Time-Varying Aggregate Short-Selling in Korea

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March 18, 2018

Abstract

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Keywords: Short-selling; Foreign investors; Individual investors; Momentum; Korean stock market

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We appreciate the Korea Exchange for providing the dataset of short sales. We thank Victor Son for his excellent research assistance. Lee appreciates financial support from the Institute of Management Research and the Institute of Finance and Banking at Seoul National University. All errors are our own.

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I. Introduction

We examine aggregate short-selling by investor types in Korean stock market in this paper. By investor types, we refer to foreign investors, domestic individual investors, and domestic institutional investors. While vast literature focuses on each of these investor types separately, studies combining the trades from *multiple* investor types to examine the dynamic relation among them are rare. Nonetheless, it is important to consider various investor types together because foreign investors, institutional investors, and individual traders are shown to have different characteristics in their trading and the significant interaction among them is quite plausible. According to Brennan and Cao (1997), foreign investors are forced to be positive feedback or momentum traders because of their informational disadvantage relative to domestic investors. Supporting this view, Grinblatt and Keloharju (2000) and Griffin, Nardari, and Stulz (2007) provide supporting empirical evidence on momentum trading behavior of foreign investors. On the contrary, individual investors are typically regarded as random or noise traders (Odean, 1999; Barber and Odean, 2000; Barber et al., 2009; Foucault et al., 2011), though some researchers find evidence that individual investors are privately informed and that the trading by individuals can help improve price efficiency (Coval et al., 2005; Dhar and Zhu, 2006; Griffin and Zhu, 2006; Boehmer et al., 2008; Kaniel et al., 2008; Nicolosi et al., 2009; Kaniel et al., 2012).

We exclusively focus on the short-selling at the *aggregate* level in this paper. Analyses at the aggregate level enable us to examine the *dynamic* nature of time-variation of short-selling in relation to market return, volatility, and other macroeconomic variables. Given that short-selling is generally riskier than taking long position, the aggregate short-selling can be more sensitive to the changes in macroeconomic environment than its long counterpart. Moreover, we can investigate at the aggregate level how short-selling behavior in Korean stock market is affected by the changes in global economic environment. As in Wang and Lee (2015), this

paper shows that major portion of short-selling trading in Korean stock market is executed by foreign investors. Since foreign short-sellers are generally largely exposed to global or U.S. economic condition, it is quite likely for them to adjust their short-selling in response to the changes in global economic environment. We can investigate this issue more explicitly at the aggregate level. Overall, we ask the following research questions: Is there any seasonal pattern in the aggregate short-selling? Are the patterns of aggregate short-selling different across investor types? Is there a dynamic relation among aggregate short-selling by various investor types and market condition? Are short-sellers in Korea affected by the global, say the U.S., market return? To the best of our knowledge, this is the first paper that investigates the time variation in short-selling at the aggregate level, examining the dynamic interaction among short-selling by individual, institutional, and foreign short-sellers, in relation to market return.

Korean stock market provides an ideal setting to address these issues. First, Korea has well-developed financial market in which individuals, institutions and foreign investors actively trade. Wang and Lee (2015) find that nearly 2% of short trading in the Korean stock market is performed by individuals, while the number is 10% and 88% for domestic institutions and foreign investors, respectively. The legal restrictions on foreign ownership and trading have been greatly reduced since the Asian financial crisis of late 1990's, providing foreign investors with increased chance of participating in the Korean stock market. Second, quality data is available for a relatively long period in Korea. Specifically, the dataset enables us to distinguish each trade by investor type since each trade in the data is marked with the identity of investors who initiated the given trade. Thanks to this prominent feature unique to our dataset, we can investigate three different types of short-selling trading, aggregated separately for individuals, institutional, and foreigners in Korean stock market. Third, we have increasing literature on short-selling in Korean stock market (Wang and Lee, 2015; Lee and Wang, 2016; Wang, Lee and Woo, 2017), possibly reflecting growing attention to the topic from both academicians and

practitioners. Prior studies, however, focus only on stock-level analyses, leaving room for improving our understanding on short-selling through study at the aggregate level.

