American stock markets were the focus of the price-volume relation study by Saatcioglu and Starks (1998). Using the monthly data, they found evidence of positive correlations between volume and price changes as well as the magnitude of price changes. In four of the six markets, they found evidence of volume causing returns. Kamath and Wang (2006) examined the P-V relation in six Asian equity markets. Their findings supported the contention that volume induces price movements in five of the six markets. They also noted a significantly positive relation between volume and returns even though this relation was found to be asymmetric with respect to the market direction. Their Granger causality test results indicated an absence of causality in either direction in four of the six developing markets. They found evidence of causality running from returns to volume in the South Korean market and a diametrically opposite direction of causality in the Taiwanese market.

The literature search found numerous papers on a variety of issues involving the ISE, the rapidly developing market of interest in the present study. For example, Kiyamaz (2001) studied the impact of rumors on prices of stocks traded on the ISE. Bildik's study (2001) was aimed at ascertaining the intra-daily seasonalities of stock returns on the ISE. Buguk and Brorsen (2003) tested for the efficient market hypothesis for the ISE utilizing weekly prices on the composite, the industrial and the financial indices. Gonenc and Karan (2003) compared the monthly returns of portfolios of value stocks with those of growth stocks and portfolios of small capitalization stocks with those of large capitalization stocks on the ISE over the 60-month period in the mid-1990s. They concluded that the growth portfolios had outperformed the value portfolios on the ISE. Their conclusions were at variance with the findings of most developed as well as developing markets. Bildik and Gulay (2006) utilized the ISE data from 1998 to 2002 to study the effects of price limits on the market. They discovered that significant price movements take place within five market sessions; two sessions before to two sessions after the 10% price limit is hit or locked. The focus of the present paper, namely, the P-V relation on the ISE, was not investigated in any of the published papers. This void in the literature provides further motivation for this study.

DATA AND METHODOLOGY

To fulfill the objectives of this investigation, the daily data of the ISE100 index of the Istanbul Stock Exchange of Turkey are utilized. The daily closing index prices and the daily trading volume on the ISE are used for the 40-month period from January, 2003 to April, 2006. Accordingly, the paper relies on 828 pairs of daily index price changes and trading volume changes.

The history of the Turkish financial market indicates that the origin of the first securities market could be traced to as far back as 1866 during the Ottoman Empire. The present day Istanbul Stock Exchange was inaugurated at the end of 1985 with the stock trading starting on January 3, 1986. The ISE indices which were computed on a weekly basis in the first 21 months of this fledgling market have been computed on a daily basis since October, 1987. The ISE initiated computerized stock trading in December, 1993 with 50 stocks, and, by the end of 1994, the stock trading was fully automated. In 1995, short selling was initiated on the ISE for the 100 stocks which were in the ISE100 index. By the end of August, 1999, both, margin trading and short selling were permissible on all stocks traded on the ISE. For the 40-month period of interest in this paper, the stock market has been open from Monday through Friday with trading conducted in two 150 minute sessions (9:30 a.m.-12:00 noon and 2:00 p.m.-4:30 p.m.).

Table 1: Raw Data on the ISE volume and the ISE100 Index, 1/2003 – 4/2006

Period	1/1/2003 –	1/1/2004 –	1/1/2005 –	1/1/2006 –
Information On	12/31/2003	12/31/2004	12/31/2005	4/30/2006
Highest Index Close	18,625.02	24,971.68	39,837.27	47,728.50
Date	12/31/2003	12/29/2004	12/29/2005	02/27/2006
Lowest Index Close	8,892.65	15,922.44	23,285.94	39,790.72
Date	03/24/2003	05/17/2004	04/18/2005	01/02/2006
Last Day Index Close	18,625.02	24,971.68	39,777.70	43,880.43
Highest Volume (000)	1,014,475.25	619,339.12	608,087.87	768,757.48
Date	10/07/2003	03/24/2004	01/14/2005	03/24/2006
Lowest Volume (000)	59,479.99	75,152.85	172.852.10	257,825.52
Date	07/30/2003	06/21/2004	04/04/2005	02/06/2006

The ISE100 index is a market value weighted index. (for a detailed information, see <http://www.ise.org/indices/stckindx.htm>). The ISE100 index began the 2003 year just under 10,600. Over the 40-month period examined in this study, the ISE100 index rose more than 310 percent to 43,880.43. The raw data on the ISE100 index prices and the ISE volume are presented in Table 1. At the time of writing this paper in mid-September, 2006, this market index had given up some of its gains and thus, the said index was around 37,370.

