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Heterogeneous Investor Behaviors and Market Volatility in the Tokyo Stock Exchange

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Heterogeneous Investor Behaviors and Market Volatility in the Tokyo Stock Exchange[1]

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Abstract

This paper examines the relationship between weekly stock market volatility and trading activities of different investor groups, such as individuals, institutions, and foreigners, in the first section of the Tokyo Stock Exchange. We define investor behaviors as net trading flows and trading fractions in the total trading value at each period. We empirically examine the relationship between market return and different trading activities. For both measures, the trading activity of foreign investors is correlated differently with returns from domestic investors. We investigate the relation between volatility and trading activity. First, we show that the contemporaneous correlations between volatility and foreign investors are significant. Second, the results of dynamic relations show that trading flows of foreign investors are negatively correlated with the subsequent volatility, although fluctuations of the trading share are not associated with the subsequent volatility.

Keywords: Volatility, Trading volume, Foreign investors, Heterogeneous behaviors

JEL classification: G12; G15; C13

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1 Introduction

Stock return volatility is varying over time. This empirical fact has stimulated the research on the econometric models of volatility dynamics and causes of changes in volatility. The autoregressive conditional heteroskedasticity (ARCH) and extended models have been developed in order to explain the persistence of volatility (i.e., volatility clustering) and have provided a good fit for many financial return time series (see, Engle (2004)). On the other hand, how economic and financial variables have influences on volatility has been investigated. Schwert (1989), for example, has analyzed the relation between stock return volatility and macroeconomic volatility, economic activity, financial leverage, and stock trading activity.

Trading volume is one of the measures that provide the degree of trading activity in financial markets. There is extensive evidence on the relation between return volatility and trading volume. Karpoff (1987) cites many studies that document a positive relation between price volatility and trading volume in financial markets. Lamoureux and Lastrapes (1990) enter trading volume directly into the GARCH volatility equation in their analysis of individual stock returns data. Schwert (1989) uses monthly aggregates of daily data and finds a positive relationship between estimated volatility and current and lagged volume growth rates in linear distributed lag regressions and VAR models. [1] Despite so many empirical studies on the volatility-volume relation, there is no general consensus about what actually drives the relation.

In this paper, we empirically investigate whether the difference of investor type have an additional relationship with the stock return volatility. In order to examine the relation between heterogeneous investor behaviors and market volatility, we use weekly trading volume data from the Tokyo Stock Exchange (TSE). The data of *Trading by Type of Investors* is coprised of shares traded and their yen value for both buy and sell trades for each investor type. The TSE categorizes the brokerage trading of member of

[1] Various theoretical models are proposed to explain this relation. These include mixture of distributions models (Clark, 1973), asymmetric information models, and differences of opinion models. "An appealing explanation for the presence of ARCH is based upon the hypothesis that daily returns are generated by a mixture of distributions, in which the rate of daily information arrival is stochastic mixing variable. (Lamoureux and Lastrapes, 1990, p.221)"

securities companies by classifying in those by individuals, foreigners, corporations and securities costomers. This categorization of investors can make detailed examination of volatility-volume relation. It is natural to raise a question: Do different types of investors have different effects on stock price dynamics, or are ther any different relation between volatility and trading activities of different categories?

Recent empirical studies, mainly in behavioral finance, have found that different investor types follow different trading patterns. The traders who have different trading patterns are categorized by trend-chasing (or momentum) traders and contrarians. Trend-chasing traders follow the trend of price changes, that is, they buy stocks when the price increases and sell when the price decreases. On the other hand, contrarians sell stocks when the price falls and buy when the price rises. A lot of empirical studies have found that individual investors trade in a contrarian pattern while foreign investors follow the price trend. For example, Kamesaka et al. (2003) and Bae et al. (2008) investigate the trading behaviors of different investor types in TSE. The evidence that foreign investors trade like trend-chasers can be found in a series of papers such as Brennan and Cao (1997), Choe et al. (1999), Froot et al. (2001) and Boyer and Zheng (2009).

Theoretical literature suggests that heterogeneous behaviors can amplify market volatility. A noisy rational expectations model of Wang (1993) suggests that volatility increases with non-informational or liquidity-driven trading. In this model, trades of uninformed traders are positively correlated with returns so they behave *like* trend-chasers. De Long et al. (1990) predict that the interaction between positive feedback traders and rational (forword-looking) speculators can increase volatility. In addition, interacting agent models like Kirman (1991) analyze price stability based on fundamentalist/chatist models. In his model, fundamentalists trade assets beased on their accurate knowledge about funadamentals, while chartists trade assets based on their technical analysis on recent price movements. The model shows when chartists dominates the market, the volatility of the exchange rate is high. Based on theoretical predictions, we can predict that the increase in fraction of trend-chasing traders associates with the increase in market volatility. Therefore, the main aim of this paper is to examine the relation between market voatility

and the fraction or intensisty of trades of trend-following traders.

Empical study of contemporaneous relation between volatility and trading activity of foreigners finds that high market volatility associates with high trading share of foreign investors and negative net trading flows. In other words, when the presence of foreign investors is large or foreign investors are net sellers, the market volatility is high. Our paper is related to the two existing papers by Hamao and Mei (2001) and Bae et al. (2008) that also analyze stock return volatility and different investor types. Hamao and Mei (2001) investigate the impact of foreign trading on market volatility by using monthly data from 1974 to 1992. They define tradings of different types as absolute values of net purchases, purchases, or sales (all divided by market capitlaization), and their empirical result shows that there is no evidence supporting the following claim: "Trading by forign investors tends to increase market volatility more than trading domestic investors. (Hamao and Mei, 2001, p.715)" Bae et al. (2008) identify who supplies and demands market liquidity and examine the relation between market volatility and trades of different investor types. They state that different investor groups have different effects on the market liquidity, then market volatility fluctuates significantly depending on which investor types participate in trades. Different from these two papers, we consider the *asymmetric volatility effect* in the analysis of volatility dynamics. Over the past several decades researchers have documentsd strong evidence that volatility is asymmetric in equity market: negative returns are generally associated with upword revisions of the conditional volatility while positive returns are associated with smaller upward or even downword revisions of the conditional volatility. This paper finds that, taking account of foreign trading flows and shares, the asymmetric volatility effect disappears.

The remainder of the paper is organized as follows. In section 2, we explain the data that we use in empirical studies. In section 3, we examine correlation between returns and trading activities by different investor groups in order to capture different patterns of investors. In section 4 explains the empirical results of relationship between volatility and investors behaviors. Section 5 is a conclusion in our study.

2 Data and Measures of Trading Behaviors

2.1 Trading Behaviors and Stock Return Volatility

Data soursce of trading activity in this study is *Trading by Type of Investors* obtained from the Japan Exchange Group. Trading volume and their yen value, i.e., trading value, for both buy and sell trades for each investor type are available from February 2008 to the present. The data cover all trades of brokered by member scurities companies of TSE with a capitalization of at least 3 billion yen. The TSE categorizes the brokerage trading of member of securities companies by classifying in those by individuals, foreigners, corporations and securities costomers. Corporations are decomposed into finer categories; investment trusts, business costomers, financial institutions and others. This study focuses on trading behaviors of individuals, foreigners, corporations and securities costomers.

This paper mainly use the data of trading value of each investor. Both purchasing and selling values are described in Figure 1 to 4. These figures show differences and similarities of trading activities among different investor types. A remarkable feature of time-series of all trading values is a surge after the late of 2012, that is, after "Abenomics" and "Kuroda easing", as explained later. The peak of trading values is in the late of May 2013 when stock price crashed[2]. After that, trading values of indiviuals and financial costomers have decreased, while those of corporations and foreigners have increased. These figures suggest that different investors have different trading activities.

The price data we use is the closing level of the TOPIX (Tokyo Stock Price Index) at daily frequency. Sample period is from Februrary 4, 2008 to Februrary 26, 2016. The purpose of the paper is to examine the relation between stock return volatility and trading behaviors of different investor types, and the data of trading activities is available at weekly frequency, so we calculate and estimate the volatility of stock returns at the same frequency. In order to calculate the weekly volatility, the raw price index series, P_τ, is differenced in the logs to create the raw price change series, $r_\tau \equiv \log P_\tau - \log P_{\tau-1}$.

[2]Stock price aggresively decreased on May 23, 2013.

