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# The Informational Role of Volume by Investor Groups*

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This paper studies the informational role of trading volume by investor groups in the Korean stock market from January 2004 to December 2006. Using 16 active common stocks, this paper shows that while the conventional GARCH (1, 1) model fits the Korean stock market well, the volume variables (daily trading volume, the absolute value of net buy volume, excess buy volume, and excess sell volume) have additional explanatory values when they are included in the variance equation of the GARCH (1, 1) model. The paper further tests whether the effects of excess sell volume and excess buy volume on volatility are asymmetric. In addition, it shows that the effects of volume on volatility differ among investor groups. Because of information disadvantages, daily return volatility is highly correlated with the volume of domestic individual investors and non-listed foreign investors. Finally, the paper extends the analysis using an expanded data set that includes 477 common stocks.

Keywords: trading volume, information, excess buy volume, excess sell volume, information asymmetry, investor group

## I. Introduction

Using daily volume data of the 20 most actively traded common stocks as a proxy for information flow, Lamoureux and Lastrapes (1990) find that volume is an

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important explanatory variable in the conditional return variance equation in the GARCH model of Bollerslev (1986). Using 16 actively traded stocks for which options are listed on the Korean market, this paper tests the GARCH effect when various volume variables are included in the variance equation of the GARCH model. Further it explores the effect of volume variables by ten investor groups. Then the analysis is extended into an expanded data set that includes 477 common stocks.

The paper builds on previous studies in three ways. First, it tests the daily volume effect on volatility. It also tests the effects of three other volume variables: the absolute value of net buy volume, excess buy volume, and excess sell volume. These additional tests are meaningful as trading volume cannot sufficiently explain the entire trading processes. In fact, due to private information and inventory problems, order imbalance may play a more important role in explaining asset returns [see Chan, Chung, and Fong (1999), and Chordia, Roll, and Subrahmanyam (2003)]. The test results show that the positive relation between volatility and volume is asymmetric; return volatility is influenced more by positive unexpected volume shocks [see Bessembinder and Seguin (1993)].

Second, this paper further explores how these aforementioned effects may vary among different investor groups. While price changes reflect the market evaluation of the information signal, investors might disagree with the market interpretation of new information (Karpoff, 1987). The extent of disagreement can be captured in their volume. After collecting information and analyzing fundamental value of the stocks, investors in different groups buy or excess sell a certain quantity of asset by their own valuation. Excess buy volume or excess sell volume by uninformed investors increase price volatility. Related studies in the futures markets include a study by Daigler and Wiley (1999). Having divided investors into ten groups (seven institutional, one individual, and two foreign investors), this paper also tests whether domestic investors have an information advantage over foreign investors. In an emerging market, who is more informed in trading domestic stocks remains a controversial research topic. By studying the volatility-volume relation among different groups of investors, we attempt

to provide additional evidences between institutional versus individual investors and domestic versus foreign investors [see Bakaert and Harvey (1997 and 2000)].

Finally, we extend the previous analysis into all of the 477 common stocks and test whether these various volume effects on the active stocks would generally hold.

This paper is organized as follows: Section II reviews the theoretical backgrounds for the subsequent empirical analysis. Section III describes data and defines the main variables used in this study. Section IV discusses empirical methodologies. Section V reports empirical findings and interprets the results. Concluding remarks are provided in Section VI.

## II. Literature Review

It is widely accepted that the daily stock return series exhibit conditional heteroskedasticity. The autoregressive conditional heteroskedasticity (ARCH) model by Engel (1982) and its extension GARCH by Bollerslev (1986), which assume that daily stock return volatility shocks persist over time, have been very successful in explaining daily stock returns. The presence of ARCH is explained by the hypothesis that daily returns are generated by a mixture of distributions. Using daily volume as a proxy for information arrival, the mixture of distribution hypothesis proposed by Clark (1973), Epps and Epps (1976), Tauchen and Pitts (1983) assumes a joint distribution of daily stock returns and volumes. Karpoff (1987) also provides a good overview on the positive correlations between volume and price changes. Lamoureux and Lastrapes (1990) insert volume into the ARCH variance equation and find that volume has a significant positive effect in explaining daily stock return variance while past return shocks become insignificant. This finding supports that daily total volume affects return volatility.

However, daily total volume alone cannot explain all of the trading processes. The effects of other volume variables and the asymmetry of those effects are further

analyzed by many other studies. Using daily data from May 1982 to March 1990, Bessembinder and Seguin (1993) examine the relations among volatility, volume and market depth in eight physical and financial futures markets. They divide the volume into expected and unexpected components, and find that the unexpected volume shock has a larger effect on volatility. They also find an asymmetry between positive and negative unexpected shocks. They explain the asymmetric effects as follows: the positive volume shock is associated with capital surplus while the negative volume shock is associated with capital shortage. Since a capital shortage has more deleterious effects on market depth[1] than a surplus, the market depth during positive volume shocks will be smaller than that during negative volume shocks. Smaller market depth results in increasing market volatility. Chordia, Roll and Subrahmanyam (2003) examine the relations among order imbalance, liquidity, and stock market return. They find that the imbalance has a significant impact on the market return. In addition, the effect is asymmetric. Excess sell orders have a larger effect on the market return than that of the excess buy orders. They explain this as a result of private information and an inventory paradigm, suggesting that order imbalance causes price pressure.

Using a two-period noisy rational expectations model of a futures market, Shalen (1993) proves that the dispersion of expectations associated with the liquidity demand of futures hedgers causes excess volatility and excess volume compared to equilibrium levels. Daigler and Wiley (1999) attempt an indirect test of Shalen's (1993) model. According to the degree of being informed, they classify traders into market makers, clearing members, floor traders, and the general public. They find that the positive effect of volume on volatility is driven by less informed liquidity traders like the general public. Clearing members and floor traders who are informed about precise order flows often drive low volatility.

The impact of investors in different groups have been studied by many researchers using the Korean market data. Cho and Lee (2001) use the daily price and volume

1) Kyle (1985) defines market depth as the order flow required to move prices by one unit.

data in the futures market from January 1995 to July 2000, and find that the volatility-volume relation is significantly positive for institutional and foreign investors who rely on both public and private information. Based on the daily data from 1997 to 2001 in the KOSPI 200 futures markets, Yoon and Lee (2003) find that changes of volume by foreign investors play an important role in explaining the return and volatility of KOSPI 200 stock index futures. The unexpected volume of foreign investors has more persistent effects on the increasing trend of volatility of futures markets. These studies that have significant implications of the maturity for volume and price changes focus mainly on futures and options markets. Contrasted with futures and options markets, the stock market is characterized as having short-sale restrictions and dividend payments. So it is meaningful to study the trading activity of different investors in the stock market. This paper examines this issue in the context of the effects of various volume variable on the market volatility.

Following increased demand for market liberalization, since 1990s such issues as the influence of foreign investors in the domestic market or an information advantage of domestic investors over foreign investors have been major concerns among financial economists. Bekaert and Harvey (1997) find that capital market liberalizations often increase the correlation between local market returns and world market returns, but significantly decrease the volatility in the 20 emerging markets for the period from January 1976 to December 1992. Bekart and Harvey (2000) find that annualized volatility slightly decreases following market liberalizations for the period January 1976 to December 1995. In addition to these studies that focus mainly on the U.S. markets, there are numerous empirical studies on the Korean market to examine the relation between domestic and foreign investors. For example, Choe, Kho and Stulz (2005) find that foreign investors pay more when they buy and receive less when they sell when trading domestic stocks. They also find that domestic individual investors had an edge over foreign investors because prices move more against foreign investors from December 1996 through November 1998. In the KOSPI 200 Index futures market from May 1996 to December 1999, Kho and Kim (2005) find that foreign

non-brokerage firms trade at a disadvantageous price compared to domestic investors while foreign brokerage firms sometimes trade at an advantageous price relative to domestic investors. When comparing their holding period returns, they find that foreign investors and domestic brokerage firms perform better than investors in other groups. Park, Bae, and Cho (2005) find that individual investors outperform foreign investors or institutional investors in terms of implicit transaction cost, stock selection and market timing for the period from January 1995 to December 2002. As contrasted with these studies, this paper uses volume as an information measure to provide an additional evidence on whether domestic investors have an information advantage.

# III. Data and Main Variables

## 1. Data

This study covers the period from January 2004 to December 2006. The daily return and total volume data used in this study are from the Korean Securities Research Institute (KSRI, henceforth). Daily transaction data (number of stocks) are obtained from the Korea Exchange. This data set includes the number of shares bought and sold and market capitalizations by ten investor groups. The ten groups are securities companies, insurance companies, investment trust companies, commercial banks, merchant banks and savings banks, pension funds and corporations, other corporations, retail investors (domestic individual investors, henceforth), the foreign investors who have their own ID (listed foreign investors, henceforth) and other foreign investors (non-listed foreign investors, henceforth).

