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THE ROLE OF INFORMATION IN STOCK MARKET

Abstract:

With relying on game theory, this paper investigates the role of information played in decisions of economic agents in Tehran Stock Exchange (TSE). The behavior of economic agents in a company in the Cement, Lime & Gypsum industry named Tehran Cement listed on the TSE has been investigated through GARCH class models for the period of July 1999 to June 2006. The results suggest that general information through GARCH (1, 1) model affects the company stock price, while private information through GARCH (2, 1) model affects the trading volume. Having explored general and private information, we studied the role of this information in determining stock price and trading volume, according to which the results demonstrate that general information has more influence than private information in determining stock price and trading volume. Therefore, we accept information cascades theory in TSE which means economic agents mostly rely on general information in their trading decisions.

Keywords:

herd behavior, social learning theory, information cascades, ARCH/ GARCH Models

JEL Classification: C58, D89, G10

1) Introduction

Financial markets and specifically stock markets are one of the markets in which the assumption of availability of full information for all participants is ignored so that the situation of uncertainty exists among market forces. Although many different theories have been developed for explaining behavior and decision making process of stock markets participants, the role of information has been ignored in those models[i]. From models in which they assigned more importance on the information role are the rational expectation models and as these models attempt to exploit model parameters from the model itself so that the discussions of rational learning have been outlined in market structure.

One of the approaches which has main role in equalizing of information to all individuals and ignores the speculative behaviors is rational social learning, which causes the improvement in individual behavior in subsequent steps of decision making process. On the basis of rational social learning and herd behavior theories, market participants consider two types of information in their decisions; the first is general information which is available to all individuals and the second is private information, personal signals, so that economic agents decision making is on the basis of their different information sources which means a trader either uses his or her available personal information or forget the own information and makes decision on the basis of general information which is a rational behavior and is called information cascades.

Theoretical foundations of herding behavior have been developed by Bikhchandani et al. (1992), Scharfstein an d Stein (1990), and Devenow and Welch (1996), and most of empirical studies have concentrated on studying the existence of herding behavior on market participants, mainly professional analysts and portfolio managers (Trueman, 1994; Graham, 1999; Welch, 2000; Hong et al., 2000; Gleason and Lee, 2003; Clement and Tse, 2005, Lakonishok et al., 1992; Wermers, 1999).

However, the role of rational social learning and herding behavior in equalizing information for all participants, first hypothesized by the Banerjee(1992), technically evolved by the Bikhchandani(1992), and Graham(1999) on the basis of these theories investigated the role of general and private information in investment analyses. Lawerence and Easly (1993) have investigated the relationship between rational expectation and rational learning in the form of decision making process and game theory. Timmerman (1996) in a study find that uncertainty event plus nonexistence of information about the factors effecting stock price causes the volatilities of stock market prices and eventually concludes that most of volatility in stock market prices arises from learning process. Kent et al (1998) believe that economic agents in financial option markets response to two types of information; the first type is personal signals and second type is general information of option market, also they believe that economic agents react to their personal signals more than general information. Esaly et al (1998) have studied the role of informed economic agents and conclude that information plays crucial role on financial markets. Banerjee (1992); Bikhandani (1992) and Ottaviani (1996) believe that rational learning affects tick volatility of stock prices in financial markets. These researchers applied the social learning theory to test their hypothesis and explained that learning took place in an environment which either the number of individuals that play a game must be high or a game is done for repeated periods.

According to the social learning theory, individuals in any markets in which uncertainty dominates in their decisions would rather general information to private information, this issue in game theory literature which is a rational behavior is known as information cascades.

In this paper we test empirically that how economic agents in TSE as a emerging market which essentially has high uncertainty and inefficiency in disseminating information to all participants, in their decisions use general information and private information (personal signals). Do they make decisions on the basis of general information or they give more importance to private information. In the other words, the main question is; is information cascades applicable in TSE?

The reminder of this paper is organized as follows; in subsequent sections, we will develop brief description of observations and some statistical properties, then modeling of information effects on stock market will be discussed and eventually we will conclude the paper with empirical results and a conclusion on it.

