Foreign Traders and Informative Stock Prices: Evidence from Korea[1]

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Abstract

This study links foreign holdings and their order flows with the short-term informational efficiency of stock prices in Korea and makes the following observations. First, stocks are priced less efficiently as foreign holdings or their order flows are greater. Second, this relationship gets stronger for stocks owned by more short-term foreign investors. Third, order flows from uninformed foreign investors are attributable to the negative effect of foreign holdings on informational efficiency. In conclusion, this study's evidence shows that foreign traders do not help price discovery processes and cause a negative externality to utilitarian traders, at least in the short run.

Keywords: Foreign trader; Price discovery; Informational efficiency

JEL classification: G14; G15

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1. Introduction

The last two decades have seen an unprecedented scale of financial liberalization, which has lifted a variety of restrictions on the mobility of foreign capital flows. In response, substantial academic attention has been paid to the effects of financial market integration on the economies of emerging countries, and, as a result, our understanding of the role and impact of foreign investors has improved dramatically.[2] While there is accumulated evidence that foreign investors materially change the macro-level structure of emerging countries' stock markets, empirical studies on the invoked changes at a genuine market microstructure level are relatively thin. This study attempts to fill the academic deficiency to some extent by analyzing how foreign trading causes market-microstructural changes in the Korean stock market, one of leading emerging stock markets, in which exceptionally detailed transaction datasets are available for all listed stocks.

We study the link between foreign trading and the process through which individual stocks are priced over time, and evaluate the economic benefit of increasing foreign participation in terms of the informational efficiency of stock prices. The informativeness of stock prices is an important element for determining the economic welfare of utilitarian traders (e.g., investors, borrowers, hedgers, and gamblers) who are motivated to trade for benefits other than trading profits. Since utilitarian traders are informationally inferior to profit-motivated traders (e.g., arbitrageurs and dealers), any trades that improve (or worsen) the informativeness of stock prices engender positive (or negative) external effects on utilitarian traders' welfare. Given the significant number of utilitarian traders in stock markets, therefore, it is interesting for scholars, practitioners, and policymakers to examine whether foreign traders and their trading enhance the efficiency of price discovery processes in emerging stock markets.

Do foreign traders help make stock prices more informative, or not? Previous studies offer mixed predictions. In principle, foreign traders will help promote the informational efficiency of domestic stock prices to the extent that they are informed and willing to correct mispricing (Grossman and Stiglitz, 1980).

[2] Existing studies show that stock market liberalization affects the costs of equity capital (Bekaert and Harvey, 2000), investment (Henry, 2000; Mitton, 2006; Chari and Henry, 2008), information transmission (Bae, Chan, and Ng, 2004; Bae, Ozoguz, Tan, and Wirjanto, 2012), and economic growth (Bekaert, Harvey, and Lundblad, 2005). Bekaert and Harvey (2003) and Karolyi and Stulz (2003) summarize the relevant studies.

There is mixed evidence that foreign traders are informationally advantaged, however. Some studies support that foreign traders are informed, since they are seasoned and have considerable investment expertise (Grinblatt and Keloharju, 2000; Froot and Ramadorai, 2008). On the other hand, Brennan and Cao (1997), Kang and Stulz (1997), Hau (2001), Choe, Kho, and Stulz (2005), and Dvořák (2005) conclude that foreign traders do not have an information edge, since their market accessibility is constrained by geographical, linguistic, and cultural distances. Moreover, some theories even predict that foreign traders, even if they were informed, would have incentives to manipulate stock prices for profits and thus cause distressed markets (e.g., Brunnermeier and Pedersen, 2005; Carlin, Lobo, and Viswanathan, 2007).

To analyze the relationship between foreign trading and price discovery processes, we consider the particular case in which profit-motivated traders monitor stock prices in real time to spot arbitrage profits, and consequently information-related shocks are impounded into transaction prices very quickly. Then, we relate daily foreign holdings and their order flows to several measures of short-term informational efficiency for all common stocks listed in the Korea Composite Stock Price Index (KOSPI) market.[3] Throughout this study, our main efficiency measure is the pricing error of Hasbrouck (1993), which estimates how far actual transaction prices deviate from their efficient prices due to non-informational market frictions. Since the transaction price closely follows the efficient price in an informationally efficient environment, the pricing error measure can function as a summary measure of the informativeness of the stock price; that is, the smaller the pricing error measure, the greater the informational efficiency. In addition to the pricing error measure, we introduce two alternative measures of informational efficiency for robustness: the autocorrelation-based measure of Chordia, Roll, and Subrahmanyam (2005) and the price delay measure of Hou and Moskowitz (2005).

If foreign traders are deemed to perform a beneficial role to produce informative prices, we would expect stocks with greater foreign holdings or greater foreign order flows to be more efficiently priced, ceteris paribus. Otherwise, the opposite case would arise. We run cross-sectional regressions for KOSPI-

[3] The KOSPI market is a benchmark stock market of Korea. All major blue-chip corporations, such as Samsung Electronics, Hyundai Motor, POSCO and LG Electronics, are listed on the KOSPI market.

listed common stocks over the sample period between June 2009 and November 2013 and make the following observations. First, foreign traders do not help price discovery processes, in that stocks are priced less efficiently as either foreign holdings or order flows increase. This means that foreign trading creates negative externalities to pricing stocks, at least in the short term. Second, we find that the effect of foreign holdings on informational efficiency is negatively related to the investment horizon of foreign traders. Corporate governance literature suggests that institutional investors with a long-term investment horizon effectively reduce information asymmetry between insiders and outside investors. Our finding favors this view, since long-term foreign ownership enhances the dissemination of corporate information and results in efficient stock prices. Third, incoming order flows from a group of uninformed foreign investors are mainly attributable to the effect of foreign holdings on informational efficiency. While this observation does not necessarily refute that foreign investors have a long-lived information advantage, it may suggest that they are informationally disadvantaged in the short term. This study's findings are robust to different informational efficiency measures, the reverse causality concern, and estimation methods.

The main finding, that foreign holdings and their order flows negatively affect the short-run information efficiency of stock prices in the Korean stock market, suggests two important implications. First, this study implies that foreign trading causes a negative externality to utilitarian traders in the Korean stock market by having stocks priced less efficiently in the short term. The utilitarian traders' welfare losses due to foreign trading are largely ignored in the current literature on financial liberalization, and consequently not appreciated properly when evaluating the well-known benefits from increasing foreign participation in emerging stock markets. In a sense, this study can be added to previous studies regarding the negative effects of financial liberalization. For instance, Stiglitz (2000) explains why speculative foreign equity flows, which are by nature short term, accelerated financial crises in the countries of East Asia and Latin America. In a related study, Boyer, Kumagai, and Yuan (2006) explore how financial market turmoil spreads across those countries, which is often referred to as contagion. These studies help one understand the economic link between foreign capital flows and macro-level financial market turmoil. In our study, particular emphasis is placed on the role and impact of foreign traders in price discovery processes. Thus,

the documented evidence that foreign trading is harmful to the economic welfare of utilitarian traders, at least in the short term, is supplementary to the current literature and gives an additional insight on the negative side effects of financial liberalization at the market microstructure level. For policymakers in emerging countries, this study's evidence requires a careful assessment of the welfare losses of domestic utilitarian traders from opening their stock markets to foreign investors. For practitioners, this study would be useful to detect arbitrage opportunities for stocks with greater foreign holdings, or their order flows, since those stocks are likely to be priced inefficiently in the short term.