Using this initial data set, I select the sample for this study under the following criteria: Among the 856 stocks listed on the Korea Exchange, I select 635 stocks listed on the Korea Stock Exchange. Considering the trading activities and accounting rules, I exclude non-manufacturing companies. Stocks with monthly trading days less

than 15 are excluded. I also exclude stocks with splits during the sample period. After making these adjustments, 477 stocks remain.

According to their ability to access or analyze data, this paper classifies local institutional investors and domestic non-individual investors (from group 1 to group 7) as the informed group and classifies domestic individual investors (group 8) and non-listed foreign investors (group 10) as the less informed group. Considering information disadvantages, I also place the foreign institutions (group 9) into the less informed group. Appendix I lists the ten investor groups.

## 2. Main Variables

Chordia, Roll, and Subrahmanyam (2002) suggest that an extreme order imbalance often signals private information, which should reduce liquidity and increase price volatility. An extreme order imbalance also causes market makers to revise bid ask spread and price quotes. So, order imbalances should play a more important role in explaining market liquidity and price volatility than total volume. In order to take these into account, we use a new variable, the absolute value of net buy volume in this paper. While volatility is influenced by both sell and buy volumes, the absolute value of net buy volume may have more information contents. The main variables used in this study are as follows:

(1) Net buy volume ($NBVOL_{t,n,s}$, henceforth) is defined as the buyer-initiated shares purchased less the seller-initiated shares sold of stock $n$ by group $s$ on day $t$. $t$=1.....$T$, $n$=1.....$N$, and $s$=1.....10.

(2) $|\ NBVOL_{t,n,s}\ |$ is the absolute value of net buy volume for stock $n$ by group $s$ on day $t$.

(3) Max[0, $NBVOL_{t,n,s}$] is excess buy volume of stock $n$ purchased by group $s$ on day $t$.

(4) -Min[0, $NBVOL_{t,n,s}$] is excess sell volume of stock $n$ purchased by group $s$ on day t.

# IV. Methodology

Among the 477 common stocks, I select 16 actively traded stocks for which options are also traded on the Korea Stock Exchange to ensure a sufficient number of volume observations to satisfy the conditions for the Central Limit Theorem.[2] Using these 16 stocks, I test the GARCH model by investor groups. First, I test whether the traditional daily GARCH (1, 1) model holds. Second, I examine whether the daily volume has additional explanatory power when the various volume variables are included in the GARCH model. These variables are daily trading volume, the absolute value of net buy volume, excess buy volume and excess sell volume. Third, I sort the transaction data into ten investor groups, and test further the various volume effects by ten investor groups. Finally, I extend this analysis into all of the 477 common stocks. When estimating the coefficients in the GARCH model, stocks that do not converge are excluded.

# V. Empirical Results

## 1. Basic Statistics

Table 1 documents the daily average percentage volumes and the cross correlations for the 16 active stocks and the 477 common stocks from January 2004 to December 2006 by investor groups. Panel A of Table I reports the average percentage volumes. For the three volume variables, group 8 (domestic individual investors), group 9 (foreign investors) and group 3 (investment trust companies) account for a majority of trading volumes. The absolute values of the net buy volume for the 16 active stocks

2) Generally, only active stocks have options listed on an exchange (Lamoureux and Lastrapes, 1990).

**Table 1.** Basic statistics and correlations

This table reports the daily average percentage volumes and the cross correlations for the 16 active stocks and the 477 common stocks from January 2004 to December 2006 by investor groups. Panel A and B report the average percentage volumes and the cross correlation, respectively, by ten investor groups.

Group 1: Securities companies, Group 2: Insurance companies, Group 3: Investment trust companies, Group 4: Commercial banks, Group 5: Merchant banks and savings banks, Group 6: Pension funds and cooperatives, Group 7: Other corporations, Group 8: Retail investors, Group 9: Listed foreign investors, Group 10: Non-listed foreign investors.

**Panel A [1] Average percentage volumes of 16 active stocks by investor groups**

| | \| NBVol \| | Max[0,NBVol] | -Min[0,NBVol] |
|---|---|---|---|
| Group1 | 5.34% | 5.54% | 5.14% |
| Group2 | 2.65% | 2.89% | 2.41% |
| Group3 | 16.58% | 17.82% | 15.33% |
| Group4 | 3.73% | 3.85% | 3.60% |
| Group5 | 1.19% | 1.14% | 1.23% |
| Group6 | 6.00% | 6.29% | 5.70% |
| Group7 | 8.49% | 8.83% | 8.14% |
| Group8 | 26.94% | 26.55% | 27.34% |
| Group9 | 28.83% | 26.87% | 30.80% |
| Group10 | 0.26% | 0.21% | 0.30% |

**Panel A [2] Average percentage volumes of 477 common stocks by investor groups**

| | \| NBVol \| | Max[0,NBVol] | - Min[0,NBVol] |
|---|---|---|---|
| Group1 | 3.96% | 3.87% | 4.06% |
| Group2 | 2.58% | 2.77% | 2.40% |
| Group3 | 14.24% | 15.40% | 13.09% |
| Group4 | 3.70% | 3.28% | 4.13% |
| Group5 | 1.62% | 1.54% | 1.69% |
| Group6 | 5.70% | 6.04% | 5.36% |
| Group7 | 10.66% | 10.22% | 11.10% |
| Group8 | 33.47% | 33.62% | 33.33% |
| Group9 | 23.34% | 22.56% | 24.12% |
| Group10 | 0.71% | 0.71% | 0.72% |

**Table 1.** (continued)

**Panel B [1] Correlations of 16 active stocks by investor groups**

| | Group1 | Group2 | Group3 | Group4 | Group5 | Group6 | Group7 | Group8 | Group9 |
|---|---|---|---|---|---|---|---|---|---|
| Group2 | 0.180 | 1.000 | | | | | | | |
| Group3 | 0.287 | 0.269 | 1.000 | | | | | | |
| Group4 | 0.206 | 0.159 | 0.199 | 1.000 | | | | | |
| Group5 | 0.152 | 0.143 | 0.184 | 0.152 | 1.000 | | | | |
| Group6 | 0.231 | 0.293 | 0.381 | 0.192 | 0.175 | 1.000 | | | |
| Group7 | 0.070 | 0.102 | 0.238 | 0.127 | 0.153 | 0.160 | 1.000 | | |
| Group8 | 0.183 | 0.199 | 0.300 | 0.220 | 0.155 | 0.234 | 0.500 | 1.000 | |
| Group9 | 0.244 | 0.244 | 0.402 | 0.228 | 0.234 | 0.310 | 0.317 | 0.547 | 1.000 |
| Group10 | 0.017 | 0.022 | 0.031 | 0.049 | 0.031 | 0.020 | 0.032 | 0.040 | 0.046 |

**Panel B [2] Correlations of 477 common stocks by investor groups**

| | Group1 | Group2 | Group3 | Group4 | Group5 | Group6 | Group7 | Group8 | Group9 |
|---|---|---|---|---|---|---|---|---|---|
| Group2 | 0.157 | 1.000 | | | | | | | |
| Group3 | 0.259 | 0.426 | 1.000 | | | | | | |
| Group4 | 0.059 | 0.381 | 0.651 | 1.000 | | | | | |
| Group5 | 0.044 | 0.043 | 0.061 | 0.034 | 1.000 | | | | |
| Group6 | 0.185 | 0.506 | 0.666 | 0.734 | 0.055 | 1.000 | | | |
| Group7 | 0.097 | 0.164 | 0.210 | 0.125 | 0.043 | 0.176 | 1.000 | | |
| Group8 | 0.284 | 0.264 | 0.409 | 0.175 | 0.262 | 0.338 | 0.447 | 1.000 | |
| Group9 | 0.252 | 0.171 | 0.294 | 0.078 | 0.056 | 0.208 | 0.495 | 0.510 | 1.000 |
| Group10 | 0.040 | 0.026 | 0.060 | 0.015 | 0.016 | 0.043 | 0.043 | 0.124 | 0.066 |

are 26.94%, 28.83% and 16.58% for group 8 (domestic individual investors), group 9 (listed foreign investors) and group 3 (Investment trust companies), respectively. The absolute value of the net buy volumes of the other seven groups are below 10%. This pattern is similar when using all of the 477 common stocks. Panel B of Table 1 reports the correlations among the ten investor groups. The correlation of group 10 (non-listed foreign investors) with the other nine groups is lowest for the 16 active stocks. When analyzing the 477 common stocks, both group 10 (non-listed foreign

investors) and group 5 (short-term finance and savings) exhibit lower correlations with the other eight groups.

## 2. Test Results with 16 Active Stocks

Tables 2 to 4 show the test results using the 16 active stocks. Table 2 reports the estimates of the traditional GARCH (1, 1) from January 2004 to December 2006 for each of the 16 stocks. It shows strong evidence that the GARCH model holds for these 16 active stocks.