2) Observations and statistical properties

For testing existence of information cascades the cement industry in TSE was selected, now, there are 32 industries which are actively operating in TSE. One of these active industries is cement industry and we selected this industry because of its long time operation and the presence of its data in TSE in comparison with other industries. Weekly data from Tehran Cement, one of cement industry companies have been used in the period of July1999 to June 2006 account for 353 weeks. The reason that we applied weekly data is because in some days trading symbol was closed, then it causes the discontinuity in data series if we would use daily data. Statistical properties for SP which stands for stock price and EXQ which stands for trading volume of Tehran Cement have been shown in figure1 and table1.

The average price and volume in the study period were 18388 and 98738 IRR, respectively. With regard to the skewness and kurtosis statistics, the probability density function of stock price and trading volume have positive skewness and their kurtosis (leptokurtosis) are so higher than for normal distributions which is confirmed by the B-J statistic.

Figure 1) Stock price and trading volume of Tehran Cement

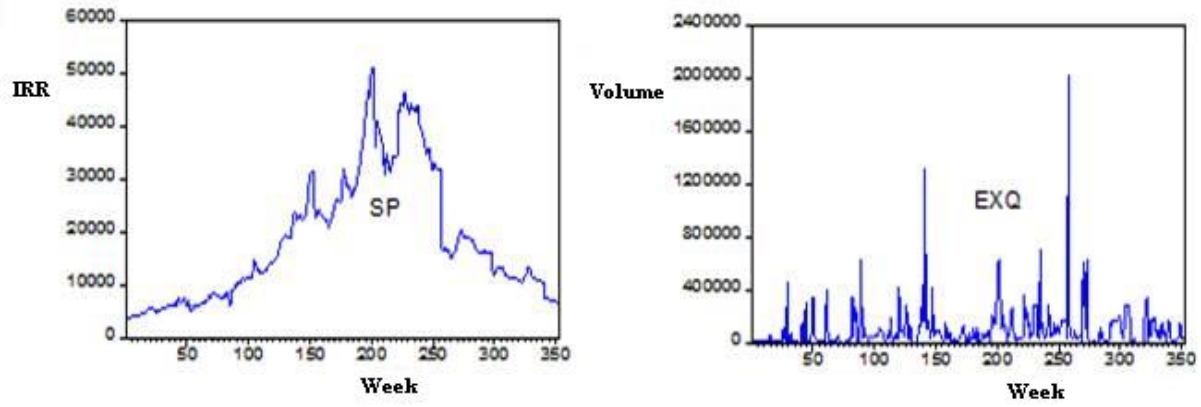


Table 1) Stock price and trading volume of Tehran Cement

	Mean	Maximum	Minimum	Standard deviation	Skewness	Kurtosis	Jarque-Bera
Stock price	18388.4	51005.0	3715.4	12063.9	0.8	2.7	43.2
Trading volume	98738.5	2015708.0	529.2	167118.6	6.2	59.5	49197.8

3) Modeling of information effects on stock market

In this section, we by considering a statistical sample, would model the information effects on the decision making process of economic agents. As discussed in the literature, economic agents use two types of information in their trading decisions. The transferring mechanism of information effects on behavior of economic agents is in a way that firstly information affects on stock price and trading volume and then economic agents by looking at these effects react to the those information. In fact, in stock market, stock prices and trading volume are under affection of these two types of information (i.e. general and private information) so that for separating this information we should formulate two equations for stock price and trading volume. Stock price equation is as follows:

1) $$SP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i EXQ_{t-i} + \varepsilon_{1t}$$

Where ε_{1t} is general information, because private information has already inverted into stock price trading through trading volume and this is because if a trader has personal signals then he or she will react through changing the trading strategy and similarly the equation of trading volume is as follows:

2) $$EXQ_t = \beta_0 + \sum_{j=1}^{q} \beta_i SP_{t-j} + \varepsilon_{2t}$$

Where ε_{1t} is private information, because general information has already inverted into equation of trading volume through the stock price.