We find that the aggregate short-selling have been increasing significantly over time during our sample period (except for two short-selling ban periods). In addition, we also show that the aggregate short-selling by all investor types have significant seasonal components such as day-of-the-week effect, calendar month effect, and holiday effect. Hence, we filter out the seasonality by taking the residuals from the regression of aggregate short-selling on seasonal components and use these filtered series in the subsequent analyses. The regression of aggregate short-selling on market condition shows that foreigners and individual investors increase their short-selling after short-term poor performance of Korean stock market, while the past market performance is not significantly related to aggregate short-selling by institutional investors. The finding of the positive feedback- or momentum-style short-selling at the aggregate level, which this paper is the first to document, contrasts with the findings of previous studies on short-selling at the stock level. For example, Wang and Lee (2015) find the contrarian-type short-selling by foreign investors in that they increase their short-selling for stocks whose past cumulative return is high. Our paper builds on Wang and Lee (2015) by providing evidence on short-selling behavior focusing on the past cumulative *market* return instead of stock return. Lee and Wang (2016) show the contrarian pattern for individual short-sellers in Korean stock market. However, their study is restricted only to day traders who cover the short-selling trades within a day and analyses are based on the intra-daily frequency at the stock level. We also examine the time variation of aggregate short-selling in relation to contemporaneous market condition. Foreigners are shown to decrease short-selling on a bull market day, but aggregate short-selling by individuals and institutional are, at best, weakly affected or even unaffected~~not, or weakly at best, affected~~ by current market situation. Additionally, we find some evidence that ~~aggregate short selling is affected by the~~ changes in

macroeconomic conditions affect aggregate short selling. CDS premium for Korean government bond is significantly and positively related to aggregate short-selling by foreigners and institutional investors. Aggregate short-selling trades by individuals is negatively related to the change in volatility index, or VIX, while those by foreigners and institutional investors are not. Individuals tend to increase short-selling when the market is volatile~~, the finding being sharp contrast to the case of~~ as opposed to institutions~~, which decrease their~~ who engage in less short-selling when the market volatility is high. Such "riding on volatility" behavior of individual short-sellers may arise from their opportunistic risk bearing tendency.

Foreign capital flows can be sensitive to market return in either the home country or the host country or both (Griffin, Nardari and Stulz, 2004). On this line, we test whether foreign short-sellers are affected by the U.S. market return.[1] To distinguish U.S. market condition from domestic market condition, which may be correlated each other, we orthogonalize Korean market return to U.S. market return. Then, by including both market returns – orthogonalized Korean market and the U.S. market – in the regression, we show that aggregate short-selling by foreigners is significantly affected by the U.S. market, even after controlling for Korean stock market return. The aggregate short-selling trades by individual and institutional investors are also affected, though not linearly, by the past U.S. market return. The pattern of reaction is, however, different for individuals and institutions. Individuals tend to increase ~~their~~ short-selling upon strong positive past market performance in the U.S.~~, while they~~ and decrease ~~their~~ short-selling when the U.S. market showed weak short-term past performance. Institutional investors, on the other hand, react only to the (strong) positive past U.S. market return, similar to foreign short-sellers. The impact of U.S. market on aggregate short selling is much stronger for ~~aggregate short-selling by~~ foreigners than for ~~that by~~ individual investors.

[1] Based on our dataset, we can distinguish short-selling trade by foreign investors from others, but the nationality of foreign short-sellers cannot be identified. Therefore, we use the U.S. market return in this paper as an aggregate proxy for foreign investors' home market returns.

