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Comments are welcome

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ABSTRACT

This paper studies the informational role of trading volume using common stocks categorized by investor group in Korean stock market from January 2004 to December 2006. The GARCH(1,1) model fits Korean stock market well and the volume variables (such as absolute value of the net buy volume, excess buy volume and excess sell volume) have additional explanatory effect when they are included in the variance equation of the GARCH(1,1) model. This paper further test whether the effects of excess sell volume and excess buy volume on volatility is asymmetric. In addition, the effects of volume on volatility are shown to be different by investor groups. Because of the information disadvantage, the daily return volatility is highly correlated with the volume of domestic individual investors and non-listed foreign investors. Finally, I extend this result to an expanded data set that includes 477 common stocks.

(*Keywords*: information, trading volume, net buy volume, net sell volume, information asymmetry, investor group)

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1. Introduction

Using daily volume data of the 20 actively traded common stocks as a proxy for information flow, Lamoureux and Lastrapes (1990) find that volume is an important explanatory variable in the conditional return variance equation in GARCH model by Bollerslev (1986). This paper is an extension of their study. I use 16 stocks for which options are listed in Korean market to test the GARCH effect when various volume variables are included in the variance equation in GARCH model, and explore further the effect of volume variables by ten investor groups. And then, I extend the results to an extended data set that includes 477 common stocks. This paper extends the previous studies in three ways. First, this paper tests the daily volume effect on volatility, it also tests three other volume variables such as the absolute value of net buy volume, excess buy volume, and excess sell volume. This additional test is meaningful since trading volume alone is not sufficient to reflect all of the trading processes. Because of the private information and inventory problems, order imbalance may have more important role in explaining the asset return. [See Chan, Chung, and Fong(1999) and Chordia,Roll and Subrahmanyam (2003)]. The paper also shows that the positive relation between volatility and volume is asymmetric. Return volatility is more influenced by positive unexpected volume shock. (See, Bessembinder and Seguin (1993)). Second, this paper further explores the effect of the various volume variables by investor group. Price change is the market evaluation of the information signal, but investors might disagree with the market interpretation of new information. [See 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 sell a certain quantity of asset by their own valuation. The excess buying or selling by uninformed investors increase price volatility. Related studies in the futures markets include Daigler and Wiley (1999). Having divided investor by ten groups (seven institutional investors, one domestic individual investors and two foreign investors), this paper also test whether domestic investors have information advantage over foreign investors. In an emerging market, who is informed in trading domestic stocks have been controversial issue. By studying the volatility-volume relation among different group of investors, I attempt to provide additional evidence between institutional v.s. individual investors and domestic v.s. foreign investors. [See, Bakaert and Harvey (1997, 2000)]. Third, I extend the result of active stocks to all of the 477 common stocks and test whether this various volume effects of the active assets would generally hold.

This paper is organized as follows: Section 2 reviews theoretical backgrounds for the subsequent empirical analysis. Section 3 describes data and defines main variables used in this study. Section 4 discusses empirical methodologies. Section 5 reports empirical findings and interprets the results. Concluding remarks are provided in Section 6.

2. 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 of GARCH by Bollerslev (1986) assuming that daily stock return volatility shocks persist over time, have been very successful in explaining daily stock return. The presence of ARCH is explained by the hypothesis that daily returns are generated by 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 return and volume. Karpoff (1987) also provides a good overview on the positive relations between volume and price changes. Lamoureux and Lastrapes (1990) insert volume into the ARCH variance equation and find that volume has significant positive effect in explaining the daily stock return variance while past return shocks become insignificant. This confirms that the daily total volume generates the return volatility.

However, the daily total volume alone can not capture all of the trading processes. The effect of various volume variables and the asymmetry of the effects are further analyzed by many researchers. Using daily data during the period from May 1982 to March 1990, Bessembinder and Seguin (1993) examine the relations between 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 the asymmetry between positive unexpected shock and negative unexpected shock. Bessembinder and Seguin (1993) 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 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. Decreasing market depth results in increasing market volatility. Chordia, Roll and Subrahmanyam (2003) study association among order imbalance, liquidity, and stock market return. They find the imbalance have significant impact on the market return. In addition, the effect is asymmetric, excess sell orders have larger effect on market return than that of the excess buy orders. They explain this result through private information and inventory paradigm

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

which suggests that the order imbalance causes price pressure.

Shalen (1993), using two-period noisy rational expectations model of a future market proves that the dispersion of expectations associated with the liquidity demand of futures hedger cause excess volatility and excess volume compared to equilibrium levels. Daigler and Wily (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 trader-the general public. Clearing members and floor traders who are informed about precise order flow often drive a low volatility. Studies on the impact of investors in different groups have been done by many researchers in Korean stock market. Cho and Lee (2001) use the daily price and volume 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 have 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 the futures markets. Because of the significant implication of the maturity for the volume and the price volatility in the futures and options markets, previous studies concerning the volume effect on volatility by different group of investors mainly focus on the futures and options markets. Few research has been done in the stock markets. In this paper, I use daily volume data in Korean stock market to test whether it is an additional explanatory variable when it is included in the variance equation in the GARCH model. In addition, I examine the role of various volume variables by different group of investors.