This study also contributes to the current debate over information asymmetries between foreign and domestic investors. We find that the negative relationship between foreign holdings and the short-term informational efficiency of stock prices are closely related to the order flows from foreign traders who are presumably uninformed relative to domestic traders. This is consistent with the observation of Choe et al. (2005) that foreign traders tend to buy at higher and sell at lower prices than do domestic traders in the Korean stock market over the sample period between December 1996 and November 1998. Boehmer and Kelley (2009) find that institutional investors facilitate information efficiency of stock prices in the U.S. stock market. Interestingly, this study's evidence draws the opposite conclusion, although foreign traders in the KOSPI market are mostly institutional investors (Choe, Kho, and Stulz, 1999). The discrepancy between Boehmer and Kelley (2009) and this study would be due to the home bias puzzle; that is, foreign institutional investors have difficulty distinguishing value-relevant information from noise when they are outside their home countries (Kang and Stulz, 1997; Dahlquist and Robertsson, 2001). Overall, this study's evidence supports that foreign traders are less informed about domestic stocks than are domestic traders, at least in the short term, in the Korean stock market.

The remainder of this paper is structured as follows. Section 2 introduces three empirical measures of the informational efficiency of stock prices. Section 3 describes sample construction and empirical proxies for foreign holdings and their order flows. Section 4 explains control variables, provides descriptive statistics, analyzes how foreign traders affect short-run informational efficiency, and, finally, checks if the

results are robust to several empirical concerns. Finally, Section 5 offers a brief summary of the findings and conclusions.

2. Empirical Measures of Informational Efficiency

We focus on the short-term aspect of stock market efficiency and study how the presence of foreign traders relates to the informativeness of stock prices on a daily basis. This approach is based on the innocuous assumption that aggressive trading initiated by profit-motivated traders prevents market prices from deviating for a long time period. Many empirical studies support this assumption. For instance, Chordia et al. (2005) present that stocks almost complete price adjustments to informational shocks within a half hour in the New York Stock Exchange. See also Busse and Green (2002) for a similar result. Motivated by this quick price adjustment observed for U.S. stocks, Boehmer and Kelley (2009) and Boehmer and Wu (2012) provide a list of empirical measures for assessing short-lived price efficiency, constructed over intraday periods, and conduct tests for the informativeness of prices. We rely on their measures to evaluate the short-run efficiency of KOSPI-listed stock prices; specifically, this study adopts pricing errors, autocorrelations, and price delays.

Our first measure is the pricing error of Hasbrouck (1993). In a similar way to the Beveridge and Nelson (1981) decomposition, Hasbrouck (1993) decomposes the logarithm of transaction price into efficient price, which is unobservable, and a stationary residual component. The efficient price in time *t* is defined by the conditional expectation of stock price on all public information accumulated up to that time. The author assumes that the efficient price follows a random walk process and is nonstationary in an informationally efficient environment. Since the stationary component corresponds to the temporary deviation of the transaction price from the efficient price, Hasbrouck (1993) calls it a pricing error and takes its standard deviation as a summary measure of informational efficiency; that is, a smaller value of the pricing error standard deviation implies greater informational efficiency.[4]

[4] If it takes too long to correct temporary deviations from efficient prices, Hasbrouck (1993) admits that the random-walk assumption erroneously attributes noise to permanent changes in efficient prices, and as a result leads to underestimating pricing errors. In response to this possibility, Boehmer and Kelley (2009) interpret the pricing error

For each stock on a daily basis, we estimate the 5th order vector autoregressive (VAR) model for a multivariate time series consisting of the first difference of transaction prices, a trade sign indicator, signed trading volume, and the signed squared root of trading volume.[5] Hasbrouck (2006) advises to include the volume-related variables in the VAR system of equations, since a larger order may have a higher information content, and this relation could be nonlinear, as documented by Barclay and Warner (1993) and others. Then, the estimated VAR coefficients enable us to compute the corresponding vector moving average (VMA) model with sufficiently large lags. Finally, the VMA representation derives the pricing error standard deviation (see Hasbrouck, 2006 for complete derivation). For cross-sectional comparison, at each trading date we standardize the pricing error standard deviation by the standard deviation of intraday transaction prices. The standardized value, denoted by PE, refers to the pricing error measure of Hasbrouck (2006) throughout this study. We restrict PEs to less than one to remove outliers.

Next, we compute the absolute value of the autocorrelation of quote midpoint returns and use it as another measure of informational efficiency. In weak-form efficiency, stock returns are assumed to exhibit no autocorrelation (Fama, 1970). In this spirit, a smaller absolute value of return autocorrelations may indicate more informative stock prices. Based on the findings of Chordia et al. (2005), we calculate the first-order autocorrelation of 20-minute quote midpoint returns, denoted by AR20, for each stock on a daily basis using the transaction closest to 9:20 a.m., 9:40 a.m., and so on.[6]

It is the sources of price adjustments that cause the fundamental difference between the pricing error and autocorrelation-based measures. Specifically, PE accounts for the effects of informational shocks on the dynamics of stock returns by including the variables of information flows (i.e., a trade sign indicator and volume-related variables) in the VAR system. This means that PE is constructed based on the premise

as a measure of the efficiency of prices relative to a prevailing market consensus (rather than true intrinsic value). We follow their interpretation.

[5] For computation, we treat trades and quotes as if they occurred at equally spaced intervals in real time.

[6] A regular transaction session operates between 9:00 a.m. and 3:00 p.m. in the KOSPI market. We compute the absolute values of 30-, 40-, and 60-minute quote midpoint return autocorrelations. Our findings are robust to the autocorrelation-based measures of different time intervals.

that the short-run deviation of price is entirely caused by non-informational shocks.[7] In contrast to PE, AR20 does not differentiate between information-related and information-unrelated price shocks, so that it measures the price adjustment to both types of shocks. As Boehmer and Wu (2012) point out, the price adjustment to the information-related price shock is not necessarily indicative of informational inefficiencies. We accept this point and thus take PE as the main measure for assessing the informational efficiency of prices. A sensible robustness check is to see how the main findings of this study change when AR20 is used alternatively.