It is plausible for market returns and the aggregate short-selling variables to significantly interact with each other. Therefore, we examine the dynamic relation among three types of aggregate short-selling and market return in a Vector Auto-Regression (VAR) framework. We first show that aggregate short-selling is affected by the market, but not vice versa. The coefficient on the lagged market return is negative and highly significant for both aggregate short-selling by foreigners and individuals, providing evidence on the dynamic short-selling behavior in Korean stock market. ~~In examining~~ Granger-causality test on ~~among~~ aggregate short-selling variable~~s~~ by investor type~~s~~ and market return~~, we find~~ reveal that the market return Granger-causes the aggregate short selling trades by foreigners and individuals, while the Granger-causality in reverse direction is not significant. The dynamic interaction among three aggregate short-selling variables are also ~~shown~~ found to be significant. The impulse-response analyses show that, while market return is not ~~affected~~ influenced by any type of aggregate short-selling, the response of the aggregate short-selling by foreigners and individuals to a market return shock is significant for more than a week before it decays. The ~~impulse response~~ analysis also ~~shows~~ confirms the significant interaction among aggregate short-selling trades by investor types. That is, foreign investors increase their short-selling upon one standard deviation shock to the aggregate short-selling by institutional investors; Individual short-sellers follow the short-selling by foreigners and are affected negatively by institutional investors' short-selling; Aggregate short-selling by institutional investors are positively ~~and negatively~~ affected by the aggregate short-selling by foreigners and negatively by individuals, respectively. All ~~the~~ results for dynamic interactions are robust to the ordering of variables and to ~~different~~ alternative lag specifications.

The rest of the paper is organized as follows. In the next section, we illustrate our sample and introduce the measure of short-selling trades. In Section III, we examine the seasonal pattern and the variation of aggregate short-selling by investor types in relation to

market condition. Specifically, we ~~examine~~ explore how aggregate short-selling by investor type varies according to short-term performance of both Korean and U.S. stock market. We also examine the dynamic relations among aggregate short-selling variables and market return in the vector auto-regression framework in this section. We conclude in Section IV.

II. Data

We obtain ~~the~~ daily short-selling data from Korea Exchange (KRX) for all common stocks listed in KOSPI market[2] from January 1, 2006 to December 31, 2015. ~~We classify the i~~Investors are classified into three types - domestic individual investors, domestic institution investors, and foreign investors. We collect data on stock return, market return, market capitalization, market trading volume and the daily market net-buy volume for each investor type from Fn Data Guide, one of the largest financial data providers in Korea. We obtain volatility index (VIX_{KR}) from KRX website and credit default swap (CDS) premium on the country's five-year foreign exchange stabilization bond from Datastream. For U.S. stock market, ~~we obtained~~ S&P500 index return and volatility index (VIX) of S&P500 index options is obtained from the center for research in security prices (CRSP) and the Chicago Board Options Exchange (CBOE), respectively. Our sample period includes two short-selling ban periods from October 1, 2008 to May 31, 2009 and August 10, 2011 to November 9, 2011, ~~the period of~~ which we exclude from our sample in order to prevent any potential ~~misleading~~ complication in results.[3]

[2] Equity market in KRX consists of three sub-markets – KOSPI, KOSDAQ and KONEX. KOSPI is the benchmark or the representative stock market for many globally renowned companies, while the KOSDAQ and the KONEX are mainly for small and medium enterprises including startup companies.

[3] As described by Lee and Wang (2015), the short-selling trades for the purpose of providing liquidity or hedging underlying positions were permitted in the ban periods.

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Following Diether, Lee, and Werner (2009a), we use the relative short-selling (*relss*) as our short-selling measure, which is defined as the daily number of shorted shares divided by the daily number of traded shares.

$$relss_{i,t} = \frac{shorted\ shares_{i,t}}{traded\ shares_{i,t}} \quad (1)$$

Table 1 shows the distribution of relative short-selling (*relss*) for *all* stocks listed in KOSPI market. We first calculate the *relss* for each stock each day and then count the number of stock-days that belongs to the range shown in the first column. Panel A presents the distribution of stock-day observations.

[INSERT TABLE 1 HERE]

The table shows that no short-selling trade is made for about 61.9% of total stock-day observations. *relss* is larger than 10% only for about 3.43% of observations. Comparing these numbers with the corresponding numbers of 78.5% (no short-selling) and 1.3% (*relss* larger than 10%) in Lee and Wang (2015) during the sample period from January 1, 2006 to May 31, 2010, we see that short-selling activities increased in Korea during more recent sample period from mid-2010 to 2015, though the activity is still less than that in the U.S market reported in Diether, Lee, and Werner (2009a).