By solving the above equations, we can express those equations as follows:

3) $$SP_t = \gamma_0 + \gamma_1 \varepsilon_{1t} + \gamma_2 \varepsilon_{2t} + \upsilon_{1t} \quad , \quad EXQ_t = \delta_0 + \delta_{1t} \varepsilon_{1t} + \delta_2 \varepsilon_{2t} + \upsilon_{2t}$$

In this case, both stock price and trading volume are functions of general and private information. We should pay attention that there is causality relationship between stock price and trading volume because executed trades by economic agents if have not been because of price variations then they will include private information and through this, affect on stock prices. The amount of price effects of this information is a direct function of the one who has this information and also the precision related to it.

These information effects on price also would affect the trading volume so that lead to changes in economic agents behavior. Thus, if price changes are not because of changing in economic agents' behavior, they will carry general information. For testing such an event we will use Granger causality test.

3-1) Empirical results

3-1-1) Causality relationship between stock price and trading volume

We used Causality test for testing the causality relationship between stock prices and trading volume of Tehran Cement. In this test following regression model estimated:

4) $$SP_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i SP_{t-1} + \sum_{j=1}^{q} \beta_j EXQ_{t-j} + \upsilon_{1t} \ , \ EXQ_t = \gamma_0 + \sum_{i=1}^{k} \gamma_i SP_{t-1} + \sum_{j=1}^{m} \varphi_j EXQ_{t-j} + \upsilon_{2t}$$

If in first equation $\sum_{j=1}^{q} \beta_j \neq 0$ and in second one $\sum_{i=1}^{k} \gamma_i = 0$, then causality would be from EXQ to SP, and if in second equation $\sum_{i=1}^{k} \gamma_i \neq 0$ `and in first one $\sum_{j=1}^{q} \beta_j = 0$ then causality would be from SP to EXQ, and eventually if both $\sum_{j=1}^{q} \beta_j \neq 0$ and $\sum_{i=1}^{k} \gamma_i = 0$, we have two way causality between SP and EXQ. The results of this test have been shown till 8 lags in table 2[ii].

According to F- Statistic these null hypotheses; "EXQ does not cause SP variations" and "SP does not cause EXQ variations" failed to be rejected, and rejected, respectively, at the 0.05 level of significance, which mean the reasons that lead to prices variations have also effected trading volume, but the information which exist in trading volume, private information, have not effected stock prices in TSE. In this case, we suggest that stock

economic agents for Tehran Cement in TSE consider price variations which include general information.

Table2) Granger causality test for stock price and trading volume of Tehran Cement

Lag	H_0	F statistic» $P-value$«	Result	H_0	F statistic» $P-value$«	Result
2	EXQ Does not cause SP variations	0.19081	failed to reject	SP Does Not cause EXQ variations	0.0000000051	rejected
3		0.25544	failed to reject		0.000000037	rejected
4		0.39589	failed to reject		0.000000026	rejected
5		0.54371	failed to reject		0.000000089	rejected
6		.053796	failed to reject		0.00000017	rejected
7		0.57163	failed to reject		0.00000043	rejected
8		0.65270	failed to reject		0.00000069	rejected

3-1-2) Time series generating process of SP and EXQ

We should identify the data generating process of SP and EXQ for exploiting the general and private information. On the basis of autocorrelation functions, i.e. AC, PAC and also Q- stat criterion, the dominating process of SP and EXQ series are recognized as AR and as the number of observations are 353 weeks, then for determining AR lags, one fourth of observations are considered as lags so that we formulate these processes as follows:

5)
$$SP_t = \alpha_0 + \alpha_1 SP_{t-1} + \eta_{1t}$$
$$EXQ_t = \beta_0 + \beta_1 EXQ_{t-1} + \beta_2 EXQ_{t-2} + \beta_3 EXQ_{t-12} + \beta_4 EXQ_{t-23} + \eta_{2t}$$