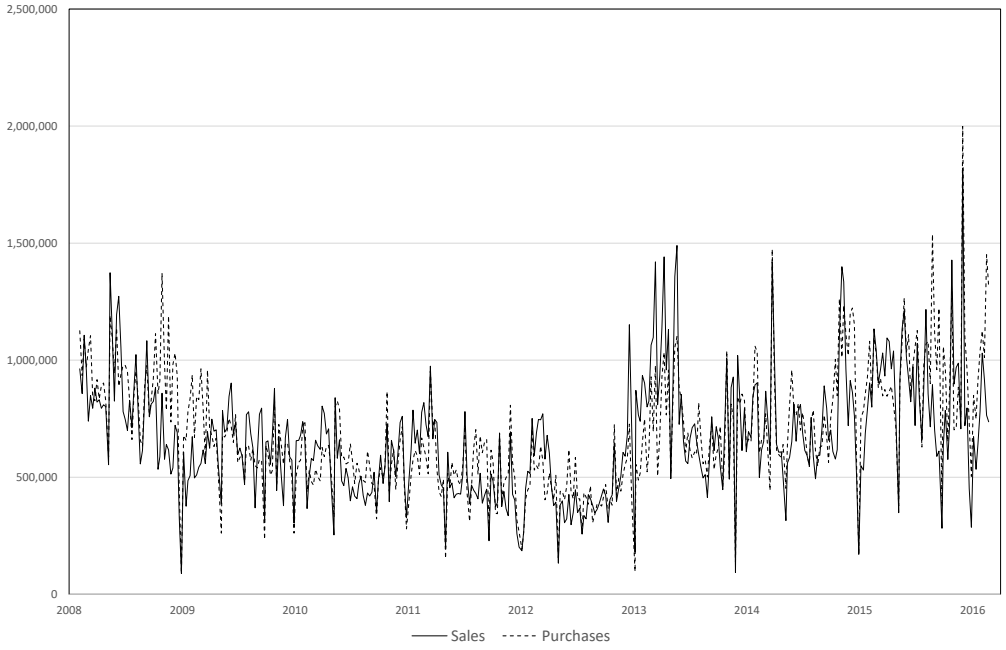

Figure 1: Trading value of corporations

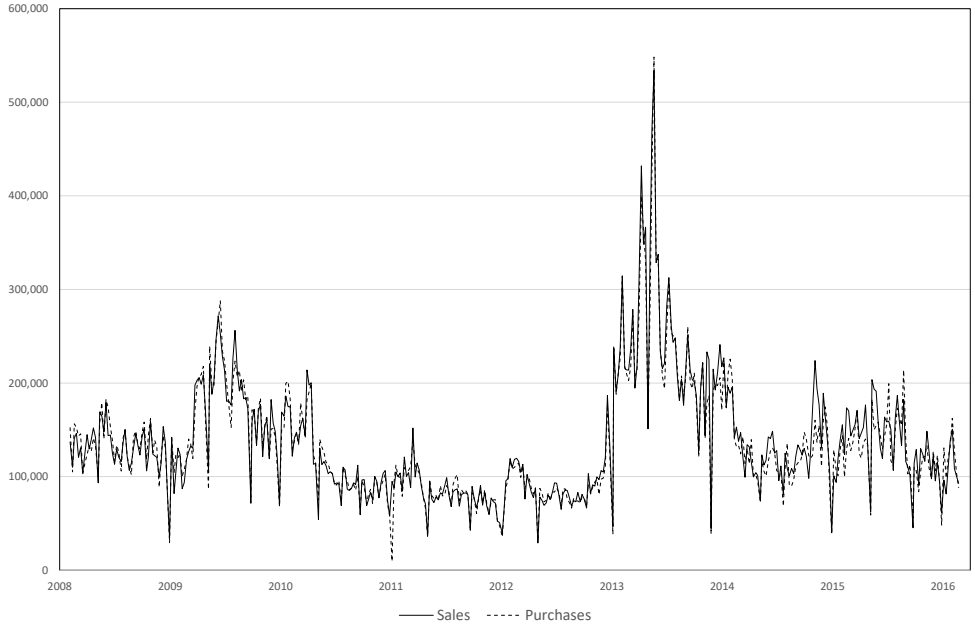

Figure 2: Trading value of financial costomers

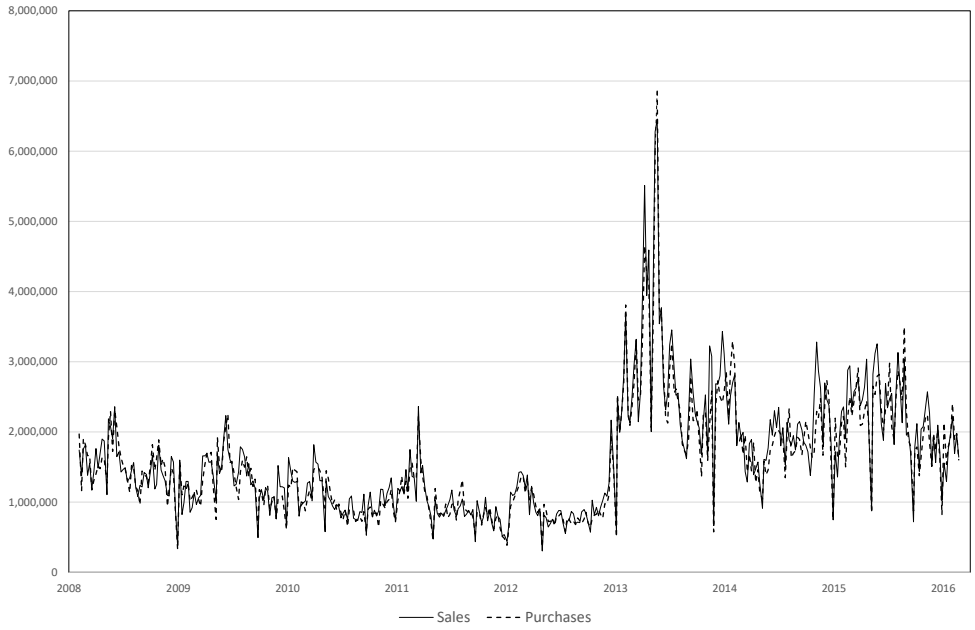

Figure 3: Trading value of individuals

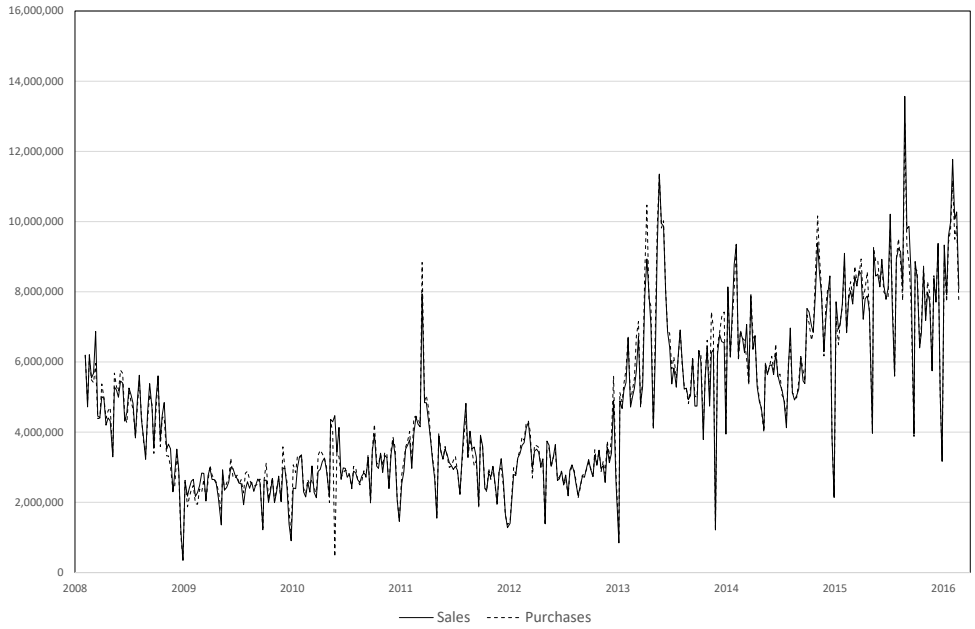

Figure 4: Trading value of foreigners

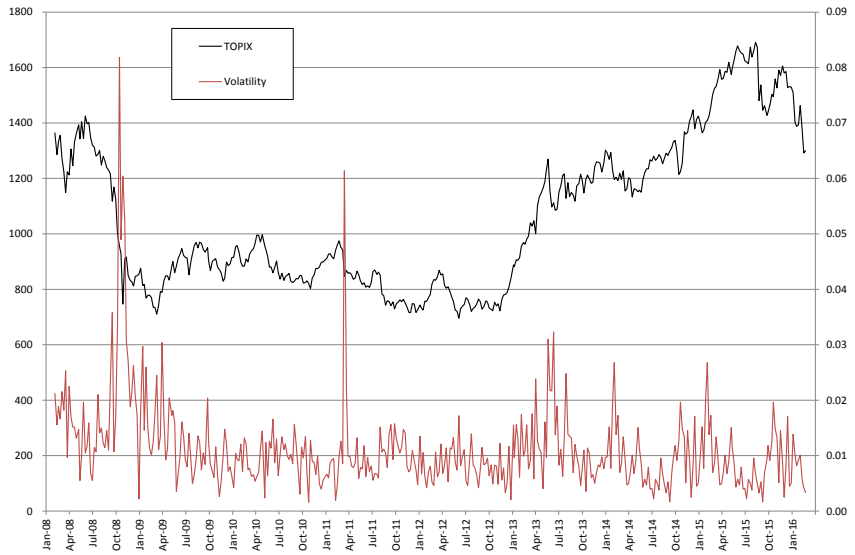

Figure 5: TOPIX and weekly realized volaility: From February 2008 to February 2016. Weekly realized volatility is calculated by equation (1).