Panel B ~~shows~~ presents the distribution at the firm-level. In the panel, we average the daily *relss* for a given stock over the sample period and count the number of firms that belongs to the range shown in the first column. The panel also shows the average firm size (in billions of Korean won). We see that 3.04% of 823 total firms experienced no short-selling trades, while 14.7%~~.~~ of total firms have *relss* over 3%. Again, by comparing these numbers with those in Lee and Wang (2015), which are based on the sample period only up to the year 2010, we see that

zero short-selling portion of 3.04% is a drastic decrease from 23.9% and the portion of 14.7% with ~~more than 3% of~~ *relss* over 3% is large increase from 3.2%. This result suggests that short-selling trades became more popular in Korean stock market in the more recent period, e.g., after 2010.

~~It~~ Firm size seems to be correlate with ~~that the~~ short-selling activity ~~and the firm size is correlated~~. The average size of stocks with *relss* being larger than 4% is 4,647 billion Korean won (KW; approximately, USD 4.2 billion), while it is only 189 billion KW (USD 0.17 billion) for stocks with zero short-selling. Given the small amount of short-selling in Korean stock market, we restrict our sample to fifty stocks each year, for which the short-selling trades have been mostly active, similar~~ly~~ to Wang and Lee (2015). As a result, we have 158 stocks in the sample. Our sample covers stocks with large market capitalization such as E-Mart, Samsung SDS, LG Electronics, S-Oil, POSCO, Samsung C&T and Hyundai Heavy Industries & Construction. Relative short-selling varies ~~a lot~~ substantially ranging from 2.7% to 12.0% for our sample stocks. The total market capitalization for our sample stocks is about half of total market capitalization of all KOSPI stocks.

[INSERT TABLE 2 HERE]

Table 2 shows summary statistics of short-selling activity by investor type for sample firms. We report time-series mean, median and standard deviation of cross-sectional average of short-selling activities (*relss*) by individuals, institutions, and foreigners. We also divide the sample period into three subperiods of before-, between-, and after-the two short-selling ban periods. The means of shorted shares for foreigners, individuals, and institutions are 23,250 shares, 460 shares, and 5,320 shares, respectively, ~~totaling~~ which sums to total of 29,030 shares. ~~The a~~Average relative short-selling ~~is~~ of 6.26%~~, which shows~~ indicates that, ~~when~~ compared to

relss of 24% for NYSE and 31% for Nasdaq (Diether, Lee, and Werner, 2009a), short-selling is less prevalent in Korea than in the U.S. market. Legal restrictions on hedge funds, ~~which~~ who often perform short sale trades to implement long–short strategies, may be responsible for the relatively small amount of short sales in the Korean stock market. The increase in short-selling by foreigners and institutional investors in recent sub-period provides supporting evidence. After the second short-selling ban period, ~~however,~~ we see that both foreigners and institutional investors drastically increased their short-selling trades. ~~The increase in short-selling by foreigners and institutional investors in recent sub-period provides supporting evidence that legal restriction on hedge funds in Korean market may be a cause of small relative short-selling in Korean market, since~~ This surge is in line with the fact that Korean hedge funds were first legally allowed and launched in December 23, 2011, when twelve hedge funds with over 150 billion Korean won (roughly USD 0.14 billion) began operation. We attribute the sharp increase in short-selling by individual investors after 2009 to the fact that Korea Securities Finance Corporation (KSFC) reopened the lending business to individual investors in January 22, 2008 (~~Chan et al., 2013; Lee~~Wang and ~~Wang~~Lee, 2015).[4]

메모 포함[V1]: Missing reference

It is worth noting that a lion's share of short-selling trades are ~~performed~~ initiated by foreign investors in the Korean stock market. While *relss* by individual and institutional domestic investors is 0.06% and 1.30%, respectively, *relss* by foreign investors is 4.90%, which ~~takes~~ accounting for approximately 78% of total relative short-selling. Turning to the number of shorted shares, we see that 23,250 shares, or 80.0%~~%~~, of 29,030 total shorted shares ~~are originated~~ originate from short-selling by foreign investors ~~short sellers~~. This is consistent with the findings of Wang and Lee (2015)~~, who show~~ that investors with large short-selling bets tend to be foreign investors in Korea.