Since 1990's, with the rapid demand for market liberalization, such issues as the influence of foreign investors in domestic market and the question as to whether domestic investors have an advantage over foreign investors have been major concerns among financial economists. Bekart and Harvey (1997) find that capital market liberalizations often increase the correlation between the local market return and the world market return but significantly decrease the volatility in the 20 emerging market for the period from January 1976 to December 1992. Bekart and Harvey (2000) find that the annualized volatility slightly decreases following market liberalizations for the period January 1976 to December 1995. Aforementioned studies mainly focus on the U. S. markets. There are numerous empirical studies in Korean market on the relation between domestic and foreign investors. Choe, Kho, 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 have an edge over foreign investors because prices toward against foreign investors from December 1996 through November 1998. In the KOSPI 200 Index Futures Markets 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 a advantageous price relative to domestic investors. When comparing their holding period return, 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 performance for the period from January 1995 to December 2002. However, these studies rely mainly on two approaches-comparing the stock return performance or comparing the trading prices. Few studies use the volume as information measure. In this paper, I use a different methodology, to provide additional evidence on whether domestic investors have an information advantage.

3. Data and main variables

3.1 Data

This study covers the period from January 2004 to December 2005. Daily return and total volume data used in this study are from the Korean Securities Research Institute (KSRI, henceforth). Daily transactions (shares of stocks) are from the Korea Exchange. This data include the number of shares bought and sold and market capitalization by ten groups. The ten groups are securities companies, insurance companies, investment trust companies, banks, short-term finances and savings, pension funds, other non-institutional firms, individual investors, listed foreign investors and non-listed foreign investors.

Using this initial data, I select the sample for this study under the following criteria: Among the 856 stocks listed in Korea Exchange, I select 635 stocks listed in 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. Considering the split effect on volume, I also exclude stocks with split during the sample period. Finally, 477 stocks remain.

[Insert Appendix I]

Appendix 1 lists the ten investor groups. According to the accessibility to data or the ability to analyze data, I classify the local institutional investors and the domestic non-individual investors (from group1 to group7) into the informed group and classify domestic individual investors (group8) and non-listed foreign investors (group10) into the less informed group. Considering the home-bias problems, I also assign the foreign institutions (group9) into the less informed group.

3.2 Main variables

Chordia, Roll, and Subrahmanyam (2002) suggest that extreme order imbalance often signal private information, which should reduce liquidity and increase price volatility. In addition, extreme order imbalance also cause market makers revise bid ask spread and price quotes. So, order imbalances should have more important role in explaining market liquidity and price volatility than total volume. 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 the 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.*

4 Methodology

I start with the 16 active trading stocks for which options trade in the Korea Exchange to ensure a sufficient number of volume observations to satisfy the conditions for the Central Limit Theorem.[2] Then I generalize the result to all of the 477 common stocks. When estimating the coefficients in the GARCH model, stocks that do not converge are excluded.

4.1 Using 16 stocks

Among the 477 ordinary common stocks I select 16 active trading stocks for which options trade in the Korea Stock Exchange. Using these 16 stocks 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 have additional explanatory effect when the various volume variables are included in the GARCH model. The variables are the absolute value of the net buy volume, the excess buy volume and the excess sell volume. Finally, I sort the transaction data into ten investor groups, and test further the various volume effects by ten investor groups.

The models that are tested are as follows.

Model 1:

The traditional GARCH (1,1) model developed by Bolleslev(1986) is as follows:

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

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

where R_t *is the rate of return and* $\alpha_0 > 0$. γ_0 *is mean* R_t *conditional on past information.* u_t *have zero mean.*

Traditional GARCH(1,1) model assumes daily return volatility shocks persist over time. Using this model, I test whether the traditional GARCH model holds. $\alpha_1 + \alpha_2$ measure the persistence of volatility.

Model 2:

When volume variable is included in the GARCH model in equation (1), the revised model (See Lamoureux and Lastrapes (1990)) can be written as follows:

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

where R_t *is the rate of return,* $volume_t$ *is daily volume and* $\alpha_0 > 0$. γ_0 *is mean* R_t *conditional on past information.* u_t *have zero mean. It is drawn from a mixture of distribution, where the variance of each distribution depends on information arrival time.*

The classic mixture of distribution theory assumes a joint volatility-volume relation and regard the number of transactions or the number of information arrivals as mixing variables. The mixture model also predicts that $\alpha 3 > 0$ and α_1 *and* α_2 should be small and statistically insignificant if daily volume is serially correlated. [See Lamoureux and Lastrapes (1990)]. Using this model, I test whether daily volume have additional explanatory power in the variance equation of GARCH(1,1).

Model 3:

The effects of the various volume variables by investor group in GARCH(1,1) can be captured in the following model.