Finally, we compute the price delay of Hou and Moskowitz (2005) using daily returns for each stock on a monthly basis. This monthly price delay measure, denoted by PD, is the percentage difference in r-squared values from unrestricted and restricted regression models of stock returns, and represents the rate at which stock prices react to market-wide information. Since it will take less time for more efficiently priced stocks to incorporate market-wide information, we interpret that smaller PD indicates greater informational efficiency. In practice, the unrestricted model regresses daily stock returns onto contemporaneous and five days of lagged market return over a month, and the restricted model sets lagged market returns to zero. By construction, the PD measure is supplementary to the high-frequency measures of PE and AR20, in the sense that it emphasizes price adjustments to market-wide informational shocks over a week, rather than a day.

We admit that our measures of informational efficiency may be problematic in capturing fundamental value changes if price adjustments to shocks occur slowly. This is because we assume that transaction prices substantially adjust to entering news within a day for the PE and AR20 measures or within a week for the PD measure. While this is not completely resolved, we believe that the concern is relatively alleviated in this study, since foreign trading in our sample largely concentrates on stocks in KOSPI 200, a benchmark stock index in the KOSPI market. The constituents of KOSPI 200 are the largest and most liquid stocks in the KOSPI market, so their transaction prices are likely to adjust to shocks very quickly.

[7] Non-informational shocks are caused by market frictions that are not related to information, such as price discreteness, inventory control, and the price impact by a block trade.

3. Data

3.1. Sample construction

From the DataGuide database, analogous to the U.S. Wharton Research Data Services, we identify all common stocks listed on the KOSPI market over the sample period between June 2009 and November 2013. We include delisted stocks to control for survivorship bias. For each stock, we obtain from the KOSCOM database, analogous to the U.S. NYSE Trades and Quotes database, transaction-by-transaction prices and quotes placed during a regular trading session between 9:00 a.m. and 3:00 p.m. over the same period. If multiple quotes are issued at the same price during the same second, these quotes are aggregated into a single trade. Trades are removed if (a) ask or bid prices are zero, (b) the ask price is greater than 150% of the bid price, or (c) the transaction price is greater than 150% or less than 50% of the previous transaction price. We set a signed quote equal to one (i.e., a buyer-initiated trade) for a trade priced at a prevailing ask and equal to minus one (i.e., a seller-initiated trade) for a trade priced at a prevailing bid. The KOSPI market operates a consolidated limit order book (CLOB) in which unexecuted limit orders are held in a single book waiting for future executions. Since all executions occur against visible limit orders at posted quotes in the CLOB system, the tick test of Lee and Ready (1991) is not necessary for the KOSPI-listed stocks in determining the trade indicator. Finally, we ignore stock days with less than one hundred trades per day.

3.2. Foreign holdings and foreign order flows

When foreigners initially trade stocks in the Korean stock market, they should register with the Korean Financial Supervisory Service (FSS), analogous to the U.S. Securities and Exchange Commission. The Korean FSS waives the registration requirements for exceptional cases in which foreign investors sell stocks acquired via oversea securities, trade stocks in association with foreign direct investment (FDI) or are entitled to national treatment. Foreign investors as a group can own 100% of each firm's shares outstanding, except for some public corporations where the foreign ownership is limited to 40%.[8] Using the DataGuide

[8] Over the sample period, this foreign ownership limitation is applied to a total of 12 stocks. In unreported results, our findings remain unchanged when those 12 KOSPI-listed stocks are dropped from the sample.

database, we compute daily (or monthly) foreign holdings, denoted by FHRD, for each stock as the ratio of shares owned by foreign investors to total shares outstanding at the daily (or monthly) frequency. We define foreign order flows, denoted by FTRD, as the fraction of the sum of all foreign buys and sells to total shares outstanding, and compute it for each stock as well.[9]

4. Empirical Results

4.1. Control variables

To examine how foreign holdings and their order flows affect the informativeness of stock prices, we apply a Fama and MacBeth (1973) regression model in which a dependent variable is the informational efficiency measure (i.e., PE, AR20, or PD). As the independent variables of main interest in the regression analysis, the FHRD and FTRD variables are responsible for capturing the marginal effects of foreign holdings and their order flows on the efficiency measure. Since the informativeness of stock prices is probably related to factors other than FHRD and FTRD, we include them as additional control variables to reduce omitted-variable bias. Previous studies suggest that the efficiency of price discovery processes depends on share price, market capitalization, trading volume, execution costs, order imbalances, and short selling, as surveyed by Madhavan (2000).

Shleifer and Vishny (1997) argue that smaller transaction costs make arbitrage strategies more profitable. In a related work, Chordia, Roll, and Subrahmanyam (2008) present that stocks with lower execution costs are more likely to be in line with their fundamental values than are those with higher execution costs. Based on the insight that transaction costs could be negatively related to the informational efficiency of stock prices, we include the volume-weighted average of relative effective spreads, denoted by VRES, as a control variable. For each stock, VRES is computed as twice the absolute value of the difference between the transaction price and the prevailing quote midpoint, divided by the prevailing quote midpoint.

[9] Alternatively, we measure the foreign order flows with the sum of foreign buys and sells divided by the sum of total buys and sells. The alternative measure does not qualitatively change this study's results.

The volume-weighted average of transaction prices, denoted by VWAP, is included for the effects of price discreteness as well as investor attention. In the KOSPI market, tick sizes vary according to share prices with larger increments at higher prices.[10] Since a smaller tick size implies greater price continuity, low-priced stocks are likely to have small bid-ask spreads. The bid-ask spread is a main component of execution costs, thereby implying that low-priced stocks could be more efficiently priced (Glosten and Harris, 1988). At the same time, however, low-priced stocks would be less efficiently priced, since noise traders prefer low- to high-priced stocks (Black, 1986).

We include end-of-day market value (denoted by MV) and total trading volume (denoted by TVOL) for the following reasons. Lo and MacKinlay (1990) and Boudoukh, Richardson, and Whitelaw (1994) find that stock returns on large firms lead those on small firms. Based on this, one may argue that the speed at which prices adjust to market-wide information is positively associated with firm size. A number of studies indicate that trading volume has predictive information content for future price changes (Campbell, Grossman, and Wang, 1993; Blume, Easley, and O'hara, 1994; Conrad, Hameed, and Niden, 1994; Llorente, Michaely, Saar, and Wang, 2002). Specifically, Chordia and Swaminathan (2000) and Gervais, Kaniel, and Mingelgrin (2001) document that high-volume stocks respond to market-wide information more quickly than do low-volume stocks. Overall, stocks with higher market value or larger trading volume could be priced more efficiently.