[4] Wang and Lee (2015) provide the details for institutional features on short sales in Korean stock market.

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III. Variation of aggregate short-selling

III.1. Calendar effect in aggregate short-selling

To investigate the relation between the aggregate short-selling and macroeconomic environment, we first construct ~~daily~~ aggregate measure of relative short-selling ($relss_{agg}$) for each day as ~~a daily~~ the average of *relss* across sample firms.

$$relss_{agg,t} = \frac{\sum_{i=1}^{N} relss_{i,t}}{N} \quad (2)$$

where N is the number of sample stocks in day t.

[INSERT FIGURE 1 HERE]

Figure 1 ~~shows~~ portrays the time-series of daily aggregate relative short-selling ($relss_{agg}$) together with KOSPI market index. Solid line and dotted line denote KOSPI market index (right axis) and $relss_{agg}$, respectively. The two grey areas denote the short-selling ban periods from October 1, 2008 to May 31, 2009 and from August 10, 2011 to November 9, 2011. ~~We see that short~~Short-selling activities increase and stock market index declines before the first short-selling ban period, reflecting ~~increased~~ heightened pessimism around 2008 global financial crisis. After the first ban, however, ~~S~~short selling activities~~, however,~~ seem to gradually increase ~~after the first short-selling ban,~~ ~~reflecting~~ indicating that the existence of time trend ~~to control for to see~~ may cloud the relation between market return and aggregate short-selling ~~more clearly~~. ~~Especially, the~~ The increasing pattern of short selling activities after second short selling ban period is ~~obvious~~ particularly noticeable. This ~~increasing pattern~~ trend may be strengthened due to launching of first Korean hedge funds~~, which carry out long short strategies,~~ at the end of the year 2011 and their long-short strategies.

As ~~we see~~ is evident from Figure 1, it is important to filter out the deterministic time-series patterns such as calendar effect (Chordia et al., 2005; Hameed et al., 2010) from our daily aggregate of relative short-selling since ~~we mostly~~ the focus of this paper lies on the time-series relation between short-selling activity and stock market condition ~~in this paper~~. Therefore, we regress $relss_{agg}$ on the variables that capture the seasonal variation of aggregate short-selling, such as weekdays, months, holidays, and other longer time trend.

$$relss_{agg,t} = \sum_{n=1}^{4} a_n Weekday_{n,t} + \sum_{n=1}^{11} b_n Month_{n,t} + \beta_1 HOLIDAY_t + \beta_2 Ban1_t + \beta_3 Ban2_t + \beta_4 Year_t + Adjrelss_{agg,t} \quad (3)$$

$Weekday_n$ is a day-of-the-week dummy variable from Monday to Thursday. $Month_n$ is month dummy from January to November. We use *Holiday* to capture the abnormal trading activity around holidays, following Chordia et al. (2005), Hameed et al. (2010), and Karolyi et al. (2012). Specifically, if holiday is on Tuesday, Wednesday, or Thursday, then the preceding day and the following day are set to one for *Holiday*. If holiday is on Monday, then the following Tuesday is set to one. If Friday is holiday, then preceding Thursday is set to one. ~~The t~~Two short-selling ban periods are separately captured by the two dummy variables of *Ban1* and *Ban2*. That is, we set *Ban1* to be one ~~from~~ during October 1, 2008 to May 31, 2009 and *Ban2* to be one ~~from~~ during August 10, 2011 to November 9, 2011. *Year* is to control for the time trend and is defined as the difference between the current year and the year of 2009.

[INSERT TABLE 3 HERE]

Table 3 reports the coefficients from the filtering regression in Eq. (3). We see that ~~the~~ seasonal effect is strong in the time series of aggregate short-selling for all investor types. Day-of-the-week dummy variables and month dummies are all significant. The coefficients of

month dummies are generally bigger in later months than in earlier months of the year. It is uncertain why short-selling is small from January to May relative to later months, but it might be driven by optimism, which is relatively more widespread at the beginning of a new year. *Holiday* dummy shows that foreign investors and institutional investors perform short-selling trades significantly more around holidays. However, it is not the case for short-selling by individuals. The coefficient for *Year* ~~shows that there exists~~indicates significant and positive time trend, ~~implying~~ which suggests that aggregate short-selling by all investor types has been increasing over the sample period.