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

where R_t *is the rate of return*, $Volume_{1,t} = \mid NBVol_{t,n,s} \mid$, $Volume_{2,t} = Max[0, NBVol_{t,n,s}]$, *and* $Volume_{3,t} = -Min[0, NBVol_{t,n,s}]$ *and* $\alpha_0 > 0$. γ_0 *is mean* R_t *conditional on past information.* u_t *have zero mean. It is drawn from a mixture of distribution, where the variance of each distribution depends on information arrival time.*

Asset pricing models under the dispersion of belief classify investors into informed and less informed traders by accessibility to trading information or different beliefs based on the same information. Informed traders buy or sell relatively small range around true value by their evaluation. Less informed traders react to all of the noisy signals of volume and prices and thus result in higher volatility. It is also generally regarded that domestic investors are familiar with local investment markets, so they are informed traders and outperform foreign investors. The coefficient of $Volume_{i,t}$ in model (3) captures the information contents by ten investor groups. Less informed traders would have a highly positive correlation with the daily return volatility. Conversely, informed traders would exhibit inverse relation between volatility and volume (See

Daigler and Wily (1999)). Bessembinder and Seguin (1993) explain the information asymmetric hypothesis as follows: the positive volume shock is associated with capital surplus while negative volume shock is associated with capital shortage. Because capital shortage have more deleterious effects on depth than a surplus, the market depth during positive volume shocks will be smaller than that during negative volume shocks. Decreasing market depth results in increasing market volatility. According to aforementioned information asymmetric theory, the coefficient of the excess buy volume should be higher than that of the excess sell volume. By analyzing the listed or non-listed foreign investors groups, this paper also provide evidence on whether domestic investors have an advantage over foreign investors in trading domestic stocks.

4.2 Using all of the 477 Stocks

Using all of the 477 stocks, I test whether the GARCH model holds in Korean stock market. I also examine whether the volume have additional explanatory power when volume is included in the variance equation in GARCH (1,1) model. Then, I test the effect of the absolute value of the net buy volume, excess buy volume and excess sell volume on daily return volatility by ten investor groups to examine the differences among ten investor groups.

5 Empirical Results

5.1 Basic Statistics

[Insert Table I]

Table I 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 group. Panel A reports the average percentage volumes. For the three volume variables, group 8 (domestic individual investors), group 9 (foreign investors) and group 3 (investment trust company) hold a majority of trading volumes. The absolute value of the net buy volume for the 16 active stocks are 26.94%, 28.83% and 16.58% for group8 (domestic individual investors), group9 (listed foreign investors) and group3 (Investment trust companies), respectively. The absolute value of the net buy volumes of other seven groups are below 10%. This pattern is similar when using all of the 477common stocks.

Table I Panel B reports the cross correlation by ten investor groups. The cross correlation of group10 (non-listed foreign investors) with other nine group are the lowest for the 16 active stocks. When analyzing the 477 common stocks, both group 10 (non-listed foreign investors) and group5 (short-term finances and savings) exhibit lower cross correlation with other eight groups.

5.2 Test results with 16 active stocks

[Insert Table II]

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

[Insert Table III]

Table III reports the estimates of the GARCH(1,1) with volume 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 the ARCH effect which is measured by α_1 disappear and the persistence of volatility which is measured by $\alpha_1 + \alpha_2$ become much smaller. This mean daily volume, as an information variable, can explain much of the daily return volatility.

[Insert Table IV]

Table IV Panel A reports the estimates of GARCH (1,1) with absolute value of the net buy volume by investor group. From January 2004 to December 2006, the transaction data are sorted by the ten investor groups, and then the coefficients are estimated using model 3 by each investor group. As expected, the coefficient of absolute value of the net buy volume generated by group 5 (Short-term finances and savings) is negative. This implies that their trading is highly associated with private information. The coefficient of the absolute value of net buy volume by the group 10 (non-listed foreign investors) is highest at 17.7875. The coefficient of absolute value of the net buy volume by the group 8 (domestic individual investors) is ranks next at 5.4529 while $\alpha_1 + \alpha_2$ is lowest at 0.13. This means daily return volatility is highly correlated with the trading of the less informed traders, and the absolute value of the net buy volume by domestic individual investors can subsume daily return volatility.

Table IV Panel B reports the estimates of GARCH (1,1) with excess buy volume by investor group using the 16 stocks. From January 2004 to December 2006, the transaction data of the 16 active stocks are sorted by the ten investor groups, and then the coefficients are estimated using the model 3 by each investor group. Although the coefficients of the excess buy volume are positive for all investors, the foreign non-listed investors, as less informed investors, are very high at 18.5313. Persistence of variance measured by $\alpha_1 + \alpha_2$ is similar for all investors.

Table IV Panel C reports the estimates of the GARCH (1,1) with excess sell volume by investor group using the 16 stocks. From January 2004 to December 2006, the transaction data of the 16 active stocks are sorted by the ten investor groups, and then the coefficients are estimated using model 3 by each investor group. Consistent with expectation, the coefficients of the net sell volume generated by the group 5 (Short-term finances and savings) and the group 6 (pension funds) which are regarded as informed traders are negative. The coefficient of the net sell volume by the group 10 is highest at 8.0906. The coefficient of net sell volume by the group 8 is second highest at 3.2564 and the $\alpha_1 + \alpha_2$ of the domestic individual investors are lowest at 0.588. This means daily return volatility is highly correlated with the liquidity trading of the non-listed foreign investors and domestic individual investors, and the excess sell volume by domestic individual investors can explain serial correlation in daily return volatility. As expected, when comparing the coefficient of α_3 between Panel B and Panel C, the coefficient of excess buy volume is higher than that of the excess sell volume. This asymmetries shows that the excess buy volume have greater effect on volatility than excess sell volume.