One-sided trading pressure has conflicting effects on the informational efficiency of stock prices. On the one hand, informed traders are expected to trade on one side of the market until they fully exploit their private information. This trading behavior suggests that the one-sided trading direction is a reflection of informed signal on mispricing. Consequently, order imbalance may act as a watchdog to guard actual transaction prices against deviation from efficient prices (Kyle, 1985; Easley and O'hara, 1987; Chordia and Subrahmanyam, 2004). On the other hand, order imbalance can be seen as a stock market failure, since

[10] Tick sizes are 1 KRW for stocks priced under 1,000 KRW, 5 KRW for those between 1,000 KRW and 5,000 KRW, 10 KRW for those between 5,000 KRW and 10,000 KRW, 50 KRW for those between 10,000 KRW and 50,000 KRW, 100 KRW for those between 50,000 KRW and 100,000 KRW, 500 KRW for those between 100,000 KRW and 500,000 KRW and 1,000 KRW for those over 500,000 KRW.

it represents the case in which liquidity providers do not immediately absorb the orders from the other side of the imbalance. We compute order imbalance as the difference between buyer- and seller-initiated volumes, normalized by total trading volume, and include its absolute value, denoted by OIB, to control for the dual implications of one-sided trading pressure.

Finally, we consider the effect of short sellers on the informativeness of prices. Many authors present that short sellers are profit-motivated traders and their trading correctly predicts price declines (e.g., Dechow, Hutton, Meulbroek, and Sloan, 2001; Desai, Ramesh, Thiagarajan, and Balachandran, 2002; Christophe, Ferri, and Angel, 2004; Asquith, Pathak, and Ritter, 2005; Boehmer, Jones, and Zhang, 2008; Diether, Lee, and Werner, 2008). Boehmer and Wu (2012) find that short selling promotes price discovery processes and thus leads to informative prices for U.S. stocks. We control the effect of short sellers by including the Shorting variable, which is defined as the number of shares shorted, divided by trading volume.

4.2. Descriptive statistics

< Table 1>

For 784 KOSPI-listed common stocks with trading days of nonzero foreign holdings over the sample period between June 2009 and November 2013, Table 1 reports the time-series averages of the daily cross-sectional averages of the descriptive statistics of various variables. On average, foreigners own about 10% of the total shares outstanding of sample firms. The median of 3.961% and the standard deviation of 14.523% suggest that the foreign ownership has a right-skewed distribution and substantially varies across firms.

<Table 2>

To understand the characteristics of foreign trading in the KOSPI market, each day we divide all stocks into quintiles by the size of foreign holdings. Table 2 reports the time-series averages of the daily cross-sectional averages of variables for stocks in each group. As foreign holdings move from the first to the fifth quintile, VRES monotonically decreases. This may support that foreign traders are liquidity demanders who pay costs for immediacy to value traders who supply liquidity. We find that MV monotonically

increases with foreign holdings; that is, foreign traders prefer large firms to small ones. Kang and Stulz (1997) make the same observation in the Japanese stock market and attribute it to a potential cause that foreign investors are not informed and tend to invest more in large firms with which they are familiar. In addition, we observe that foreign traders prefer high-priced stocks. Finally, orders are less imbalanced and short selling is more active for stocks with larger foreign holdings.

<Table 3>

For preliminary analysis, we calculate the time-series averages of the cross-sectional correlations of the informational efficiency measures of PE, AR20, and PD with control variables. Table 3 reports the daily time-series averages for PE and AR20 in columns 2 and 3, and the corresponding monthly averages for PD in column 4. We find that the PE, AR20, and PD measures are negatively correlated with FHRD. One should be careful of reading these results as evidence that foreign holdings might positively affect the informativeness of prices. This is because the sample correlations neither account for the confounding effects of related variables nor clarify true causality between foreign holdings and efficiency measures. Next, the correlations of several control variables broadly have the expected signs. VRES has positive correlation coefficients, which is consistent with the notion that stocks with higher execution costs are less attractive to arbitrageurs and thus remain less informative. The negative correlation coefficients of MV, TVOL, and Shorting support the previous argument that the speed of price adjustments is faster for stocks with larger size, higher trading volume, or more active short selling. We also find that short-run informational efficiency is positively correlated with VWAP. This means that high-priced stocks would be more informative than low-priced stocks, possibly owing to the relative absence of noise traders. Finally, the positive correlation between PE and OIB indicates that order imbalances may be a reflection of market failure for the KOSPI-listed stock of our sample.

4.3. Foreign holdings and informational efficiency

In the following empirical analysis, we use the Fama-MacBeth regression of the form

$$\text{Efficiency measure}_{i,t} = \beta_{0,t} + \beta_{1,t}\text{FHRD}_{i,t-1} + \beta'_{2,t}\text{Control variables}_{i,t-1} + \varepsilon_{i,t},$$

where *i* and *t* denote firm and trading date, respectively. Implementation requires two steps. In a first step, we run the daily cross-sectional ordinary least squares (OLS) regression for all firms on the first sample date. After repeating the same procedure until the last sample date, we construct a time series of estimated coefficients over the entire sample period. In a second step, we estimate parameters as the sample average of the cross-sectional regression estimates. Robust *t*-statistics are based on the heteroscedasticity and autocorrelation consistent (HAC) standard errors of Newey and West (1987).

A couple of comments regarding the model specification proposed above: First, we impose a lead-lag relationship between the informational efficiency measure and independent variables. This approach is motivated to avoid bias caused by potential simultaneity between efficiency and right-hand side variables. As a simple remedy for the simultaneity bias, we use independent variables lagged by one period and take them as instruments.[11] Second, we include a lagged value of the dependent variable as a control variable, since our informational efficiency measures are fairly persistent over time and may cause the autocorrelated error problem.

<Table 4>

Table 4 reports the daily/monthly time-series means of cross-sectional OLS estimates from Fama-MacBeth regressions along with HAC standard errors in parentheses. Several findings emerge. First, the daily univariate regression result of PE in column 2 reports that the coefficient of the FHRD variable is negative and statistically significant at the 5% level. We attribute this negative association between foreign holdings and the pricing error measure to the omission of relevant variables. After controlling for other covariates that affect informational efficiency, we find that the pricing error measure marginally increases with foreign ownership in column 3. This evidence supports that greater foreign holdings lead to less informative prices of stocks in the KOSPI market. In other words, the presence of foreign trading can be a negative externality to uninformed utilitarian traders, since their utilities are positively related to the degree of pricing efficiency.

[11] We replace the lagged independent variables with the corresponding current values and find that our results remain qualitatively unchanged.

Second, the positive marginal effect of foreign holdings on pricing efficiency remains robust under the alternative measures of informational efficiency. In column 4, we replace PE with AR20 and find that the coefficient of FHRD is still positive and statistically significant at the 5% level. Likewise, the monthly Fama-MacBeth regression of PD leads to the same observation. Therefore, we conclude that transaction prices are more autocorrelated or take longer to adjust to market-wide information for stocks with greater foreign holdings, and confirm the finding observed in column 2.