The weekly realized volatility, defined as RV_t, at time period t is calculated by

$$RV_t = \sqrt{\frac{1}{N_t} \sum_{\tau=\tau_t}^{\tau_t+N_t-1} r_\tau} \tag{1}$$

where N_t is the number of trading day in the week t, and τ_t is the first day of the week. It means standard deviations of daily returns within a week. Figure 5 shows the dynamics of TOPIX and the volatility of its return. The volatility has significantly high levels after the collapse of Lehman Brothers in 2008 and the Earthquake in 2011. During other periods, the volatility fluctuates over time.

We also use weekly returns of the TOPIX in the volatility analysis in order to investigate the asymmetric volatility. Here, we calculate weekly stock returns, R_t, of the week t by using the closing level of the last day of the current week and the previous week.

Table 1: Correlations: Total trading values and trading values by different investor types.

	Corporations	Security Firms	Individuals	Foreigners
$Corr(V_t, V_t^i)$	0.87	0.64	0.88	0.94

2.2 Measures of Trading Behaviors

In this subsection, we investigate the different measures of trading behaviors of different investor groups. As shown in Figure 1 to 4, both purchasing and selling values move in a similar pattern for each trading group. In order to capture the differences between investor groups, we define several measures of trading behaviors. At first, we define the trading values of each investor type as follows:

$$V_t^i \equiv \frac{1}{2}(\text{Purchacing Value}_{i,t} + \text{Selling Value}_{i,t}), \tag{2}$$

where $i(\in I)$ indicates investor groups and let I denote as the set of investor groups: corporations, security firms, individuals and foreigners, that is, average values of purchasing and selling values. Trading values as definition 2 simply show the values traded by each investor group within a week.

The data of Trading by Type of Investors also has the data of total trading values in the first section of TSE, i.e., the total values of shares traded in the first section of TSE. Total trading values V_t are comprised of values of all brokered trading (by above four groups) and proprietary trading (by security firms). The literature of the volume-volatility relation usually uses trading volume, trading value and turnover as measures of trading activities in stock markets. Our purpose is to examine whether there is an additional effect of differences in trading behaviors. Trading values of different investor types are significantly correlated with the total trading value (see Table 1). For this reason, trading values are insufficient to capture the heterogeneity of investors.

In order to capture the different trading patterns of investor groups, we introduce net trading flows (or net purchasing values) which are calculated by

$$NTF_t^i \equiv \text{Purchasing Value}_{i,t} - \text{Selling Value}_{i,t}$$

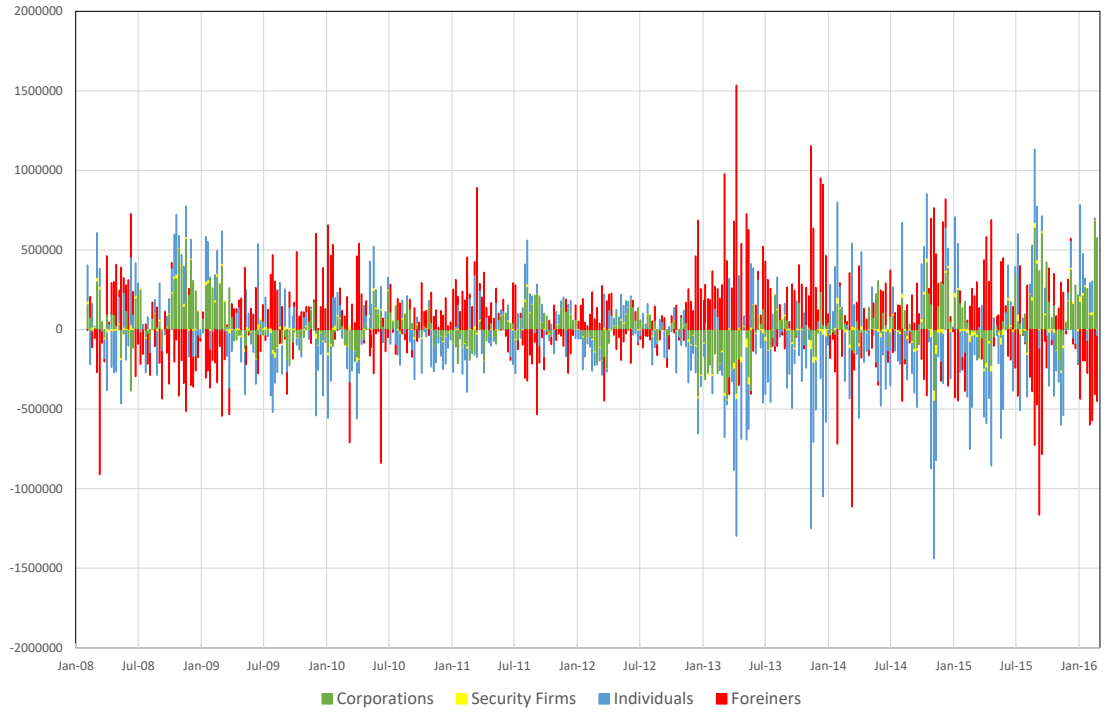

Figure 6: Weekly net purchasing values (million yen) of different investor types in the 1st section of Tokyo Stock Exchange: Februrary 2008 through Februrary 2016. Investor types include foreign investors, individuals, security firms and institutions. *Source*: Japan Exchange Group.

for investor type $i \in I$. Net trading flows represent imblances between amounts to buy and to sell stocks. When $NTF_t^i < 0$, investor type i is net seller at time period t. When $NTF_t^i > 0$, investor type i is net buyer at time period t. Figure 6 shows weekly net trading flows of different investor types and apparent heterogeneity between domestic and foreign investors. Figure 7 also shows monthly net purchasing values of each individual investor groups. These figures clearly show that the periods of being net buyer (or net seller) tend to continue for several months.

Figure 8 to 11 show the evolution of TOPIX and the net trading flows of each different investor group. These figures show some striking patterns of trading behaviors. For example, in figure 8, the net trading flow of institutions has a strong cyclicality: When price index rises, institutions tend to sell stocks, and vice versa. Likewise, security firms

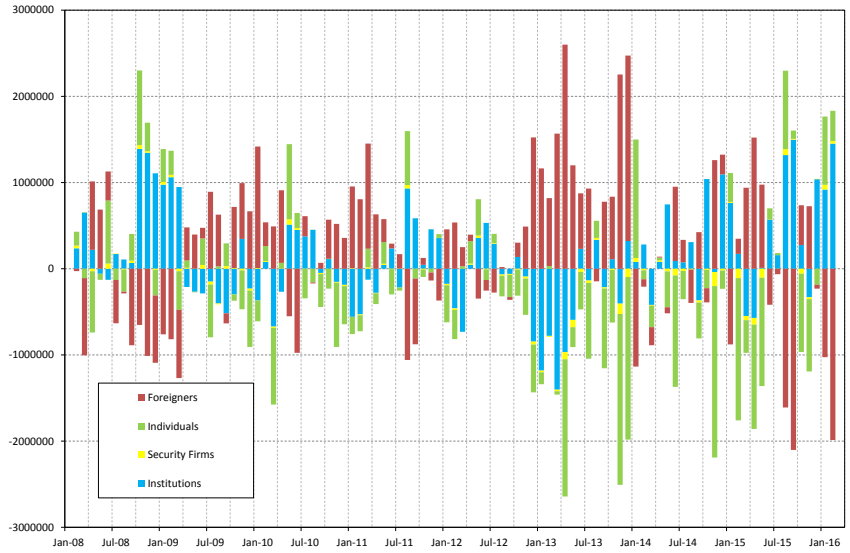

Figure 7: Monthly net purchasing values (million yen) of different investor types in the 1st section of Tokyo Stock Exchange: Februrary 2008 through Februrary 2016. Investor types include foreign investors, individuals, security firms and institutions. *Source*: Japan Exchange Group.

and individuals has the same patterns as institutions but relationships between net flows and price are weak (Figure 9 and 10). On the other hand, the net trading flow of foreigners has an adverse relation to domestic investors (Figure 11). When price index rises, foreigners tend to buy stocks, and vice versa.