5.3 Tests results with all of the 477 stocks

[Insert Table V]

From Table V to Table VII report the results using all of the 477 common stocks. Table V report the average estimates of the traditional GARCH (1,1) using the 477 ordinary common stocks. This table shows that there exists daily GARCH effect in Korean stock market.

[Insert Table VI]

Table VI report the average estimates of GARCH (1,1) with daily volume from January 2004 to December 2006 using the 477 ordinary common stocks. The average volume coefficients are positive and statistically significant but the ARCH effect which is measured by α_1 is negligible and the persistence of volatility which is measured by $\alpha_1 + \alpha_2$ become much smaller. This mean daily volume, as an information variable, can explain much of the return volatility in Korean stock market.

[Insert Table VII]

Table VII Panel A report the estimates of GARCH (1,1) with absolute value of net buy volume by the ten investor groups using the 477 ordinary common stocks. From January 2004 to December 2006, the transaction data of the 477 common stocks are sorted by the ten investor groups, and then the coefficients are estimated using the model 3 by each investor group. We can observe similar results with the Table 3. The coefficients of the absolute value of the net buy volume of the non-listed foreign investors are highly correlated with daily return volatility. The

$\alpha_1 + \alpha_2$ of the domestic individual investors are lowest at 0.5449. This means that the daily trading volume generated by domestic individuals can subsume much of the GARCH effects.

Table VII Panel B reports the estimates of GARCH (1, 1) with the excess buy volume by the ten investor groups using the 477 ordinary common stocks. From January 2004 to December 2006, the transaction data of the 477 stocks are sorted by the ten investor groups, and then the coefficients are estimated using the model 3 by each investor group. The coefficient generated by non-listed foreign investors is highest. Although the $\alpha_1 + \alpha_2$ of the domestic individual investors is lower than that of the other nine groups, the difference is not significant.

Table VII Panel C reports the estimates of GARCH (1,1) with excess sell volume by investor group using the 477 ordinary common stocks. From January 2004 to December 2006, the transaction data of the 477 stocks are sorted by ten investor groups, and then the coefficients are estimated using model 3 by each investor group. Similar to Panel B of the Table3, the coefficient generated by non-listed foreign investors is highest. Although the $\alpha_1 + \alpha_2$ of the domestic individual investors is lowest, the difference is not significant. The coefficient of the excess buy volume in Table VII Panel B and excess sell volume in Table VII Panel C also exhibit asymmetries. The excess buy volume have more important role in explaining the return volatility.

The results in Table VII are consistent with the findings by Shalen (1993) and Daigler and Wiley(1999) that less informed traders who can not identify the liquidity demand from the fundamental value increase volatility. The results are also consistent with information asymmetric hypothesis by Bessembinder and Seguin (1993). In addition, when using volume as a information measure, I find different result compare to previous studies. Non-listed foreign investors and domestic individual investors have information disadvantage over the other group of investors.

6 Conclusion

This paper studies the informational role of volume by investor groups in Korean stock market from January 2004 to December 2006. There are three main findings. First, the daily GARCH model is valid in Korean stock market. Second, the volume is important explanatory variable in the variance equation of the GARCH model. Daily volumes can subsume much of the GARCH effect in daily return volatility. This explanatory effect of the volume mainly comes from the absolute value of net buy volume and the excess sell volume by domestic individual investors. In addition, the effects of these two volume variables on volatility are asymmetric. The effect of daily excess buy volume is higher than that of excess sell volume. Third, the various volume effects are different by investor group. The behavior of the less informed traders, the domestic individual investors and the non-listed and listed foreign investors, are different from that of the other seven informed groups. The trading volume generated by non-listed foreign investors are main source of volatility in the Korean stock market. All of these results are still valid in tests using 477 stocks, but the effects are pronounced when using the 16 active stocks.

Appendix I

Ten Investor Groups

	Name
Group1	Securities companies
Group2	Insurance companies
Group3	Investment trust companies
Group4	Banks
Group5	Short-term finances and savings
Group6	Pension funds
Group7	Other non-institutional firms
Group8	Domestic individual investors
Group9	Listed foreign investors
Group10	Non-listed foreign investors

Table I

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 group. Panel A reports the average percentage volumes and Panel B reports the cross correlation by ten investor groups.

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

	| 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 group

	| 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 I

Panel B [1] Cross correlations of 16 active stocks by investor group

	Group1	*Group2*	*Group3*	*Group4*	*Group5*	*Group6*	*Group7*	*Group8*	*Group9*	*Group10*
Group1	1.000									
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	1.000

Panel B [2] Cross correlation of 477 common stocks by investor group

	Group1	*Group2*	*Group3*	*Group4*	*Group5*	*Group6*	*Group7*	*Group8*	*Group9*	*Group10*
Group1	1.000									
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	1.000

Table II
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. $\alpha_0 > 0$ and $\alpha_1 + \alpha_2$ represents persistence of variance.
t-statistics are shown in parenthesis below the coefficient estimates.

