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Separate Title Page

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March 19, 2017

Abstract

The purpose of this paper is twofold: investigates how *different types* of investors affect stock return volatility, and provides some explanations based on investors' trading behavior. Norway provides an excellent setting with monthly holding data of *all* investors on *all* listed firms over a period of 15 years. The results show that foreign investors increase stock return volatility because they trade the most, are momentum traders, and have the shortest investment horizon. In contrast, individual investors reduce stock return volatility because they trade the least, are contrarian traders, and have the longest investment horizon, and domestic institutional investors fall in-between.

JEL classification: G11, G23, D12.
Keywords: stock return volatility, investor types, ownership holdings, foreign investors, individual investors, financial institutional investors

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***Highlights (for review)**

- Foreign (domestic individual) investors increase (reduce) stock return volatility.
- Foreign (domestic individual) investors trade the most (least).
- Foreign (domestic individual) investors are momentum (contrarian) traders.
- Foreign (individual) investors have the shortest (longest) investment horizon.
- Domestic institutional investors fall in-between.

Investor types and stock return volatility

March 27, 2017

Abstract

The purpose of this paper is twofold: investigates how *different types* of investors affect stock return volatility, and provides some explanations based on investors' trading behavior. Norway provides an excellent setting with monthly holding data of *all* investors on *all* listed firms over a period of 15 years. The results show that foreign investors increase stock return volatility because they trade the most, are momentum traders, and have the shortest investment horizon. In contrast, individual investors reduce stock return volatility because they trade the least, are contrarian traders, and have the longest investment horizon, and domestic institutional investors fall in-between.

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1 Introduction

Which type of investors increases stock return volatility? On the one hand, the behavioral finance literature shows that individual investors, who are usually considered as noise traders, have poor performance, and exacerbate stock return volatility (Odean (1998), Barber and Odean (2000), Barber et al. (2009), Foucault et al. (2011)). However, there is evidence that individual investors are contrarian traders (Grinblatt and Keloharju (2000), Kaniel et al. (2008)), which reduces volatility (Avramov et al. (2006)). On the other hand, French and Roll (1986) find that private information is the foremost factor behind high trading-time variances, which indicates that informed investors increase return volatility through their informed trading. Evidence shows that institutional investors are informed investors and follow a momentum strategy (Grinblatt and Keloharju (2000)), and momentum trading increases stock return volatility (De Long et al. (1990)). Hence, which type of investors increases volatility warrants an empirical investigation.

The extant literature on volatility and investor ownership mainly focuses on one type of investors, either institutional or individual investors (Foucault et al. (2011), Brandt et al. (2010), Malkiel and Xu (2003), Bennett et al. (2003), Sias (1996)), or foreign investors (Choe et al. (1999)). This paper is the first, to the best knowledge of the author, to study *multiple* types of investors in the same setting using finer data and hence provides a deeper understanding of how different groups of investors influence the price formation and affect return volatility. Stock return volatility plays an essential role in e.g., asset pricing, risk control, portfolio management, derivative pricing, and the cost of capital.[1] Campbell et al. (2001) provide strong arguments for the importance of total (idiosyncratic) volatility at the firm level.[2] However, our understanding of the determinants of stock return volatility is limited (Foucault et al. (2011)). This paper sheds new insights on the behavior of stock prices, which crucially depends on the nature of investor heterogeneity (Wang (1994)).

This paper investigates how various types of investors affect return volatility at the security level by utilizing a unique and extensive dataset of month-end holding data of *all* investors on *all* the stocks listed in the Oslo stock market over a long period of 15

[1]For example, many studies have shown that stock return volatility matters for asset pricing (e.g., Ang et al. (2006), Ang et al. (2009), Goyal and Santa-Clara (2003)). Furthermore, excess volatility could lead to a higher cost of capital, and thereby affect corporate investment and the fundamental value of the company (Froot et al. (1992)).

[2]For example, stock options depend on total volatility of stock returns, firm-level volatility affects event studies and arbitragers that exploit mis-pricing of individual stocks, and higher total volatility could cause larger pricing errors.

years. All investors are categorized into five main groups: foreign (institutional) investors, (domestic) financial institutional investors, individual investors, corporate investors, and state investors.[3] The purpose of this paper is twofold: first, it examines how different types of investors affect stock return volatility; second, it provides some explanations based on investors' trading behavior. The focus in this study is on foreign investors, financial institutional investors, and individual investors, as state investors primarily hold stocks for political incentives and corporate investors are often motivated for strategic reasons.[4]

This paper is related to Brandt et al. (2010) but has at least three main differences and hence new contributions to the literature. First, rather than investigating the time-series behavior of volatility, which is a major focus of Brandt et al. (2010), this paper aims to understand how volatility is affected by *different* types of investors. While Brandt et al. (2010) focuses on examining the surge and subsequent reversal in return volatility, this paper studies the impact of investors on volatility *per se*. The second main difference is that this paper uses a unique and extensive datasets that contains monthly shareholdings of *all* investors on *all* stocks (i.e., the whole population), and focuses on *three types* of investors. In contrast, Brandt et al. (2010) focuses on one type of investors. Another major distinction from Brandt et al. (2010) is that I investigate several potential channels through which investors influence return volatility, which support the documented impacts of different types of investors and bolster the contributions of this paper.

As stock return volatility is a key variable in this paper, I use five measures, both total and idiosyncratic volatility, to proxy return volatility. The monthly holding of each type of investors is the aggregated number of shares held by all the investors in each investor type divided by a proxy for free float, which is similar to the definition of free float used in the MSCI return index and measures the number of shares that are freely available to the investing public. The holdings are also normalized by the number of shares outstanding, and the results are qualitatively similar. The main analyses use the Fama and MacBeth (1973) technique by regressing volatility on one-month lagged holdings of one type of

[3]Foreign investors are mainly institutional investors. Other investors are domestic investors and "domestic" is often dropped for brevity. Financial investors, institutional investors, and financial institutional investors are used interchangeably.

[4]As the literature has focused on institutional, individual, or foreign investors, the categorization of investors in this paper follows the literature (Foucault et al. (2011), Brandt et al. (2010), Malkiel and Xu (2003), Bennett et al. (2003), Sias (1996), Choe et al. (1999)). The literature has (implicitly) assumed that the heterogeneous behavior within a type of investors is less than that across different types of investors.

investors and control variables, and use Pontiff (1996) and Petersen (2009) to correct the standard errors for potential higher order serial correlation.

This paper finds that foreign investors increase stock return volatility, individual investors reduce return volatility, and institutional investors fall in the middle ground and have a weaker negative impact on stock return volatility. These findings are robust to tests using different measures of volatility, different price and size categories, the abolition of restrictions on foreign holdings and short sales, changes in holdings, among others. I also use a different approach by double sorting stocks on market capitalization and holdings, and computing future return volatility for each portfolio. The results provide qualitatively similar inferences as the Fama and MacBeth (1973) regressions.

To address the concerns of endogeneity issues, I examine the possibility of reverse causality and take advantage of an exogenous shock that triggers more investment of foreign investors. Analyses on reverse causality show that foreign investors invest in stocks with lower return volatility, and individual investors prefer stocks with higher return volatility, which mitigate the concern of reverse causality. The difference-in-difference analysis based on the exogenous shock indicates that the main results hold.

The second purpose of this paper is to provide some explanations for the impacts of different types of investors on return volatility. While there could be several potential explanations, I focus on investors' investment and trading behavior and consider three important ones: trading strategy, trading turnover, and investment horizons. Though investors' information could be interesting to explore, similar to Dennis and Strickland (2009), this paper does not investigate which type of investors is informed and whether investors' impact on return volatility is stabilizing or destabilizing.

The first explanation is trading style, momentum trading (positive feedback trading) or contrarian trading (negative feedback trading). De Long et al. (1990) develop a model that shows positive feedback trading (momentum trading) increases stock return volatility. Avramov et al. (2006) present evidence that contrarian trading reduces volatility and momentum trading increases volatility. The hypothesis is that foreign investors pursue a momentum trading strategy and individual investors follow a contrarian trading strategy. This hypothesis is consistent with the results in Grinblatt and Keloharju (2000).

The next explanation is trading volume or trading turnover. Many studies show a positive correlation between trading volume and volatility (Schwert (1989), Gallant et al. (1992)). Malkiel and Xu (2003) argue that the high trading turnover by institutional investors is the reason for a positive correlation between stock return volatility and lagged

institutional ownership. As I find that foreign investors increase stock return volatility, individual investors reduce stock return volatility, and institutional investors fall in-between, the expectation is that foreign investors have the highest trading volume, and individual investors have the lowest.

The third explanation is investment horizon. Cella et al. (2013) show that shorter (longer) investment horizons increase (decrease) volatility. Markowitz (1991) suggests that individual investors may make investment decisions based on long-term horizon. Friedman (1995) argues that institutional investors have plausible reasons to adopt short horizons compared to individual investors. Given the results of investors' impact on return volatility, I hypothesize that foreign investors have the shortest investment horizons, individual investors have the longest investment horizons, and institutional investors fall in-between.

The empirical analyses provide support to the hypotheses for all the three explanations. These results suggest that trading style, trading volume, and investment horizon are among the channels through which investors affect return volatility. Hence, this paper shows that foreign investors increase stock return volatility because they trade the most, are momentum traders, and have the shortest investment horizons, among others. In contrast, individual investors decrease stock return volatility because they trade the least, are contrarian traders, and have the longest investment horizons, and financial investors fall in-between.

This paper adds several contributions to the literature. First and most importantly, this paper is the first to analyze how *multiple* types of investors, i.e., foreign investors, financial institutional investors, and individual investors, affect stock return volatility in the same setting. The extant literature on ownership structure and return volatility focuses on one type of investors. The detailed and unique holding data in this paper enables a deeper understanding of how volatility is affected by various investor groups. For example, although both foreign investors and domestic financial investors are institutional investors, they have opposite impacts on return volatility. If the domestic institutional investors and foreign (institutional) investors were categorized into one group, the results would show that the aggregate institutional investors increase stock return volatility, which would conceal the negative impact of domestic institutional investors.

The second main contribution is that this paper explores several potential channels through which different types of investors affect return volatility. More specifically, it undertakes comprehensive analyses on investors' trading and investment behaviors, which

explain and support the documented impact of different types of investors on volatility. Third, this paper uses a more accurate measure of investors' holdings and therefore provides more reliable results. The institutional holding data used in the U.S. studies focus on "large" institutions with asset under management over $100 million. In addition, institutional investors only report their holding positions which are more than 10,000 shares or $200,000. The rest, including small institutions, holding position under report requirements, and other types of investors, are categorized as individual investors. Hence, the imprecise measure due to crude categorization may give cause for concerns. In contrast, the holding data employed in this study is not reported by investors themselves, but is registered (for all the investors that hold shares in the Norwegian stock market) by a company authorized by law. The holding data contains the number of shares held by each investor on all the stocks over the sample period.

Fourth, using monthly holding data, instead of quarterly or annual frequencies as employed in previous studies, over a long sample period of 15 years, this paper is able to provide more precise evidence with stronger statistical power on the impact of investor types on stock return volatility. Furthermore, in addition to the academics, the results in this paper could be useful for domestic regulators to be aware of how stock return volatility is affected by different types of investors, especially foreign investors.

The rest of the paper proceeds as follows. Section 2 describes the data, variable measurements, and descriptive statistics. The analysis of the impact of different types of investors on stock return volatility, various robustness tests, and analysis on endogeneity issues are conducted in section 3. Section 4 provides explanations for the main findings. Concluding remarks are offered in section 5.

2 Data, variables, and descriptive statistics

2.1 Data

This paper uses a unique and extensive dataset of month-end holding data on *all* the stocks held by *all* the investors that have ever invested in the Norwegian stock market over the sample period from December 1992 to September 2007.[5] Hence, this is a complete data set consisting of the whole investor population. All the investors are categorized

[5]The sample period is from 1992 to 2007, which does not cover the more recent period. Nevertheless, a time period of 15 years is long enough to capture various phenomenons, e.g., the Dot-com stock bubble, and therefore is representative.

into five main types: domestic individual investors, financial institutional investors, non-financial corporate investors, state investors and foreign investors. Non-financial corporate investors and state investors are excluded in this analysis, because the former might hold shares for corporate strategic purpose and the latter have strong political motives in their holdings and are, in general, passive.

The Norwegian stock market is a developed but under investigated market. At the end of June 2003, the Oslo Stock Exchange (OSE) ranks 11th out of twenty-three European stock exchanges based on market capitalization and 12th based on the number of listed companies.[6] Thus, compared to other European exchanges, the OSE is close to the "median exchange" when it comes to market capitalization and the number of shares listed. Looking at stock market turnover (measured as annualized electronic order book transactions), the exchange has the eighth highest turnover. Bohren et al. (1997) show that the intensity of seasoned equity offerings is comparable to that of active markets like the New York Stock Exchange. In short, the OSE is an established and mature market where liquidity and turnover are high enough to be an interesting laboratory to study investor behaviour.