Figure 11 also shows the recent experience of "Abenomics" since the late of 2012. Since the late 2012, Japanese stock prices started to rise and the yen started to weaken outstandingly. In this period, Shinzo Abe, the President of Japan's Liberal Democratic Party at that time, started to place unprecedentedly strong pressure on the Bank of Japan to ease monetary policy aggressively. The BOJ responded in early April 2013 by announcing "Quantitative and Qualitative Easing" (QQE). Such a series of events regarding monetary policy has created sharp responses of asset prices. Behind the rise of asset prices, foreign investors have bought aggressively stocks in response to Abenomics and monetary easing, while domestic investors (individuals and corporations) have stayed on the sideline (Ueda, 2013; Fukuda, 2015). Foreign investors have been large net buyers during the period. One may speculate that investors differently interpret the effectiveness

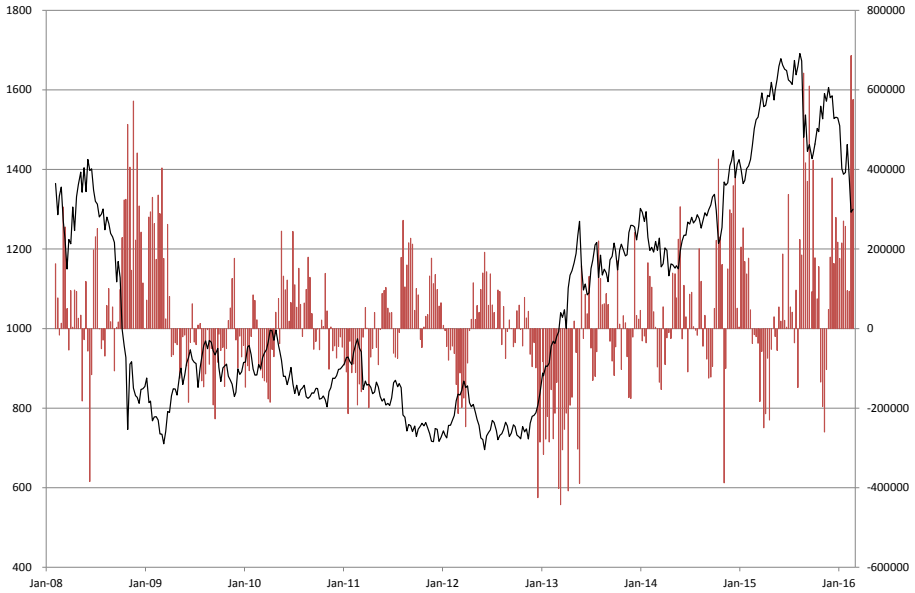

Figure 8: TOPIX (black line; left axis) and net puchasing value (million yen) of institutions (red bar; right axis) in the 1st section of Tokyo Stock Exchange: February 2008 through February 2016. *Source*: Japan Exchange Group.

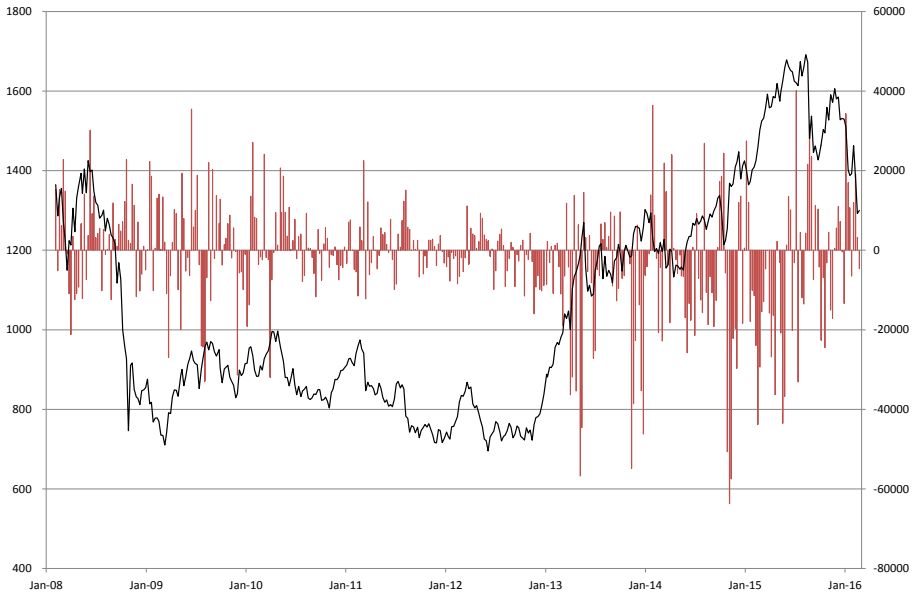

Figure 9: TOPIX (black line; left axis) and net puchasing value (million yen) of security firms (red bar; right axis) in the 1st section of Tokyo Stock Exchange: February 2008 through February 2016. *Source*: Japan Exchange Group.

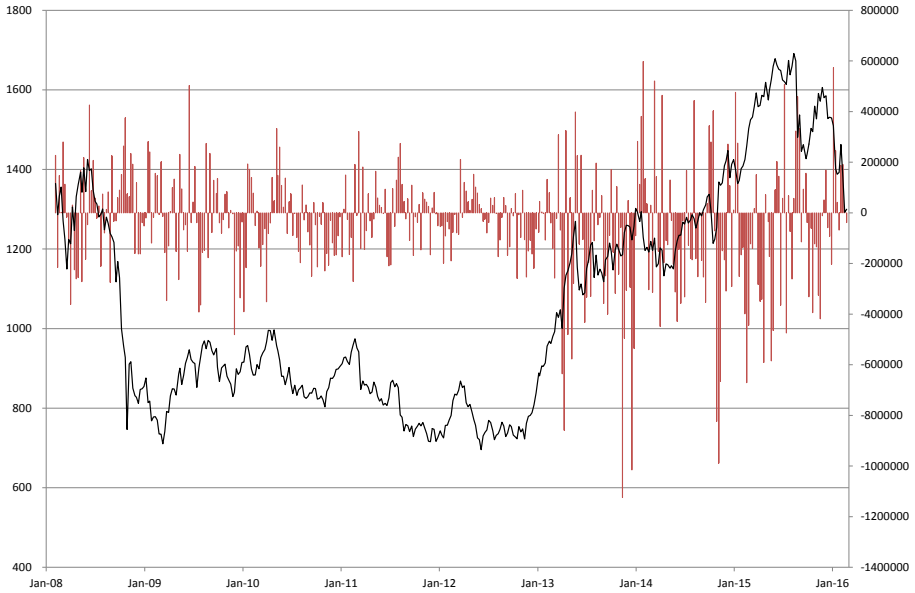

Figure 10: TOPIX (black line; left axis) and net puchasing value (million yen) of individuals (red bar; right axis) in the 1st section of Tokyo Stock Exchange: February 2008 through February 2016. *Source*: Japan Exchange Group.

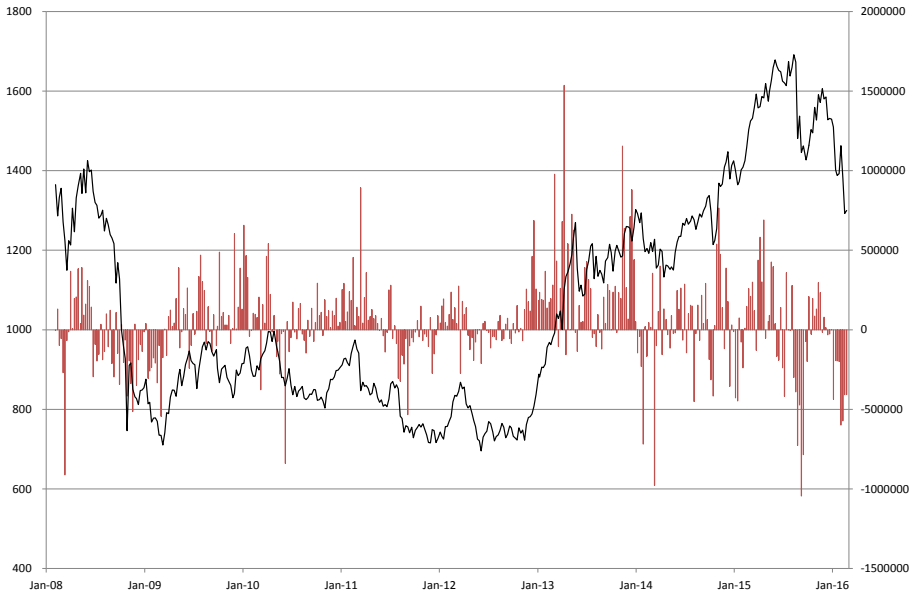

Figure 11: TOPIX (black line; left axis) and net puchasing value (million yen) of foreigners (red bar; right axis) in the 1st section of Tokyo Stock Exchange: February 2008 through February 2016. *Source*: Japan Exchange Group.

of monetary policy and have different expectations after Abenomics and Kuroda easing. Accordingly, the Japanese stock market has been characterized by heterogeneous trading behaviors of foreign and domestic investors.