Table 3 reports the estimates of the GARCH (1, 1) with volumes from January 2004 to December 2006 for each of the 16 stocks. The results show that nearly all of the volume coefficients are positive and statistically significant, but that the ARCH effect measured by $\alpha_1$ disappears, and the persistence of volatility measured by $\alpha_1 + \alpha_2$ decreased significantly. This means that the daily volume, as an information variable, can explain much of the daily return volatility.

Panel A-Panel C of Table 4 reports the estimates of the GARCH (1, 1) with the three imbalance variables. Through Panel A-Panel C, all of the coefficients of the three imbalance variables in group 8 are much smaller than those of the other groups. Given the lowest ($\alpha_1 + \alpha_2$) at 0.1733, absolute value of the net buy volume in Panel A is the best to capture the persistence of daily return volatility among the three imbalance variables.

The coefficients of excess sell volume in Panel C are much lower than those of the other two variables for eight of the ten groups. Among the ten investor groups in Panel C, the coefficients of excess sell volume generated by group 5 (short-term finances and savings) and group 6 (pension funds) which are regarded as informed traders, are -3.8928 and -0.1830, respectively. This negative relation implies that their excess sell volume is highly associated with private information.[3)]

3) In this study, we provide the Mann-Whitney-Wilcoxon test only for Panel B and Panel C in Table IV.

**Table 2.** Estimates of the traditional GARCH (1, 1) using the 16 active stocks

This table reports the estimates of the traditional GARCH (1, 1) from January 2004 to December 2006 for each of the 16 stocks. Traditional GARCH (1, 1):

$$R_t = \gamma_0 + u_t;\ u_t \mid (u_{t-1}, u_{t-2} \ldots) \sim N(0, \sigma_t^2);\ \sigma_t^2 = \alpha_0 + \alpha_1 \cdot u_{t-1}^2 + \alpha_2 \cdot \sigma_{t-1}^2$$

where $R_t$ is the rate of return. $\alpha_0 > 0$, $\alpha_1 > 0$ and $\alpha_2 > 0$. $\alpha_1 + \alpha_2$ represents the persistence of volatility. $\gamma_0$ is the mean of $R_t$ conditional on past information. $u_t$ has zero mean. t-statistics are shown in parenthesis below the coefficients estimates. * denotes significance at the 10% level. ** denotes significance at the 5% level. *** denotes significance at the 1% level.

| | Code | $\alpha_0$ | | $\alpha_1$ | | $\alpha_2$ | | $\alpha_1 + \alpha_2$ |
|---|---|---|---|---|---|---|---|---|
| 1 | 000240 | 0.0001 | | 0.1416 | | 0.6733 | | 0.8149 |
| | | (2.69) | *** | (3.61) | *** | (7.30) | *** | |
| 2 | 000270 | 0.0000 | | 0.0689 | | 0.9016 | | 0.9705 |
| | | (2.10) | ** | (3.71) | *** | (37.44) | *** | |
| 3 | 000700 | 0.0000 | | 0.0709 | | 0.8938 | | 0.9647 |
| | | (1.69) | * | (2.91) | *** | (22.17) | *** | |
| 4 | 000830 | 0.0000 | | 0.0349 | | 0.9554 | | 0.9903 |
| | | (1.34) | | (3.00) | *** | (62.01) | *** | |
| 5 | 001040 | 0.0000 | | 0.0570 | | 0.9229 | | 0.9798 |
| | | (2.04) | ** | (3.70) | *** | (45.68) | *** | |
| 6 | 001740 | 0.0001 | | 0.1279 | | 0.8460 | | 0.9739 |
| | | (2.44) | ** | (4.28) | *** | (22.96) | *** | |
| 7 | 003490 | 0.0000 | | 0.0511 | | 0.9075 | | 0.9585 |
| | | (1.31) | | (2.95) | *** | (20.83) | *** | |
| 8 | 003550 | 0.0000 | | 0.0844 | | 0.9128 | | 0.9972 |
| | | (1.87) | * | (4.39) | *** | (52.44) | *** | |
| 9 | 004020 | 0.0000 | | 0.1035 | | 0.8872 | | 0.9906 |
| | | (1.39) | | (4.07) | *** | (31.54) | *** | |
| 10 | 005380 | 0.0000 | | 0.0597 | | 0.9192 | | 0.9789 |
| | | (1.59) | | (3.24) | *** | (35.54) | *** | |
| 11 | 005490 | 0.0000 | | 0.0950 | | 0.8874 | | 0.9823 |
| | | (2.11) | ** | (4.68) | *** | (42.57) | *** | |
| 12 | 005930 | 0.0000 | | 0.0259 | | 0.9671 | | 0.9930 |
| | | (1.20) | | (3.71) | *** | (108.48) | *** | |
| 13 | 006400 | 0.0000 | | 0.0797 | | 0.9118 | | 0.9915 |
| | | (2.15) | ** | (4.37) | *** | (50.86) | *** | |
| 14 | 009150 | 0.0000 | | 0.0579 | | 0.8642 | | 0.9221 |
| | | (2.04) | ** | (2.81) | *** | (17.65) | *** | |
| 15 | 012330 | 0.0000 | | 0.0629 | | 0.8574 | | 0.9203 |
| | | (1.81) | * | (2.60) | *** | (13.95) | *** | |
| 16 | 015760 | 0.0000 | | 0.0920 | | 0.8991 | | 0.9911 |
| | | (1.58) | | (3.38) | *** | (31.81) | *** | |

**Table 3.** Estimates of GARCH (1, 1) with volume using the 16 active stocks

This table reports the estimates of the GARCH (1, 1) with volume from January 2004 to December 2006 for each of the 16 stocks. GARCH (1, 1) with Volume:

$$R_t = \gamma_0 + u_t;\ \ u_t \mid (V_t, u_{t-1}, u_{t-2} \ldots) \sim N(0, \sigma_t^2);\ \ \sigma_t^2 = \alpha_0 + \alpha_1 \cdot u_{t-1}^2 + \alpha_2 \cdot \sigma_{t-1}^2 + \alpha_3 \cdot V_t$$

where $R_t$ is the rate of return and $V_t$ is the daily volume and weakly exogenous in the sense of Engle, Hendry and Richard (1983). $\alpha_0 > 0$, $\alpha_1 > 0$ and $\alpha_2 > 0$. $\alpha_1 + \alpha_2$ represents the persistence of volatility. $\gamma_0$ is the mean of $R_t$ conditional on past information. $u_t$ has zero mean. t-statistics are shown in parenthesis below the coefficients estimates. * denotes significance at the 10% level. ** denotes significance at the 5% level. *** denotes significance at the 1% level.

| | Code | $\alpha_0$ | $\alpha_1$ | | $\alpha_2$ | | $\alpha_3$ | | $\alpha_1 + \alpha_2$ |
|---|---|---|---|---|---|---|---|---|---|
| 1 | 000240 | 0.0000 | 0.1191 | | 0.0000 | | 1.0832 | | 0.1191 |
| | | (0.06) | (2.88) | *** | | | (8.27) | *** | |
| 2 | 000270 | 0.0000 | 0.0849 | | 0.8161 | | 0.0243 | | 0.9010 |
| 3 | 000700 | 0.0000 | 0.0695 | | 0.0000 | | 0.6358 | | 0.0695 |
| | | | (1.89) | * | | | (15.31) | *** | |
| 4 | 000830 | 0.0000 | 0.0000 | | 0.0000 | | 0.3065 | | 0.0000 |
| | | | | | | | (19.33) | *** | |
| 5 | 001040 | 0.0000 | 0.0000 | | 0.0000 | | 3.5485 | | 0.0000 |
| | | (0.59) | | | | | (9.13) | *** | |
| 6 | 001740 | 0.0000 | 0.1860 | | 0.0000 | | 11.8997 | | 0.1860 |
| | | (1.17) | (4.41) | *** | | | (10.67) | *** | |
| 7 | 003490 | 0.0000 | 0.0445 | | 0.0000 | | 0.8815 | | 0.0445 |
| | | | (1.40) | | | | (15.99) | *** | |
| 8 | 003550 | 0.0000 | 0.0237 | | 0.0000 | | 0.4414 | | 0.0237 |
| | | | (0.68) | | | | (15.14) | *** | |
| 9 | 004020 | 0.0000 | 0.0218 | | 0.0000 | | 1.0482 | | 0.0218 |
| | | | (0.50) | | | | (14.32) | *** | |
| 10 | 005380 | 0.0000 | 0.0040 | | 0.0000 | | 0.2935 | | 0.0040 |
| | | | (0.11) | | | | (15.53) | *** | |
| 11 | 005490 | 0.0000 | 0.0332 | | 0.0000 | | 0.9453 | | 0.0332 |
| | | | (1.06) | | | | (16.29) | *** | |
| 12 | 005930 | 0.0000 | 0.0000 | | 0.0000 | | 0.5322 | | 0.0000 |
| | | | | | | | (19.28) | *** | |
| 13 | 006400 | 0.0000 | 0.0927 | | 0.8865 | | 0.0267 | | 0.9792 |
| | | | (4.04) | *** | (32.05) | *** | (2.18) | ** | |
| 14 | 009150 | 0.0000 | 0.0000 | | 0.0000 | | 0.6192 | | 0.0000 |
| | | | | | | | (19.31) | *** | |
| 15 | 012330 | 0.0000 | 0.0000 | | 0.0000 | | 1.2270 | | 0.0000 |
| | | | | | | | (19.31) | *** | |
| 16 | 015760 | 0.0000 | 0.1068 | | 0.8761 | | 0.0048 | | 0.9829 |
| | | | (2.98) | *** | (20.33) | *** | (1.44) | | |