The trend of stock return volatility has drawn much attention in the literature. Campbell et al. (2001) show a positive trend in idiosyncratic volatility in the period of 1962 1997. However, Brandt et al. (2010) find that volatility falls back by 2003. The trend of Norwegian stock return volatility during the period December 1992 to September 2007 shows a similar pattern to that in Brandt et al. (2010). Figure 1 plots the value-weighted and equal-weighted average of total return volatility across all the stocks in each month. The graph shows a strong downward trend in the beginning of the period, probably due to the recovery from the Iraq war oil shock. A low volatility regime follows afterwards and remains until 1997 or so. Volatility surges around 1998, falls substantially in 2002, and maintains a low volatility regime in the rest of the sample period.

The monthly holding data are provided by the Norwegian Central Securities Depository (NCSD).[7] NCSD is a Norwegian company authorized to register rights to securities. Companies listed on the OSE are required by law to report to a security register. During the sample period, all listed companies registered their shares with NCSD. All investors that invest in stocks registered at NCSD must have a NCSD-account. When securities

[6]See www.fese.eu.

[7]The Norwegian name for the Norwegian Central Securities Depository (NCSD) is VPS ASA—or better known as "Verdipapirsentralen".

are traded, NCSD performs the settlement by transferring the security from the seller's NCSD-account to the buyer's NCSD-account. The Norwegian Central Bank subsequently performs the cash settlement. The NCSD-registry is used by the Norwegian government for taxation of investors. Thus, the quality of the data is very high.

The other data sets, provided by Oslo Bors Information (OBI), include daily and monthly stock returns, monthly stock market capitalization, monthly stock prices, monthly number of shares outstanding, monthly number of shares traded, and adjustment factors for stock splits and stock mergers.

2.2 Measures of stock return volatility and holdings

2.2.1 Measures of stock return volatility

As stock return volatility is one of the key variables in this study, several measures of total return volatility and idiosyncratic return volatility are used to strenghten the validity of the results. Daily returns in each month are used to measure monthly return volatility.[8] Using non-overlapping samples of daily data to estimate the monthly variance creates estimation error that is uncorrelated through time (Schwert (1989)). I apply the following five measures: (1) the standard deviation of raw daily returns (square root of the sum of the squared demeaned daily returns) in each month (the standard measure of return volatility); (2) the sum of absolute daily returns; (3) the square root of the sum of squared daily returns; (4) the standard deviation of the daily difference between stock return and the market return, and (5) the square root of the sum of squared errors from the market-model regression in each month. The first three methods measure total return volatility while the last two proxy idiosyncratic volatility.

2.2.2 Measures of investors' holdings

For each stock i in each month t, the fraction of shareholdings for investor type j, $Holding^{j}_{i,t}$ is the aggregated number of shares held by all investors belonging to investor type j divided by the free float (or the number of shares outstanding) of stock i in month t.

$$Holding^{j}_{i,t} = \frac{\sum_{k=1}^{K^j} S^{k}_{i,t}}{FreeFloat_{i,t}} \tag{1}$$

[8]French et al. (1987), Schwert (1989), and Schwert (1990) primarily rely on daily return observations for the construction of monthly realized stock volatilities.

where $S_{i,t}^k$ is the number of shares of stock i held by investor k that belongs to investor type j, and j∈{individual investors, financial investors, and foreign investors}. In month t, there are K^j investors in investor type j that hold stock i. $\sum_{k=1}^{K^j} S_{i,t}^k$ measures the aggregated number of shares of stock i held by investor type j in month t.

$FreeFloat_{i,t}$ is free float and measures the number of shares of stock i that are freely available to the investing public in month t. The definition of free float is similar to that of the MSCI return index, which defines free float as "total shares outstanding excluding shares held by strategic investors such as governments, corporations, controlling shareholders and management, and shares subject to foreign ownership restrictions".[9] Free float reflects the shares that are freely available for trading, which should be reflected in the computation of holding variable.[10]

To compute monthly free float, I subtract the number of shares held by state investors and corporate investors from the number of shares outstanding. In addition, due to the lack of data on controlling shareholders and management, I exclude the number of shares held by large block holders with a minimum holding of X among individual investors, financial investors, and foreign investors, where X∈{10%, 20%, 30%, 50%, and 70%}. I also use the number of shares to normalize holdings. The results are qualitatively similar and are not tabulated for brevity.

2.3 Equal- and value-weighted holding ownership by investor types

The equal- and value-weighted holding ownerships by different measures across all the stocks for each investor type are reported in Table 1. The first five columns present the holding ownership of individual investors (Ind), financial investors (Fin), and foreign investors (For), using different measures of free float. The last column reports the holding measure adjusted by the total number of shares outstanding.

Panel A reports the equal-weighted average of ownership holdings. The first five columns show that individual investors have the highest proportion of equal-weighted

[9] See the link $http://https://www.msci.com/eqb/pressreleases/archive/20001210_pr01.pdf$

[10] Assume that investor i owns 400 shares and the number of shares outstanding is 10,000 shares. The holding of investor i is 4% (=400/10,000) when it is normalized by the number of shares outstanding. If there are only 5,000 shares available for trading (free float), the measure of holding based on free float would be 8% (=400/5,000). The holding normalized by free float may better reflect the potential impact of investor i in terms of the amount of shares available for trading than that normalized by the number of shares outstanding.

holdings and foreign investors have the lowest proportion. For example, when the free float measure excludes state investors, corporate investors and large block holders with a minimum holding fraction of 50% (column [4]), individual investors hold 37.7% of the shares on average, financial investors hold 31.6%, and foreign investors account for 30.7%. There is no significant difference among investors' holdings when different measures of free float are used. The holding measure adjusted by the free float excluding state investors, corporate investors, and large block holders with a minimum of 50% holdings is used for all the analyses in this paper, and other measures of free float are used as robustness tests, which provide qualitatively similar (untabulated) results.

The last column reports the equal-weighted holdings of the three groups using the holding measure scaled by the number of shares outstanding. Naturally, these holding fractions are smaller than the ones using free float. Individual investors and foreign investors have similar holdings, about 20%, and financial investors have slightly higher, at 24%. The last row in Panel A of Table 1 reports the free float ratio ($FreeFloatRatio$) , which is the free float divided by the number of shares outstanding, across all the stocks. When requiring large block holders with a minimum holding of 10%, the equal-weighted free float ratio is 48% (column[1]). When the requirement of a minimum holding by large block holders is 70%, the equal-weighted free float ratio becomes 59% (column [5]).

Panel B of Table 1 reports the value-weighted average of ownership holdings. In contrast to Panel A, foreign investors are the largest investor group and individual investors are the smallest investor group. The differences between the three types of investors' holdings are dramatic. For example, in column [4] when excluding large block holders with a minimum holding fraction of 50%, individual investors hold only 14.4%, financial investors 28.3%, while foreign investors have a share fraction of 57.3%, which is around four times of the holding of individual investors and twice that of financial investors. The last column, which reports value-weighted holdings based on the total number of shares outstanding, depicts a similar picture. The last row in Panel B presents the value-weighted average of free float ratio, which is from 53.9% to 63.9% when the requirement of the minimum holding of large block holders ranges from 10% to 70%. The comparison between Panel A and Panel B indicates that, on average, foreign investors hold large stocks, individual investors hold small stocks, and financial investors hold medium-sized stocks.

Figure 2 exhibits the equal-weighted average of monthly holdings (Panel A) and the value-weighted average of monthly holdings (Panel B) for the three groups from December 1992 to September 2007. In Panel A, before January 2004, individual investors have the

highest equal-weighted average of monthly holdings, while foreign investors have the lowest equal-weighted holdings in most of the months. However, since January 2004, individual investors' holdings have been declining dramatically over time and foreign investors are the counter parties that increase their holdings substantially. Financial investors have also reduced their holdings since January 2004, though to a lesser extent.

The value-weighted average of monthly holdings in Panel B presents a similar story. Foreign investors have been increasing their value-weighted average of holdings while domestic individual and financial investors have been decreasing their holdings. Consistent with the two panels of Table 1, the fact that foreign investors have the highest value-weighted holdings but relatively lower equal-weighted holdings indicates that they hold large stocks. The upward trend in foreign investors' holdings since January 2004, in both Panel A and Panel B, shows that foreign investors have increased their holdings in both large stocks and small stocks in the later part of the sample.

2.4 Stock characteristics sorted on investors' holdings

To understand how investors' holdings are related to stock characteristics, I sort stocks into quintiles based on holdings for each type of investors in each month. Focusing on stock characteristics such as market capitalization (size), price, volatility, return, and turnover, I calculate the equal-weighted average of each variable for each portfolio in each month, and then report the time series average for each portfolio in Table 2.[11]

Panel A in Table 2 presents the mean and median of stock characteristics across all the stocks. The last column shows that there are 194 stocks on average. The two rows in Panel A indicate that all the variables are positively skewed. For example, the market capitalization has a mean of 3 520 million NOK, while the median value is only 679 million NOK.

Panel B reports stock characteristics sorted on holdings of individual investors. The first column (Holding) presents the average holdings of individual investors. Consistent with the literature, individual investors hold small stocks, with a monotonic negative relationship between individual holdings and stock size. The volume "Price" shows that the top portfolio with the highest individual holdings contains high priced stocks, at 104, which is higher than the middle three portfolios, but lower than the bottom portfolio with the lowest individual holdings. This means that although individual investors prefer

[11]Trading turnover is the monthly total trading volume divided by the number of shares outstanding. Return volatility is the standard measure – measure (1) in subsection 2.2.

small stocks, they hold both high and low priced stocks. There is a positive relationship between individual holdings and stock return volatility. The last two columns show that stocks with higher individual holdings have lower turnover and higher returns, though the relationship is not monotonic.

Panel C presents stock characteristics sorted on the holdings of financial investors. There is no clear relationship between financial investors' holdings and size, although it is obvious that financial investors hold larger stocks compared to individual investors. There is a positive and monotonic relation between financial investors' holdings and price, which indicates that domestic financial investors prefer high-priced stocks. Financial investors' holdings are negatively related to volatility, turnover, and return.

Panel D reports stock characteristics sorted on the holdings of foreign investors. There is a strong positive and monotonic relationship between foreign holdings and stock market capitalization, consistent with the literature that foreign investors prefer large stocks. Compared to financial investors, foreign investors hold much larger stocks in the top portfolio, which has an average market capitalization of 11.3 billion NOK, while the top portfolio with the highest financial investors' holdings consists of stocks with an average market capitalization of 2.3 billion NOK. The column "Price" in Panel D shows that although foreign investors hold higher-priced stocks in general, they shy away from stocks with very high prices. The top portfolio with the highest foreign holdings has an average price of 100, which is lower than that of individual investors and financial investors, and the bottom portfolio with the lowest foreign holdings has a much higher price, at 144. There is a negative relationship between foreign holding and volatility, and a positive relationship between foreign holding and turnover. There is no clear pattern between foreign holding and return.

Panel E presents the correlation matrix of investors' holdings and the stock characteristics. With the exception that individual holdings have relatively high correlation, above 60% in magnitude, with size and foreign holdings, other correlations are reasonably low.

3 Main analysis, robustness tests, and endogeneity issues

This section investigates how the domestic individual investors, financial investors, and foreign investors affect stock return volatility at the firm security level. Following the

literature (Brandt et al. (2010)), I employ the Fama and MacBeth (1973) methodology and regress monthly stock return volatility on one-month lagged holdings of each type of investors, respectively, and control variables.

$$\begin{aligned} Vol_{i,t} = \beta_t^j Holding_{i,t-1}^j + \gamma_{Vol} Vol_{i,t-1} + \gamma_{Ret} Ret_{i,t-1} + \gamma_{TO} TO_{i,t-1} \\ + \gamma_{Size} Size_{i,t-1} + \gamma_{price} Price_{i,t-1} + \gamma_{B/M} B/M_{I,t-1} \\ + \gamma_{FreeFloatRatio} FreeFloatRatio_{i,t-1} + \gamma_{StateDummy} StateDummy_{i,t} + \epsilon_{i,t}, \end{aligned} \tag{2}$$

where the dependent variable, $Vol_{i,t}$, is the logarithm value of return volatility of stock i in month t.[12] The first variable on the right hand side, $Holding_{i,t-1}^j$, is the key variable for the analysis, and measures the holding fraction of stock i held by investor type j in the end of month t-1, where j denotes individual investors, financial investors, and foreign investors, respectively.

As volatility is persistent, one-month lagged return volatility is included as a control to account for the auto-correlation. It is well known that market capitalization is negatively correlated to volatility. Sias (1996) shows that the result of regressing return volatility on investors' holdings will be misleading, without controlling for stock size. Cheung and Ng (1992) show that future return volatility is also negatively related to stock prices. Brandt et al. (2010) find that price is important in explaining volatility. Hence, one-month lagged market capitalization ($Size$) and stock price ($Price$) are included as controls, where size and price are measured by the natural logarithm of market capitalization and stock price. I include trading turnover (TO), which is the number of shares traded in one month divided by the number of shares outstanding, to control for the liquidity of stocks. Returns (Ret) are included because of the well known negative relation between volatility and lagged returns.