The results of estimated parameters for above regression models are:

$$SP_t = 196.8 + 0.98 * SP_{t-1}$$

5-1) std : (160.4) (0.0072)

$$\bar{R}^2 = 0.98 \quad D-W = 2.01 \quad F = 18442$$

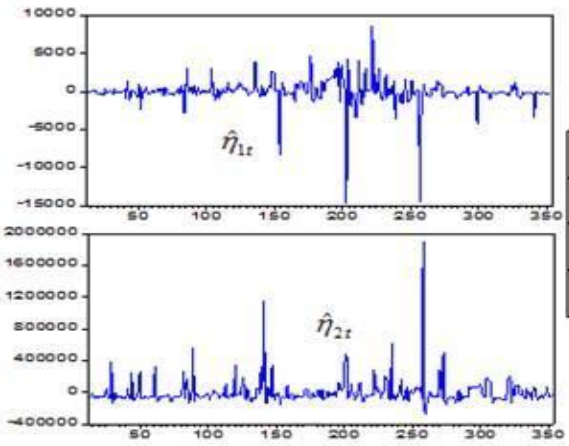
$$EXQ_t = 55755.9 + 0.1338EXQ_{t-1} + 0.1185EXQ_{t-2} + 0.108EXQ_{t-12} + 0.109EXQ_{t-23}$$

5-2) std : (14500.6) (0.0554) (0.0554) (0.0551) (0.0555)

$$\bar{R}^2 = 0.48 \quad D-W = 1.99 \quad F = 5.04$$

Regression residuals for SP and EXQ are shown as $\hat{\eta}_{1t}$ and $\hat{\eta}_{2t}$ which denote the unpredictable component of stock price and trading volume, respectively. In fact, these unpredictable components are general information $\hat{\eta}_{1t}$ and private information $\hat{\eta}_{2t}$. The empirical results for unpredictable components of stock price and trading volume show the clustering event which implies the existence of ARCH process. Ljung- Box statistic for squared of residuals and ARCH test statistic imply on the significance of ARCH effects. These statistics and charts are shown in the following figure:

Figure2) unpredictable components of stock price and trading volume (general and private information)



$\hat{\eta}_{2t}$, $\hat{\eta}_{1t}$ **Statistics**

	$Q(1)$	$Q^2(1)$	$ARCH(1)$
$\hat{\eta}_{1t}$	0.005 (0.944)	70.85(0.0000)	74.28(0.0000)
	$Q(1)$	$Q^2(2)$	$ARCH(2)$
$\hat{\eta}_{2t}$	0.004 (0.97)	38.4 (0.0000)	17.24 (0.0000)

3-1-3) the dominant process on general and private information

As we observed the conditional hetroscedasticity in residuals, we applied GARCH modeling for stock price and trading volume regressions:

6) $$\left\{Y_t = X'\beta + \varepsilon_t\right\}, \left\{h_t = \omega + \sum_{i=1}^{q}\alpha_i\varepsilon_{t-i}^2 + \sum_{j=1}^{p}\gamma_j h_{t-j}\right\}, \left\{\varepsilon_t = \nu_t\sqrt{h_t} \quad , \quad \mathrm{var}(\varepsilon_t) = h_t\right\}$$

On the basis of Akaike Information Criterion (AIC), the GARCH (1, 1) was the best model for exploiting general information from stock prices:

$$7)\quad \left\{\begin{array}{l} SP_t = 109.13 + 0.971 * SP_{t-1} \\ std: \quad (8.17) \qquad (0.0005) \end{array}\right\}, \left\{\begin{array}{l} h_t = 3047.8 + 7.68 * \hat{\eta}^2_{1t-1} + 0.048 * h_{t-1} \\ std: (5285.3) \quad (0.4017) \qquad (0.009) \end{array}\right\}$$
$$\left\{\bar{R}^2 = 0.97 \quad D-W = 1.89 \quad F-stat = 4219.8\right\}$$

The estimated model is composed of two equations, in which the first one is mean equation and the second one is related to variance or volatility equation which explains the dominant process over general information. Thus, the general information effect in the form of GARCH (1, 1) is reflected in stock prices.