**Table 4.** Estimates of GARCH (1, 1) with three order imbalance variables by investor group using the 16 active stocks

**Panel A. Estimates of GARCH (1, 1) with the absolute value of net buy volume by investor groups**

From January 2004 to December 2006, the transaction data of the 16 active stocks are sorted by ten investor groups, and then the coefficients are estimated using the following model by each investor group: GARCH(1, 1) with the absolute value of net buy volume:

$$R_t = \gamma_0 + u_t;\ u_t \mid (V_{1,t}, u_{t-1}, u_{t-2} \ldots) \sim N(0, \sigma_t^2);\ \sigma_t^2 = \alpha_0 + \alpha_1 \cdot u_{t-1}^2 + \alpha_2 \cdot \sigma_{t-1}^2 + \alpha_3 \cdot V_{1,t}$$

where $R_t$ is the rate of return and $V_{1,t}$=|$NBVOL_{t,n,s}$|, |$NBVOL_{t,n,s}$| is the absolute value of net buy volume of stock $n$ purchased by group $s$ on day $t$. $V_{1,t}$ is weakly exogenous in the sense of Engle, Hendry and Richard (1983). The net buy volume ($NBVOL_{t,n,s}$, *henceforth*) is the buyer-initiated shares purchased less the seller-initiated shares sold of stock $n$ purchased by group $s$ on day $t$. $t$=1.....$T$, $n$=1.....$N$, and $s$=1.....$S$. $\alpha_0 > 0$, $\alpha_1 > 0$ and $\alpha_2 > 0$. $\alpha_1 + \alpha_2$ represents the persistence of volatility. $\gamma_0$ is the mean of $R_t$ conditional on past information. $u_t$ has zero mean. *Obs.* is the number of stocks. t-statistics are shown in parenthesis below the coefficients estimates. * denotes significance at the 10% level. ** denotes significance at the 5% level. *** denotes significance at the 1% level. Group 1: Securities companies, Group 2: Insurance companies, Group 3: Investment trust companies, Group 4: Commercial banks, Group 5: Merchant banks and savings banks, Group 6: Pension funds and cooperatives, Group 7: Other corporations, Group 8: Retail investors, Group 9: Listed foreign investors, Group 10: Non-listed foreign investors.

| | Obs. | $\gamma_0$ | $\alpha_0$ | $\alpha_1$ | $\alpha_2$ | $\alpha_3$ | $\alpha_1 + \alpha_2$ |
|---|---|---|---|---|---|---|---|
| Group1 | 16 | 0.0012 | 0.0000 | 0.0907 | 0.8527 | 1.3827 | 0.9434 |
| | | (7.15) *** | (3.59) *** | (8.79) *** | (42.89) *** | (1.71) * | (68.06) *** |
| Group2 | 16 | 0.0011 | 0.0000 | 0.0817 | 0.8310 | 3.6484 | 0.9127 |
| | | (6.81) *** | (2.64) *** | (9.73) *** | (22.96) *** | (2.18) ** | (27.31) *** |
| Group3 | 16 | 0.0010 | 0.0001 | 0.0878 | 0.7593 | 0.9658 | 0.8470 |
| | | (6.34) *** | (2.25) ** | (10.02) *** | (11.43) *** | (2.43) ** | (13.10) *** |
| Group4 | 16 | 0.0010 | 0.0000 | 0.0812 | 0.8184 | 3.7116 | 0.8996 |
| | | (6.36) *** | (2.80) *** | (8.32) *** | (19.21) *** | (1.83) * | (19.50) *** |
| Group5 | 16 | 0.0011 | 0.0000 | 0.0811 | 0.8578 | -0.6565 | 0.9389 |
| | | (6.82) *** | (2.80) *** | (11.81) *** | (47.79) *** | (-0.17) | (60.87) *** |
| Group6 | 16 | 0.0011 | 0.0000 | 0.0939 | 0.8304 | 1.1155 | 0.9243 |
| | | (7.09) *** | (2.94) *** | (10.11) *** | (30.80) *** | (2.62) *** | (41.75) *** |
| Group7 | 16 | 0.0010 | 0.0000 | 0.0804 | 0.8431 | 1.8904 | 0.9234 |
| | | (6.82) *** | (2.97) *** | (9.33) *** | (25.56) *** | (1.60) | (31.25) *** |
| Group8 | 16 | 0.0001 | 0.0002 | 0.1012 | 0.0721 | 5.3710 | 0.1733 |
| | | (0.50) | (5.90) *** | (4.89) *** | (2.43) ** | (2.82) *** | (3.75) *** |
| Group9 | 16 | 0.0007 | 0.0001 | 0.1018 | 0.5990 | 3.9168 | 0.7008 |
| | | (2.70) *** | (2.78) *** | (5.53) *** | (6.72) *** | (1.30) | (8.38) *** |
| Group10 | 16 | 0.0012 | 0.0000 | 0.0792 | 0.8674 | 17.7114 | 0.9466 |
| | | (7.37) *** | (2.37) ** | (8.65) *** | (32.96) *** | (1.55) | (47.52) *** |

**Panel B. Estimates of GARCH (1, 1) with excess buy volume by investor groups**

From January 2004 to December 2006, the transaction data of the 16 active stocks are sorted by ten investor groups, and then the coefficients are estimated using the following model by each investor group: GARCH (1, 1) with excess volume:

$$R_t = \gamma_0 + u_t;\ u_t \mid (V_{2,t}, u_{t-1}, u_{t-2} \ldots) \sim N(0, \sigma_t^2);\ \sigma_t^2 = \alpha_0 + \alpha_1 \cdot u_{t-1}^2 + \alpha_2 \cdot \sigma_{t-1}^2 + \alpha_3 \cdot V_{2,t}$$

where $R_t$ is the rate of return and $V_{2,t}$=*Excess Buy Volume=Max[0,NBVOL*$_{t,n,s}$*]*. $V_{2,t}$ is weakly exogenous in the sense of Engle, Hendry and Richard (1983). The net buy volume (*NBVOL*$_{t,n,s}$, *henceforth*) is the buyer-initiated shares purchased less the seller-initiated shares sold of stock $n$ purchased by group $s$ on day $t$. $t$=1.....$T$, $n$=1.....$N$, and $s$=1.....$S$. $\alpha_0 > 0$, $\alpha_1 > 0$ and $\alpha_2 > 0$. $\alpha_1 + \alpha_2$ represents the persistence of volatility. $\gamma_0$ is the mean of $R_t$ conditional on past information. $u_t$ has zero mean. *Obs.* is the number of stocks. t-statistics are shown in parenthesis below the coefficients estimates. * denotes significance at the 10% level. ** denotes significance at the 5% level. *** denotes significance at the 1% level. Group 1: Securities companies, Group 2: Insurance companies, Group 3: Investment trust companies, Group 4: Commercial banks, Group 5: Merchant banks and savings banks, Group 6: Pension funds and cooperatives, Group 7: Other corporations, Group 8: Retail investors, Group 9: Listed foreign investors, Group 10: Non-listed foreign investors.