The interrelation between stock returns and investment flows of domestic and foreign investors has been investigated for several decades. Empirical studies suggest that foreign investors behave like trend-followers and domestic investors behave like contrarians: Flows from foreign investors are positively correlated with contemporaneous returns while flows from foreign investors are negatively correlated with contemporaneous returns. Brennan and Cao (1997) provide an information based explanation of trend-chasing behaviors of foreign investors. They argue that, if foreign investors are less informed relative to domestic investors, foreign investors need to gather more information from market prices. Therefore, when prices of domestic stock rises, foreign investors tend to buy more, which generate trend-following patterns.[3]

The second measure of trading behaviors of different investors group is a *share of trading volume*. The share of each type is calculated by

$$S_t^i = \frac{(\text{Purchasing Value}_{i,t} + \text{Selling Value}_{i,t})/2}{\text{Total Trading Value}_t}.$$

Figure 8 shows the evolution of shares of investor types in trading volumes.

Trading share is the proportion of trading volume of each invetor type to total trading volume. Because this study uses value-weighted trading volume (i.e., the unit is yen), the definition of trading shares are transformed as follows:

$$\begin{aligned} S_t^i &= \frac{(\text{Purchasing Value}_{i,t} + \text{Selling Value}_{i,t})/2}{\text{Market Capitalization}_t} \Big/ \frac{\text{Total Trading Value}_t}{\text{Market Capitalization}_t} \\ &= \frac{\text{Trading Value}_{i,t}}{\text{Market Capitalization}_t} \Big/ \frac{\text{Total Trading Value}_t}{\text{Market Capitalization}_t} \\ &= \frac{\text{Turnover}_{i,t}}{\text{Turnover}_{M,t}} \end{aligned}$$

where $\text{Turnover}_{i,t}$ is turnover ratio of each investors group and $\text{Turnover}_{M,t}$ is market-level

[3]See also Brennan et al. (2005) for theoretical study. Froot et al. (2001) investigate daily international portfolio flows and their relationship with equity returns.

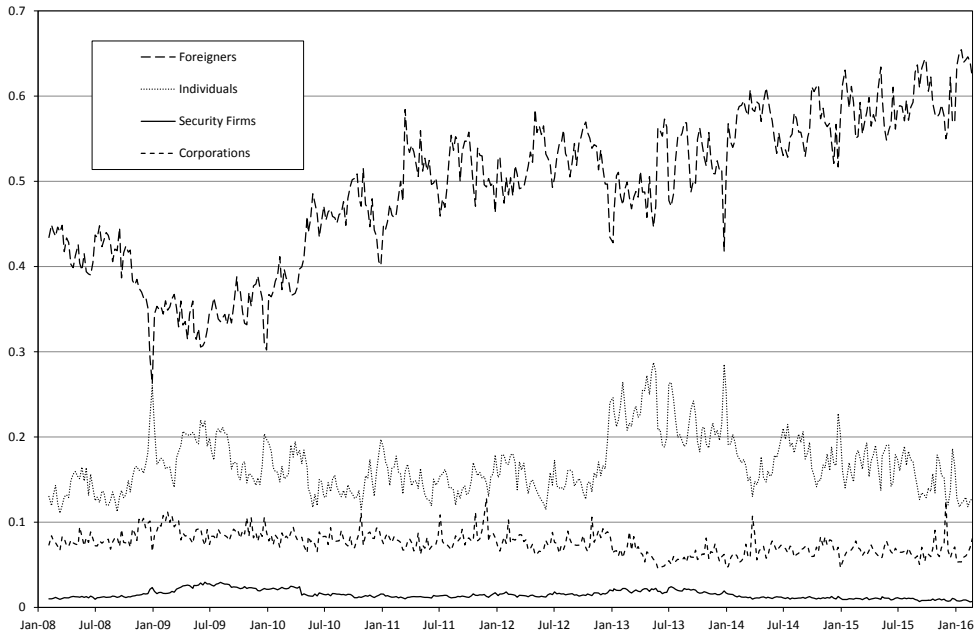

Figure 12: Shares in trading volumes of different investor types in the 1st section of Tokyo Stock Exchange: February 2008 through February 2016. Investor types include foreign investors, individuals, security firms and institutions. *Source*: Japan Exchange Group.

turnover ratio. The last expression means that the trading share indicates the ratio of turnover of each investors group to the market level turnover. Turnover is caluculated by dividing the total number of shares traded over a period by the average number of shares outstanding for the period. It represents the degree of trading activity relative to market size. Thus, the measure of trading share indicates the degree of contribution by each investor type to the trading activity in the entire market. Equivalently, trading share represents the participation rate of each type in the transactions. Therefore, when the trading share of one investor group is high, the partitipation rate or the intensity of trade in the market is high.

The time series of trading values shows nonstationarity (see, Andersen (1996) and Lo and Wang (2000)). We use the method of four-lag moving-average nomalization (Lo and

Table 2: Summary statistics and unit root test.

	Summary statistics				Unit root test
	Mean	Std. dev.	Skewness	Kurtosis	ADF-stat.
Market return ($\times 10^2$)	-0.0024	3.1131	-1.25	9.44	-20.30*
Total Trading Value ($\times 10^{-6}$)	9.2900	3.6516	0.61	3.11	-3.15
a. Net trading flows ($\times 10^{-6}$)					
Corporations	0.0267	0.1670	0.52	4.50	-3.70*
Security Firms	-0.0020	0.0145	-0.79	5.32	-7.18*
Individuals	-0.0477	0.2300	-0.70	5.59	-7.48*
Foreigners	0.0450	0.2793	0.28	6.84	-5.25*
b. Trading shares					
Corporations	0.08	0.01	0.53	3.72	-4.58*
Security Firms	0.02	0.01	0.86	2.98	-2.34
Individuals	0.17	0.03	0.62	3.86	-2.98
Foreigners	0.49	0.09	-0.38	2.22	-3.39

* : p-value < 0.05

Wang (2000)) as follows:

$$\hat{V}_t = \frac{V_t}{(V_{t-1} + V_{t-2} + V_{t-3} + V_{t-4})/4} \tag{3}$$

where V_t is trading volume at time period t and $\hat{V}_t$ is detrended trading volume.[4] Trading shares also show nonstationarity as shown in Table 2. The result of the augmented Dickey-Fuller (ADF) test are reported in Table 2. The hypothesis of unit root process are not rejected for all series except for individuals. Thus, we also adjust time-series of trading shares by using the same method:

$$\hat{S}^i_t = \frac{S^i_t}{(S^i_{t-1} + S^i_{t-2} + S^i_{t-3} + S^i_{t-4})/4} \tag{4}$$

Table 2 also shows some statistics of market returns, trading values, net trading flows and trading shares.

[4]Lo and Wang (2000) introduce several detrending procedures and their characteristics in the weekly frequency.

3 Relationship between Return and Heterogeneous Trading Activity

3.1 Contemporaneous Correlations

In the previous section, we introduced two measures of trading behaviors for different investors gourps: Net trading flows and trading shares. Before moving on empirical analysis about the relation between volatility and these measures, we discuss the relation between these measures and stock returns and highlight the heterogeneity in trading behaviors.

Table 3 shows correlations between returns and trading activities of different investor groups. Panel a in Table 3 shows the contemporaneous correlations between returns and trading flows of different investor groups. Returns are positively correlated with domestic investors (coporations, security firms and individual investors) and negatively correlated with foreign investors. Accordingly, flows of foreign investors are negatively correlated with those of other groups. This result suggests that (i) foreign investors buy stocks on balance when stock prices rise and vice versa, and (ii) domestic investors tend to be the counterparty of foreign investors for trading in TSE.

Panel b shows correlations between returns and trading shares of different investor groups. Returns are positively and siginficantly correlated with trading shares of security firms and individuals, and negatively and significantly correlated with that of foreign investors. In other words, foreign investors tend to trade stocks more intensively when stock prices decrease rather than when prices rise.[5] This positive correlation is reffered as "trend-chasing" behaviors. On the other hand, domestic investors have negative correlations with current returns, thus they are "contrarians" in the sense that they tend to purchase stocks on balance when prices fall. These result shows that there is a different relations between returns and trading behaviors of domestic investors and foreign investors.

[5]It should be noted that adjusted trading shares used in statistical analysis are defined as the difference between a share in trading value and its trend (four-lags moving average). Therefore, we can interpret the positive correlation as an association of positive returns and increases in shares from the trend.