	Code	α_0	α_1	α_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	0.0692	0.9012	0.9704
		(2.10)	(3.71)	(37.24)	
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	0.1039	0.8865	0.9905
		(1.40)	(4.06)	(31.23)	
10	005380	0.0000	0.0597	0.9192	0.9789
		(1.59)	(3.24)	(35.54)	
11	005490	0.0000	0.0956	0.8868	0.9824
		(2.11)	(4.68)	(42.29)	
12	005930	0.0000	0.0259	0.9671	0.9930
		(1.20)	(3.71)	(108.48)	
13	006400	0.0000	0.0802	0.9113	0.9915
		(2.15)	(4.38)	(50.59)	
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 III
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:

$R_t = \gamma_0 + u_t$

$u_t \mid (u_{t-1,} u_{t-2} ...) \sim N(0, \sigma_t^2)$

$\sigma_t^2 = \alpha_0 + \alpha_1 \cdot u_{t-1}^2 + \alpha_2 \cdot \sigma_{t-1}^2 + \alpha_3 \cdot Volume_t$

where R_t *is the rate of return,* $volume_t$ *is daily volume,* $\alpha_0 > 0$, *and* $\alpha_1 + \alpha_2$ *represents persistence of variance.* t *- statistics are shown in parenthesis below the coefficient estimates.*

	Code	α_0	α_1	α_2	α_3	$\alpha_1+\alpha_2$
1	000240	0.0000	0.1128	-0.0938	1.1967	0.0190
		(0.23)	(2.77)	(-1.30)	(7.13)	
2	000270	0.0001	0.0196	-0.1175	0.2768	-0.0979
		(2.06)	(0.82)	(-5.38)	(9.03)	
3	000700	0.0000	0.0818	-0.3294	0.9560	-0.2476
		(-1.71)	(12.59)	(-23.92)	(16.42)	
4	000830	0.0000	-0.0232	-0.1678	0.3977	-0.1909
		(-1.34)	(-2.26)	(-4.83)	(14.90)	
5	001040	0.0000	-0.0189	-0.1913	4.1016	-0.2102
		(1.26)	(-2.03)	(-4.50)	(10.43)	
6	001740	0.0001	0.1448	-0.1084	13.6995	0.0365
		(1.51)	(4.22)	(-2.87)	(10.08)	
7	003490	0.0001	0.0226	-0.3209	0.9561	-0.2982
		-	-	-	-	
8	003550	-0.0001	0.0175	0.0082	0.5332	0.0258
		(-3.13)	(0.50)	(0.22)	(11.66)	
9	004020	0.0000	0.0175	-0.1799	1.2134	-0.1624
		(0.36)	(0.49)	(-4.64)	(11.73)	
10	005380	-0.0001	-0.0172	-0.0591	0.4174	-0.0763
		(-4.10)	(-0.55)	(-2.01)	(11.51)	
11	005490	-0.0001	0.0361	-0.1100	1.4182	-0.0739
		(-2.93)	(1.16)	(-1.59)	(10.50)	
12	005930	-0.0001	-0.0016	-0.1388	0.8737	-0.1403
		(-16.09)	(-0.21)	(-4.53)	(18.63)	
13	006400	-0.0001	0.0981	-0.1557	1.6092	-0.0575
		(-9.32)	(3.51)	(-3.77)	(16.96)	
14	009150	0.0000	0.0031	-0.4203	0.8137	-0.4172
		(1.28)	(0.38)	(-19.92)	(12.74)	
15	012330	-0.0001	-0.0093	-0.2123	1.7023	-0.2216
		(-1.74)	(-0.47)	(-3.51)	(13.09)	
16	015760	-0.0001	0.0979	-0.1698	0.2771	-0.0719
		(-2.32)	(3.42)	(-3.81)	(9.74)	

Table IV

Panel A Estimates of GARCH(1,1) with Absolute Value of the Net Buy Volume by Investor Group Using the 16 active stocks

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 following model by each investor group:

GARCH(1,1) with absolute value of the net buy volume:

$R_t = \gamma_0 + u_t$

$u_t \mid (u_{t-1,} u_{t-2} \ldots) \sim N(0, \sigma_t^2)$

$\sigma_t^2 = \alpha_0 + \alpha_1 \cdot u_{t-1}^2 + \alpha_2 \cdot \sigma_{t-1}^2 + \alpha_3 \cdot Volume_{1,t}$

where R_t is the rate of return, $Volume_{1,t} = |NBVol_{t,n,s}|$, $|NBVol_{t,n,s}|$ is the absolute value of net buy volume of stock n purchased by group s on day t. 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. $t = 1\ldots,T$, $n = 1\ldots N$, and $s = 1\ldots10$. $\alpha_0 > 0$, and $\alpha_1 + \alpha_2$ represents persistence of variance. t - statistics are shown in parenthesis below the coefficient estimates.