| | Obs. | $\gamma_0$ | $\alpha_0$ | $\alpha_1$ | $\alpha_2$ | $\alpha_3$ | $\alpha_1 + \alpha_2$ |
|---|---|---|---|---|---|---|---|
| Group1 | 16 | 0.0011 | 0.0000 | 0.0765 | 0.8833 | 2.4820 | 0.9597 |
| | | (7.05) *** | (2.98) *** | (8.10) *** | (48.48) *** | (1.11) | (81.15) *** |
| Group2 | 16 | 0.0010 | 0.0000 | 0.0746 | 0.8774 | 3.5748 | 0.9520 |
| | | (7.29) *** | (2.40) ** | (9.63) *** | (42.80) *** | (1.89) * | (63.23) *** |
| Group3 | 16 | 0.0008 | 0.0001 | 0.0830 | 0.7871 | 1.1036 | 0.8701 |
| | | (4.29) *** | (2.43) ** | (9.08) *** | (12.32) *** | (2.33) ** | (14.90) *** |
| Group4 | 16 | 0.0011 | 0.0000 | 0.0778 | 0.8799 | 7.1467 | 0.9577 |
| | | (6.95) *** | (2.75) *** | (9.55) *** | (52.80) *** | (1.20) | (75.60) *** |
| Group5 | 16 | 0.0011 | 0.0000 | 0.0771 | 0.8808 | 2.4528 | 0.9579 |
| | | (6.56) *** | (2.59) *** | (9.94) *** | (55.18) *** | (4.02) *** | (81.76) *** |
| Group6 | 16 | 0.0011 | 0.0000 | 0.0762 | 0.8800 | 1.1205 | 0.9561 |
| | | (7.11) *** | (2.78) *** | (9.66) *** | (48.71) *** | (1.58) | (72.65) *** |
| Group7 | 16 | 0.0011 | 0.0000 | 0.0751 | 0.8834 | 0.6507 | 0.9584 |
| | | (7.50) *** | (2.73) *** | (9.50) *** | (53.62) *** | (2.31) ** | (79.73) *** |
| Group8 | 16 | 0.0016 | 0.0000 | 0.0856 | 0.7934 | 0.4890 | 0.8790 |
| | | (6.07) *** | (2.83) *** | (9.31) *** | (15.47) *** | (2.00) ** | (17.37) *** |
| Group9 | 16 | 0.0008 | 0.0000 | 0.0890 | 0.8444 | 4.0112 | 0.9334 |
| | | (3.76) *** | (2.75) *** | (6.31) *** | (26.97) *** | (1.04) | (47.36) *** |
| Group10 | 16 | 0.0012 | 0.0000 | 0.0739 | 0.8826 | 18.5095 | 0.9565 |
| | | (7.60) *** | (2.80) *** | (8.35) *** | (47.37) *** | (1.78) * | (70.94) *** |

**Panel C. Estimates of GARCH (1, 1) with excess sell volume by investor groups**

From January 2004 to December 2006, the transaction data of the 16 active stocks are sorted by ten investor groups, and then the coefficients are estimated using the following model by each investor group: GARCH (1, 1) with excess sell volume:

$$R_t = \gamma_0 + u_t;\ u_t \mid (V_{3,t}, u_{t-1}, u_{t-2} \ldots) \sim N(0, \sigma_t^2);\ \sigma_t^2 = \alpha_0 + \alpha_1 \cdot u_{t-1}^2 + \alpha_2 \cdot \sigma_{t-1}^2 + \alpha_3 \cdot V_{3,t}$$

where $R_t$ is the rate of return and $V_{3,t}$=*Excess Sell Volume*=*-Min[0,NBVOL*$_{t,n,s}$*]*. $V_{3,t}$ is weakly exogenous in the sense of Engle, Hendry and Richard (1983). The net buy volume (*NBVOL*$_{t,n,s}$, *henceforth*) is the buyer-initiated shares purchased less the seller-initiated shares sold of stock $n$ purchased by group $s$ on day $t$. $t$=1.....$T$, $n$=1.....$N$, and $s$=1.....$S$. $\alpha_0 > 0$, $\alpha_1 > 0$ and $\alpha_2 > 0$. $\alpha_1 + \alpha_2$ represents the persistence of volatility. $\gamma_0$ is the mean of $R_t$ conditional on past information. $u_t$ has zero mean. *Obs.* is the number of stocks. t-statistics are shown in parenthesis below the coefficients estimates. * denotes significance at the 10% level. ** denotes significance at the 5% level. *** denotes significance at the 1% level. Group 1: Securities companies, Group 2: Insurance companies, Group 3: Investment trust companies, Group 4: Commercial banks, Group 5: Merchant banks and savings banks, Group6:Pension funds and cooperatives, Group 7: Other corporations, Group 8: Retail investors, Group 9: Listed foreign investors, Group 10: Non-listed foreign investors.

| | Obs. | $\gamma_0$ | $\alpha_0$ | $\alpha_1$ | $\alpha_2$ | $\alpha_3$ | $\alpha_1 + \alpha_2$ |
|---|---|---|---|---|---|---|---|
| Group1 | 16 | 0.0012 | 0.0000 | 0.0875 | 0.8625 | 1.8559 | 0.9500 |
| | | (7.07) *** | (3.35) *** | (8.46) *** | (47.08) *** | (1.93) * | (74.18) *** |
| Group2 | 16 | 0.0011 | 0.0000 | 0.0754 | 0.8793 | 0.5018 | 0.9546 |
| | | (7.87) *** | (3.09) *** | (8.07) *** | (49.61) *** | (1.65) * | (80.15) *** |
| Group3 | 16 | 0.0011 | 0.0000 | 0.0752 | 0.8864 | 0.6374 | 0.9616 |
| | | (7.58) *** | (2.64) *** | (7.82) *** | (51.73) *** | (1.10) | (89.72) *** |
| Group4 | 16 | 0.0011 | 0.0000 | 0.0714 | 0.8851 | 1.7204 | 0.9565 |
| | | (7.36) *** | (2.63) *** | (8.23) *** | (50.66) *** | (2.39) ** | (75.35) *** |
| Group5 | 16 | 0.0012 | 0.0000 | 0.0721 | 0.8887 | -3.8918 | 0.9608 |
| | | (7.28) *** | (2.48) ** | (9.09) *** | (51.78) *** | (-0.73) | (77.38) *** |
| Group6 | 16 | 0.0012 | 0.0000 | 0.0828 | 0.8628 | -0.1830 | 0.9456 |
| | | (8.64) *** | (3.16) *** | (10.23) *** | (41.76) *** | (-0.32) | (57.81) *** |
| Group7 | 16 | 0.0011 | 0.0000 | 0.0749 | 0.8827 | 3.0377 | 0.9576 |
| | | (6.61) *** | (3.36) *** | (8.06) *** | (48.97) *** | (1.04) | (85.10) *** |
| Group8 | 16 | -0.0008 | 0.0001 | 0.1006 | 0.5174 | 3.2318 | 0.6180 |
| | | (-1.74) | (3.39) *** | (5.54) *** | (5.04) *** | (1.73) * | (6.04) *** |
| Group9 | 16 | 0.0012 | 0.0000 | 0.0767 | 0.8637 | 0.1415 | 0.9404 |
| | | (7.48) *** | (2.60) *** | (8.83) *** | (32.47) *** | (0.72) | (44.35) *** |
| Group10 | 16 | 0.0011 | 0.0000 | 0.0754 | 0.8852 | 7.6012 | 0.9606 |
| | | (7.63) *** | (2.68) *** | (9.57) *** | (50.34) *** | (1.83) * | (77.23) *** |

**Table 5.** Mann-Whitney-Wilcoxon test using the 16 active stocks

This table shows the results of the Mann-Whitney-Wilcoxon test in each investor group. Class-1 and class-2 consist of the coefficient of excess buy volume and excess sell volume in model 3 during the sample period, respectively. Group 1: Securities companies, Group 2: Insurance companies, Group 3: Investment trust companies, Group 4: Commercial banks, Group 5: Merchant banks and savings banks, Group 6: Pension funds and cooperatives, Group 7: Other corporations, Group 8: Retail investors, Group 9: Listed foreign investors, Group 10: Non-listed foreign investors.

| | Class | N | SumOfScores | ExpectedSum | StdDevOfSum | MeanScore |
|---|---|---|---|---|---|---|
| Group1 | 1 | 16 | 213 | 264 | 26.53 | 13.31 |
| | 2 | 16 | 315 | 264 | 26.53 | 19.69 |
| Group2 | 1 | 16 | 319 | 264 | 26.53 | 19.94 |
| | 2 | 16 | 209 | 264 | 26.53 | 13.06 |
| Group3 | 1 | 16 | 274 | 264 | 26.53 | 17.13 |
| | 2 | 16 | 254 | 264 | 26.53 | 15.88 |
| Group4 | 1 | 16 | 258 | 264 | 26.53 | 16.13 |
| | 2 | 16 | 270 | 264 | 26.53 | 16.88 |
| Group5 | 1 | 16 | 308 | 264 | 26.53 | 19.25 |
| | 2 | 16 | 220 | 264 | 26.53 | 13.75 |
| Group6 | 1 | 16 | 272 | 264 | 26.53 | 17.00 |
| | 2 | 16 | 256 | 264 | 26.53 | 16.00 |
| Group7 | 1 | 16 | 298 | 264 | 26.53 | 18.63 |
| | 2 | 16 | 230 | 264 | 26.53 | 14.38 |
| Group8 | 1 | 16 | 198 | 264 | 26.53 | 12.38 |
| | 2 | 16 | 330 | 264 | 26.53 | 20.63 |
| Group9 | 1 | 16 | 274 | 264 | 26.53 | 17.13 |
| | 2 | 16 | 254 | 264 | 26.53 | 15.88 |
| Group10 | 1 | 16 | 279 | 264 | 26.53 | 17.44 |
| | 2 | 16 | 249 | 264 | 26.53 | 15.56 |

The coefficients of the three imbalance variables generated by group 8 (domestic individual investors) and group 10 (non-listed foreign investors) are positive and significantly higher than those of the other groups. The coefficient of net buy volume by group 10 is highest, and it is up to 18.5095 with 10% significant level. This means that the daily return volatility is highly correlated with the liquidity trading of the less informed traders.