From the raw data of the ISE, the daily rates of return (R), absolute values of returns (AR) and volume measures (V) were computed using the following three equations.

$$R = \left(\left(P_t / P_{t-1} \right) - 1 \right) \times 100 \quad (1)$$

$$V = \left(\left(V_t / V_{t-1} \right) - 1 \right) \times 100 \quad (2)$$

$$AR = \text{Absolute value of } R \quad (3)$$

In above equations, P_t and V_t stand for closing market index price on day t and the ISE volume on day t , respectively. The definition of the volume variable adopted in this study is identical to the return computation. Thus, both, R and V are % change functions and therefore, both measures can take on positive as well as negative values. Different definitions of both, volume as well as returns, can be found in previous studies. For example, while Jain and Joh (1988) have used raw values of trading volume,

Martikainen, et. al (1994) and Chen and Zhou (2001) have utilized natural logarithm of raw volume. The volume measure definition in the Saatcioglu and Starks (1998) is unique in which they utilize the ratio of raw volume to the market capitalization. The common link in all these measures of volume is that they lead to performing regressions in which one variable can assume positive as well as negative values (returns) but the other can assume only positive values (volume). This methodological shortcoming is overcome with the way the volume measure is computed in the present study as was done in the Kamath and Wang study (2006) while still retaining the essence of the properties needed to test the main postulates of the P-V relations.

The first econometric testing in this paper is conducted to ascertain if on the ISE, the rising market index is accompanied by rising volume and if the falling market index is accompanied by falling volume. Equation (4) is utilized to determine if the estimated coefficient, B, for the overall market is positive and statistically significant.

$$V = A + B(R) \tag{4}$$

The second objective of the paper attempts to determine if on the ISE, the P-V relation is “fundamentally different” for different market direction as shown in Figure 1 of Karpoff (1987, p121). To meet this objective, the equation (4) is separately estimated, first for all the days when the ISE100 index gained and second for all the days when the ISE100 index lost.

The third objective of the paper is to ascertain if it takes volume to make the ISE100 index move. Thus, the econometric testing will determine if large volume accompany large magnitudes of returns and vice versa. In other words, the test will determine if the estimated coefficient, D, is positive and statistically significant.

$$V = C + D(AR) \tag{5}$$

In equations (4) and (5), the estimated constant terms are denoted by A and C, respectively, and B and D are the estimated coefficients of independent variables, returns and absolute returns, respectively.

The tests described so far test for the contemporaneous relations between price changes and volume changes. For example, if the estimated coefficient D of absolute returns is found to be significantly positive, it would indicate that volume contemporaneously cause returns on the ISE. The final objective of the paper is to determine existence of and the direction of causality between returns and volume on the ISE as per the conventions of the Granger causality methodology (Granger, 1969). In essence, the objective is to ascertain if the changes in the first variable, such as the returns, cause the second variable, such as the volume, to change even when controlled for the past changes in the second variable (volume). Two null hypotheses tested in this study are outlined by equations (6) and (7). In this paper, lags of up to 5 business days are used for estimating Granger Causality as described by complete equations (8) and (9).

$$R \text{ does not Granger cause } V \tag{6}$$

$$V \text{ does not Granger cause } R \tag{7}$$

$$V_t = G_0 + \sum_{i=1}^5 G_i V_{t-i} + \sum_{j=1}^5 H_j R_{t-j} \tag{8}$$

$$R_t = S_0 + \sum_{i=1}^5 S_i R_{t-i} + \sum_{j=1}^5 Q_j V_{t-j} \tag{9}$$

With the help of equation (8), if the estimated coefficients H_j are found to be statistically significant, it would lead to a conclusion that volume is Granger caused by returns on the ISE. Specifically, it would indicate that the prediction of future daily volume would be better if the independent variables include the past 5 values of daily volume along with the past 5 values of daily returns rather than just the past 5 values of daily volume. On the other hand, if the F-test fails to reject the hypothesis that $H_1, H_2, H_3, H_4, H_5 = 0$, the conclusion would be that returns do not Granger cause volume. Similarly if the F-test fails to reject the hypothesis that $Q_1, Q_2, Q_3, Q_4, Q_5 = 0$, the conclusion would be that volume do not Granger cause returns.