Group	γ_0	α_0	α_1	α_2	α_3	$\alpha_1+\alpha_2$
Group1	0.0012	0.0000	0.0907	0.8529	1.3929	0.9436
	(7.20)	(3.55)	(8.78)	(42.66)	(1.73)	(67.59)
Group2	0.0011	0.0000	0.0791	0.8569	3.2326	0.9360
	(6.85)	(2.58)	(8.77)	(37.20)	(2.09)	(52.97)
Group3	0.0009	0.0001	0.0854	0.7570	1.0071	0.8424
	(5.21)	(1.93)	(9.42)	(10.24)	(2.53)	(11.68)
Group4	0.0011	0.0000	0.0812	0.8192	3.7559	0.9004
	(6.47)	(2.74)	(8.38)	(19.15)	(1.86)	(19.47)
Group5	0.0011	0.0000	0.0810	0.8581	-0.6621	0.9391
	(6.83)	(2.79)	(11.87)	(47.82)	(-0.17)	(60.81)
Group6	0.0011	0.0000	0.0924	0.8332	1.1290	0.9257
	(7.10)	(2.83)	(10.04)	(31.01)	(2.67)	(42.01)
Group7	0.0010	0.0000	0.0797	0.8440	1.8869	0.9237
	(6.85)	(2.93)	(9.42)	(25.56)	(1.60)	(31.01)
Group8	0.0000	0.0002	0.0970	0.0322	5.4529	0.1291
	(0.03)	(5.33)	(4.59)	(0.83)	(2.86)	(2.41)
Group9	0.0006	0.0001	0.1016	0.5913	3.9434	0.6929
	(2.37)	(2.60)	(5.51)	(6.31)	(1.31)	(7.80)
Group10	0.0012	0.0000	0.0789	0.8680	17.7875	0.9469
	(7.36)	(2.35)	(8.65)	(32.94)	(1.56)	(47.46)

Table IV
Panel B Estimates of GARCH(1,1) with Excess Buy Volume by Investor Group Using the 16 active stocks

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 following model by each investor group:

GARCH(1,1) with excess volume:

$$R_t = \gamma_0 + u_t$$

$$u_t \mid (u_{t-1}, u_{t-2} \ldots) \sim N(0, \sigma_t^2)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \cdot u_{t-1}^2 + \alpha_2 \cdot \sigma_{t-1}^2 + \alpha_3 \cdot Volume_{2,t}$$

where R_t *is the rate of return,* $Volume_{2,t} \equiv Excess\ Buy\ Volume = Max[0, NBVol_{t,n,s}]$*. 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.* $t = 1\ldots, T$, $n = 1\ldots N$, *and* $s = 1\ldots 10$. $\alpha_0 > 0$, *and* $\alpha_1 + \alpha_2$ *represents persistence of variance. t - statistics are shown in parenthesis below the coefficient estimates.*

Group	*Obs.*	γ_0	α_0	α_1	α_2	α_3	$\alpha_1+\alpha_2$
Group1	16	0.0011	0.0000	0.0766	0.8832	2.4789	0.9598
		(7.07)	(2.98)	(8.10)	(48.54)	(1.10)	(81.37)
Group2	16	0.0010	0.0000	0.0743	0.8785	3.6627	0.9528
		(7.24)	(2.34)	(9.56)	(42.44)	(1.94)	(62.75)
Group3	16	0.0008	0.0001	0.0830	0.7872	1.1061	0.8703
		(4.27)	(2.42)	(9.08)	(12.32)	(2.33)	(14.91)
Group4	16	0.0011	0.0000	0.0778	0.8799	7.1475	0.9577
		(6.96)	(2.74)	(9.55)	(52.76)	(1.20)	(75.59)
Group5	16	0.0011	0.0000	0.0771	0.8808	2.4456	0.9579
		(6.57)	(2.59)	(9.94)	(55.18)	(4.03)	(81.81)
Group6	16	0.0011	0.0000	0.0763	0.8797	1.1267	0.9560
		(7.12)	(2.80)	(9.68)	(48.76)	(1.58)	(72.60)
Group7	16	0.0011	0.0000	0.0750	0.8833	0.6512	0.9583
		(7.50)	(2.73)	(9.52)	(53.53)	(2.32)	(79.45)
Group8	16	0.0016	0.0000	0.0849	0.7949	0.4900	0.8798
		(6.08)	(2.83)	(9.27)	(15.55)	(2.02)	(17.47)
Group9	16	0.0008	0.0000	0.0870	0.8473	4.0118	0.9343
		(3.35)	(2.68)	(6.23)	(27.09)	(1.04)	(47.32)
Group10	16	0.0012	0.0000	0.0739	0.8827	18.5313	0.9565
		(7.64)	(2.80)	(8.35)	(47.37)	(1.79)	(70.92)

Table IV
Panel C Estimates of GARCH(1,1) with Excess Sell Volume by Investor Group Using the 16 active stocks

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 following model by each investor group:

GARCH(1,1) with excess sell volume:

$$R_t = \gamma_0 + u_t$$

$$u_t \mid (u_{t-1,} u_{t-2} ...) \sim N(0, \sigma_t^2)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \cdot u_{t-1}^2 + \alpha_2 \cdot \sigma_{t-1}^2 + \alpha_3 \cdot Volume_{3,t}$$

where R_t *is the rate of return*, $Volume_{3,t} \equiv Excess\,Sell\,Volume = -Min[0, NBVol_{t,n,s}]$. *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* $s = 1...10$. $\alpha_0 > 0$, *and* $\alpha_1 + \alpha_2$ *represents persistence of variance. t - statistics are shown in parenthesis below the coefficient estimates.*