There is evidence that growth options are an explanation for the increase in stock idiosyncratic volatility. Malkiel and Xu (2003) show that idiosyncratic volatility is positively associated with future growth opportunities. High market-to-book firms might have greater growth opportunities (Hotchkiss and Strickland (2003)). Hence, the book to market ratio (B/M) is included in the analysis to control for firms' growth options. Cohen et al. (1976) show that the thinness of stocks, measured by stock price and floating

[12]Recall that I document that stock return volatility is positively skewed. Andersen et al. (2001) also find that the distributions of the realized variances are skewed to the right. They show that the logarithms of the realized variances are approximately normal.

supply, is also a determinant of volatility. I therefore add one-month lagged free float ratio (*FreeFloatRatio*) as a control variable. Furthermore, since state owners are generally passive investors, the stocks with the existence of state investors might have lower volatility than those without state owners, ceteris paribus. I add a dummy variable to indicate the presence of state owners (*StateDummy*). In each month, *StateDummy* is set to 1 for stocks with the existence of state owners and 0 otherwise.[13] Note that except for the *StateDummy* variable, all the other control variables are one month lagged.[14]

In order to compare the coefficients across both different types of investors and across different variables, I follow Bennett et al. (2003) and Brandt et al. (2010) and standardize all the variables, both the dependent variable and independent variables, so that each variable has mean 0 and standard deviation 1.[15] The coefficient β is interpreted as the expected standard deviation change in the dependent variable when there is one standard deviation change in the independent variable.

Regression (2) is performed for each month from December 1992 to September 2007. I then use the time series of each coefficient estimate to calculate the time series average of the coefficient.

$$\hat{\beta}_j = \frac{1}{T}\sum_{t=1}^{T} \hat{\beta}_t^j, \tag{3}$$

where $\hat{\beta}_t^j$ is the coefficient estimate on the holdings of investor type j in month t. $\hat{\beta}_j$ is the time-series average of the coefficient estimate, $\hat{\beta}_t^j$.

Since both volatility and holdings are persistent, the error terms will be correlated and the standard errors will be biased. I follow Brandt et al. (2010) to correct the standard errors for potential higher order serial correlation by using the Pontiff (1996) method and the Petersen (2009) technique. The t-statistics from these two different correction methods render similar statistical inferences. I only report the adjusted t-values using Pontiff (1996), as Brandt et al. (2010) have done.

The results are reported in Table 3. Attention is first directed to the coefficients on holdings as they are the focus of this paper. The first three columns report the regression results when the dependent variable is total return volatility (measure 1 in section 2.2)

[13]Dummy for the presence of corporate investors is not included since almost all stocks have corporate investors.

[14]StateDummy is not lagged because it captures the effect of the presence of state investors in month t. In addition, as the presence of state investors is very stable, it should not matter much.

[15]There is no intercept on the right hand size because all the variables are standardized and have mean 0.

and the last three columns for the regression results when idiosyncratic volatility (measure 5 in section 2.2) is the measure of the dependent variable. The Pontiff (1996) adjusted t-values are presented in parentheses in the rows below the coefficients. The first two rows in column [1] show that individual investors have a significant and negative impact on return volatility, with a coefficient of -0.06 and a t-statistic of -5.3. The next two rows in column [2] indicate that financial investors also have a significant and negative coefficient, -0.038, which is smaller in magnitude than that of individual investors. The results presented in column [3] show that foreign investors have a significant and positive impact on stock return volatility, with a coefficient of 0.1 and t value of 12.8. The last three columns, using the idiosyncratic volatility as the dependent variable, present similar results. The coefficients on individual investors, financial investors, and foreign investors are -0.054, -0.035, and 0.090, respectively, and all are significant at the 1% significance level.

The results show that foreign investors increase stock return volatility, individual investors and financial investors dampen return volatility, and individual investors have the strongest negative impact on return volatility. It is interesting to note that domestic financial institutional investors and foreign investors, both as institutional investors, have opposite impacts on stock return volatility. This indicates that it is important to distinguish foreign and domestic institutional investors.

The coefficients on the control variables are consistent in all the regressions. Volatility is highly autocorrelated, with a coefficient of about 0.55 that is highly significant. The coefficient on lagged returns is negative, which indicates that high (low) returns predict lower (higher) future volatility. This is consistent with the existing evidence (Christie (1982) and Cheung and Ng (1992)). Turnover, size, and price are also negatively related to return volatility. Return volatility is negatively related to stocks' free float ratio, which is consistent with the thinness story of Cohen et al. (1976). The negative coefficient on the dummy variable, *StateDummy*, shows that state investors reduce stock return volatility, ceteris paribus. The adjusted R^2 is about 50% for all the regressions.

The results that monthly holdings of individual investors have a negative impact on return volatility in this paper might seem to contradict the positive effect of retail trading documented in Brandt et al. (2010). The difference is that I examine the impact of individual *holdings* while Brandt et al. (2010) focus on retail *trading*. To reconcile the results in these two papers, I construct a variable of retail trading, similar to that in Brandt et al. (2010), and regress volatility on retail trading in addition to holdings of individual

investors and other control variables used in the main analysis.[16] The untabulated results show that stocks with higher retail trading have higher volatility and stocks with higher individual holding have lower volatility after controlling for other factors. These analyses show that although this paper provides new evidence to the literature, they are not contradicting Brandt et al. (2010).[17]

3.1 Robustness tests

The analysis in the previous section finds that individual investors and financial investors dampen return volatility while foreign investors increase return volatility. This section conducts various tests to check whether these results are robust. I use the same control variables as in the main analysis in regression (2), the same Pontiff (1996) correction for the error terms, and standardize all the variables (both dependent and independent variables). As Goyal and Santa-Clara (2003) argue that most total volatility is idiosyncratic risk, I only use the total return volatility, which is the standard measure of volatility (measure 1 in subsection 2.2) and is used in the first three columns in Table 3. For brevity, I only report the coefficients and t statistics on investors' holdings, which are the focus of this paper.

3.1.1 Restrictions on foreign holdings and short sales

Holding restrictions were imposed on foreign investors in the Norwegian stock market and were not lifted until January 1995.[18] To examine whether this affects the results and whether the impact of foreign investors and other types of investors on stock return volatility have changed before and after the restriction was lifted, I divide the entire sample into two sub-samples. I also examine whether the abolition of the short-sales constraint in January 1997 matters for investors' impact on stock return volatility. I redo the Fama and MacBeth (1973) regression for subsamples before and after January 1995, and before and after January 1997.

[16]For each stock in each month, I calculate the proportion of retail trading, where trading is measured by aggregating the absolute changes in monthly holdings of each investor due to the unavailability of trading data, and define an indicator variable, *RetailTrading*, as 1 if the proportion of retail trading is among the top 10% (25%), and 0 otherwise.

[17]Brandt et al. (2010) show (in Table 3) that both the proportion of retail trading and institutional ownership have a positive significant coefficient. As retail ownership equals 1- institutional ownership in the US data, this suggests that individual investors' holdings have a negative effect while their trading has a positive effect on return volatility.

[18]See more detailed information in Bohren and Odegaard (2001)

The results are reported in Panel A of Table 4. The first two columns present the coefficients and Pontiff (1996) adjusted t statistics (in the parentheses) on the lagged investors' holdings before and after the abolition of the restriction on foreign holdings in January 1995. The last two columns report the results for the subsamples before and after the abolition of the short sales constraint in January 1997. Before the abolition of the restriction on foreign holdings (column [1]), individual investors have no impact on future stock return volatility, with a small and insignificant coefficient of -0.0101. Individual investors also have an insignificant impact, with a coefficient of -0.0149 and t statistics of -1.63, on return volatility before the lift of the short sales constraint in January 1997 (column [4]). The negative impact of individual investors on return volatility in the period after January 1995 (column [2]) and January 1997 (column [4]) is consistent with the evidence in the main analysis. Financial investors have a negative and significant coefficients on holdings, and foreign investors have a positive and significant impact on return volatility, in all the 4 subsamples. However, although foreign investors have a positive impact on return volatility before the abolition of constraints on foreign holdings, the magnitude of the coefficient on foreign holdings is much smaller than that in the later period. For example, the coefficient on foreign holding is only 0.0487 with a t-value of 4.05 before the lift of foreign holding constraints (column [1]), but the coefficient rises to 0.109 with a much higher t-value of 13.91 after the abolition of the constraint (column [4]). The stronger positive impact of foreign investors on return volatility after the event than before the event indicates that the availability of more investment from foreign investors strengthen their positive impact on return volatility.

3.1.2 Small vs. large stocks and low- vs. high- priced stocks

It is possible that the same type of investors has different impacts for stocks with different size and prices. Brandt et al. (2010) find that individual investors increase return volatility among low-priced stocks, while institutional investors increase volatility for stocks with high prices. I redo the Fama and MacBeth (1973) regressions for low-priced stocks (the 50% stocks with the price below the median), high-priced stocks (the 50% stocks with the price above the median), small stocks (the 50% stocks smaller than the median), and large stocks (the 50% stocks larger than the median). The results are presented in Panel B of Table 4.

The first two columns report the coefficients and t-statistics (in parentheses) on lagged investors' holdings for low- and high-priced stocks, and the last two columns for small

and large stocks. Domestic individual investors and financial institutional investors have a negative impact on return volatility for both small and large stocks and for both low and high priced stocks, and all the coefficients are significant at the 1% level. The results for foreign investors describe a consistent picture as the main finding. For both small and large stocks, and for both high-priced and low-priced stocks, foreign investors have a similar positive and significant impact on future return volatility. The results in Panel B of Table 4 show that all the three types of investors have similar impacts on stocks with different size and prices.

3.1.3 Additional supplementary tests using different measures

To reconcile the results with the literature and to render more reliable inferences, the following three sets of Fama and MacBeth (1973) analyses are conducted: (1) tests using holdings measured at quarterly or annual frequencies, rather than monthly frequency; (2) regressions using changes in holdings rather than holding levels; and (3) analyses using other measures of stock return volatility. All the tests provide qualitatively similar results. Detailed descriptions of these analyses are provided in Appendix A.

3.1.4 Volatility of portfolios double sorted on size and holdings

This subsection employs a different approach to examine whether investors' holdings have predictive power for future stock return volatility by sorting stocks on investors' holdings and forming portfolios. If one type of investors has a positive impact on stock return volatility, then the stock portfolio with higher holdings of this type of investors should have higher future return volatility. However, it is important to bear in mind that stock market capitalization is an important determinant of volatility. Sias (1996) examines stock return volatility by sorting stocks both on institutional investors' holdings alone and on size and holdings. He shows that the results could be misleading, without controlling for stock market capitalization. I therefore double sort stocks on both size and investors' holdings, following Sias (1996).

For each month t, stocks are sorted into size quintiles based on stock market capitalization at t-1, and within each size quintile, stocks are further sorted into holding quintiles based on the fraction of shares held by each type of investors at t-1. I calculate the equal-weighted portfolio returns, using stock monthly return at t, for each of the 25 portfolios in each month, and then compute, for each portfolio, the monthly standard deviation of

the time series portfolio returns. Both portfolio return volatility (the first five columns) and ownership holdings for the 25 portfolios (the last five columns) are reported in Table 5.

Panel A reports results for portfolios sorted on market capitalization and individual investors' holdings. As individual investors prefer small stocks, we first look at portfolio return volatility of small stocks in column 5 ("Small"). Stocks with the highest individual investors' holdings in the first row ("High") have much lower monthly volatility than the portfolio with the lowest individual investors' holdings in the 5th row ("Low"), 0.076 vs. 0.147. The size portfolios in columns 2, 3, and 4 also indicate that stocks with higher individual investors' holdings have lower future return volatility than stocks with lower individual investors' holdings, which support the inferences derived from the Fama and MacBeth (1973) analysis. Note that the portfolio with the largest stock size in column 1 does not support the previous evidence, which might be due to the fact that individual investors are small players in large stocks and other investors might have more impact on return volatility of large stocks than individual investors.

Panel B presents the results for portfolios sorted on size and financial investors' holdings. Similar to Panel A, except for the largest size portfolio in column 1, stocks with higher financial holdings have lower return volatility. Panel C presents the results of sorting stocks on size and foreign holdings. Except for the largest size portfolio, stocks with higher foreign holdings have higher volatility, consistent with the results from the Fama and MacBeth (1973) analysis. For the portfolio with the largest stock size in column 1, the lower volatility of stocks with higher foreign investors' holdings may seem puzzling. This might be because large stocks with high foreign holdings have also high state holdings, which reduces stock return volatility.[19]

To sum up, various robustness tests support the results from the main analysis that foreign investors have a positive impact on stock return volatility, domestic individual investors dampen future return volatility, and financial investors have a weaker negative impact on return volatility.

[19]The state holds a high proportion of shares in some of the largest listed companies, such as banks and oil companies. Recall that state investors have a negative impact on return volatility, documented in Table 3.