Finally, marginal effects of other explanatory variables are broadly consistent with previous studies' findings and provide additional insights. We find that stocks with smaller transaction costs (VRES) or larger trading volume (TVOL) tend to have smaller pricing errors, ceteris paribus, which is consistent with the previous findings reviewed earlier. The negative coefficient of the logarithm of VWAP may support Black (1986), in that low-priced stocks attract noise traders rather than informed traders and are consequently priced less efficiently. While the coefficients of MV are positive in columns 3 and 4, where the dependent variables of PE and AR20 are measured at the daily frequency, the same coefficient is negative in column 5, in which the dependent variable of PD is a weekly measure. This would indicate that larger stocks are likely to overreact to informational shock at first and that the overshooting is diminished over some time period, for instance, a week. We decide to leave full explanation of this for future research. The coefficients of OIB exhibit different signs in columns 3 and 4. The observed distinction could be attributable to the fact that the PE measure accounts for the information-related shock of order imbalances to some extent but the AR measure does not. Unlike Boehmer and Wu (2012), we fail to find that the negative effect of short selling on PE is statistically significant for KOSPI-listed stocks. This could be because short selling in Korea is not currently as common as in the United States due to various legal regulations.

The results in Table 4 provide evidence that stocks are priced less efficiently as a higher fraction of shares are owned by foreigners, ceteris paribus. To investigate this further, we consider the case in which the documented relationship is conditional on the informational role of foreign investors. A stream of corporate governance studies argues that institutional investors can reduce agency and information asymmetry problems (e.g., Shleifer and Vishny, 1986; Jarrell and Poulsen, 1987). Particularly, Attig,

Cleary, El Ghoul, and Guedhami (2012) emphasize that institutional investors with a long-term investment horizon benefit from economies of scale in gathering and processing firm-specific information. Given that foreign investors are institutional investors in the Korean stock market, we propose a testable hypothesis that long-term foreign ownership enhances the dissemination of corporate information and results in efficient stock prices. Put differently, the null hypothesis states that the marginal effect of foreign holdings on informational efficiency is negatively related to the foreigners' investment horizon.

<Table 5>

Table 5 reports results from testing the proposed hypothesis. Motivated by Gaspar, Massa, and Matos (2005), we take foreign turnover, denoted by FTURN, as a proxy for the investment horizon of foreign investors, in that high (low) turnover represents a short-term (long-term) investment horizon. In practice, we compute two foreign turnover variables. The FTURN1 variable is computed as the ratio of the sum of foreign trades to twice total shares held by foreign investors. The FTURN2 variable is computed as the difference between the FTURN1 variable and the ratio of the sum of domestic trades to twice total shares held by domestic investors. Models 1 and 2 report estimates from Fama-MacBeth regressions of the PE measure in which the FTURN variables and their interaction terms with FHRD are introduced as additional independent variables. In model 1, we find that the coefficient of the interaction term is positive and statistically significant at the 5% level. This is evidence supporting the hypothesis; that is, the positive effect of foreign holdings on pricing error, observed in Table 4, gets smaller for stocks with longer-term foreign ownership, ceteris paribus. The same conclusion is made in model 2, in which we measure the investment horizon of foreign ownership relative to that of domestic ownership.

4.4. Foreign order flows and informational efficiency

Having observed the relationship between foreign holdings and pricing efficiency, we turn to analyzing how foreign order flows relate to the effectiveness of price discovery processes. Specifically, this subsection aims to discover economic mechanisms that govern the documented linkage between foreign ownership and the informational efficiency of stock prices.

<Table 6>

Table 6 reports the time-series means of cross-sectional OLS estimates (along with HAC robust standard errors in parentheses) from daily Fama-MacBeth regressions in which the PE variable is a dependent variable.[12] In models 1 to 3, we introduce several variables of foreign order flows as additional independent variables and question whether different information contents, extracted from various foreign order flows, may have different impacts on informational efficiency. As a benchmark result, we find that the marginal effect of the FTRD variable is positive in model 1. Coupled with the positive coefficient of FHRD, this implies that stocks are less efficiently priced as either foreign holdings or their order flows increase. In fact, this result is not surprising, since it is anticipated from the mechanical relationship between holdings and flows. In the remaining models, we classify foreign order flows according to pre-specified rules that presumably reflect fundamental differences in information among foreign traders. Then we investigate whether the order flows of different information sets have distinct impacts on pricing errors.

The first classification is intended to disentangle the effects of order flows initiated by registered traders from those by unregistered ones. Owing to the exemption code for the registration requirement in the Korean stock market, unregistered foreign investors are likely to be more informed than registered ones. For instance, the registration requirement is not applied to selling stock shares acquired via FDI. Since FDI is made after doing extensive research on investee companies, foreign investors involved in FDI can acquire valuable private information on the firms' fundamentals. Indeed, a significant time gap between the acquisition and sale of shares of investee companies endows unregistered foreign investors with another opportunity to gather additional information.

In model 2, we introduce the foreign order flow variables of FTRD_R and FTRD_NR as new independent variables. The FTRD_R variable is defined by the ratio of trades initiated by registered foreign investors to total shares outstanding. Likewise, the FTRD_NR variable is the same ratio computed

[12] The results remain qualitatively unchanged when the PE measure is replaced with the alternative informational efficiency measures of AR20 and PD.

for unregistered foreign investors. As anticipated, order flows from both registered and unregistered foreign traders marginally increase the pricing errors of stocks. More interestingly, we find that the marginal effect of FTRD_R is 12.771, about 10 times the marginal effect of FTRD_NR. This sharp contrast suggests that transaction prices deviate more from their true values as a greater number of orders are initiated by registered foreign investors who are likely to be relatively uninformed.

Next, we classify foreign order flows by their direction relative to domestic order flows. According to previous studies, informed order flows exhibit a trend reversing pattern, whereas uninformed ones follow a trend chasing behavior (e.g., Bohn and Tesar, 1996; Brennan and Cao, 1997; Barberis, Shleifer, and Vishny, 1998). If a group of foreign investors is better informed than domestic investors, then they would implement a trend-reversing strategy by submitting orders against the market consensus of domestic investors. This implies that foreign order flows moving against domestic order flows may be initiated by informed foreign investors. In a similar vein, uninformed foreign investors may submit orders in the same direction as domestic investors do.

We compute the following variables for each stock on a daily basis. FBUY_DBUY (FSELL_DBUY) is the fraction of foreign buys (foreign sells) to shares outstanding on days when domestic investors are net buyers. FSELL_DSELL (FBUY_DSELL) is the fraction of foreign sells (foreign buys) to shares outstanding on days when domestic investors are net sellers. By construction, FBUY_DBUY and FSELL_DSELL represent foreign order flows with domestic order flows, and FSELL_DBUY and FBUY_DSELL represent foreign order flows against domestic order flows. Model 3 reports results from a daily Fama-MacBeth regression in which the variables are added as additional independent variables. Interestingly, we find that foreign order flows with domestic order flows exhibit a greater negative effect on price discovery processes than do those against domestic order flows. When domestic investors are net buyers, for instance, the coefficient of FBUY_DBUY is 12.121, while the corresponding coefficient of FSELL_DBUY is 3.225. The same observation is made for the case in which domestic investors are net sellers; that is, 2.527 for FSELL_DSELL versus -2.811 for FBUY_DSELL.