Again, on the basis of Akaike Information Criterion (AIC), the GARCH (2, 1) was the best model for exploiting the private information process. The estimation result from this model is as follows:

$$EXQ_t = 5373.4 + 0.24 * EXQ_{t-1} + 0.11 * EXQ_{t-2} + 0.104 * EXQ_{t-12} + 0.43SP_{t-1} + 0.46SP_{t-2}$$
$$std: \quad (21475.9) \quad (0.074) \qquad (0.059) \qquad (0.021) \qquad (3.14) \qquad (2.98)$$

$$8)\quad h_t = 1.6 + 0.47 * \hat{\eta}^2_{2,t-1} + 0.41 * \hat{\eta}^2_{2,t-2} - 0.102 * h_{t-1}$$
$$std: (2.3) \quad (0.137) \qquad (0.061) \qquad (0.039)$$
$$\bar{R}^2 = 0.62 \qquad D-W = 2.1 \qquad F-stat = 3.49$$

Because of Granger causality test we inverted the stock price variable in mean equation which confirms that the causality is through stock price to trading volume. In fact, variables with the lags of EXQ, SP show the predictable component of trading volume and unpredictable component of private information is $\hat{\eta}_{2,t}$ which in the form of GARCH(2, 1) model influences on trading volume.

In the two above estimated regression models, residuals follow random walk which the results of Ljung- Box statistic for squared residuals and ARCH test statistic in table 3 confirm that residuals in above regressions follow random walk process.

Table3) results of residuals test

	$ARCH(1)$		for squared residuals $Ljung-Box$	
$\hat{\eta}_{1,t}$	**1.11**	**[0.292]**	**1.12**	**[0.290]**
$\hat{\eta}_{2,t}$	**0.102**	**[0.749]**	**0.1058**	**[0.745]**

3-1-4) Stock prices and trading volume reaction to general and private information

Up to here, we have exploited the general and private information, in this section; we have studied the effects of general and private information on the stock price and trading volume of Tehran Cement. The results from estimated regression models in equation3 are as follows:

$$SP_t = 19209.1 + 0.51 * public\inf - 0.0003 * private\inf + 1.48 * AR(1) - 0.49 * AR(2)$$

$$std: \quad (7232.2) \qquad (0.019) \qquad (0.0038) \qquad (0.0001) \qquad (0.051)$$

$$\bar{R}^2 = 0.99 \qquad D-W = 1.69 \qquad F-stat = 11756.1$$

9)

$$EXQ_t = 94733.6 + 24.2 * public\inf + 0.82 * private\inf + 0.78 * AR(1) - 0.20 * AR(2)$$

$$std: \quad (10289.8) \qquad (2.04) \qquad (0.0203) \qquad (0.055) \qquad (0.054)$$

$$\bar{R}^2 = 0.78 \qquad D-W = 1.93 \qquad F-stat = 302.2$$

Where, $public\inf$ and $private\inf$ are as same as $\hat{\eta}_1$ and $\hat{\eta}_2$, residuals of regressions.

Above results show that in both equations the role of general information is much more than that of private information in determining stock price and trading volume. In the other words economic agents in their own decision prefer general information to private information in TSE and this is in consistent with theoretical foundation founded in information cascades theory.

4) Conclusion

In this paper, we applied one of interaction based models named information cascades in the framework of social learning theory which is a part of game theory, to determine the information effects on the economic agents 'decisions on Tehran Cement in TSE. We used the GARCH class models as we observed conditional hetroscedasticity in stock price and trading volume series. Results suggest that general information through GARCH (1, 1) model and private information through GARCH (2, 1) influences on trading volume. In studying the general and private information effects on stock price and trading volume, we observed that general information plays an essential role in determining stock price and trading volume, so that we can say in an investment environment in which economic agents that have not equal availability to information, will rely on the general information which confirms the existence of information cascades in TSE.

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[i] We mean theories which determine price and returns (i.e. portfolio theory of Markowitz (1952) and capital asset pricing theory of Sharp (1964).

[ii] We should note that this test was run for 48 lags and the results were same.