In Figure 2, we ~~show~~ illustrate adjusted aggregate relative short-selling ($Adjrelss_{agg}$) over the sample period. The $Adjrelss_{agg}$ looks stable over time with time trend ~~being significantly~~ removed by filtering regression in Eq. (3). Dickey-Fuller tests show that the aggregate short-selling ($Adjrelss_{agg}$) and that by each investor type (e.g. $Adjrelss_{fore}$, $Adjrelss_{indi}$, $Adjrelss_{inst}$) are all stationary (unreported).

[INSERT FIGURE 2 HERE]

In the next section, we investigate the relation between the aggregate short-selling and market condition, using the time-series of aggregate short-selling net of seasonal patterns, $Adjrelss_{agg}$, obtained from the residual of the regression in Eq. (3).

III.2. What drives changes in aggregate short-selling?

Given the time series of aggregate short-selling, adjusted by filtering regression of Eq. (3), we now turn to ~~examine~~ the relation between aggregate short-selling by investor types and market returns. At the *stock*-level, Diether, Lee, and Werner (2009a) show that short-sellers are contrarian traders in the U.S. in that they increase short-selling for stocks with a large

cumulative stock returns for the past five days. Similarly, Wang and Lee (2015) show, ~~at~~ from the stock-level analyses, that foreign short-sellers are contrarians in Korean stock market. Since contrarian traders are shown to help reduce future volatility (Avramov et al., 2006), the findings can be linked to the destabilizing role of short-sellers in emerging markets (Choe, Kho, and Stulz, 1999). In this section, we investigate how the aggregate short-selling is related to stock *market* condition such as market return, market volatility, market liquidity, and other macroeconomic environment. We especially focus on how aggregate short-selling in Korean market is affected by the short-term past performance of market. In doing so, we regress daily adjusted aggregate short-selling ($Adjrelss_{agg}$) by each investor type on market returns, volatility, and other variables of interest.

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[INSERT TABLE4 HERE]

Table 4 ~~shows~~ presents the results of the regressions for each investor type in separate panels. In panel A, we see that foreigners' aggregate short-selling decreases with cumulative KOSPI market returns for the past five days, $R_{m,-5,-1}$. The finding seems to be in contrast ~~to~~ with Wang and Lee (2015), in which analyses are performed at the stock level. Specifically, their study shows that foreign investors increase short-selling when the past cumulative *stock* return is high. Our finding builds to their study by providing evidence on short-selling behavior at the aggregate level focusing on the past cumulative *market* return instead of stock return. Interestingly, the significance of $R_{m,-5,-1}$ is largely associated with the negative and significant coefficient for $R_{m,-5,-1}^{Large\ Down}$, which is defined to be equal to $R_{m,-5,-1}$ if $R_{m,-5,-1}$ is ~~smaller by~~ more than one standard deviation below average market return over the sample period~~,~~ and zero otherwise ((3) in panel A of Table 4). That is, increase in short-selling after

five-days of bearish market, rather than the reduction in short-selling after five-days of bull market, drives the aggregate short-selling by foreign investors.

Further evidence in panel A shows that foreign investors reduce their short-selling on a day with high market return ($R_{m,t}$) and this pattern is ~~even~~ stronger when the current market returns is positive ($R_{m,t}^{Up}$)~~,~~ than when the market return is negative ($R_{m,t}^{Down}$). ~~We also see that~~ In addition, both large up and down movement of current market return are significantly related to aggregate short-selling by foreign investors. The coefficient on the change in CDS premium for five-year Korean government bond, $\Delta CDS\ prem.$, is positive and significant, ~~showing~~ meaning that foreign investors increase their short-selling when the sovereign default risk, captured by credit default swap (CDS) rate, becomes higher.