Group	*Obs.*	γ_0	α_0	α_1	α_2	α_3	α_1+α_2
Group1	16	0.0012	0.0000	0.0878	0.8626	1.8565	0.9504
		(7.10)	(3.34)	(8.28)	(47.10)	(1.93)	(74.03)
Group2	16	0.0011	0.0000	0.0742	0.8809	0.5059	0.9551
		(8.01)	(3.06)	(7.47)	(47.94)	(1.67)	(79.56)
Group3	16	0.0011	0.0000	0.0751	0.8867	0.6393	0.9618
		(6.48)	(2.61)	(7.84)	(51.70)	(1.11)	(89.26)
Group4	16	0.0011	0.0000	0.0698	0.8872	1.7532	0.9570
		(7.45)	(2.59)	(7.90)	(49.69)	(2.42)	(74.87)
Group5	16	0.0012	0.0000	0.0721	0.8887	-3.8828	0.9608
		(7.28)	(2.48)	(9.09)	(51.77)	(-0.73)	(77.41)
Group6	16	0.0012	0.0000	0.0769	0.8731	-0.0374	0.9499
		(8.21)	(3.03)	(9.76)	(44.15)	(-0.08)	(60.13)
Group7	16	0.0011	0.0000	0.0749	0.8828	3.0389	0.9578
		(6.62)	(3.38)	(8.07)	(49.30)	(1.04)	(85.91)
Group8	16	-0.0009	0.0002	0.0982	0.4909	3.2564	0.5880
		(-1.80)	(3.25)	(5.28)	(4.31)	(1.74)	(5.17)
Group9	16	0.0012	0.0000	0.0768	0.8638	0.1445	0.9406
		(7.44)	(2.58)	(8.81)	(32.41)	(0.74)	(44.30)
Group10	16	0.0011	0.0000	0.0744	0.8870	8.0906	0.9614
		(7.63)	(2.60)	(9.66)	(50.22)	(1.87)	(76.54)

Table V
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, $\alpha_0 > 0$, and $\alpha_1 + \alpha_2$ represents persistence of variance.
t-statistics are shown in parenthesis below the coefficient estimates.

Obs.	γ_0	α_0	α_1	α_2	$\alpha_1+\alpha_2$
364	0.0014	0.0001	0.1501	0.7448	0.8949
	(29.78)	(17.43)	(30.56)	(85.00)	(140.81)

Table VI
Estimates of the GARCH (1,1) with Volume Using the 477 Common Stocks.

The table reports the average estimates of the 477 stocks from January 2004 to December 2006 using following model.

GARCH(1,1) with volume:

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

where R_t *is the rate of return, volume*$_t$ *is daily volume.* $\alpha_0 > 0$ *and* $\alpha_1 + \alpha_2$ *represents persistence of variance. t - statistics are shown in parenthesis below the coefficient estimates.*

Obs.	γ_0	α_0	α_1	α_2	α_3	$\alpha_1+\alpha_2$
327	-0.0004	0.0001	0.0964	-0.0370	17.5834	0.0594
	(-7.38)	(17.98)	(20.73)	(-3.00)	(8.70)	(3.91)

Table VII

Panel A Estimates of the GARCH (1,1) with Absolute Value of the Net Buy Volume by Investor Group Using the 477 Common Stocks by Investor Groups

From January 2004 to December 2006, the transaction data of the 477 common stocks are sorted by ten investor groups, and then the coefficients are estimated using following model by each investor group:

GARCH(1,1) with absolute value of the net buy volume:

$$R_t = \gamma_0 + u_t$$

$$u_t \mid (u_{t-1,} u_{t-2} \ldots) \sim N(0, \sigma_t^2)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \cdot u_{t-1}^2 + \alpha_2 \cdot \sigma_{t-1}^2 + \alpha_3 \cdot Volume_{1,t}$$

where R_t is the rate of return, $Volume_{1,t} = |NBVol_{t,n,s}|$, $|NBVol_{t,n,s}|$ is the absolute value of net buy volume of stock n purchased by group s on day t. 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. $t = 1\ldots,T$, $n = 1\ldots N$, and $s = 1\ldots10$. $\alpha_0 > 0$, and $\alpha_1 + \alpha_2$ represents persistence of variance. t-statistics are shown in parenthesis below the coefficient estimates.

Group	*Obs.*	γ_0	α_0	α_1	α_2	α_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)

Table VII

Panel B Estimates of the GARCH (1,1) with the Excess Buy Volume by Investor Group Using the 477 Common Stocks

From January 2004 to December 2006, the transaction data of the 477 common stocks are sorted by ten investor groups, and then the coefficients are estimated using following model by each investor group:

GARCH(1,1) with excess buy volume:

$$R_t = \gamma_0 + u_t$$

$$u_t \mid (u_{t-1,} u_{t-2} ...) \sim N(0, \sigma_t^2)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \cdot u_{t-1}^2 + \alpha_2 \cdot \sigma_{t-1}^2 + \alpha_3 \cdot Volume_{2,t}$$

where R_t *is the rate of return*, $Volume_{2,t} \equiv Excess\ Buy\ Volume = Max[0, NBVol_{t,n,s}]$. *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* $s = 1...10$. $\alpha_0 > 0$ *and* $\alpha_1 + \alpha_2$ *represents persistence of variance. t - statistics are shown in parenthesis below the coefficient estimates.*