By definition, when a share in trading volume of one group increaces, shares of other groups decrease. Thus, one can predict that all shares of trading values have negative correlations. The result shows that the degrees of correlations is different across groups. Corporations have no correlations with other domestic investor groups but negative correlation with foreiners. Security firms have a positive correlation with individuals but a negative correlation with foreigners, and individuals have a positive correlation with foreigners. The share of foreigners is positively correlated with those of security firms and individuals, therefore, when a foreigners' proportion rises, both proportions of individuals and security firms decrease. Accordingly, the correlation between shares of security firms and individuals is positive.

Panel c shows the correlations between the net trading flow and the trading share for each investor groups. These two variables of all groups except corporations are negatively correlated with each other. Thus, for three groups, we can speculate that, when they are net buyers, their shares in trading values decrease. They tend to trade more intensively when they sell stocks on balance rather than when they buy stocks on balance.

It should be noted that the nature of high correlations involves a multicollinearity problem if we use all variables as regressors. Therefore, we use only trading behaviors of foreigners to avoid multicollinearity problem in the following regression analysis.

3.2 VAR model

Next, we employ the VAR model for return and each measure for trading activity by following Boyer and Zheng (2009) and Kamesaka et al. (2003). Boyer and Zheng (2009) investigate the interaction between return and net trading flows of different investor groups by using first-order VAR model. Kamesaka et al. (2003) estimate coefficients of bivariate VAR model of TOPIX returns and net investment flows for each investor groups in order to avoid multicollinearity problem because of large correlations between flows.

We use VAR model in order to study the interaction of market return and trading

Table 3: Correlations

a. Correlations: Net trading flow.

	Return	Corporations	Security Firms	Individuals	Foreigners
Corporations	-0.3500*	1.0000			
Security Firms	-0.2820*	0.2687*	1.0000		
Individuals	-0.2576*	0.2652*	0.9187*	1.0000	
Foreigners	0.2728*	-0.5889*	-0.6923*	-0.7153*	1.0000

* indicates that p-value < 0.01.

b. Correlations: Shares in (detrended) trading volume.

	Return	Corporations	Security Firms	Individuals	Foreigners
Corporations	0.0483	1.0000			
Security Firms	0.3034*	-0.0346	1.0000		
Individuals	0.3914*	-0.0369	0.7401*	1.0000	
Foreigners	-0.3589*	-0.3359*	-0.5387*	-0.6587*	1.0000

* indicates that p-value < 0.01.

c. Correlations: Net trading flows and shares in (detrended) trading volume.

	Corporations	Security Firms	Individuals	Foreigners
$Corr(NTF^i, \hat{S}^i)$	0.10	-0.21	-0.39	-0.17

activity of different investor groups. The general form of the VAR model is

$$\mathbf{Y}_t = \boldsymbol{\alpha} + \boldsymbol{\beta}\mathbf{Y}_{t-1} + \mathbf{e}_t \tag{5}$$

where $\mathbf{Y}_t$ is a 2×1 vector, $\boldsymbol{\alpha}$ is a 2×1parameter vector, $\boldsymbol{\beta}$ is a 2×2 parameter matrix, and $\mathbf{e}_t$ is a 2×1 vector of residuals. Random variables in $\mathbf{Y}_t$ include market return and measures of trading activity of one investor group: corporations, financial firms, individuals and foreigners.

Estimation results for the VAR model which includes net trading flows of four investor types are give in Table 4. First, net trading flows of all investor types exhibit a positive autocorrelation. Trading flows of all investor types are significantly related to their own previous trading flows. Second, only a coefficient of lagged returns on flows of corporations is statistically significant and negative. This result that behaviors of corporations are contrarian in the sense that they tend to purchase stocks on balance after stock prices decline. Other investors flows have no significant relations with first lagged returns, thus they do not follow feedback trading intertemporally at a weekly frequency.

Estimation results for the VAR model which includes adjusted trading shares of four investor types are given in Table 5. The result is similar to the case of net trading flows. First, all adjusted trading shares of different investor groups are positively autocorrelated. The intensity of trading by all investor types persists to the subsequent periods. Second, the trading share of corporations is correlated with past returns negatively and significantly. Correlations of oher shares with past returns are not statistically significant, thus we cannat reject the hypothesis that past returns have no effects on the current trading shares.

In summary, both measures of trading activities by different investor types are posively autocorrelated but have no correlation with past returns (except corporations). Trading activities persist to the subsequent periods. Contemporaneous correlations obtained in the previous subsection suggests that returns are significantly correlated with trading activities. In the case of trading flows, the correlations of returns with domestic investors are negative while that with foreign investors is positive. In the sense of intra-period,

Table 4: VAR estimates: Dependent variables include net trading flows and returns

Dep. Var.	Parameters (Std. Err.)						Adjusted R^2
	Const.		R_{t-1}		NTF^i_{t-1}		
Corporations							
R_t	0.0006	(0.0016)	-0.1767***	(0.0513)	-0.0318***	(0.0105)	0.0312
NTF^C_t	0.0098	(0.0060)	-0.4247**	(0.1884)	0.6526***	(0.0388)	0.4603
Security firms							
R_t	-0.0028**	(0.0013)	-0.2819***	(0.0421)	-1.3271***	(0.0985)	0.3102
NTF^S_t	-0.0013**	(0.0006)	-0.0043	(0.0202)	0.3630***	(0.0474)	0.1303
Individuals							
R_t	-0.0043***	(0.0013)	-0.2776***	(0.0404)	-0.0894***	(0.0059)	0.3551
NTF^I_t	-0.0346***	(0.0110)	-0.0858	(0.3271)	0.2877***	(0.0483)	0.0807
Foreigners							
R_t	-0.0026*	(0.0014)	-0.2472***	(0.0451)	0.0558***	(0.0055)	0.2055
NTF^F_t	0.0257**	(0.0125)	0.1187	(0.3784)	0.4216***	(0.0462)	0.1763

Significane at the 1%, 5%, 10% levels is indicated respectively by ***, **, *.

domestic investors are contrarians and foreign incestors are trend-chasers. On the other hand, in the case of adjusted trading flows, the correlations of returns with domestic investors are positive while that with foreign investors is negative. This result suggest that, foreign investors trade more actively during the periods of rises in prices than those of falls in preces. For both measures, a trading behavior of foreign investors has unique relations with current returns, therefore we use measures of foreigners in the subsequent analysis in order to avoid multicollinearity problems.

4 Empirical Study: Volatility and Heterogeneous Trading Behaviors

4.1 Contemporaneous Correlation

The relationships between volatility and trading activity have been examined empirically for a long time. The result is that there is a positive contemporaneous correlation between volume and volatility. In other words, when trading activity is large, volatility

Table 5: VAR estimates: Dependent variables include adjusted trading shares and returns

Dep. Var.	Parameters (Std. Err.)						Adjusted R^2
	Const.		R_{t-1}		$\hat{S}^i_{t-1}$		
Corporations							
R_t	-0.0395***	(0.0122)	-0.1192**	(0.0481)	0.0394***	(0.0121)	0.0326
$\hat{S}^C_t$	0.8602***	(0.0493)	-0.4125**	(0.1935)	0.1430***	(0.0487)	0.0248
Security firms							
R_t	-0.0555***	(0.0166)	-0.1633***	(0.0504)	0.0555***	(0.0165)	0.0342
$\hat{S}^S_t$	0.5759***	(0.0470)	0.0046	(0.1430)	0.4242***	(0.0468)	0.1760
Individuals							
R_t	-0.0931***	(0.0147)	-0.2376***	(0.0504)	0.0928***	(0.0145)	0.0966
$\hat{S}^I_t$	0.5221***	(0.0475)	-0.0803	(0.1633)	0.4799***	(0.0471)	0.2185
Foreigners							
R_t	0.1602***	(0.0291)	-0.2112***	(0.0503)	-0.1597***	(0.0289)	0.0757
$\hat{S}^F_t$	0.5256***	(0.0468)	0.0401	(0.0809)	0.4759***	(0.0466)	0.2152

Significane at the 1%, 5%, 10% levels is indicated respectively by ***, **, *.

is also large. We develop the study of a volume-volatility relation by entering trading activities by different investor groups. In this section, we estimate the contemporaneous correlations between volatility and trading behaviors of different investor groups. Second, we estimate dynamic relation of volatility with trading behaviors of foreign investors.

At first, we examine the comtemporaneous correlation between volatility and trading activity of foreign investors. In order to estimate the correlation between those variables, we employ a simple model of regression:

$$\log h_t = \phi + \theta X^F_t + \psi \log h_{t-1} + \delta \hat{V}_t + \eta_t. \tag{6}$$

where h_t is market volatility at time t estimated by RV_t, X^F_t is a variables that reparesnts a trading activity of foreigners, $\hat{V}_t$ is an adjusted trading volume and η_t is residuals. We adopts net trading flows NTF^F_t and trading shares $\hat{S}^F_t$ as trading activities of foreign investors. As studied in existing literature, volatility is correlated with the trading volume and the past volatility, thus we include the trading value and the lagged volatility as control variables.