The test results of the asymmetry between excess buy volume and excess sell

volume are as follows: When comparing the results in Panel B and in Panel C of Table 4, the coefficients of excess buy volume in Panel B are higher than the coefficients of excess sell volume in Panel C except for that of group 7 and group 8. In addition, the Mann-Whitney-Wilcoxon test in Table 5 shows that the mean score in class-1 is greater than that of class-2 for seven of the ten groups. This means that the volatility response to the excess buy volume is significantly more than that to the excess sell volume.

## 3. Test Results with 477 stocks

Tables 6 to 9 report the test results using all of the 477 common stocks that consists mainly of non-active stocks. In both studies with active and less active stocks, we observe the following common results. First, the daily trading volume, as an information variable, can subsume much of the daily return volatility in the Korean stock market. Table 6 reports the average estimates of the traditional GARCH (1, 1) using the 477 ordinary common stocks. At this stage, the coefficients of 362 stocks converged. But when the daily trading volumes are included in the conditional variance equation of GARCH (1, 1) using the 362 ordinary common stocks that converged in the previous stage, Table 7 reports that the average volume coefficients are significantly positive, but that the ARCH effect measured by $\alpha_1$ is negligible, and the persistence of volatility measured by ($\alpha_1$ + $\alpha_2$) dropped from 0.8945 to 0.1600. Second, the coefficient of excess buy volume in Panel B and excess sell volume in Panel C of Table 8 exhibit asymmetries. Excess buy volumes have a more important role in explaining the return volatility. The Mann-Whitney-Wilcoxon statistics in Table 9 confirm the results. Third, in both tests, foreign investors are shown to be disadvantageous in trading domestic stocks. The coefficients of the three imbalance variables in Panel A-Panel C in Table 8 for non-listed investors are 262.5393, 225.9883 and 136.518, respectively. These are significantly higher than those of any other investor group.

**Table 6.** Estimates of the traditional GARCH (1, 1) using the 477 common stocks.

The table reports the average estimates of the 477 stocks from January 2004 to December 2006 using traditional GARCH(1, 1). Traditional GARCH (1, 1):

$$R_t = \gamma_0 + u_t;\ u_t \mid (u_{t-1}, u_{t-2} \ldots) \sim N(0, \sigma_t^2);\ \sigma_t^2 = \alpha_0 + \alpha_1 \cdot u_{t-1}^2 + \alpha_2 \cdot \sigma_{t-1}^2$$

where $R_t$ is the rate of return. $\alpha_0 > 0$, $\alpha_1 > 0$ and $\alpha_2 > 0$. $\alpha_1 + \alpha_2$ represents the persistence of volatility. $\gamma_0$ is the mean of $R_t$ conditional on past information. $u_t$ has zero mean. *Obs.* is the number of stocks. t-statistics are shown in parenthesis below the coefficients estimates. * denotes significance at the 10% level. ** denotes significance at the 5% level. *** denotes significance at the 1% level.

| Obs. | $\gamma_0$ | $\alpha_0$ | $\alpha_1$ | $\alpha_2$ | $\alpha_1 + \alpha_2$ |
|---|---|---|---|---|---|
| 362 | 0.0014 | 0.0001 | 0.1501 | 0.7445 | 0.8945 |
| | (29.76) *** | (17.10) *** | (30.58) *** | (86.01) *** | (143.22) *** |

**Table 7.** Estimates of the GARCH (1, 1) with volume using the 362 common stocks.

The table reports the average estimates of the 362 stocks during the sample period that converged in the previous stage using the following model.
GARCH (1, 1) with volume:

$$R_t = \gamma_0 + u_t;\ u_t \mid (V_t, u_{t-1}, u_{t-2} \ldots) \sim N(0, \sigma_t^2); \sigma_t^2 = \alpha_0 + \alpha_1 \cdot u_{t-1}^2 + \alpha_2 \cdot \sigma_{t-1}^2 + \alpha_3 \cdot V_t$$

where $R_t$ is the rate of return and $V_t$ is the daily volume and weakly exogenous in the sense of Engle, Hendry and Richard (1983). $\alpha_0 > 0$, $\alpha_1 > 0$ and $\alpha_2 > 0$. $\alpha_1 + \alpha_2$ represents the persistence of volatility. $\gamma_0$ is the mean of $R_t$ conditional on past information. $u_t$ has zero mean. *Obs.* is the number of stocks. t-statistics are shown in parenthesis below the coefficients estimates. * denotes significance at the 10% level. ** denotes significance at the 5% level. *** denotes significance at the 1% level.

| Obs. | $\gamma_0$ | $\alpha_0$ | $\alpha_1$ | $\alpha_2$ | $\alpha_3$ | $\alpha_1 + \alpha_2$ |
|---|---|---|---|---|---|---|
| 362 | -0.0003 | 0.0001 | 0.0980 | 0.0620 | 16.7513 | 0.1600 |
| | (-5.15) | (20.10) *** | (22.40) *** | (6.53) *** | (9.09) *** | (13.73) *** |

**Table 8.** Estimates of the GARCH (1, 1) with three order imbalance variables by investor groups using the 362 common stocks

**Panel A. Estimates of the GARCH (1, 1) with the absolute value of net buy volume by investor groups**

From January 2004 to December 2006, the transaction data of the 362 common stocks are sorted by ten investor groups, and then the coefficients are estimated using the following model by each investor group. GARCH (1, 1) with absolute value of the net buy volume:

$$R_t = \gamma_0 + u_t;\ u_t \mid (V_{1,t}, u_{t-1}, u_{t-2} \ldots) \sim N(0, \sigma_t^2);\ \sigma_t^2 = \alpha_0 + \alpha_1 \cdot u_{t-1}^2 + \alpha_2 \cdot \sigma_{t-1}^2 + \alpha_3 \cdot V_{1,t}$$

where $R_t$ is the rate of return and $V_{1,t}$=$|NBVOL_{t,n,s}|$, $|NBVOL_{t,n,s}|$ is the absolute value of net buy volume of stock $n$ purchased by group $s$ on day $t$. $V_{1,t}$ is weakly exogenous in the sense of Engle, Hendry and Richard (1983). The net buy volume ($NBVOL_{t,n,s}$, *henceforth*) is the buyer-initiated shares purchased less the seller-initiated shares sold of stock $n$ purchased by group $s$ on day $t$. $t$=1.....$T$, $n$=1.....$N$, and $s$=1.....$S$. $\alpha_0 > 0$, $\alpha_1 > 0$ and $\alpha_2 > 0$. $\alpha_1 + \alpha_2$ represents the persistence of volatility. $\gamma_0$ is the mean of $R_t$ conditional on past information. $u_t$ has zero mean. *Obs.* is the number of stocks. t-statistics are shown in parenthesis below the coefficients estimates. * denotes significance at the 10% level. ** denotes significance at the 5% level. *** denotes significance at the 1% level. Group 1: Securities companies, Group 2: Insurance companies, Group 3: Investment trust companies, Group 4: Commercial banks, Group 5: Merchant banks and savings banks, Group 6: Pension funds and cooperatives, Group 7: Other corporations, Group 8: Retail investors, Group 9: Listed foreign investors, Group 10: Non-listed foreign investors.