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Group	*Obs.*	γ_0	α_0	α_1	α_2	α_3	$\alpha_1+\alpha_2$
Group1	37	0.0017	0.0001	0.1258	0.7596	17.6294	0.8854
		(11.81)	(5.86)	(10.90)	(27.73)	(3.13)	(43.95)
Group2	38	0.0017	0.0001	0.1260	0.7599	21.7919	0.8859
		(12.46)	(5.54)	(11.34)	(30.42)	(2.72)	(50.14)
Group3	37	0.0015	0.0001	0.1307	0.7190	17.2939	0.8498
		(10.96)	(5.75)	(10.68)	(21.40)	(3.87)	(30.55)
Group4	38	0.0016	0.0001	0.1237	0.7628	25.1536	0.8866
		(13.44)	(5.65)	(9.48)	(28.29)	(3.00)	(46.37)
Group5	38	0.0017	0.0001	0.1239	0.7673	27.1875	0.8912
		(12.59)	(5.35)	(10.88)	(31.74)	(2.51)	(52.77)
Group6	38	0.0016	0.0001	0.1277	0.7488	10.2920	0.8765
		(11.73)	(6.09)	(11.84)	(29.51)	(4.90)	(45.85)
Group7	35	0.0017	0.0001	0.1290	0.7370	16.3627	0.8659
		(11.17)	(5.80)	(10.40)	(24.92)	(2.80)	(39.75)
Group8	37	0.0020	0.0001	0.1304	0.6959	18.8277	0.8263
		(12.71)	(5.94)	(10.73)	(21.55)	(2.01)	(32.10)
Group9	37	0.0015	0.0001	0.1281	0.7081	9.0782	0.8362
		(9.87)	(6.30)	(10.55)	(20.24)	(4.46)	(28.30)

Group10	35	0.0018	0.0001	0.1253	0.7532	170.7646	0.8784
		(11.85)	(5.00)	(9.36)	(26.93)	(2.13)	(48.74)

Table VII

Panel C Estimates of the GARCH (1,1) with Excess Sell Volume by Investor Group Using the 477 Common Stocks

From January 2004 to December 2006, the transaction data of the 477 common stocks are sorted by ten investor groups, and then the coefficients are estimated using following model by each investor group:

GARCH(1,1) with excess sell volume:

$$R_t = \gamma_0 + u_t$$

$$u_t \mid (u_{t-1,}\, u_{t-2} \ldots) \sim N(0, \sigma_t^2)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 \cdot u_{t-1}^2 + \alpha_2 \cdot \sigma_{t-1}^2 + \alpha_3 \cdot Volume_{3,t}$$

where R_t is the rate of return, $Volume_{3,t} \equiv Excess\,Sell\,Volume = -Min[0, NBVol_{t,n,s}]$. 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. $t = 1\ldots,T$, $n = 1\ldots N$, and $s = 1\ldots10$. $\alpha_0 > 0$, and $\alpha_1 + \alpha_2$ represents persistence of variance. t-statistics are shown in parenthesis below the coefficient estimates.

Group	*Obs.*	γ_0	α_0	α_1	α_2	α_3	$\alpha_1+\alpha_2$
Group1	38	0.0017	0.0001	0.1245	0.7641	16.1919	0.8886
		(12.02)	(5.81)	(11.01)	(28.25)	(2.86)	(44.73)
Group2	38	0.0017	0.0001	0.1260	0.7599	21.7919	0.8859
		(12.46)	(5.54)	(11.34)	(30.42)	(2.72)	(50.14)
Group3	38	0.0015	0.0001	0.1296	0.7242	16.8493	0.8538
		(11.18)	(5.71)	(10.82)	(21.87)	(3.86)	(31.20)
Group4	38	0.0016	0.0001	0.1237	0.7628	25.1536	0.8866
		(13.44)	(5.65)	(9.48)	(28.29)	(3.00)	(46.37)
Group5	38	0.0017	0.0001	0.1239	0.7673	27.1875	0.8912
		(12.59)	(5.35)	(10.88)	(31.74)	(2.51)	(52.77)
Group6	38	0.0016	0.0001	0.1277	0.7488	10.2920	0.8765
		(11.73)	(6.09)	(11.84)	(29.51)	(4.90)	(45.85)
Group7	37	0.0016	0.0001	0.1245	0.7487	15.1171	0.8732
		(11.57)	(5.69)	(10.27)	(25.70)	(2.70)	(41.16)
Group8	37	0.0020	0.0001	0.1304	0.6959	18.8277	0.8263
		(12.71)	(5.94)	(10.73)	(21.55)	(2.01)	(32.10)
Group9	37	0.0015	0.0001	0.1281	0.7081	9.0782	0.8362

		(9.87)	(6.30)	(10.55)	(20.24)	(4.46)	(28.30)
Group10	37	0.0017	0.0001	0.1237	0.7614	160.4682	0.8851
		(11.88)	(4.98)	(9.74)	(28.15)	(2.10)	(50.11)

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