3.2 Endogeneity issues

All the analyses above have used *one-period lagged* holdings to predict return volatility, and have corrected the standard errors for potential higher order serial correlation. Nevertheless, there are still potential concerns for endogeneity, such as reverse causality. I first address the issue of reverse causality and then conduct a difference-in-difference analysis taking advantage of an exogenous shock that may trigger more investment of foreign investors.

3.2.1 Reverse causality

The analyses have so far shown that investors' holdings affect future stock return volatility. One concern is that the positive (negative) correlation between return volatility and holdings of foreign (individual) investors is because foreign (individual) investors are more likely to invest in stocks with higher (lower) volatility rather than that foreign (individual) investors increase (decrease) stock return volatility. To investigate whether the reverse-causality concern is valid, this subsection examines whether higher (lower) volatility induces more holdings of foreign (individual) investors. Using the Fama and MacBeth (1973) method, I regress the holding level of each type of investors on lagged volatility, controlling for lagged holding level and the control variables as in the main analysis. I also regress changes in holdings of each type of investors on lagged volatility and the control variables. As the main analysis in the previous subsection uses both the total return volatility and the idiosyncratic volatility, I employ both measures of volatility. The results are reported in Panel A of Table 6. Only the coefficient on the lagged return volatility, which is the focus of this analysis, is reported.

The first three columns report the coefficient estimates and the Pontiff (1996) adjusted t values on lagged total return volatility, while the last three columns report the results on lagged idiosyncratic volatility. The first two rows, which report the results when using the level of holdings as the dependent variable, show that all the three types of investors' holdings are not affected by lagged return volatility. The last two rows, which present the results when using changes in holdings as the dependent variable, show that when stock return volatility is higher, individual investors increase their holdings while foreign investors decrease their holdings. This indicates that individual investors have a tendency to invest in stocks with higher volatility and foreign investors prefer stocks with relatively lower volatility, which is in line with the literature, but contradicts the main results.

Hence, the findings that foreign investors increase stock return volatility, and individual investors and financial investors dampen stock return volatility are not induced by reverse causality.

3.2.2 Difference-in-difference analysis based on an exogenous shock

If foreign investors truly increase stock return volatility, stocks in periods with higher holdings of foreign investors should have higher volatility than periods with lower holdings of foreign investors, ceteris paribus. The Norwegian setting provides an excellent opportunity to examine this issue. On May 27, 2002 the OSE adopts the SAXESS trading system, which is already in use by the exchanges in Sweden, Denmark, and Iceland. The SAXESS trading environment makes it easier for foreigners to trade on the OSE. The SAXESS trading system enables foreign investors to have the same access to the stock exchanges of all the member countries with low transaction costs. Hence, the reduced transaction barrier for foreign investors to the access of the Norwegian stock market would increase the trading of the foreign investors in the post-SAXESS period (Jorgensen and Priestley (2012)).

I take advantage of this exogenous shock and use a difference-in-difference method to examine whether stocks with more foreign holdings in the post-SAXESS period have higher return volatility than in the pre-SAXESS period. Two sample periods are used: (1) three years pre-SAXESS (May 1999 - April 2002) and three years post-SAXESS (June 2002 - May 2005), and (2) five years pre-SAXESS (May 1997 - April 2002) and five years post-SAXESS (June 2002 - May 2007).[20]

I calculate the aggregated changes in foreign holdings in the three (five) years in the post-SAXESS period, and include stocks on the top X% in the treatment group, where X$\in\{20, 30, \text{and } 40\}$. The rest of the stocks are in the control group. I run the following difference-in-difference regression:

$$Vol_{i,t} = \alpha_{i,t} + \beta_1 Post_t + \beta_2 TreatX_i + \beta_3 PostTreatX_{i,t} + controls + \epsilon_{i,t} \qquad (4)$$

where *Post* is a dummy variable, which equals 1 if month t is in the post-SAXESS period, and 0 otherwise. *TreatX* is 1 if stock i is among the top X% of stocks that have

[20]Though the reduced transaction costs for foreign investors post-SAXESS make it more attractive for foreign investors to invest in Norwegian stocks, this does not mean that they would increase their investment immediately. Figure 1 shows that foreign investors increase their holdings several months after the adoption of the SAXESS system.

the highest increase in foreign holdings, and 0 otherwise. *PostTreatX* is an interaction term between *Post* and *TreatX*, which is the focus of this analysis. The control variables are the same as the ones in the main regression (Equation 2).

The regression results are presented in Panel B of Table 6. For brevity, only the coefficients and t-values for *Post*, *TreatX*, and *PostTreatX* are presented. The first (last) three columns report results for the sample period of three (five) years before and after the adoption of the SAXESS system. Column (1), where stocks on the top 20% of the highest increases in foreign holdings are in the treatment group, shows that volatility is lower after the post-SAXESS period, as the coefficient on *Post* is negative and significant at the 1% level. The coefficient on *Treat20* is also negative and significant, which indicates that the stocks with higher foreign holdings have lower volatility. This is intuitive because it is well documented that foreign investors prefer large stocks, which have lower return volatility.

Most importantly, the coefficient on the interaction term, *PostTreat20*, the focus of this analysis, is positive with a t-value of 2.21. The significant and positive coefficient indicates that, conditional on stock return volatility is lower in the post-SAXESS period and is lower for stocks in the treatment group, stocks with more investment from foreign investors have higher volatility post-SAXESS than pre-SAXESS, compared to the control group.

The next two columns (columns 2 and 3), where treatment stocks are among the top 30% and 40% of the highest increase in foreign holdings, present similar results. The last three coloumns show that, when requiring five years in the pre- and post-SAXESS period, the coefficients on *PostTreatX* remain positive and are even more significant, at the 1% level. The coefficients on *Post* and *TreatX* remain negative and significant.

The significant and consistent results for *PostTreatX* show that foreign investors increase stock return volatility because stocks in periods with more investment from foreign investors have higher volatility than in periods with lower foreign investment, compared to the control group. This provides strong supports to the results documented above and greatly alleviates the concern of endogeneity issues.

4 Explanations

4.1 Theories and hypotheses

There could be several potential explanations for the impact of different types of investors on stock return volatility documented in the previous section. As investors affect stock prices mainly through trading, I focus on investors' trading behavior and consider three potential determinants of stock return volatility: investors' trading style, trading turnover, and investment horizon. Though investors' information could be interesting to explore, similar to Dennis and Strickland (2009), this paper does not investigate which type of investors is informed and whether investors' impact on return volatility is stabilizing or destabilizing.

The first explanation for investors' impact on return volatility is their trading strategy, momentum trading (positive feedback trading) or contrarian trading (negative feedback trading). De Long et al. (1990) develop a model showing that positive feedback trading increases stock return volatility. Koutmos and Saidi (2001) show that positive feedback trading may lead to excess volatility. Avramov et al. (2006) provide evidence that contrarian trading decreases volatility and momentum trading increases stock return volatility. Based on the results that individual investors reduce return volatility and foreign investors increase return volatility, the hypothesis is that individual investors are contrarian traders, foreign investors are momentum traders and domestic institutional investors have a trading strategy in between. The contrarian strategy of individual investors could resemble fundamental trading as evidence shows that individual investors trade on private information.[21] Meanwhile, it is possible that individual investors provide liquidity to the market (Bloomfield et al. (2009)). The foreign investors' engagement in momentum strategy may be driven by their retail investor customer base whose biased behavior could increase volatility.[22] At the same time, foreign investors' momentum trading behavior could be driven by private information as Grinblatt and Keloharju (2000) show that foreign investors are most sophisticated.

[21]Several studies find that individual investors are sophisticated or trade on private information using the U.S. data (e.g., Kaniel et al. (2012); Kelley and Tetlock (2013)). In addition, evidence shows that short-horizon contrarian strategies consistently make substantial profits (e.g., Jegadeesh (1990); Lehman (1990)). Furthermore, Kaniel et al. (2008) show that U.S. individual investors follow a contrarian trading style and their trades can be used to forecast future returns.

[22]Evidence shows that momentum trading styles could be driven by investors overweighting their private signals (self-attribution bias) (Daniel et al. (1998)), or conservativeness bias (Hong and Stein (1999), Barberis et al. (1998)), among other explanations

The second explanation involves trading turnover or trading volume. Many studies have shown a positive correlation between contemporaneous trading volume and volatility (Schwert (1989) and Gallant et al. (1992)). Schwartz and Shapiro (1992) show that institutions turn over their portfolios and trade more often than individuals do. For example, mutual funds typically have to trade when exogenous shocks of cash withdrawals or infusions occur as they are committed to provide funds to unit holders on demand and to comply with their stated investment policy. In some instances, institutional portfolio turnover may be driven by agency problems (window dressing). Dennis and Strickland (2002) show that a higher level of institutional investors is associated with a higher level of trading turnover. I hypothesize that investors that increase volatility have higher trading volume and investors that decrease volatility have lower trading volume.

The third explanation is investors' investment horizon. All other things being equal, shorter investment horizons would increase stock return volatility and vice versa. Cella et al. (2013) show that, during market turmoil, stocks primarily held by short-horizon investors experience larger price drops and subsequent reversal compared to stocks primarily held by long-horizon investors. There is also evidence that shareholders' investment horizons matter for firms' investment and performance. Stein (1989), Shleifer and Vishny (1990), and Bebchuk and Stole (1993) model how shareholders' short-term focus can lead to suboptimal investment behavior. Froot et al. (1992) argue that many hold the view that shorter horizons for stockholders lead inevitably to shorter horizons for managers when they evaluate investment opportunities. Gaspar et al. (2005) show that investment horizons of a firm's institutional shareholders impact the market for corporate control stock returns. Moreover, industry practitioners seem to devote considerable attention to investor horizon considerations, and many firms implement investor relation activities aimed at attracting long-term investors to their shareholder base.

Markowitz (1991) suggests that individual investors may make investment decisions based on long-term horizons. Friedman (1995) argue that institutional investors, who compete among one another for the business of ultimate savers, systematically adopt a time horizon that is too short, and there are plausible reasons to think that institutional capital is less patient than individuals own capital. I investigate whether individual investors, who dampen return volatility, have the longest investment horizon, and foreign investors, who increase stock return volatility, have the shortest investment horizon.

4.2 Trading strategy

Two methods are employed to test investors' trading strategy. The main approach follows the measures of trading styles based on Grinblatt and Keloharju (2000). Another method based on Fama and MacBeth (1973) regression finds similar results and is provided in Appendix B.

In this subsection, I follow the method in Grinblatt and Keloharju (2000) to examine investors' investment styles related to past returns, by using "buy ratio" – the number of shares bought divided by the sum of the number of shares bought and the number of shares sold. The difference between this paper and Grinblatt and Keloharju (2000) is that the latter use daily transaction data and 16 Finnish large stocks, while the former uses monthly holding data and all the stocks in the Norwegian stock market.

In each month t, I sort stocks on past returns into quartiles and calculate the cross-sectional average of equal-weighted buy ratio for each portfolio. The difference between the average buy ratio in the top quartile (with the highest past return) and that in the bottom quartile (with the lowest past return) is the measure of investment style in month t. If the difference for investor type j in month t is positive (negative), then investor type j is considered as momentum (contrarian) trader in month t, since the buy ratio for past winning stocks is higher (lower) than the buy ratio for past losing stocks.

The investment style for each type of investors is determined by the fraction of months for which the buy ratio is positive. If the fraction for one investor type is larger (lower) than 0.5, this type of investors is considered as momentum (contrarian) traders. I measure trading style conditional on returns up to six months in the past, as Grinblatt and Keloharju (2000) have done. The past returns for month t are the cumulative monthly returns from month t-k to t-1, where k$\in\{1, 2, 3, \text{and } 6\}$.

Table 7 presents the fraction of months with positive buy ratio (P{Buy ratio diff >0}) and its binomial test p-value for individual investors, financial institutional investors, and foreign investors. The columns (-k, -1) indicate that the fraction is computed conditional on past returns from month t-k to t-1. The first row ("Ind") and the third row ("For") show that individual investors are contrarian traders as all values are well below 0.5, and foreign investors are momentum traders as all values are above 0.50. These results are significant with p-values of zero. The second row ("Fin") shows that the fraction of months for positive buy ratio is around 0.5 for financial investors when using returns in the past one, two, or three months, and is only significant at the 10% level. Financial investors become momentum investors when conditioning on past returns up to six months. These

results are consistent with Grinblatt and Keloharju (2000), who, using Finnish data, show that foreign investors are momentum traders, individual investors are contrarian traders and financial investors fall in between.

There is other evidence that individual investors follow a contrarian trading strategy. Kaniel et al. (2008) show that individuals tend to buy stocks following declines in the previous month and sell following price increases. Barber et al. (2007) analyze all the trading activity on the Taiwan Stock Exchange and show that Taiwanese individual investors are selling winners at a faster rate than losers. Odean (1998) finds that investors at a US brokerage house are reluctant to realize loses. Calvet et al. (2009) also show that individuals in Sweden are selling winning stocks. All these studies present evidence that is consistent with contrarian trading strategies of individual investors and momentum trading of foreign (institutional) investors.