| | Obs. | $\gamma_0$ | $\alpha_0$ | $\alpha_1$ | $\alpha_2$ | $\alpha_3$ | $\alpha_1 + \alpha_2$ |
|---|---|---|---|---|---|---|---|
| Group1 | 200 | 0.0013 | 0.0001 | 0.1496 | 0.7014 | 33.9342 | 0.8510 |
| | | (22.98) *** | (12.09) *** | (25.30) *** | (48.10) *** | (5.76) *** | (72.96) *** |
| Group2 | 201 | 0.0014 | 0.0001 | 0.1425 | 0.7282 | 29.7087 | 0.8707 |
| | | (23.30) *** | (12.16) *** | (26.15) *** | (57.27) *** | (4.88) *** | (87.94) *** |
| Group3 | 202 | 0.0012 | 0.0001 | 0.1496 | 0.6486 | 30.0464 | 0.7982 |
| | | (21.33) *** | (12.91) *** | (26.17) *** | (37.80) *** | (5.53) *** | (51.68) *** |
| Group4 | 202 | 0.0013 | 0.0001 | 0.1474 | 0.7028 | 28.0568 | 0.8503 |
| | | (22.60) *** | (12.70) *** | (23.88) *** | (48.50) *** | (5.55) *** | (68.83) *** |
| Group5 | 200 | 0.0014 | 0.0001 | 0.1457 | 0.7285 | 52.3163 | 0.8741 |
| | | (23.46) *** | (12.07) *** | (24.70) *** | (56.18) *** | (5.21) *** | (90.12) *** |
| Group6 | 202 | 0.0013 | 0.0001 | 0.1483 | 0.7104 | 21.4860 | 0.8587 |
| | | (22.17) *** | (12.79) *** | (26.16) *** | (53.78) *** | (5.76) *** | (82.66) *** |
| Group7 | 203 | 0.0013 | 0.0001 | 0.1497 | 0.6759 | 34.9816 | 0.8257 |
| | | (21.50) *** | (11.81) *** | (26.44) *** | (43.40) *** | (6.21) *** | (65.37) *** |
| Group8 | 204 | 0.0007 | 0.0002 | 0.1541 | 0.3908 | 30.5050 | 0.5449 |
| | | (11.73) *** | (15.04) *** | (24.78) *** | (18.82) *** | (11.10) *** | (23.79) *** |
| Group9 | 203 | 0.0012 | 0.0001 | 0.1530 | 0.6092 | 38.1714 | 0.7622 |
| | | (20.43) *** | (14.30) *** | (24.92) *** | (33.80) *** | (2.53) ** | (43.59) *** |
| Group10 | 201 | 0.0014 | 0.0001 | 0.1452 | 0.7144 | 262.5393 | 0.8597 |
| | | (23.51) *** | (11.98) *** | (24.37) *** | (50.38) *** | (4.18) *** | (75.04) *** |

**Panel B. Estimates of the GARCH (1, 1) with the excess buy volume by investor groups**

From January 2004 to December 2006, the transaction data of the 362 common stocks are sorted by ten investor groups, and then the coefficients are estimated using the following model by each investor group: GARCH(1, 1) with excess buy volume:

$$R_t = \gamma_0 + u_t;\ \ u_t \mid (V_{2,t}, u_{t-1}, u_{t-2} \ldots) \sim N(0, \sigma_t^2);\ \ \sigma_t^2 = \alpha_0 + \alpha_1 \cdot u_{t-1}^2 + \alpha_2 \cdot \sigma_{t-1}^2 + \alpha_3 \cdot V_{2,t}$$

where $R_t$ is the rate of return and $V_{2,t}$=*Excess Buy Volume=Max[0,NBVOL*$_{t,n,s}$*]*. $V_{2,t}$ is weakly exogenous in the sense of Engle, Hendry and Richard (1983). The net buy volume ($NBVOL_{t,n,s}$, *henceforth*) is the buyer-initiated shares purchased less the seller-initiated shares sold of stock $n$ purchased by group $s$ on day $t$. $t$=1.....$T$, $n$=1.....$N$, and $s$=1.....$S$. $\alpha_0 > 0$, $\alpha_1 > 0$ and $\alpha_2 > 0$. $\alpha_1 + \alpha_2$ represents the persistence of volatility. $\gamma_0$ is the mean of $R_t$ conditional on past information. $u_t$ has zero mean. *Obs.* is the number of stocks. t-statistics are shown in parenthesis below the coefficients estimates. * denotes significance at the 10% level. ** denotes significance at the 5% level. *** denotes significance at the 1% level. Group 1: Securities companies, Group 2: Insurance companies, Group 3: Investment trust companies, Group 4: Commercial banks, Group 5: Merchant banks and savings banks, Group 6: Pension funds and cooperatives, Group 7: Other corporations, Group 8: Retail investors, Group 9: Listed foreign investors, Group 10: Non-listed foreign investors.

| | Obs. | $\gamma_0$ | $\alpha_0$ | $\alpha_1$ | $\alpha_2$ | $\alpha_3$ | $\alpha_1 + \alpha_2$ |
|---|---|---|---|---|---|---|---|
| Group1 | 179 | 0.0013 | 0.0001 | 0.1315 | 0.7715 | 31.2604 | 0.9030 |
| | | (20.53) *** | (14.48) *** | (23.56) *** | (76.10) *** | (5.40) *** | (136.40) *** |
| Group2 | 180 | 0.0013 | 0.0001 | 0.1283 | 0.7727 | 31.9307 | 0.9009 |
| | | (20.81) *** | (13.49) *** | (24.50) *** | (78.99) *** | (4.10) *** | (130.58) *** |
| Group3 | 179 | 0.0012 | 0.0001 | 0.1329 | 0.7427 | 17.6719 | 0.8756 |
| | | (18.27) *** | (13.54) *** | (23.81) *** | (59.41) *** | (3.72) *** | (84.40) *** |
| Group4 | 180 | 0.0013 | 0.0001 | 0.1286 | 0.7735 | 23.7027 | 0.9021 |
| | | (20.87) *** | (14.21) *** | (23.27) *** | (79.24) *** | (5.66) *** | (139.35) *** |
| Group5 | 181 | 0.0013 | 0.0001 | 0.1284 | 0.7763 | 58.8374 | 0.9046 |
| | | (20.55) *** | (13.38) *** | (24.28) *** | (75.29) *** | (3.68) *** | (123.70) *** |
| Group6 | 181 | 0.0013 | 0.0001 | 0.1316 | 0.7635 | 16.7981 | 0.8951 |
| | | (20.32) *** | (12.98) *** | (24.00) *** | (70.91) *** | (4.22) *** | (106.91) *** |
| Group7 | 179 | 0.0013 | 0.0001 | 0.1299 | 0.7511 | 20.4879 | 0.8810 |
| | | (19.64) *** | (12.06) *** | (24.85) *** | (61.00) *** | (5.55) *** | (86.71) *** |
| Group8 | 181 | 0.0016 | 0.0001 | 0.1371 | 0.7054 | 18.5069 | 0.8425 |
| | | (21.64) *** | (12.06) *** | (24.52) *** | (48.74) *** | (5.46) *** | (68.29) *** |
| Group9 | 181 | 0.0011 | 0.0001 | 0.1383 | 0.7122 | 30.7305 | 0.8506 |
| | | (15.03) *** | (12.54) *** | (23.58) *** | (48.37) *** | (1.71) * | (64.95) *** |
| Group10 | 179 | 0.0014 | 0.0001 | 0.1298 | 0.7628 | 225.9883 | 0.8926 |
| | | (20.70) *** | (12.10) *** | (23.27) *** | (64.09) *** | (3.22) *** | (94.57) *** |

**Panel C. Estimates of the GARCH (1, 1) with the excess sell volume by investor groups**

From January 2004 to December 2006, the transaction data of the 362 common stocks are sorted by ten investor groups, and then the coefficients are estimated using the following model by each investor group: GARCH (1, 1) with excess sell volume:

$$R_t = \gamma_0 + u_t;\ u_t \mid (V_{3,t}, u_{t-1}, u_{t-2} \ldots) \sim N(0, \sigma_t^2);\ \sigma_t^2 = \alpha_0 + \alpha_1 \cdot u_{t-1}^2 + \alpha_2 \cdot \sigma_{t-1}^2 + \alpha_3 \cdot V_{3,t}$$

where $R_t$ is the rate of return and $volume_{3,t}$=*Excess Sell Volume*=$-Min[0, NBVOL_{t,n,s}]$. $V_{3,t}$ is weakly exogenous in the sense of Engle, Hendry and Richard (1983). The net buy volume ($NBVOL_{t,n,s}$, *henceforth*) is the buyer-initiated shares purchased less the seller-initiated shares sold of stock $n$ purchased by group $s$ on day $t$. $t$=1.....$T$, $n$=1.....$N$, and $s$=1.....$S$. $\alpha_0 > 0$, $\alpha_1 > 0$ and $\alpha_2 > 0$. $\alpha_1 + \alpha_2$ represents the persistence of volatility. $\gamma_0$ is the mean of $R_t$ conditional on past information. $u_t$ has zero mean. *Obs.* is the number of stocks. t-statistics are shown in parenthesis below the coefficients estimates. * denotes significance at the 10% level. ** denotes significance at the 5% level. *** denotes significance at the 1% level. Group 1: Securities companies, Group 2: Insurance companies, Group 3: Investment trust companies, Group 4: Commercial banks, Group 5: Merchant banks and savings banks, Group 6: Pension funds and cooperatives, Group 7: Other corporations, Group 8: Retail investors, Group 9: Listed foreign investors, Group 10: Non-listed foreign investors.