The results of Table 6 show that incoming orders from a group of foreign investors who are relatively uninformed are mainly attributable to the negative effect of daily foreign holdings on short-run informational efficiency. This is in line with the conclusion from Table 5, in that foreign investors with a short-term investment horizon tend to have difficulty gathering and processing corporate information, and consequently are uninformed relative to those with a long-term investment horizon. Overall, the negative relationship between foreign ownership and short-term informational efficiency in this study may indicate that foreign investors are informationally disadvantaged relative to domestic investors, at least in the short term, in the Korean stock market. One may think that our findings confirm the conclusion of Choe et al. (2005). After observing that foreign investors buy at higher and sell at lower prices than do domestic investors on a daily basis in the KOSPI market, Choe et al. (2005) conclude that foreign investors are informationally disadvantaged. Of course, this study's evidence does not necessarily refute the possibility that foreign investors correctly estimate firms' fundamental values and perform better in the long term; that is, they may have a long-lived information advantage (Dvořák, 2005).

4.5. Reverse causality

One may raise the concern of a reverse causality problem in our empirical results. Specifically, it is possible that the degree of informational efficiency may influence the trading decisions of foreign investors, rather than our hypothesized causality. If this is the case, our results are subject to endogeneity bias and may lead to misleading conclusions. To alleviate this concern, we rely on a VAR model for a multivariate time series of the first differences of the informational efficiency measure, the FHRD variable, and other control variables. If reverse causality is present, then there should be a corresponding lead-lag relationship between the informational efficiency measure and the FHRD variable.

<Table 7>

We run the first order VAR model for each stock and report the averages of coefficients from the regression equation of ΔFHRD_t in Table 7. The relevant efficiency measures are ΔPE_t in model 1, ΔAR20_t in model 2, and ΔPD_t in model 3. We find that none of the coefficients of ΔPE_{t-1}, ΔAR20_{t-1}, and ΔPD_{t-1}

are statistically significant. In unreported VAR results, we can verify that the efficiency measures of ΔPE_t, $\Delta AR20_t$, and ΔPD_t are significantly related to $\Delta FHRD_{t-1}$, however. In sum, the results in Table 7 verify that our results are not harmed by the reverse causality problem.

4.6. Panel regressions

In general, OLS standard errors are no longer consistent unless residuals are independent both across firms for a given moment (i.e., no time effect) and over time for a given firm (i.e., no firm effect). A typical panel data set often exhibits the time effect, the firm effect, or both. Petersen (2009) shows that the Fama-MacBeth standard errors are unbiased in the presence of the time effect. At the same time, however, he finds that the Fama-MacBeth approach is vulnerable to residual dependence over time, since standard errors are biased downward in the presence of the firm effect. According to the critique, one may be concerned that this study's findings might be overemphasized owing to neglecting potential firm effect and consequently overestimating *t*-statistics.

<Table 8>

To address the firm effect in the Fama-MacBeth approach, we implement a pooled regression model with standard errors clustered by both firm and time. Thompson (2011) provides a simple formula for standard errors that correctly adjusts for simultaneous effects of firm and time; specifically, the robust variance matrix is formularized as the sum of two variance matrices that cluster by firm and time, respectively, minus the White (1980) heteroscedasticity-robust variance matrix. Columns 2 and 4 of Table 8 reports results for PE, AR20, and PD, respectively. We find that the marginal effects of foreign holdings are positive and significant at the 5% level, even after addressing the firm effect in standard errors. Thus, our finding regarding the relationship between foreign ownership and the informational efficiency of stock prices is robust to the firm effect.

5. Conclusions

We examine the role and impact of foreign traders on price discovery processes in the Korean stock market by directly linking daily foreign holdings and their order flows with the empirical measures of the short-term informational efficiency of stock prices. For KOSPI-listed stocks over the period between June 2009

and November 2013, we find that foreign traders do not help short-run information efficiency, in that greater foreign holdings or greater foreign order flows cause less efficient pricing, ceteris paribus. This relationship is stronger for stocks with the presence of short-term foreign investors who are less motivated or advantaged to gather and process firm-specific information. Finally, we find that incoming order flows from a group of foreign investors who are uninformed relative to domestic investors are mainly attributable to the negative effect of foreign holdings on short-run informational efficiency. Our findings are free from the endogeneity bias of reverse causality and remain robust under different samples, various efficiency measures, and different estimation methods.

The main contributions of this study are twofold. First, this study argues that foreign trading causes a negative externality to utilitarian traders, at least in the short term. While the utilitarian traders' welfare losses due to foreign trading are largely ignored in the current literature on financial liberalizations, we believe that it should be recognized to accurately evaluate the well-known benefits from increasing foreign participation in emerging stock markets. Second, this study contributes to the current debate over information asymmetries between foreign and domestic investors. Consistent with Choe et al. (1999), we find that the negative relationship between foreign holdings and the short-term informational efficiency of stock prices is closely related to some order flows from foreign traders who are presumably uninformed relative to domestic traders. While this observation does not necessarily refute the possibility that foreign traders have a long-lived information edge, it supports that on average they are less informed about domestic stocks than are domestic traders in the short term in the Korean stock market.

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Table 1. Descriptive statistics.

This table reports time-series averages of the daily cross-sectional descriptive statistics for the sample of 784 KOSPI-listed common stocks with positive foreign holdings from June 2009 to November 2013. For each stock in the sample, transaction prices and quotes are collected during a regular trading session between 9:00 and 15:00. If multiple quotes are issued at the same price during the same second, the quotes are aggregated into a single trade. Trades are removed if (a) the ask or bid prices are zero, (b) the ask price is greater than 150% of the bid price, or (c) the transaction price is greater than 150% or less than 50% of the previous transaction price. For each stock, the following variables are computed for each trading day with more than 100 transactions. PE is the information efficiency measure of Hasbrouck (1993) standardized by the standard deviation of intraday transaction prices. AR20 is the absolute value of the first-order autocorrelation of quote midpoint returns measured in 20-minute intervals. FHRD is the ratio of shares owned by foreign traders to total shares outstanding. FTRD is the sum of foreign trades divided by total shares outstanding. VRES is the volume-weighted average of relative effective spreads, where the relative effective spread is the ratio of twice the absolute difference between the transaction price and the quote midpoint to the quote midpoint. VWAP is the volume-weighted average of intraday transaction prices. MV is end-of-day market value. TVOL is daily trading volume. OIB is the absolute value of order imbalance, where the order imbalance is the difference between buyer- and seller-initiated trades, divided by trading volume. Shorting is the number of shares shorted, divided by trading volume.