To sum up, the analysis of investors' trading style provides supportive evidence for the hypothesis that foreign investors, who increase stock return volatility, are momentum traders, and individual investors, who have the strongest negative impact on return volatility, are contrarian traders. The trading behavior of financial investors, who have a weaker negative impact on return volatility, fall in the middle ground.

4.3 Trading volume

In this subsection, I investigate whether foreign investors, who increase stock return volatility, trade more than the other types of investors that decrease stock return volatility. Due to the unavailability of trading data, I use monthly changes in holdings of each investor to proxy this investor's trading. For each stock i in each month t, I calculate the net traded shares, the number of shares held in month t minus the number of shares held in month t-1, adjusting for stock split/merge, for each investor. The total trading of investor type j on stock i in month t is the sum of the absolute value of the net traded shares of stock i in month t by all the investors in investor type j, divided by the free float or the number of shares outstanding in month t-1.

$$TotTrade^{j}_{i,t} = \frac{\sum_{k=1}^{K^j} |\Delta S^{k}_{i,t}|}{SHS_{i,t-1}}, \tag{5}$$

where $\Delta S^{k}_{i,t}$ is the change in holding shares of stock i from month t-1 to month t by investor k who belongs to investor type j, and j denotes individual investors, financial

investors, and foreign investors. $\sum_{k=1}^{K^j} |\Delta S_{i,t}^k|$ measures the aggregate number of shares net traded by all the investors in type j. There are K^j investors in type j. $SHS_{i,t-1}$ measures free float or the number of shares outstanding of stock i in month t-1.

In addition to investigating the total trading of each investor type, I also check total trading per holding, which is investors' total trading divided by their proportion of holding. The intuition is as follows. Even though investor type A trades less actively than investor type B, if investor type A holds a much higher fraction of shares than investor type B, the total trading of investor type A might be higher than that of investor type B. The total trading per holding reveals how actively each type of investors trades, given one unit of holding. I report both total trading and total trading per holding for all the three types of investors.

In each month t, I sort stocks on market capitalization into three portfolios and calculate the equal-weighted average of total trading of individual, financial, and foreign investors for each portfolio. I then compute the time series average of total trading for each size portfolio. The same procedure is used for total trading per holding. Table 8 reports total trading and total trading per holding for individual, financial, and foreign investors. The total trading is adjusted by free float in Panel A, and by the number of shares outstanding in Panel B. The last row in Panel A shows that, on average, individual investors have the lowest total trading, at 0.063, while foreign investors have the highest trading, at 0.144. Financial investors fall in a middle ground, at 0.106. The first three rows in Panel A, which present results for each size portfolio, show that while individual investors have the lowest total trading for the medium and large size portfolios, they have the highest total trading for the small size portfolio. Since individual investors hold most small stocks, the highest total trading of individual investors in small stocks might be due to their high holding instead of their active trading.

The last three columns of Panel A present total trading per unit of holding. For the small size portfolio, the total trading per holding of individual investors is 0.145, while the numbers for financial and foreign investors are 0.176 and 0.389. Foreign investors are more than twice as active as individual investors in small stocks, conditional on their holdings. This shows that the high total trading of individual investors among small stocks is due to their high holding, not because they are the most active traders.

For all the size portfolios in the first three rows, individual investors have the lowest total trading per holding. The last three columns in the last row of Panel A show that the average total trading per holding for individual investors is 0.194, while the numbers

are 0.317 and 0.426 for financial and foreign investors, respectively. The results in Panel B, where total trading is adjusted by the number of shares outstanding, provide similar stories as Panel A. In line with this evidence, Hotchkiss and Strickland (2003) find that volume is significantly higher when firms have a higher proportion of momentum investors, and lower when there are higher proportion of low turnover investors.

In summary, this table shows that individual investors, who reduce stock return volatility, have the lowest trading turnover, and are the least active traders, while foreign investors, who increase stock return volatility, have the highest trading volume and are the most active traders. Financial investors fall in between. The evidence is consistent with Gompers and Metrick (2001) and Schwartz and Shapiro (1992), who show that institutions tend to trade much more than retail investors. This analysis indicates that investors' trading volume is one of the determinants of their impacts on return volatility.

4.4 Investment horizons

To investigate whether individual investors in the Norwegian stock market are long-horizon investors while foreign investors are short-horizon investors, I examine investors' ownership duration by counting how many months each investor has been participating in the Norwegian stock market over the sample of 178 months. For each investor, I count the number of months this investor holds at least one share of the listed Norwegian stocks. I then split investors into categories (m, n], conditional on the number of months they hold shares of Norwegian stocks over the sample period, where (m, n]$\in${(0,6], (6,12],..., and (144, 178]}, and indicates that investors have been invested in the Norwegian stock market for longer than m months, but shorter than or equal to n months. The results are reported in Panel A of Table 9. The last column shows that there are in total 792 578 individual investors that have held at least one share of Norwegian stocks over the whole sample period. The total number of financial investors and foreign investors are 1 198 and 102 158, respectively. The first column of Panel A indicates that the number of investors that have been participating in the Norwegian stock market for a very short time period, less than or equal to six months, is 71 441, 123, and 27 621 for individual, financial, and foreign investors. To make it easier to compare, I present the percentage of investors in each investment horizon category for each type of investors in Panel B of Table 9. The first column of Panel B shows that while there are 9.01% of individual investors that have less than or equal to six months holdings, there are 27.04% of foreign

investors, three times as large as the percentage of individual investors. The last column presents the percentage of investors that have longer than 60 months' holdings (> 60). While the percentage of individual investors with longer than five years' holdings is 60%, the percentage is 49% for financial investors and only 24% for foreign investors.

Panel B shows that individual investors have a lower percentage in shorter investment horizon categories while a higher percentage in longer investment horizons, and foreign investors have the shortest investment horizons. Financial investors have shorter investment horizons than individual investors, but still much longer compared to foreign investors.

However, the results in panels A and B might be biased. Recall that foreign investors hold more Norwegian stocks in the later period of the sample. If more foreign investors enter the Norwegian stock market late or at the end of the sample period, there will be a higher percentage of foreign investors with shorter investment horizons. I therefore require investors to have been in the sample before January 2000 in order to be included in this analysis. To avoid miscounting the holding period of investors that have been participating in the Norwegian stock market before the beginning of the sample (December 1992) and were about to exit the market during the early period of the sample, I also require investors to be in the data after January 1995. Panels C and D report the number and percentage of each type of investors in different investment horizon categories for investors that have been participating in the Norwegian stock market during the period from January 1995 to January 2000.

The last column in Panel C shows that the total number of individual investors has decreased from 792 578 in Panel A to 486 261, while the numbers of financial investors and foreign investors have dropped from 1 198 and 102 158 to 756 and 41 922, respectively. Panel D reports the percentages of investors. The first column in Panel D shows that while there are only 1.98% individual investors that are very short-term investors, i.e., have investment horizons less than six months, the percentage for foreign investors is as high as 10.77%, more than five times that of individual investors. 2.91% financial investors have less than six months' holding period. The last column in Panel D shows that while there are 80.32% of individual investors, only 47.66% of foreign investors have been investing in the Norwegian market for longer than 60 months, conditional on the requirement that they have to be in the market during the period from January 1995 to January 2000. The percentage of financial investors that have longer than 60 months' investment horizon is 66.01%, between that of individual investors and foreign investors. Panels C and D provide consistent results as in panels A and B. The findings that foreign

investors have the shortest investment horizons, and domestic individual investors have the longest holding period on the Norwegian stock market are robust to the timing of entry and exit.

4.5 Summary

In summary, this section provides three explanations: trading style, trading volume, and investment horizons, for the results of foreign investors' positive impact and domestic individual and financial investors' negative impact on stock return volatility. The literature has shown that momentum trading style increases stock return volatility while contrarian trading reduces return volatility; trading volume is positively related to return volatility; and investment horizons have a negative correlation with return volatility. The results in this section show that foreign investors, who increase stock return volatility, are momentum traders, have the highest trading volume, and have the shortest investment horizons; individual investors, who have the strongest negative impact on return volatility, are contrarian traders, trade the least, and have the longest investment horizons; and financial investors with a weaker negative impact on return volatility, have trading behavior in the middle ground.

Investor information could be one of the potential explanations for the impacts of different types of investors on volatility. Grinblatt and Keloharju (2000), using Finnish data, show that foreign investors are most informed while individual investors are least informed. If this is true in the Norwegian stock market, the positive impact of foreign investors on volatility might indicate that foreign investors contributes positively to shareholder wealth (Bartram et al. (2012)), or the Norwegian market is dominated by private information (French and Roll (1986)). However, it is also possible that foreign investors incorporate noise into stock prices. This is beyond the scope of this paper and would be interesting for future research to explore.

5 Conclusion

Given the importance of return volatility in finance, understanding which type of investors increases stock return volatility would advance our knowledge of the determinants of volatility. While the extant literature on investors' holdings and stock return volatility focuses on institutional investors *or* individual investors due to data limitation, this paper

is the first to examine how three types of investors in the same setting affect stock return volatility. Taking advantage of a unique and detailed dataset of monthly holding data of *all* investors on all stocks listed on the Oslo stock exchange over a long period of 15 years, this paper investigates how foreign investors, domestic financial investors, and individual investors affect stock return volatility at the firm level, and provides some explanations based on investors' trade behavior.

The results show that foreign investors increase stock return volatility, individual investors dampen stock return volatility, and financial institutional investors have a weaker negative impact on return volatility than individual investors. The findings remain robust to various tests using different measures of both total volatility and idiosyncratic volatility, size portfolios and price portfolios, pre- and post-lift of constraints on foreign holding and short sales, changes in holdings, among others. It is interesting that although both foreign (institutional) investors and domestic institutional investors are institutional investors, they have different impacts on stock return volatility. While the former increase return volatility, the letter do the opposite. This indicates that institutional investors, e.g., from different geographical regions, could have different behavior and impacts on stock return volatility. Reverse causality and a difference-in-difference analysis based on an exogenous shock are conducted to address the concerns of endogeneity. The results indicate that endogeneity is not a threat to the findings.

As investors affect stock return volatility mainly through trading processes that incorporate information or noise into stock prices, I examine investors' behavior on trading style, trading turnover, and investment horizons, to shed light on why foreign investors have a positive impact, while individual and financial investors have negative impacts on return volatility. The results show that foreign investors pursue a momentum trading strategy, trade the most, and have the shortest investment horizon; individual investors follow a contrarian trading style, trade the least, and have the longest investment horizon; and financial investors fall in the middle ground. This study contributes to the literature by providing new evidence on how various types of investors affect stock return volatility.

As this paper finds that foreign (institutional) investors increase return volatility, it would be interesting for future research to explore whether this is because they are informed and hence increase volatility by incorporating private information into stock prices (French and Roll (1986)), or because they act like noise traders. While it is likely that both aspects co-exist, one fruitful research area could be to investigate when institutional investors act like informed traders and when they have similar behaviour as retail traders

(uninformed investors).

Appendices

Appendix A: Additional supplementary tests

A Tests using quarterly and annual frequencies

Sias (1996) and Malkiel and Xu (2003) use annual holding data and Brandt et al. (2010) employ quarterly holding data to check the relation between institutional investor holdings and stock return volatility. To reconcile our results with previous studies and to check whether our previous evidence still holds for lower holding data frequency, I use quarterly and annual frequencies in this subsection to redo the Fama and MacBeth (1973) regression for domestic individual investors, financial institutional investors, and foreign investors. The results are presented in Panel A of Table A1. The findings that individual investors and financial investors reduce volatility while foreign investors increase volatility remain. All the Pontiff (1996) adjusted t-statistics are significant at the 1% level, except that the coefficient on financial investors with annual frequency is significant at the 5% level. This analysis shows that our results are robust to different data frequencies.

B Regressing volatility on changes in holdings

Bennett et al. (2003) find evidence that firm-specific volatility is positively related to lag changes in institutional ownership, using quarterly institutional ownership data. Using changes in holdings also provide stronger references as holdings are persistent. The drawback is that changes in holdings may have much less power than holding levels, since investors' information, investment style, and other characteristics are more likely to be reflected in holding levels than in changes in holdings. Rubin (2007) shows that ownership level proxies for group-specific trading behavior. Gompers and Metrick (2001) study how institutional investors' demand for stock characteristics affects stock returns. They find that the level of institutional holdings forecasts returns better than the change in holdings, since changes in holdings reflect only a small fraction of institutional trade and is a much noisier measure. Nevertheless, I redo the Fama and MacBeth (1973) regression,

by replacing investors' holding levels with changes in holdings. I use quarterly and annual changes in holdings, which are consistent with the literature (Brandt et al. (2010) and Malkiel and Xu (2003)), and might reflect larger preference changes than monthly changes in holdings.

The results are presented in Panel B of Table A1. The two columns, which present the coefficients on quarterly and annual changes in holdings, provide consistent results for individual investors and foreign investors as in the main analysis. However, the magnitude and statistical power of the coefficients are much lower than the ones using holding levels. Changes in holdings of financial investors can not predict subsequent stock return volatility. The analysis in this subsection shows that while the results are quite similar when changes in holdings are used, changes in holdings contain less information and provide weaker results than the levels of investors' holdings.