Table 6: Estimated parameters of the contemporaneous relation between volatility and foreign investors.
Dependent variable is logarithm of weekly realized volatility. Explanatory variables are a lagged dependent variable, an adjusted trading volume, and trading activity of foreignes: a net trading flow and a trading share. Newey-West corrected standard errors are reported in parenthesis below the coefficients. Data cover February 2008 to February 2016. (421 observations)

Variable	Coefficient (Std. Err.)	
Intercept	-3.0857***	-4.7849***
	(0.2238)	(0.4524)
Lagged log volatility	0.4163***	0.4476***
	(0.0432)	(0.0424)
Trading volume	0.3882***	0.2841***
	(0.1060)	(0.1055)
Net trading flow of foreigners	-0.4402***	
	(0.0904)	
Trading share of foreigners		1.9236***
		(0.0424)
Adjusted R^2	0.2554	0.2556

Significance at the 1%, 5%, 10% levels is indicated respectively by ***, **, *.

The estimated parameters of regressions are reported in Table 6. First, the coefficient of net trading flows of foreigners is negative and statistically significant. Volatility is low when net trading flows of foreigners are positive, that is, when foreigners are net buyers. According to the result of the previous section, foreigners buy stocks on balance when stock prices rise. Therefore, volatility falls during the periods of rises in prices.

Second, the coefficient of trading shares of foreigners is positive and statistically significant. This result suggests that volatility is high when trading shares of foreigners increase, that is, when foreigners trade stocks more actively. Contemporaneous correlation between returns and trading shares shows that the share of foreigners increases when stock prices fall. Therefore, volatility rises during the periods of falls in prices.

4.2 Volatility Dynamics

In this subsection, we estimate dynamice relation between volatility and trading activities of foreigners. Empirical studies of volatility dynamics have developed the models focusing only on return and volatility dynamics such as GARCH and SV models (Engle, 2004; Taylor, 2011). In addition, for the purpose of studying the relationships between volatility and trading activities, researchers have developed different specifications of volatility dynamics (for example, Schwert, 1989; Andersen, 1996; Avramov et al., 2006). We investigate the volatility dynamics by entering the past trading activity of foreigners into volatility equations.

In addition, we also consider the asymmetric volatility effects. Over the past several decades researchers have documentsd strong evidence that volatility is asymmetric in equity market: negative returns aregenerally associated with upword revisions of the conditional volatility while positive returns are associated with smaller upward or even downword revisions of the conditional volatility. Nelson (1991) constructs exponential GARCH (or EGARCH) model to capture a such negative relation between past return and current volatility. We follow volatility equations with asymmetric relationship between market return and volatility by following the model of Avramov et al. (2006).

At first, we explain the general form which includes measures of trading behaviors of foreign investors. It should be noted that each trading behavior of different investor groups is correlated with each other, and thus, multicollinearity problem occurs if we include all trading flow variables in regression equations. Therefore, we focus on the behavior of foreign investors in this section.

The weekly aggregate return is first regressed on its own first lags using the spesification

$$R_t = \alpha + \beta R_{t-1} + \gamma X_t^F + u_t \tag{7}$$

where R_t is the market return on period t and Z_t^F is the measure of trading activity by foreigners: net trading flow or share of trading volume. h_t is the conditional volatility and u_t is assumed to be a error term with zero mean and variance h_t^2. Return equation

7 means that current return is decomposed into the expected return and the unexpected error term.

Therefore, the conditional volatility is assumed to evolve in the following regression:

$$\log h_t = \phi + \psi \log h_{t-1} + \rho_1 z_{t-1} + \rho_2 |z_{t-1}| + \delta_1 \hat{V}_t + \delta_2 X^F_{t-1} + \eta_t.$$

where $z_t \equiv u_t/h_t$ is the standardized residual, $\hat{V}_t$ is normalized trading volume and η_t is an error term. As noted above, volatility is related to trading volume, we enter the normalized trading volume into the volatility equation. The coeffcients ρ_1 and ρ_2 capture the effect of asymmetric volatility. Specifically, a negative ρ_1 suggests that a positive lagged unexpected return reduces volatility, but a negative lagged unexpected return increases volatility. We estimate h_t by RV_t defined in the previous section.

The main purpose of this paper is to examin the relationship of heterogeneous behaviors of different investors groups. First, we estimate the relation of net trading flows. Accordingly, return and volatility equations are expressed by

$$R_t = \alpha + \beta R_{t-1} + \gamma NTF^F_t + u_t, \qquad u_t \sim (0, h^2_t) \qquad \text{(Model 1)}$$

and

$$\log(h_t) = \phi + \psi \log(h_{t-1}) + \rho_1 z_{t-1} + \rho_2 |z_{t-1}| + \delta_1 \hat{V}_t + \delta_2 NTF^F_{t-1} + \eta_t. \qquad \text{(Model 1)}$$

Table 7 shows the estimation results of model 1. Standard errors reported in the parenthesis are corrected by using heteroskedasticity and autocorrelation consistent (HAC) covariance matrix estimators (Newey and West, 1987, 1994).

Estimated parameters of model 1 show that market volatility is negatively correlated with net trading flows of foreign investors ($\delta_2 < 0$). The coeffcient of first lagged net trading flow of foreign investors is negative and statistically significant. In other words, after foreign investors are net buyers volatility decreases, and vice versa. In addition, the coefficients of lagged standardized residuals are statisitically insignificant. This result

indicates that we cannot reject the hypothesis that $\rho_1 = 0$ or $\rho_2 = 0$, respectively. Note that NTF_t^F in the return equation of model 1 orthogonalizes residuals and net trading flows of foreigners in the volatility equation. The results in the existing literature of the asymmetric volatility effect have documented that current volatility is negatively associated with past returns: positive returns lower subsequent volatility while negative returns heighten subsequent volatility. The results shown in table 7 suggest that an uncorrelated component of returns with trading flows of foreigners is not correlated with subsequent volatility. Accordingly, the information that results in affecting the subsequent volatility is incorporated with net trading flows of foreigners.

Next, we estimate the effect of the share of foreign investors in trading volume. Return evolves as

$$R_t = \alpha + \beta R_{t-1} + \gamma \hat{S}_t^F + u_t, \qquad u_t \sim (0, h_t^2) \tag{8}$$

and

$$\log h_t = \phi + \psi \log h_{t-1} + \rho_1 z_{t-1} + \rho_2 |z_{t-1}| + \delta_1 \hat{V}_t + \delta_2 \hat{S}_{t-1}^F + \eta_t. \tag{9}$$

Table 8 shows the estimated parameters of model 2.

Estimated parameters of model 2 show that market volatility is positively but insignificantly correlated with trading shares of foreign investors. The coeffcient of first lagged trading shares of foreign investors is statistically insignificant. Accordingly, we cannot reject the hypothesis that trading share of foreigners affect subsequent market volatility. In addition, the coefficient of lagged standardized residual is statisitically insignificant but one of its absolute value is statistically significant. This result ($\rho_1 = 0$) indicates that there is no asymmetry in the relation between return and volatility. As noted above, $\hat{S}_t^F$ in the return equation of model 2 orthogonalizes residuals and trading shares of foreigners in the volatility equation. The results shown in table 8 suggest that signs of an uncorrelated component of returns with trading shares of foreigners are not correlated with subsequent volatility ($\rho_1 = 0$), while magnitudes are positively correlated subsequenr volatility ($\rho_2 > 0$).

Table 7: Estimated parameters of the weekly asymmetric volatility models 1.
In return equation, the dependent variable is the current return of TOPIX, and explanatory variables include first lagged return and current net trading flow of foreiners. In volatility equation of model 1, the dependent variable is the logarithm of realized standard deviations of TOPIX returns in a week: weekly realized volatility. The explanatory variables include the lagged dependent variable, lagged standardized residuals, lagged absolute standardized residuals, contemporaneous detrended trading volume and first-lagged net trading flows of foreign investors. Newey-West corrected standard errors are reported in parenthesis below the coefficients. Data cover February 2008 to February 2016. (421 observations)

Variable	Coefficient (Std. Err.)
Return	
Intercept	-0.0017
	(0.0016)
Lagged return	-0.1600***
	(0.0467)
Net trading flow of foreigners	0.0358***
	(0.0057)
Adjusted R^2	0.2229
Volatility	
Intercept	-2.9624***
	(0.3719)
Lagged log volatility	0.4543***
	(0.0740)
Lagged std. residual	0.0046
	(0.0084)
Absolute value of lagged std. residual	0.0252
	(0.0155)
Trading volume	0.3761***
	(0.1404)
Net trading flow of foreigners	-0.3657***
	(0.0899)
Adjusted R^2	0.2641

Significance at the 1%, 5%, 10% levels is indicated respectively by ***, **, *.