	Mean	Median	Standard deviation
PE	0.200	0.155	0.152
AR20	0.167	0.146	0.12
FHRD (%)	10.363	3.961	14.523
FTRD (%)	0.056	0.028	0.088
VRES	0.004	0.004	0.003
VWAP (KRW thousands)	50.334	11.138	140.799
MV (KRW billions)	1465.014	144.709	6896.984
TVOL (thousands)	659.154	140.533	2694.718
OIB	0.260	0.235	0.179
Shorting (%)	1.533	0.080	3.331

Table 2. Descriptive statistics sorted by foreign holdings.

For 784 KOSPI-listed common stocks from June 2009 to November 2013, this table divides stocks into quintiles by FHRD each day, and reports time-series averages of the daily cross-sectional averages of variables for stocks categorized in five groups. The variables include FTRD, VRES, VWAP, MV, TVOL, OIB, and Shorting. The last column reports *t*-statistics from two-sample *t*-tests of the mean difference between the first and fifth quintiles.

	FHRD					
	Q1 (smallest)	Q2	Q3	Q4	Q5 (largest)	*t*-Statistic
FTRD (%)	0.054	0.054	0.050	0.046	0.080	32.76
VRES	0.007	0.007	0.006	0.005	0.003	-94.16
VWAP (KRW thousands)	5.830	5.833	12.667	16.373	126.756	247.93
MV (KRW billions)	71.318	71.353	116.420	203.889	5369.897	277.03
TVOL (thousands)	1028.324	1027.656	1040.666	847.707	477.179	-34.86
OIB	0.291	0.291	0.287	0.281	0.224	-45.26
Shorting (%)	0.263	0.264	0.574	0.885	2.573	62.50

Table 3. Sample correlations.

For 784 KOSPI-listed common stocks from June 2009 to November 2013, this table reports time-series averages of the cross-sectional correlations of PE, AR20, and PD with various variables. The PD variable represents the monthly price delay measure and is analogous to the annual price delay measure of Hou and Moskowitz (2005). The variables include FHRD, VRES, log(VWAP), log(MV), log(TVOL), OIB, and Shorting. Columns 2 and 3 report the daily averages of correlations, while column 4 reports the monthly averages of correlations.

	PE	AR20	PD
FHRD	-0.069	-0.015	-0.120
VRES	0.365	0.023	0.176
log(VWAP)	-0.142	-0.027	-0.121
log(MV)	-0.205	-0.030	-0.247
log(TVOL)	-0.365	-0.019	-0.084
OIB	0.181	0.011	0.080
Shorting	-0.100	-0.017	-0.124

Table 4. Pricing efficiency and foreign holdings.

For 784 KOSPI-listed common stocks from June 2009 to November 2013, this table reports coefficients (with Newey-West standard errors in parentheses) from Fama-MacBeth regressions. Columns 2 and 3 report results from daily regressions of PE_t. Column 4 reports result from a daily regression of $AR20_t$. Column 5 reports results from a monthly regression of PD_t. Independent variables include $FHRD_{t-1}$, $VRES_{t-1}$, $\log(VWAP_{t-1})$, $\log(MV_{t-1})$, $\log(TVOL_{t-1})$, OIB_{t-1}, $Shorting_{t-1}$, and DV_{t-1}. The DV_{t-1} variable represents a lagged value of the dependent variable. The subscript *t*-1 and *t* represent lagged and current values. * indicates statistical significance at the 5% level.

	PE_t	PE_t	$AR20_t$	PD_t
Constant	0.096*	0.133*	0.205*	1.426*
	(0.001)	(0.012)	(0.004)	(0.068)
$FHRD_{t-1}$	-0.026*	0.032*	0.003*	0.041*
	(0.002)	(0.002)	(0.001)	(0.011)
$VRES_{t-1}$		8.721*	0.250*	2.966*
		(0.260)	(0.088)	(0.521)
$\log(VWAP_{t-1})$		-0.027*	-0.004*	0.001
		(0.000)	(0.000)	(0.003)
$\log(MV_{t-1})$		0.018*	0.001*	-0.029*
		(0.000)	(0.000)	(0.003)
$\log(TVOL_{t-1})$		-0.023*	-0.002*	-0.011*
		(0.000)	(0.000)	(0.002)
OIB_{t-1}		0.019*	-0.002*	-0.037
		(0.001)	(0.001)	(0.026)
$Shorting_{t-1}$		-0.030	0.003	0.016
		(0.043)	(0.025)	(0.137)
DV_{t-1}	0.523*	0.353*	0.005*	0.160*
	(0.004)	(0.004)	(0.001)	(0.016)
Adjusted R^2	0.271	0.330	0.004	0.122

Table 5. Marginal effects of foreign holdings with different investment horizons.

For 784 KOSPI-listed common stocks from June 2009 to November 2013, this table reports coefficients (with Newey-West standard errors in parentheses) from daily Fama-MacBeth regressions in which PE_t is a dependent variable. Independent variables include $FHRD_{t-1}$, $FTURN1_{t-1}$, $FTURN2_{t-1}$, $FHRD_{t-1} \times FTURN1_{t-1}$, $FHRD_{t-1} \times FTURN2_{t-1}$, $VRES_{t-1}$, $\log(VWAP_{t-1})$, $\log(MV_{t-1})$, $\log(TVOL_{t-1})$, OIB_{t-1}, $Shorting_{t-1}$, and PE_{t-1}. In model 1, the FTURN1 variable is computed as the ratio of the sum of foreign buys and sells to twice total shares held by foreign investors. In model 2, the FTURN2 variable is computed as the FTURN1 variable in model 1 minus the ratio of the sum of domestic buys and sells to twice total shares held by domestic investors. The subscript *t*-1 and *t* represent lagged and current values. * indicates statistical significance at the 5% level.

	Model 1	Model 2
Constant	0.133*	0.138*
	(0.012)	(0.012)
$FHRD_{t-1}$	0.029*	0.038*
	(0.002)	(0.002)
$FTURN1_{t-1}$	-0.002*	
	(0.001)	
$FTURN2_{t-1}$		-0.002*
		(0.001)
$FHRD_{t-1} \times FTURN1_{t-1}$	5.666*	
	(0.672)	
$FHRD_{t-1} \times FTURN2_{t-1}$		1.066*
		(0.128)
$VRES_{t-1}$	8.757*	8.754*
	(0.264)	(0.263)
$\log(VWAP_{t-1})$	-0.028*	-0.026*
	(0.000)	(0.000)
$\log(MV_{t-1})$	0.019*	0.018*
	(0.000)	(0.000)
$\log(TVOL_{t-1})$	-0.024*	-0.023*
	(0.000)	(0.000)
OIB_{t-1}	0.019*	0.019*
	(0.001)	(0.001)
$Shorting_{t-1}$	-0.030	-0.030
	(0.044)	(0.043)
PE_{t-1}	0.352*	0.353*
	(0.004)	(0.004)
Adjusted R^2	0.330	0.329

Table 6. Various foreign trading activities.