C Tests using other measures of stock return volatility

To investigate whether the results are robust to different measures of stock return volatility, this subsection applies the other three measures of stock return volatility: 2, 3, and 4 discussed in section 2.2, where measures 2 and 3 are for total return volatility and measure 4 is for idiosyncratic volatility. The results, which are reported in Panel C of Table A1, are very similar to the main results reported in Table 3. This demonstrates that the main results are robust to different measures of total and idiosyncratic return volatility.

Table A1: Impacts of holdings on volatility using other measures of holdings and volatility

This table presents the impacts of holdings on stock return volatility using quarterly and annual data frequency (Panel A), changes in holdings (Panel B), and different volatility measurements (Panel C), over the sample period from December 1992 to September 2007 on the Norwegian stock market. I perform the following Fama and MacBeth (1973) regression of stock monthly volatility on one month lagged holdings, volatility, stock return (Ret), turnover (TO), natural logarithm of market capitalization (Size), natural logarithm of price (Price), free float divided by the number of shares outstanding (FreeFloatRatio), book to market ratio (B/M), and a contemporary dummy variable for the presence of state investors (StateDummy).

$$Vol_{i,t} = \beta_j Holding^j_{i,t-1} + Controls + \epsilon_{i,t}$$

The regressions are conducted for each investor type j, where j indicates individual investors (Ind), financial investors (Fin), and foreign investors (For), respectively. Both the dependent variable and independent variables are standardized to have the same mean (0) and standard deviation (1) to make the coefficient estimates comparable across investor types. The standard errors are corrected for potential higher order serial correlation by using the Pontiff (1996) method. The Pontiff (1996) adjusted t-values are reported in the parentheses in the rows below the coefficients. Panel A reports the coefficients and t-statistics on the lagged holding using data at quarterly and annual frequency. Panel B reports the results using changes in holdings to predict future return volatility, using quarterly and annual changes in holdings. Panel C presents the coefficients and t-statistics using the other three measures of volatility. The first column in panel C ("Measure 2") uses the square root of sum of squared daily returns in one month to measure the monthly return volatility. The second column in panel B ("Measure 3") uses the sum of absolute daily returns in one month to measure the monthly return volatility. The last column in panel C ("Measure 4") uses the standard deviation of the daily difference between its return and the market return in one month to measure the monthly idiosyncratic volatility.

Panel A. Quarterly and annual frequency

Type	Quarterly	Annual
Ind	-0.0683	-0.0872
	(-3.69)	(-3.83)
Fin	-0.0472	-0.0388
	(-2.92)	(-2.03)
For	0.1178	0.1187
	(10.14)	(7.32)

Panel B. Use changes in holding

Type	Quarterly	Annual
Ind	-0.0119	-0.0188
	(-2.38)	(-2.47)
Fin	-0.0050	-0.0112
	(-1.14)	(-1.50)
For	0.0125	0.0205
	(2.45)	(3.50)

Panel C. Use other 3 volatility measures

Type	Measure 2	Measure 3	Measure 4
Ind	-0.0497	-0.0514	-0.0460
	(-4.47)	(-4.53)	(-4.31)
Fin	-0.0452	-0.0370	-0.0463
	(-5.64)	(-4.39)	(-6.60)
For	0.0945	0.0906	0.0907
	(11.04)	(10.20)	(9.39)

Appendix B: Investors' trading strategy based on Fama and MacBeth (1973) analysis

To investigate how investors' trading is affected by past returns, I regress both changes in holding and holding levels of each type of investors in month t on past returns from month t-1 to t-k, where k∈{1, 2, 3, and 6}, and other control variables, which are the same as in Equation 2.

$$\Delta Holding^{j}_{i,t} = \beta^{j} Ret_{i,t-k,t-1} + Controls + \epsilon_{i,t}, \tag{6}$$

$$Holding^{j}_{i,t} = \beta^{j} Ret_{i,t-k,t-1} + Controls + \epsilon_{i,t}, \tag{7}$$

where $\Delta Holding^{j}_{i,t}$ measures the change in holding ownership of stock i by investor type j from month t-1 to month t, $Holding^{j}_{i,t} - Holding^{j}_{i,t-1}$, where j∈{individual investors, financial investors, and foreign investors}. $Ret_{i,t-k,t-1}$ measures cumulative returns on stock i from month t-k to month t-1, where k∈{1, 2, 3, and 6} and is corresponding to the horizons in Grinblatt and Keloharju (2000). If the coefficient on lagged returns is positive (negative) and significant, investors buy (sell) shares and increase (decrease) their holdings if stocks have performed well. This indicates a momentum (contrarian) trading strategy. I follow the Fama and MacBeth (1973) analysis in the previous sections, standardize both the dependent variable and the independent variables, and employ the Pontiff (1996) method to correct for standard errors.

The results are reported in Table A2. Panel A is for changes in holdings in regression (6) and Panel B is for holding levels in regression (7). The four columns (-k, -1) exhibit the coefficients and t statistics (in parentheses) on past returns from month t-k to t-1, where k∈{1, 2, 3, and 6}. Panels A and B provide consistent results that individual investors are contrarian investors and foreign investors are momentum investors. All the coefficients on past returns are negative and significant for individual investors, and are positive and significant for foreign investors. This means that individual investors sell when past returns are high and buy when past returns are low, while foreign investors increase their holdings when stock prices go up and decrease their holdings when stock prices go down. These results are consistent with the hypotheses and imply that trading style could be one of the channels that foreign investors increase return volatility and individual investors reduce return volatility. Both panels indicate that financial investors' holdings are not affected by past returns, except when regressing changes in holdings on past returns up

to 6 months, which has a positive coefficient with a t-statistic of 1.95. These results are consistent with those based on the methodology of Grinblatt and Keloharju (2000).

Table A2: Trading behavior based on past returns

This table presents results for the Fama and Macbeth (1973) regression of changes in monthly ownership holdings (in Panel A) and holding levels (in Panel B) on past stock returns from month t-k to month t-1, controlling for one-month lagged stock return volatility, stock return (Ret), turnover (TO), natural logarithm of market capitalization (Size), natural logarithm of price (Price), free float divided by the number of shares outstanding (FreeFloatRatio), book to market ratio (B/M), and a contemporary dummy variable for the presence of state investors (StateDummy).

$$\Delta Holding^{j}_{i,t} = \beta ret_{i,t-k,t-1} + controls + \epsilon_{i,t},$$

$$Holding^{j}_{i,t} = \beta ret_{i,t-k,t-1} + controls + \epsilon_{i,t},$$

where $\Delta Holding^{j}_{i,t}$ measures the change in ownership holdings of stock i by investor type j from month t-1 to month t, and $Holding^{j}_{i,t}$ measures the holding level of stock i at t for investor type j, where j indicates individual investors, financial investors, and foreign investors. $Ret_{i,t-k,t-1}$ measures the cumulative stock return from month t-k to month t-1, where k$\in\{1, 2, 3, \text{and } 6\}$ and corresponds to the horizons in Grinblatt and Keloharju (2000). Both the dependent variable and independent variables are standardized to have the same mean (0) and standard deviation (1) to make the coefficient estimates comparable across investor types. The standard errors are corrected for potential higher order serial correlation by using the Pontiff (1996) method. The t values are reported in the parentheses in the rows below the coefficients. For brevity, only coefficients on past returns, β, and its t value are reported.

Panel A reports the results when the dependent variable is the change in holdings and panel B presents the results when the dependent variable is holding levels. For both panels, the results for individual investors (Ind) are reported in the first two rows, the results for financial investors (Fin) are in the middle two roles, and the results for foreign investors (For) are in the last two rows. The column [-m,-1] presents the coefficients on past return, which is the cumulative return from month t-m to month t-1, where m$\in\{1, 2, 3, \text{and } 6\}$.

Panel A: Regress Changes in holdings on past returns

Type		[-1,-1]	[-2,-1]	[-3,-1]	[-6,-1]
Ind	tot ret	-0.0409	-0.0465	-0.0553	-0.0652
		(-3.86)	(-4.60)	(-5.53)	(-6.05)
Fin	tot ret	-0.0032	0.0026	0.0058	0.0157
		(-0.29)	(0.26)	(0.68)	(1.95)
For	tot ret	0.0382	0.0400	0.0430	0.0441
		(3.28)	(3.37)	(3.92)	(4.56)

Panel B: Regress Holding Levels on past returns

Type		[-1,-1]	[-2,-1]	[-3,-1]	[-6,-1]
Ind	tot ret	-0.0049	-0.0046	-0.0058	-0.0069
		(-2.62)	(-2.82)	(-4.01)	(-4.43)
Fin	tot ret	-0.0003	-0.0013	-0.0012	-0.0003
		(-0.10)	(-0.61)	(-0.69)	(-0.16)
For	tot ret	0.0052	0.0056	0.0066	0.0068
		(2.29)	(2.77)	(3.73)	(3.85)

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Table 1: Holding ownership of three types of investors

This table presents equal- and value-weighted holding ownership for three types of investors on the Norwegian stock market over a period of 178 months from December 1992 to September 2007. The three types of investors are (domestic) individual investors, financial investors, and foreign investors. Holding ownership is calculated as follows:

$$Holding^{j}_{i,t} = \frac{\sum_{k=1}^{K^j} S^{k}_{i,t}}{FreeFloat_{i,t}},$$

where $Holding^{j}_{i,t}$ measures holding ownership of stock i held by investor type j, where j indicates individual, financial, and foreign investors, in month t. $S^{k}_{i,t}$ is the number of shares of stock i held by investor k that belongs to investor type j in month t. There are K^j investors in investor type j that held stock i in month t. $\sum_{k=1}^{K^j} S^{k}_{i,t}$ measures the aggregate number of shares of stock i held by investor type j in month t. The investors' holding ownership is adjusted by free float. $FreeFloat_{i,t}$ measures the number of shares of stock i freely available to the investing public in month t. The proxy of free float follows that of the MSCI return index. The number of shares held by state investors, corporate investors, and large block holders are subtracted from the number of shares outstanding. Large block holders are investors with a minimum holding of X among individual investors, financial investors, and foreign investors, where X∈{10%, 20%, 30%, 50% and 70%}. The holdings that are adjusted by free floats are reported in the first five columns. Last column reports the holdings adjusted by the number of shares outstanding. Panel A reports the equal-weighted average of holding ownership for individual investors (Ind), financial investors (Fin), and foreign investors (For), while Panel B presents the value weighted average of holding ownership.

	Free float adjusted holding					
Type	Ex min. 10% blockholders	Ex min. 20% blockholders	Ex min. 30% blockholders	Ex min. 50% blockholders	Ex min. 70% blockholders	All Shares
	[1]	[2]	[3]	[4]	[5]	[6]
Panel A. Equal-weighted average of holding ownership						
Ind	0.395	0.387	0.383	0.377	0.380	0.197
Fin	0.329	0.323	0.320	0.316	0.309	0.238
For	0.276	0.289	0.297	0.307	0.312	0.199
FreeFloatRatio	0.478	0.524	0.543	0.571	0.591	
Panel B. Value-weighted average of holding ownership						
Ind	0.150	0.146	0.147	0.144	0.147	0.081
Fin	0.310	0.296	0.290	0.283	0.277	0.149
For	0.540	0.559	0.564	0.573	0.576	0.315
FreeFloatRatio	0.539	0.584	0.602	0.623	0.639	

Table 2: Stock characteristics sorted on investors' holdings

Panel A presents the equal-weighted average (Mean) and median (Median) of stock characteristics using monthly data on the Norwegian stock market from December 1992 to September 2007. The reported stock characteristics are monthly stock market capitalization (Size), price (Price), return volatility (Volatility), trading turnover (Turnover), and return (Return). Panels A, B, and C present stock characteristics sorted on holdings of individual investors (Panel B), financial investors (Panel C), and foreign investors (Panel D), respectively. In each month t, all the stocks are sorted into quintile portfolios by ownership holdings of one type of investors at t-1. For each portfolio, equal-weighted cross-sectional average of stock characteristics is calculated for each month, and then the time series average is reported in the panels. Panel E reports the correlation matrix among investors' holdings and the stock characteristics.

rank	Holding	Size mNOK	Price	Volatility	Turnover	Return	NumSec
Panel A. Average across all the stocks							
Mean		3520	95	0.178	0.076	0.022	193.5
Median		679	59	0.136	0.035	0.009	193.5
Panel B. Sorted on Individual investors' ownership							
High	0.797	390	104	0.217	0.066	0.028	39.1
2	0.527	691	84	0.193	0.079	0.022	38.9
3	0.314	1531	78	0.180	0.081	0.023	38.7
4	0.161	4203	91	0.158	0.072	0.019	38.5
Low	0.055	10908	118	0.142	0.081	0.018	38.3
Panel C. Sorted on Financial investors' ownership							
High	0.662	2335	112	0.158	0.049	0.017	39.1
2	0.427	1952	101	0.158	0.068	0.021	38.9
3	0.281	4129	91	0.165	0.087	0.022	38.7
4	0.164	7099	90	0.176	0.098	0.025	38.5
Low	0.052	2097	80	0.235	0.078	0.026	38.3
Panel D. Sorted on Foreign investors' ownership							
High	0.732	11259	100	0.163	0.093	0.024	39.1
2	0.442	2802	79	0.174	0.090	0.020	38.9
3	0.237	1672	81	0.175	0.085	0.020	38.7
4	0.102	1122	75	0.193	0.068	0.023	38.5
Low	0.020	640	140	0.187	0.042	0.023	38.3
Panel E. Correlations							
	Fin	For	Vol	Ret	TO	Size	Price
Ind	-0.467	-0.654	0.167	0.022	-0.037	-0.626	-0.210
Fin		-0.351	-0.173	-0.024	-0.049	0.223	0.240
For			-0.022	-0.002	0.077	0.465	0.013
Vol				0.104	0.111	-0.402	-0.389
Ret					0.179	0.039	0.068
TO						0.091	-0.151
Size							0.424

Table 3: Impacts of holdings on volatility

This table presents results of Fama and MacBeth (1973) regression of monthly stock return volatility on one-month lagged holding ownership, controlling for one month lagged natural logarithm of volatility and stock characteristics: monthly return (Ret), turnover (TO), natural logarithm of market capitalization (Size), natural logarithm of price (Price), free float divided by the number of shares outstanding (FreeFloatRatio), book to market ratio (B/M), and a contemporary dummy variable for the presence of state investors (StateDummy).

$$Vol_{i,t} = \beta_j Holding^j_{i,t-1} + Controls + \epsilon_{i,t}$$

Both the dependent variable and independent variables are standardized to have the same mean (0) and standard deviation (1) to make the coefficient estimates comparable across investor types. The standard errors are corrected for potential higher order serial correlation by using the Pontiff (1996) method. The Pontiff (1996) adjusted t-values are reported in the parentheses in the row below the coefficients. The first three columns use total return volatility as dependent variable, while the last three columns use idiosyncratic volatility as dependent variable.