The statistical properties of the daily rates of return on the ISE100 index and the trading volume % changes on the ISE are contained in Table 2. During the period under investigation, this table shows that the mean as well as the median returns were positive. The measure of risk per unit of return, namely, the coefficient of variation of daily returns, can be computed to be 10.37 on the ISE (standard deviation / mean). For a somewhat comparable period, the Kamath and Wang study (2006) has reported the coefficients of variation values of 14.66, 12.33, 11.79, 14.92 and 29.58 for the markets of Hong Kong, Malaysia, Singapore, South Korea and Taiwan, respectively. Only for the Jakarta Composite Index of Indonesia, they had found a smaller coefficient of variation (8.60) during the 2003 to 2005 period. For the overall period, the table exhibits a negatively skewed return distribution of the ISE100 index. This finding is similar to that found for all 9 developed markets studied by Chen, et. al (2001) as well as for Indonesia, Singapore, South Korea and Taiwan reported by Kamath and Wang (2006). For the 40-month study period, Table 2 shows Kurtosis of the return distribution to be far in excess of 3.0, as has been reported for the developed as well as the developing markets around the world. Thus, the evidence clearly points to a peaked and fat tailed return distribution for the ISE100 index. The distribution of weekly returns on the ISE over the 1992 to 2001 period also had a negative skewness and a large kurtosis (see Alper and Yilmaz, 2004). The statistical distribution of the volume variable of the ISE is characterized by large standard deviation coupled with a positive skew and a large kurtosis. These characteristics of volume on the Turkish market are very much comparable to those reported by Kamath and Wang (2006) for the six Asian Markets during the 2003-2005 period.

FINDINGS

Table 2: Statistical Attributes of Daily Returns and Volume on the Istanbul Stock Exchange, 1/2003 – 4/2006.

Which days	All market days		The days when the market went up		The days when the market went down	
	Return %	Volume %	Return %	Volume %	Return %	Volume %
Mean	0.191	4.594	1.468	11.329	-1.460	-4.119
Median	0.268	-0.268	1.210	4.512	-1.157	-8.077
Maximum	11.585	319.92	11.585	319.92	-0.012	120.30
Minimum	-12.489	-59.98	0.014	-59.98	-12.489	-49.63

Std. Dev.	1.98	33.57	1.30	37.14	1.38	25.86
Skewness	-0.17	2.02	2.73	2.11	-2.99	1.01
Kurtosis	8.39	13.82	17.78	13.90	19.31	4.87
Jarque-Bera	1004.7	4599.6	4830.8	2656.5	4539.7	113.7
Observations	828	828	467	467	361	361

Since, one of the goals of this study is to test for the asymmetric relation between returns and volume with respect to the market direction, the overall data is divided into two sets as per the market direction. Out of the 828 total market days included in this study, the ISE registered gains on 467 days and lost ground on 361 days. The statistical attributes of distributions in the two sets are largely similar except for the direction of the market itself.

Table 3: Contemporaneous Relationship Between Volume and Return on the Istanbul Stock Exchange, 1/2003 – 4/2006.

Which days	Equation 4 $V = A + B(R)$					
	All market days		The days when the market went up		The days when the market went down	
Variable	A	B	A	B	A	B
Coefficient	3.66	4.902	-4.74	10.95	-8.499	-3.00
t-statistic	3.26	8.66	-1.98	8.98	-4.34	-3.08
Probability	0.0012	0.0000	0.0479	0.0000	0.0000	0.0022
Adjusted R-square	0.083		0.148		0.026	
Log Likelihood	-4047.7		-2312.8		-1681.3	
F-Statistic	74.96		80.72		9.50	

The findings with respect to the contemporaneous relation between volume and return are first estimated for the entire study period utilizing equation (4). The outcomes are summarized in Table 3. The tabulated results provide an overwhelming support for the notion that rising markets are accompanied by

rising volume and the declining markets are accompanied by the falling volume. This evidence on the ISE is in agreement with the evidence reported for many of the developed as well as developing markets.