For 784 KOSPI-listed common stocks from June 2009 to November 2013, this table reports coefficients (with Newey-West standard errors in parentheses) from daily Fama-MacBeth regressions of PE_t. Independent variables include $FTRD_{t-1}$, $FTRD\_R_{t-1}$, $FTRD\_NR_{t-1}$, $FBUY\_DBUY_{t-1}$, $FSELL\_DBUY_{t-1}$, $FSELL\_DSELL_{t-1}$, $FBUY\_DSELL_{t-1}$, $FHRD_{t-1}$, $VRES_{t-1}$, $\log(VWAP_{t-1})$, $\log(MV_{t-1})$, $\log(TVOL_{t-1})$, OIB_{t-1}, $Shorting_{t-1}$, and PE_{t-1}. The FTRD_R (or FTRD_NR) variable is the ratio of trades by registered (or unregistered) foreign investors to shares outstanding. The FBUY_DBUY (or FBUY_DSELL) variable is the ratio of foreign buys to shares outstanding on days when domestic investors are net buyers (or sellers). The FSELL_DBUY (or FSELL_DSELL) variable is the ratio of foreign sells to shares outstanding on days when domestic investors are net buyers (or sellers). The subscript *t*-1 and *t* represent lagged and current values. * indicates statistical significance at the 5% level.

	Model 1	Model 2	Model 3
Constant	0.132*	0.139*	0.139*
	(0.012)	(0.012)	(0.012)
$FTRD_{t-1}$	2.642*		
	(0.332)		
$FTRD\_R_{t-1}$		12.771*	
		(0.872)	
$FTRD\_NR_{t-1}$		1.314*	
		(0.375)	
$FBUY\_DBUY_{t-1}$			12.121*
			(0.776)
$FSELL\_DBUY_{t-1}$			3.225*
			(0.809)
$FSELL\_DSELL_{t-1}$			2.527*
			(0.444)
$FBUY\_DSELL_{t-1}$			-2.811*
			(0.685)
$FHRD_{t-1}$	0.029*	0.028*	0.029*
	(0.002)	(0.002)	(0.002)
$VRES_{t-1}$	8.716*	8.705*	8.674*
	(0.261)	(0.261)	(0.261)
$\log(VWAP_{t-1})$	-0.028*	-0.028*	-0.028*
	(0.000)	(0.000)	(0.000)
$\log(MV_{t-1})$	0.019*	0.019*	0.019*
	(0.000)	(0.000)	(0.000)
$\log(TVOL_{t-1})$	-0.024*	-0.025*	-0.025*
	(0.000)	(0.000)	(0.000)
OIB_{t-1}	0.019*	0.019*	0.018*
	(0.001)	(0.001)	(0.001)
$Shorting_{t-1}$	-0.030	-0.027	-0.033
	(0.043)	(0.042)	(0.042)
PE_{t-1}	0.353*	0.352*	0.353*
	(0.004)	(0.004)	(0.004)
Adjusted R^2	0.330	0.330	0.329

Table 7. Reverse causality.

For 784 KOSPI-listed common stocks from June 2009 to November 2013, this table reports the averages of coefficients (with ordinary standard errors in parentheses) from the regression equations of ΔFHRD_t in the VAR models for a multivariate time series of Y_t. The time-series Y_t consists of Δx_{t-1}, ΔFHRD_{t-1}, ΔVRES_{t-1}, $\Delta\log(\text{VWAP}_{t-1})$, $\Delta\log(\text{MV}_{t-1})$, $\Delta\log(\text{TVOL}_{t-1})$, ΔOIB_{t-1}, and $\Delta\text{Shorting}_{t-1}$, where Δx_{t-1} is ΔPE_{t-1} in model 1, ΔAR20_{t-1} in model 2, and ΔPD_{t-1} in model 3. Models 1 and 2 report the results from daily regressions, while model 3 reports the results from a monthly regression. The subscript *t*-1 and *t* represent lagged and current values. * indicates statistical significance at the 5% level.

	Model 1	Model 2	Model 3
Constant	0.000*	0.000*	0.000*
	(0.000)	(0.000)	(0.000)
ΔPE_{t-1}	0.000		
	(0.000)		
ΔAR20_{t-1}		0.000	
		(0.000)	
ΔPD_{t-1}			0.000
			(0.000)
ΔFHRD_{t-1}	0.151*	0.151*	0.292*
	(0.008)	(0.008)	(0.012)
ΔVRES_{t-1}	0.002	0.002	-0.677*
	(0.006)	(0.006)	(0.330)
$\Delta\log(\text{VWAP}_{t-1})$	0.003*	0.003*	-0.070*
	(0.001)	(0.001)	(0.012)
$\Delta\log(\text{MV}_{t-1})$	-0.005*	-0.005*	0.074*
	(0.001)	(0.001)	(0.012)
$\Delta\log(\text{TVOL}_{t-1})$	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)
ΔOIB_{t-1}	0.000	0.000	-0.001
	(0.000)	(0.000)	(0.001)
$\Delta\text{Shorting}_{t-1}$	-0.010	-0.010	2.027
	(0.006)	(0.007)	(2.546)
Adjusted R^2	0.085	0.085	0.168

Table 8. Panel regressions.

This table reports coefficients (with robust standard errors in parentheses) from pooled regressions in which independent variables include FHRD_{t-1}, VRES_{t-1}, $\log(\text{VWAP}_{t-1})$, $\log(\text{MV}_{t-1})$, $\log(\text{TVOL}_{t-1})$, OIB_{t-1}, Shorting_{t-1}, and DV_{t-1}. Based on Thompson (2011), the standard errors are clustered by firm and time. Columns 2 reports the result from a daily regression of PE_t. Column 3 reports the result from a daily regression of AR20_t. Column 4 reports the result from a monthly regression of PD_t. The subscript *t*-1 and *t* represent lagged and current values. * indicates statistical significance at the 5% level.

	PE_t	AR20_t	PD_t
Constant	0.161*	0.213*	1.439*
	(0.006)	(0.004)	(0.090)
FHRD_{t-1}	0.034*	0.003*	0.060*
	(0.001)	(0.001)	(0.020)
VRES_{t-1}	6.840*	-0.103	1.287
	(0.194)	(0.068)	(0.761)
$\log(\text{VWAP}_{t-1})$	-0.026*	-0.003*	0.002
	(0.000)	(0.000)	(0.004)
$\log(\text{MV}_{t-1})$	0.016*	0.000*	-0.032*
	(0.000)	(0.000)	(0.005)
$\log(\text{TVOL}_{t-1})$	-0.023*	-0.002*	-0.010*
	(0.000)	(0.000)	(0.003)
OIB_{t-1}	0.022*	-0.003*	-0.045*
	(0.002)	(0.001)	(0.019)
Shorting_{t-1}	-0.078*	-0.020*	0.176
	(0.006)	(0.005)	(0.099)
DV_{t-1}	0.373*	0.005*	0.211*
	(0.003)	(0.001)	(0.030)
Adjusted R^2	0.317	0.001	0.099