Table 8: Estimated parameters of the weekly asymmetric volatility models 2.
In return equation, the dependent variable is the current return of TOPIX, and explanatory variables include first lagged return and current net trading flow of foreiners. In volatility equation of model 1, the dependent variable is the logarithm of realized standard deviations of TOPIX returns in a week: weekly realized volatility. The explanatory variables include the lagged dependent variable, lagged standardized residuals, lagged absolute standardized residuals, contemporaneous detrended trading volume and first-lagged trading share of foreign investors. Newey-West corrected standard errors are reported in parenthesis below the coefficients. Data cover February 2008 to February 2016. (421 observations)

Variable	Coefficient (Std. Err.)
Return	
Intercept	0.2216***
	(0.0263)
Lagged return	-0.1705***
	(0.0456)
Trading share of Foreigners	-0.2210***
	(0.0262)
Adjusted R^2	0.1532
Volatility	
Intercept	-3.1641***
	(0.7521)
Lagged log variance	0.4845***
	(0.0871)
Lagged std. residual	-0.0053
	(0.0080)
Absolute value of lagged std. residual	0.0351**
	(0.0163)
Trading volume	0.2966**
	(0.1423)
Trading share of foreigners	0.3883
	(0.4563)
Adjusted R^2	0.2236

Significance at the 1%, 5%, 10% levels is indicated respectively by ***, **, *.

4.3 Discussion

In the previous subsections, we examin the relationship between trading behaviors and market volatility. We find contemporaneous correlations between volatlity and trading activity by foreiners. The net trading flows are negatively correlated with current market volatility, while the trading shares are positively correlated with volatility. On the other hand, while net trading flows of foreign investors have a negative relation with the subsequent volatility, the trading share of them have no correlation with the subsequent volatility.

Our study is motivated by the empirical facts about heterogeneity in different investor behaviors and theoretical preditictions about the volatility amplification because of trend-chasing trading patterns. In our results, foreign investors are trend-chasers in the sense that they purchase stock on balance when stock prices increase. However, both current and past net trading flows of foreigners are negatively correlated with market volatility. This is not consistent with the story that trend-chasing behaviors amplify volatility.

Avramov et al. (2006) decompose sell trades into contrarian and herding trades and find that contrarian sell trades decrease volatility of daily individual stocks while herding sell trades increase volatility. The authors provide an information-based explanation suggeting that contratian trades are informed trades that stabilize prices while herding is driven by uninformed investors that increase volatility. While it is difficult to find out whether foreigners are informed or uninformed, we evaluate the relative market timing ability of the investor groups over the entire period by using the cumulative performance measure defined by Kamesaka et al. (2003). Figure 13 shows the cumulative performance of different investor groups calculated by

$$\text{Cumulative Performance} = \sum_{t=1}^{T} (\text{Purchases}_{t-1} - \text{Sales}_{t-1}) R_t$$

Cumulative performances of domestic investor groups are overwhelmed by foreign investors. This suggests that the performance of trend-chasing trades by foreign investors is not inferior to other investor types.

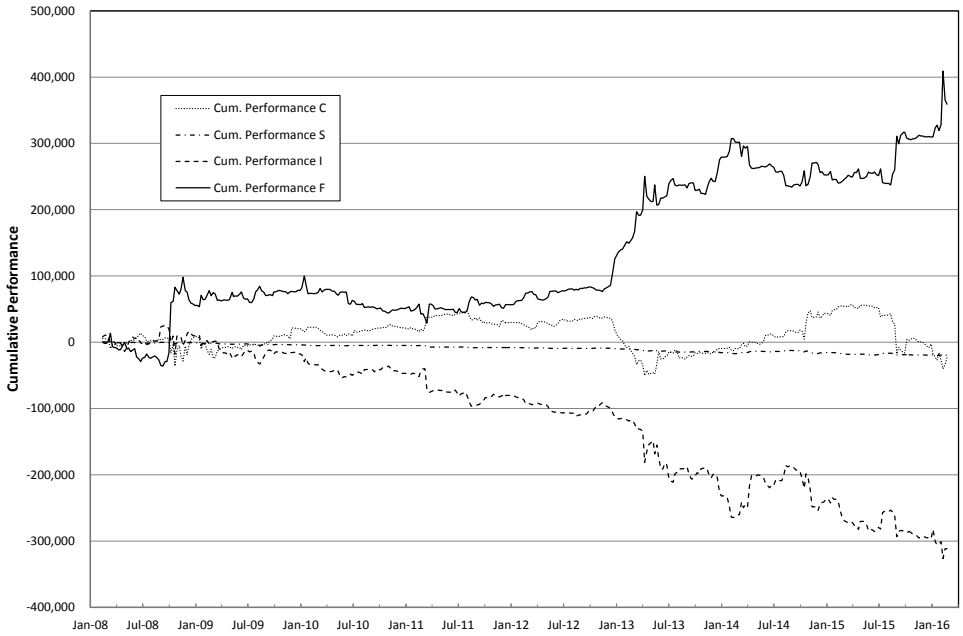

Figure 13: Cumulative performance of different investor groups in the first section of Tokyo Stock Exchange: Februrary 2008 through Februrary 2016. Investor types include foreign investors, individuals, security firms and institutions.

Foreigners trade stocks intensively when stock prices decline. At the same periods, they tend to sell stocks on balance. Accordingly, there is an asymmetry in the trading behaviors of foreigners: When they sell stocks, they intensively trade stocks relative to other investors. It is possible to explain that they sell stocks rapidly and frequently to avoid losses due to price decline and frequent trading results in high volatility.

Trading frequency is also a key when investigating volatility. Jones et al. (1994) investigate the relation between transaction size, trading frequency and volatility and conclude that trading frequency itself generates volatility. Dufour and Engle (2000) find that as the waiting time between transactions decreases, the price impact of trades increase because of reduced market liquidity. Zhang (2010) shows high-frequency trading is positively correlateed with stock volatility. Fluctuations of trading frequency by heterogeneous investors can generate imbalances of demand and supply of liquidity (Bae et al., 2008). The resulting fluctuations of market liquidity can generate market volatility.

5 Conclusion

In this paper, we investigated the relationship between trading behaviors of different investor types and market volatility. First, we examin the relationship between market returns and trading activities of different investor types. As the existing literature, we found that different trader types have different trading patterns. Domestic investors like individuals tend to be net-sellers when price increases, while foreign investors tend to be net-buyers when price increases. Trading shares are different from net trading flows. When returns are positive, shares of domestic investors increase. The trading share of foreign investors is negatively correlated with market returns. Thus, we conclude that the trading by foreign investors is intensive when price declines. We also employ the VAR model to examine the dynamic relation between return and trading activities. We found that all trading activities are positively autocorrelated.

In the analysis of volatility, we investigated the contemporaneous relation between volatility and foreigners' trading activity. Empirical results show that the trading share of foreign investors is possitively correlated with market volatility while net trading flows are negatively associated with market volatility. Both results suggests that volatility rises during periods of falls in prices.

We also investigate the dynamic relation of volatility with trading activity of foreigners. By regressing returns on trading activity, we generated residuals which are orthogonal to trading activity of foreigners. We examine whether the asymmetric volatility effect exists. The result shows that there is no correlations between volatility and signs of past residuals, that is, the asymmetric volatility effect does not stem from uncorrelated compornents of return with trading activity.

Our study is motivated by the empirical facts about heterogeneity in different investor behaviors and theoretical preditictions about the volatility amplification because of trend-chasing trading patterns. In our results, foreign investors are trend-chasers in the sense that they purchase stock on balance when stock prices increase. However, both current and past net trading flows of foreigners are negatively correlated with market volatility. This is not consistent with the story that trend-chasing behaviors amplify volatility.

While it is difficult to find out whether foreigners are informed or uninformed, we evaluate the relative market timing ability of the investor groups over the entire period by using the cumulative performance measure. We found cumulative performances of domestic investor groups are overwhelmed by foreign investors. This suggests that the performance of trend-chasing trades by foreign investors is not inferior to other investor types.

According to the results in this study, foreigners trade stocks intensively when stock prices decline.and, at the same periods, they tend to sell stocks on balance. Accordingly, there is an asymmetry in the trading behaviors of foreigners: When they sell stocks, they intensively trade stocks relative to other investors. It is possible to explain that they sell stocks rapidly and frequently to avoid losses due to price decline and frequent trading results in high volatility. Existing literature of the volatility-volume relation have documented that trading frequency generates volatility: high-frequency trading is positively correlated with market volatility. The relation between volatility and trade frequency may result from the fluctuation of market liquidity.

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