Table 3 also displays the findings of the equation (4) estimations separately for the up market days and the down market days. As per the empirical propositions forwarded by Karpoff (1987), the correlation between volume and positive (negative) price changes is likely to be positive (negative). Indeed, the empirical results provide significantly robust evidence of an asymmetric relation between returns and volume depending on the market direction. Moreover, this finding on the Turkish equity market is in agreement with that reported for the Asian Equity Markets.

The finding of the contemporaneous relations between daily volume and the magnitudes of the daily rates of return are exhibited in Table 4. The strongly significant positive correlation between volume and the magnitudes of the daily returns provide a convincing support for the contention that trading volume bring about stock market movements on the ISE. In this respect, the evidence observed on the ISE is very much in line with the evidence uncovered for all nine developed markets by Chen, et. al (2001) and for numerous developing markets from the Latin America by Saatcioglu and Starks (1998) and from Asia by Kamath and Wang (2006).

Table 4: Contemporaneous Relationship between Volume and Absolute Return on the Istanbul Stock Exchange, 1/2003 – 4/2006.

Equation 5 $V = C + D (AR)$		
Variable	C	D
Coefficient	-6.05	7.27
t-statistic	-3.65	8.70
Probability	0.0003	0.0000
Adjusted R-square	0.084	
Log Likelihood	-4047.4	
F-Statistic	75.75	

Table 5: A Summary of Granger Causality Test Results, 1/2003-4/2006.

Null Hypothesis	Return Does Not Granger Cause Trading Volume	Trading Volume Does Not Granger Cause Return
F-Statistic	9.866	3.485
(Probability)	(0.0000)	(0.0040)

The findings for the ISE described so far indicate that in a contemporaneous setting, daily returns cause trading volume changes (Table 3) and daily trading volume changes cause stock prices to move (Table 4). Table 5 summarizes the empirical findings regarding the existence of and the direction of Granger causality between daily returns and trading volume changes on the ISE. Since, this study utilizes lags of up to 5 market days in testing for the Granger causality hypotheses, the right hand sides of equations (8) and (9) require estimating 11 coefficients. Instead of providing all 11 estimated coefficients and the associated t-values, only the resulting F-statistics are tabulated in the exhibit. The findings indicate an unmistakable support for rejecting both null hypotheses of Granger causality. Specifically, there is clear evidence of daily returns Granger causing daily trading volume changes and to a somewhat lesser extent, daily trading volume changes Granger causing daily returns on the Istanbul Stock Exchange of Turkey. The clear evidence of a bi-directional feedback between returns and volume on the ISE, that is, the evidence showing returns being impacted by volume changes and volume changes being impacted by

returns is unlike that reported for most developing markets as well as many of the developed markets. The Turkish evidence is comparable to that reported for the stock markets of Finland, Hong Kong, Switzerland and the Netherlands.

SUMMARY

This empirical study examined the relations between the price changes on the ISE100 index and the associated changes in trading volume on the Istanbul Stock Exchange of Turkey. The four-fold objective of the paper was met by utilizing the daily observations spanning the recent 40-month period ending in April, 2006. During the study period, the ISE100 index had registered gains in excess of 300 percent. The coefficient of variation of daily returns on the ISE was found to be 10.37. This measure of risk per unit of daily return on the nascent stock market of Turkey was smaller than that found for five Asian stock markets during the comparable period.

On the ISE, the findings were overwhelmingly supportive of the view that rising market index is accompanied by rising volume on the exchange and declining market index is accompanied by falling volume on the exchange. The findings were equally robust in pointing out that the return-volume relation in this emerging market is asymmetric with respect to the market direction itself. Moreover, the contemporaneous relation between the volume and the magnitudes of returns was found to be positive and strongly significant. Thus, this finding indicated that trading volume provide the energy to generate the market movements.

The results of the Granger causality test were also found to be robustly significant. The uncovered evidence exhibited a profound bi-directional feedback between returns and volume on the ISE. Thus, the returns were found to influence the trading volume and the trading volumes were found to influence the returns. While similar findings have been reported for the developed stock markets of Finland, Hong Kong, Switzerland and the Netherlands, such evidence has not been reported for developing markets. One unique aspect of the ISE is that the daily trading is conducted in two sessions, separated by a 2 hour break. Accordingly, one possible direction for future research is to investigate the extent to which the clearly defined multi-sessions of stock trading on each day affects the return-volume relations.

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