| | Obs. | $\gamma_0$ | $\alpha_0$ | $\alpha_1$ | $\alpha_2$ | $\alpha_3$ | $\alpha_1 + \alpha_2$ |
|---|---|---|---|---|---|---|---|
| Group1 | 185 | 0.0014 | 0.0001 | 0.1323 | 0.7591 | 33.5625 | 0.8913 |
| | | (21.17) *** | (10.88) *** | (22.19) *** | (65.54) *** | (5.04) *** | (107.23) *** |
| Group2 | 185 | 0.0014 | 0.0001 | 0.1264 | 0.7783 | 18.4287 | 0.9046 |
| | | (21.41) *** | (10.97) *** | (22.14) *** | (72.19) *** | (2.88) *** | (120.81) *** |
| Group3 | 185 | 0.0014 | 0.0001 | 0.1286 | 0.7609 | 17.2373 | 0.8895 |
| | | (21.95) *** | (11.22) *** | (22.49) *** | (67.91) *** | (4.24) *** | (112.34) *** |
| Group4 | 185 | 0.0013 | 0.0001 | 0.1279 | 0.7645 | 27.6428 | 0.8924 |
| | | (21.24) *** | (10.76) *** | (20.30) *** | (66.26) *** | (3.61) *** | (104.14) *** |
| Group5 | 185 | 0.0014 | 0.0001 | 0.1285 | 0.7770 | 54.5263 | 0.9055 |
| | | (21.45) *** | (10.58) *** | (20.68) *** | (72.29) *** | (4.09) *** | (125.36) *** |
| Group6 | 185 | 0.0014 | 0.0001 | 0.1266 | 0.7705 | 13.8972 | 0.8971 |
| | | (21.28) *** | (10.81) *** | (22.41) *** | (70.38) *** | (5.05) *** | (106.57) *** |
| Group7 | 185 | 0.0014 | 0.0001 | 0.1273 | 0.7588 | 25.3808 | 0.8861 |
| | | (21.74) *** | (10.93) *** | (23.21) *** | (66.18) *** | (5.80) *** | (103.82) *** |
| Group8 | 185 | 0.0004 | 0.0002 | 0.1418 | 0.5800 | 17.9015 | 0.7218 |
| | | (3.60) *** | (13.01) *** | (23.80) *** | (27.24) *** | (8.87) *** | (33.99) *** |
| Group9 | 185 | 0.0014 | 0.0001 | 0.1314 | 0.7553 | 22.8709 | 0.8867 |
| | | (22.11) *** | (11.03) *** | (23.90) *** | (64.34) *** | (4.89) *** | (102.26) *** |
| Group10 | 185 | 0.0013 | 0.0001 | 0.1296 | 0.7701 | 136.5180 | 0.8997 |
| | | (20.88) *** | (10.28) *** | (22.88) *** | (70.81) *** | (3.48) *** | (119.02) *** |

**Table 9.** Mann-WhitneyWilcoxon test using the 362 stocks

This table shows the results of the Mann-Whitney-Wilcoxon test in each investor group. Class-1 and class-2 consist of the coefficient of excess buy volume and excess sell volume in model 3 during the sample period, respectively. Group 1: Securities companies, Group 2: Insurance companies, Group 3: Investment trust companies, Group 4: Commercial banks, Group 5: Merchant banks and savings banks, Group 6: Pension funds and cooperatives, Group 7: Other corporations, Group 8: Retail investors, Group 9: Listed foreign investors, Group 10: Non-listed foreign investors.

| | Class | N | SumOfScores | ExpectedSum | StdDevOfSum | MeanScore |
|---|---|---|---|---|---|---|
| Group1 | 1 | 179 | 32747.5 | 32667.5 | 1003.606 | 182.9469 |
| | 2 | 185 | 33682.5 | 33762.5 | 1003.606 | 182.0676 |
| Group2 | 1 | 180 | 32917 | 32940 | 1005.762 | 182.8722 |
| | 2 | 185 | 33878 | 33855 | 1005.762 | 183.1243 |
| Group3 | 1 | 183 | 33881.5 | 33763.5 | 1020.209 | 185.1448 |
| | 2 | 185 | 34014.5 | 34132.5 | 1020.209 | 183.8622 |
| Group4 | 1 | 179 | 32778.5 | 32667.5 | 1003.081 | 183.1201 |
| | 2 | 185 | 33651.5 | 33762.5 | 1003.081 | 181.9000 |
| Group5 | 1 | 180 | 33164.0 | 32940 | 1007.761 | 184.2444 |
| | 2 | 185 | 33631.0 | 33855 | 1007.761 | 181.7892 |
| Group6 | 1 | 181 | 33370.5 | 33213.5 | 1011.249 | 184.3674 |
| | 2 | 185 | 33790.5 | 33947.5 | 1011.249 | 182.6514 |
| Group7 | 1 | 181 | 33360.5 | 33213.5 | 1011.959 | 184.3122 |
| | 2 | 185 | 33800.5 | 33947.5 | 1011.959 | 182.7054 |
| Group8 | 1 | 181 | 33385.5 | 33213.5 | 1011.959 | 184.4503 |
| | 2 | 185 | 33775.5 | 33947.5 | 1011.959 | 182.5703 |
| Group9 | 1 | 183 | 33753.5 | 33763.5 | 1020.303 | 184.4454 |
| | 2 | 185 | 34142.5 | 34132.5 | 1020.303 | 184.5541 |
| Group10 | 1 | 181 | 33302.5 | 33213.5 | 1011.959 | 183.9917 |
| | 2 | 185 | 33858.5 | 33947.5 | 1011.959 | 183.0189 |

Despite the common results between the analyses using 16 active and 477 less active stocks, there are also several differences. First, less active stocks have a greater impact on volatility than do active stocks given the fact that all of the coefficients of three imbalance variables using 477 less active stocks are higher than those of using 16 active stocks. Second, the effect of capturing the persistence of variance for three imbalance variables in less active stocks are weaker compared with active stocks. Third, through Panel A-Panel C in Table 8, there are no negative coefficients of imbalance variables and the differences of coefficients within informed group are not

significant. These results may be caused by the fact that less active stocks do not have a sufficient number of observations to meet the condition of the Central Limit Theorem.

These results are consistent with the findings of Shalen (1993) and Daigler and Wiley (1999) that less informed traders, who can not identify liquidity demand from fundamental value, increase volatility. The results are also consistent with the information asymmetry hypothesis by Bessembinder and Seguin (1993). In addition, when using volume as an information measure, the results are consistent with the previous studies in that non-listed foreign investors have an information disadvantage compared with the other groups of investors in the Korean stock market as well as in the futures and option markets.

## VI. Conclusions

This paper studies the informational role of volume by investor groups in the Korean stock market from January 2004 to December 2006. There are three main findings. First, the daily GARCH model is valid for the Korean stock market. Second, volume is an important explanatory variable in the variance equation of the GARCH model. Daily volumes can subsume much of the GARCH effect in the daily return volatility. This explanatory effect of volume comes mainly from the absolute value of net buy volume and excess sell volume by domestic individual investors. In addition, the effects of these two volume variables on volatility are asymmetric. The effect of the former is larger than that of the latter. Third, the various volume effects differ among investor groups. The behavior of the less informed traders, such as the domestic individual investors and the non-listed and listed foreign investors, is different from that of the other seven informed groups. The trading volume generated by non-listed foreign investors is the main source of volatility in the Korean stock market. While all of these results are still valid in tests using 477 stocks, the effects

are more pronounced when using the 16 most active stocks.

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**Appendix 1.** Ten investor groups

| | Name | |
|---|---|---|
| Group1 | Securities companies | |
| Group2 | Insurance companies | |
| Group3 | Investment trust companies | Informed group |
| Group4 | Commercial banks | |
| Group5 | Merchant banks and savings banks | |
| Group6 | Pension funds and cooperatives | |
| Group7 | Other corporations | |
| Group8 | Retail investors | Less informed |
| Group9 | Listed foreign investors | group |
| Group10 | Non-listed foreign investors | |

# 투자자별 거래량 정보효과에 관한 연구

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조 재 호**

이 연구에서는 2004년 1월부터 2006년 12월까지 한국주식시장에 상장된 보통주를 대상으로 거래량의 정보효과를 투자자 그룹별로 검증하였다. 거래가 활발하게 진행되는 16개 주식자료를 사용하여 분석한 결과 전통적인 GARCH(1,1) 모델이 한국시장에 적합한 모형이지만 거래량변수(예를 들면 일별거래량, 순매수거래량의 절대값, 순매수거래량, 순매도거래량)를 전통적인 GARCH(1,1) 모형에 포함하였을 때 추가적인 설명력이 있었다. 본 연구에서는 또한 순매수거래량과 순매도거래량의 일별변동성에 대한 비대칭효과도 검증하였으며 거래량의 일별변동성에 주는 영향을 투자자별로 분석하였다. 정보의 불이익으로 인해 수익률의 일별변동성은 개인투자자와 비등록된 외국인 투자자들의 거래량과 높은 상관관계를 보였다. 마지막으로 자료를 477개 보통주로 확장하여 재분석하였다.

핵심단어: 정보, 거래량, 순매수거래량, 순매도거래량, 정보비대칭, 투자자그룹

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