	[1]	[2]	[3]	[4]	[5]	[6]
Indep. var.	Dep. var: Total volatility			Dep. var: Idiosyncratic volatility		
Ind	-0.060			-0.054		
	(-5.3)			(-4.4)		
Fin		-0.038			-0.035	
		(-5.3)			(-5.0)	
For			0.100			0.090
			(12.8)			(8.9)
Vol	0.551	0.556	0.541	0.520	0.525	0.514
	(57.7)	(56.9)	(60.2)	(52.3)	(50.7)	(53.9)
Ret	-0.059	-0.062	-0.060	-0.061	-0.064	-0.061
	(-10.8)	(-10.9)	(-10.4)	(-9.0)	(-9.1)	(-8.7)
TO	-0.036	-0.038	-0.036	-0.044	-0.046	-0.044
	(-4.2)	(-4.8)	(-4.2)	(-5.2)	(-5.6)	(-5.2)
Size	-0.185	-0.139	-0.213	-0.200	-0.163	-0.222
	(-19.2)	(-14.0)	(-21.6)	(-23.1)	(-16.5)	(-26.7)
Price	-0.087	-0.084	-0.070	-0.078	-0.076	-0.065
	(-9.0)	(-7.5)	(-7.3)	(-7.5)	(-6.5)	(-6.6)
FreeFloatRatio	-0.054	-0.060	-0.081	-0.048	-0.055	-0.074
	(-8.1)	(-9.5)	(-10.5)	(-8.0)	(-9.0)	(-9.9)
B/M	-0.068	-0.070	-0.071	-0.077	-0.078	-0.080
	(-8.3)	(-7.9)	(-8.7)	(-9.0)	(-8.4)	(-9.6)
StateDummy	-0.030	-0.022	-0.017	-0.037	-0.029	-0.023
	(-4.0)	(-2.7)	(-2.3)	(-5.8)	(-4.1)	(-3.9)
AdjR^2	0.521	0.518	0.523	0.492	0.489	0.495

Table 4: Impacts of holdings on return volatility in sub-samples

This table presents the results, for different sub-samples, for the Fama and MacBeth (1973) regressions of stock monthly volatility on one month lagged holdings, natural logarithm of volatility, and one month lagged stock return (Ret), turnover (TO), natural logarithm of market capitalization (Size), natural logarithm of price (Price), free float divided by the number of shares outstanding (FreeFloatRatio), book to market ratio (B/M), and a contemporary dummy variable for the presence of state investors (StateDummy).

$$Vol_{i,t} = \beta_j Holding^j_{i,t-1} + Controls + \epsilon_{i,t}$$

where $Holding^j_{i,t}$ indicates monthly holdings of investor type j, and j indicates individual investors (Ind), financial investors (Fin), and foreign investors (For), respectively. Both the dependent variable and independent variables are standardized to have the same mean (0) and standard deviation (1) to make the coefficient estimates comparable across investor types. The standard errors are corrected for potential higher order serial correlation by using the Pontiff (1996) method. The Pontiff (1996) adjusted t-values are reported in the parentheses in the rows below the coefficients. For brevity, only the coefficients on holdings are reported.

Panel A reports the results for the subsamples before and after the lift of foreign holding constraints in January 1995 (column [1] and [2]) and before and after the abolition of short sales constraints in January 1997 (column [3] and [4]). Panel B presents the results for low-priced and high-priced stocks (column [1] and [2]), and small size and large size stocks (column [3] and [4]). Low-priced stocks are the 50% stocks below the median price and high-priced stocks are stocks with price above the median price. Small stocks are the 50% stocks below the median stock market capitalization and large stocks are the 50% stocks above the median market capitalization.

	[1]	[2]	[3]	[4]
Panel A. Periods pre and post constraints				
	Foreign holding constraint		Short sales constraint	
Type	Pre 199501	Post 199501	Pre 199701	Post 199701
Ind	-0.0101	-0.0678	-0.0149	-0.0767
	(-0.81)	(-5.72)	(-1.63)	(-6.00)
Fin	-0.0460	-0.0361	-0.0613	-0.0285
	(-3.39)	(-4.65)	(-6.74)	(-3.67)
For	0.0487	0.1087	0.0755	0.1096
	(4.05)	(13.91)	(6.33)	(12.06)
Panel B. Size and price portfolios				
	Price portfolios		Size portfolios	
Type	Low price	High price	Small size	Large size
Ind	-0.0484	-0.0853	-0.0705	-0.0509
	(-3.41)	(-7.74)	(-6.18)	(-5.41)
Fin	-0.0480	-0.0385	-0.0235	-0.0484
	(-3.98)	(-5.75)	(-2.89)	(-3.32)
For	0.0920	0.1387	0.0953	0.0883
	(8.89)	(11.82)	(10.11)	(6.61)

Table 5: Return volatility of portfolios sorted on market capitalization and holdings

In each month t, all stocks are sorted into size quintile portfolios based on stock market capitalizations at t-1, and stocks within each size quintile are further sorted into holding quintile based on the fraction of shares held by investor type j, where i indicates individual investors, financial investors, and foreign investors, in month t-1. In each month, for each of the 25 portfolios, portfolio returns are calculated by equally weighting monthly returns of all the stocks in the portfolio. Monthly return volatility on the 25 portfolios are calculated and presented in the first five columns in this table. The last five columns present the time-series cross-sectional average of investors' holdings. Panel A reports volatility and holdings of portfolios sorted on size and holdings of individual investors. Panels B, and C report volatility and holdings of portfolios sorted on size and holdings of Norwegian financial investors, and on size and holdings of foreign investors, respectively. In each panel, the first row (High) presents the results for the portfolio with the highest holdings and the last row (Low) for the portfolio with the lowest holdings.

	Volatility					**Holdings**				
	Panel A. On size and individual holdings									
	Large	2	3	4	Small	Large	2	3	4	Small
High	0.075	0.068	0.067	0.077	0.076	0.346	0.568	0.725	0.828	0.923
2	0.068	0.070	0.074	0.093	0.089	0.160	0.310	0.504	0.626	0.778
3	0.095	0.076	0.083	0.093	0.095	0.099	0.194	0.347	0.463	0.649
4	0.063	0.072	0.087	0.095	0.089	0.062	0.114	0.199	0.302	0.488
Low	0.068	0.073	0.077	0.090	0.147	0.030	0.044	0.077	0.147	0.266
	Panel B. On size and Financial holdings									
	Large	2	3	4	Small	Large	2	3	4	Small
High	0.081	0.061	0.066	0.083	0.092	0.688	0.708	0.675	0.584	0.524
2	0.146	0.071	0.073	0.078	0.100	0.429	0.518	0.440	0.370	0.294
3	0.065	0.067	0.080	0.087	0.096	0.289	0.378	0.297	0.239	0.168
4	0.063	0.082	0.089	0.096	0.111	0.197	0.233	0.180	0.137	0.073
Low	0.072	0.077	0.080	0.096	0.103	0.103	0.085	0.063	0.046	0.013
	Panel C. On size and foreign holdings									
	Large	2	3	4	Small	Large	2	3	4	Small
High	0.062	0.078	0.089	0.096	0.140	0.826	0.743	0.663	0.601	0.450
2	0.070	0.082	0.093	0.108	0.105	0.676	0.477	0.377	0.301	0.170
3	0.061	0.070	0.074	0.095	0.097	0.529	0.296	0.210	0.157	0.070
4	0.142	0.060	0.072	0.081	0.072	0.341	0.166	0.099	0.066	0.025
Low	0.084	0.060	0.053	0.068	0.054	0.135	0.058	0.026	0.017	0.004

Table 6: Endogeneity issues

Panel A presents the results for reverse causality using the Fama and MacBeth (1973) regression. It regresses investors' holding levels (changes in holdings) on one monthly lagged natural logarithm of volatility, control for one month lagged monthly return (Ret), turnover (TO), natural logarithm of market capitalization (Size) and price (Price), free float divided by the number of shares outstanding (FreeFloatRatio), book to market ratio (B/M), and a contemporary dummy variable for the presence of state investors (StateDummy). Both the dependent variable and independent variables are standardized to have the same mean (0) and standard deviation (1) to make the coefficient estimates comparable across investor types. The standard errors are corrected for potential higher order serial correlation by using the Pontiff (1996) method. The Pontiff (1996) adjusted t-values are reported in the parentheses in the row below the coefficients. The first (last) two rows report the coefficients and t statistics on lagged volatility when investors' holding levels (changes in holdings) are used as dependent variable. The first (last) three columns present the results for the coefficients on total (idiosyncratic) return volatility for individual investors' holding ("Ind"), financial investors' holding ("Fin"), and foreign investors' holding ("For"), respectively. Panel B reports the results for the difference-in-difference analysis based on the adoption of the SAXESS trading system by the Oslo Stock Exchange on May 27, 2002. Stocks with changes in holding of foreign investors among the top X% (X=20, 30, and 40) in the post-SAXESS period are included in the treatment group, and the rest are in the control group.

$$Vol_{i,t} = \alpha_{i,t} + \beta_1 Post_t + \beta_2 TreatX_i + \beta_3 PostTreatX_{i,t} + controls + \epsilon_{i,t}$$

where $Vola_{i,t}$ measures total stock return volatility of stock i in month t. *Post* is a dummy variable, which equals 1 if month t is in the post-SAXESS period (after June 2002), and 0 otherwise. *TreatX* is 1 if stock i is among the top X% of stocks that have the highest increase in foreign holdings, and 0 otherwise. *PostTreatX* is an interaction term between *Post* and *TreatX*. The control variables are the same as the ones used in Panel A. Panel A (B) reports the results when three (five) years pre- and post-SAXESS period is used.

	[1]	[2]	[3]	[4]	[5]	[6]
Panel A: Reverse causality from volatility to holdings						
	Total volatility			Idiosyncratic volatility		
Dep. var.	Ind	Fin	For	Ind	Fin	For
Hold level	0.001	-0.003	0.001	0.003	-0.003	-0.001
	(0.54)	(-1.22)	(0.67)	(1.57)	(-1.07)	(-0.34)
Hold Changes	0.020	-0.001	-0.015	0.029	0.000	-0.023
	(2.17)	(-0.09)	(-1.62)	(2.76)	(-0.01)	(-2.30)
Panel B: Difference-in-difference method based on an exogeneous shock						
	Three years			Five years		
Dep. var.	Top 20%	Top 30%	Top 40%	Top 20%	Top 30%	Top 40%
Post	-0.034	-0.034	-0.035	-0.038	-0.039	-0.040
	(-11.11)	(-10.62)	(-9.85)	(-17.67)	(-16.74)	(-16.04)
Treat20	-0.033			-0.020		
	(-6.89)			(-6.13)		
PostTreat20	0.015			0.017		
	(2.21)			(3.66)		
Treat30		-0.031			-0.019	
		(-7.47)			(-6.45)	
PostTreat30		0.013			0.013	
		(2.22)			(3.17)	
Treat40			-0.035			-0.029
			(-8.99)			(-10.75)
PostTreat40			0.012			0.013
			(2.15)			(3.32)

Table 7: Additional analyses of investors' trading style

This table reports the results for trading styles related to past returns for individual investors, financial investors, and foreign investors, using the method in Grinblatt and Keloharju (2000). For each stock in each month, the buy ratio – the number of shares bought divided by the sum of the number of shares bought and the number of shares sold, is calculated for each type of investors. In each month t, stocks are sorted on past returns from month t-m to month t-1, [-m,-1], where m∈{1, 2, 3, and 6}, into quartiles, and the equal-weighted cross-sectional average of buy ratio is calculated for each portfolio of investor type j, where j indicates individual investors (Ind), financial investors (Fin), and foreign investors (For). The difference between the average buy ratio in the top quartile (with the highest past return) and the average buy ratio in the bottom quartile (with the lowest past returns) is the measure of investment style in month t for investor type j. If the difference for investor type j in month t is positive, then investor type j is considered as momentum trader in month t, since the buy ratio for past winning stocks is higher than the buy ratio for past losing stocks. On the other hand, investor type j with a negative value of the difference between buy ratio in the top and bottom quartile, is considered as contrarian. In the first four columns, the fraction of months for which the buy ratio is positive, is reported conditional on returns in the past, as Grinblatt and Keloharju (2000) have done. The past return for month t is the cumulative return of monthly return from month t-m to t-1, (-m,-1), where m∈{1, 2, 3, and 6}. The last 4 columns report the binomial test p-values.

	Past return from month t-m to t-1 (-m,-1)							
	P{ buy ratio diff>0}				**Binomial test p-value**			
Investor type	-1,-1	-2,-1	-3,-1	-6,-1	-1,-1	-2,-1	-3,-1	-6,-1
Ind	0.1977	0.1695	0.1130	0.1582	0.0000	0.0000	0.0000	0.0000
Fin	0.4802	0.4859	0.5085	0.5819	0.0522	0.0558	0.0584	0.0056
For	0.7401	0.7175	0.6893	0.7627	0.0000	0.0000	0.0000	0.0000

Table 8: Trading turnover

This table reports the total trading turnover and the total trading turnover adjusted for holding for the three types of investors: individual, financial, and foreign investors, in the Norwegian stock market over the sample period December 1992 to September 2007. The total trading of stock i in month t by investor type j is:

$$TotTrade^{j}_{i,t} = \frac{\sum_{k=1}^{K^j} |\Delta S^{k}_{i,t}|}{SHS_{i,t-1}},$$

where $\Delta S^{k}_{i,t}$ is the change in holding shares of stock i from month t-1 to month t by investor k who belongs to investor type j, and j denotes individual investors, financial investors, and foreign investors. $\sum_{k=1}^{K^j} |\Delta S^{k}_{i,t}|$ measures the aggregate number of shares net traded by all the investors in type j. There are K^j investors in type j. $SHS_{i,t-1}$ measures free float or the number of shares outstanding of stock i in month t-1. In each month t, stocks are sorted on size into quintiles and the equal-weighted average of total trading (in the first 3 columns) and of total trading adjusted for holdings (in the last 3 columns) are calculated for each type of investors. Panel A reports the results where trading is adjusted by free float. Panel B reports the results where trading is adjusted by the total number of shares outstanding. For both panels, the first row reports results for small stocks (Small), and the next two rows present results for medium-sized stocks (Medium) and large stocks (Large).

Panel A. Trading adjusted by free float

	Total trading			**Total trading/Holding**		
Rank	Individual	Financial	Foreign	Individual	Financial	Foreign
Small	0.084	0.043	0.069	0.145	0.176	0.389
Medium	0.050	0.100	0.069	0.135	0.298	0.236
Large	0.054	0.176	0.294	0.301	0.476	0.653
Average	0.063	0.106	0.144	0.194	0.317	0.426

Panel B. Trading adjusted by shares outstanding

	Total trading			**Total trading/Holding**		
Rank	Individual	Financial	Foreign	Individual	Financial	Foreign
Small	0.044	0.022	0.037	0.138	0.165	0.314
Medium	0.027	0.035	0.038	0.131	0.185	0.178
Large	0.019	0.053	0.091	0.186	0.272	0.283
Average	0.030	0.036	0.055	0.152	0.207	0.258

Table 9: Investment horizon

This table presents the number and percentage of investors in each type that have stock holdings for different investment horizons on the Norwegian stock market from December 1992 to September 2007. There are three types of investors: (domestic) individual investors (Ind), financial investors (Fin), and foreign investors (For). Panel A and Panel B, using all the investors in the data sample, report the number and percentage of investors that have invested in the Norwegian stock for a period between m and n months, (m, n]. For example, the Column "(0,6]" reports the number and fraction of investors that have held Norwegian stocks equal to or less than six months in the sample period. Column "(6,12]" shows the number and fraction of investors that have invested in stocks for longer than six months, but less than or equal to 12 months. The last column in Panel A reports the total number of investors in each sector. The last column in Panel B reports the fraction of investors in each type that have held Norwegian stocks for longer than 60 months (60). Panels C and D repeat the procedure in Panel A and Panel B, but require the investors have to be in the data sample between January 1995 to January 2000.

Panel A. Number of investors in the whole sample period

Type	(0,6]	(6,12]	(12,24]	(24,36]	(36,48]	(48,60]	(60,84]	(84,120]	(120,144]	(144,178]	all
Ind	71,441	58,636	68,127	43,365	42,843	35,841	160,241	113,739	52,509	145,836	792,578
Fin	123	96	110	106	93	84	144	145	57	240	1,198
For	27,621	14,986	13,541	9,691	6,763	5,158	10,326	8,621	2,071	3,380	102,158

Panel B. Percentage of investors in the whole sample period

Type	(0,6]	(6,12]	(12,24]	(24,36]	(36,48]	(48,60]	(60,84]	(84,120]	(120,144]	(144,178]	> 60
Ind	9.01	7.40	8.60	5.47	5.41	4.52	20.22	14.35	6.63	18.40	59.59
Fin	10.27	8.01	9.18	8.85	7.76	7.01	12.02	12.10	4.76	20.03	48.91
For	27.04	14.67	13.25	9.49	6.62	5.05	10.11	8.44	2.03	3.31	23.88

Panel C. Number of investors in the data between 1995 and 2000

Type	(0,6]	(6,12]	(12,24]	(24,36]	(36,48]	(48,60]	(60,84]	(84,120]	(120,144]	(144,178]	all
Ind	9,614	6,737	14,168	21,201	23,082	20,887	93,017	99,210	52,509	145,836	486,261
Fin	22	27	46	59	52	51	79	123	57	240	756
For	4,514	2,022	2,933	6,177	4,054	2,244	6,832	7,695	2,071	3,380	41,922

Panel D. Percentage of investors in the data between 1995 and 2000

Type	(0,6]	(6,12]	(12,24]	(24,36]	(36,48]	(48,60]	(60,84]	(84,120]	(120,144]	(144,178]	> 60
Ind	1.98	1.39	2.91	4.36	4.75	4.30	19.13	20.40	10.80	29.99	80.32
Fin	2.91	3.57	6.08	7.80	6.88	6.75	10.45	16.27	7.54	31.75	66.01
For	10.77	4.82	7.00	14.73	9.67	5.35	16.30	18.36	4.94	8.06	47.66

Equal-weighted (EW) and value-weighted (VW) average of stock return volatility

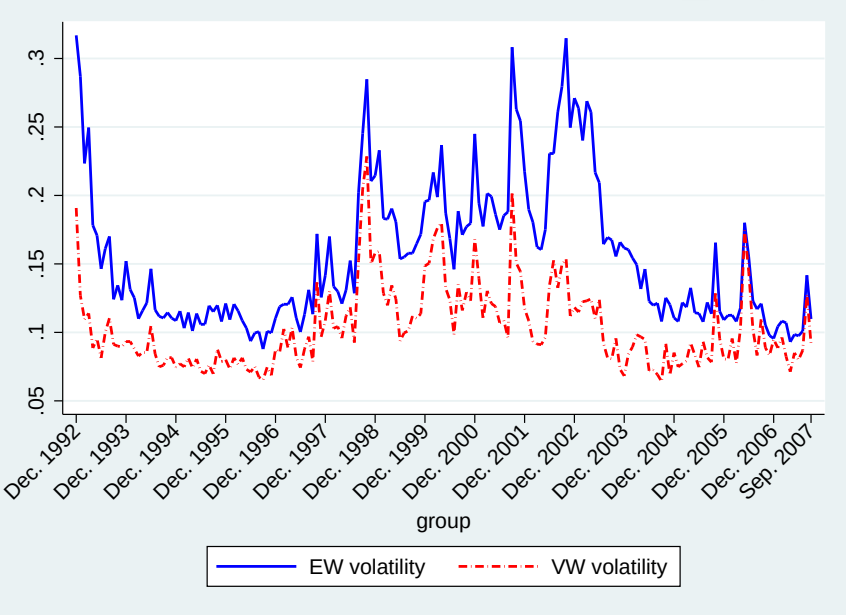
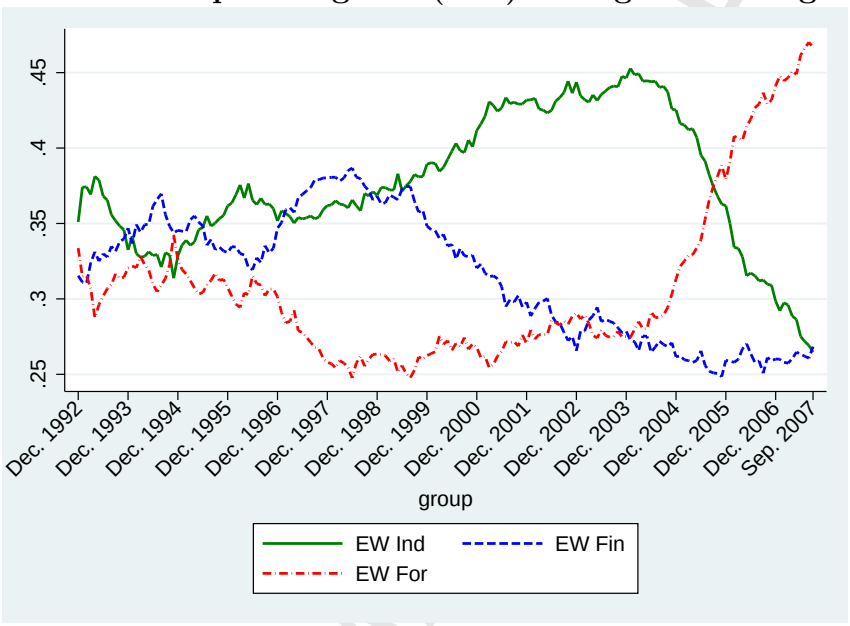


Figure 1: Monthly stock return volatility

Time series plots of monthly equal-weighted (EW) and value-weighted (VW)average of stock return volatility across all the stocks in the Norwegian stock market from December 1992 to September 2007. Return volatility is measured by the standard deviation of raw daily returns (square root of the sum of the squared demeaned daily returns) in each month (the standard measure of return volatility).

Panel A: Equal-weighted (EW) average of holdings



Panel B: Value-weighted (VW) average of holdings

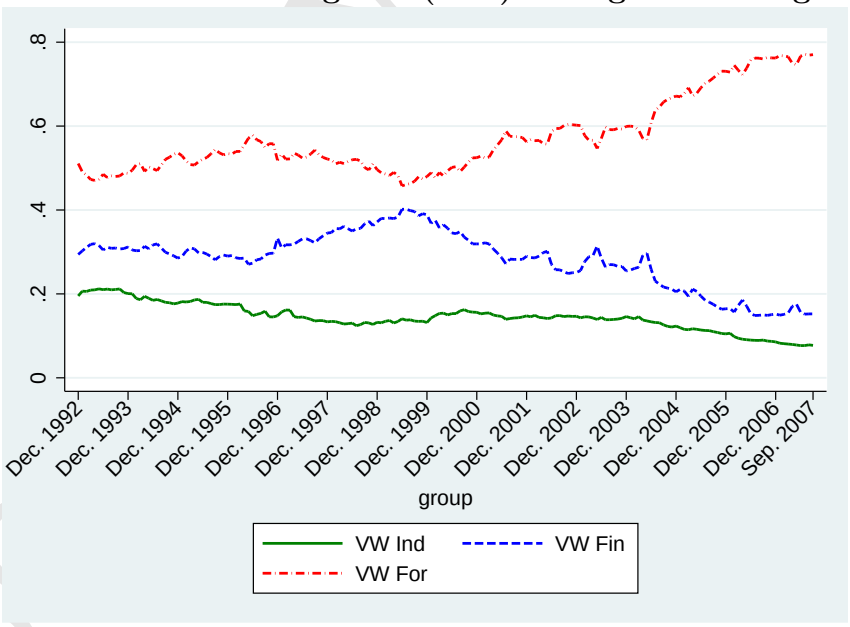


Figure 2: Holding ownership

Time series plots of monthly equal-weighted (Panel A) and value-weighted (Panel B) average holding ownership of three types of investors in the Norwegian stock market from December 1992 to September 2007. The three types of investors are domestic individual investors (Ind), domestic financial investors (Fin) and foreign investors (For).