Aggregate short-selling by individuals in panel B ~~shows~~ describes the pattern of short-selling~~, which is~~ similar to that ~~for~~ of foreign short-sellers ~~shown~~ in panel A. The coefficient of $R_{m,-5,-1}$ is negative and significant and the significance is mostly driven by negative coefficient on $R_{m,-5,-1}^{Down}$~~, similar to~~ as in the case of foreign short-sellers. That is, the pattern is driven by the reduction in short-selling after five-days of bullish market, rather than the increase in short-selling after five-days of bearish market. ~~The~~ This finding adds to the contrarian short selling by individual investors in Korean stock market, documented in ~~finding of~~ Lee and Wang (2016)~~, which shows the existence of contrarian pattern for individual short-sellers in Korean stock market.~~ ~~Contrasting~~ Contrary to our paper, their study is restricted only to individual day traders~~,~~ who initiate and cover the short-selling trades within a day~~,~~ and the analyses are based on the stock level data with intra-daily frequency ~~at the stock level~~.

Reflecting the possibility that individual investors tend to bet on short-term market fluctuation, individual short-selling increases significantly with market volatility (*MktVol*), which is defined as the difference between the daily high and low prices of the index scaled by the high price ~~of the index~~ at day *t*. This result is consistent with Wang, Lee and Woo (2017)~~,~~

who show that the profitability of individual short-selling is attributable to their ability to exploit short-run price reversal. Such "riding on volatility" behavior of individual short-sellers may arise from their opportunistic risk bearing tendency. Interestingly, the coefficient on the change in VIX_{KR}, a volatility index similar to U.S. VIX but is based on the price of KOSPI 200 option, is *negative* and significant. This result may be driven by the propensity of individual short-sellers to exit~~,~~ rather than to take short positions on~~,~~ the stock market when the fear on the future stock market is material. The explanatory power of market-related variables is, however, generally smaller for individuals than ~~the case of~~ for foreign short~~-selling~~ sellers, as we can see from small values of *R*-squares in panel B.

In panel ~~Panel~~ C~~,~~ ~~shows that the~~ aggregate short-selling by institutions is generally insignificantly related to past market returns, ~~showing~~ drawing sharp contrast to the cases of foreign and individual investors in the earlier panels. ~~Rather~~ Instead, institutional short-sellers seem to react to the variables such as market volatility and market illiquidity. Both market illiquidity (*Mktill*) and market volatility (*MktVol*) ~~are~~ negatively related to aggregate institutional short-selling. The result suggests that institutional investors are not trading to exploit stock market volatility and tend to short when market liquidity is high. This pattern may arise from the regulation imposed on active short-selling trades of institutional investors such as Pension Fund ~~regarding their active short-selling trading~~. Consistent with this conjecture, the *R*-squares are the smallest for institutional short-seller ~~case,~~ compared to other short-seller types.

III.3. Is aggregate short-selling affected by U.S. market condition?

We showed so far that aggregate short-selling in Korean market is significantly related to Korean stock market conditions. Given the large presence of foreign short-sellers in Korean stock market and the ~~dominant~~ leading role of U.S. ~~market~~ in global financial market, it would

be interesting to ~~see~~ explore whether aggregate short-selling in Korea is affected by changes in the U.S. market environment. Wang and Lee (2015) ~~show~~ find that the major portion of short-selling ~~trading~~ trade is performed by foreign investors in Korean stock market (Figure 2 of their paper~~, which~~ shows that the portion of short-selling initiated by foreign investors varies over time ~~at~~ around 90% of total short-selling ~~from~~ during 2006 to 2010, except for the two short-selling ban periods). Consistent with their result, our Table 2 also ~~shows~~ confirms the ~~dominant portion~~ preponderance of short-selling by foreign investors, ~~e.g.~~ i.e., 80% of total shorted shares and 82% of total shorted value, ~~of short-selling by foreign investors~~ relative to other types of short-sellers in Korean market. Foreign investors are, however, generally more prone to ~~be affected by~~ influences of global~~,~~ or U.S.~~,~~ economic conditions. Moreover, the role of U.S. stock market in the global financial market has been emphasized much in the literature. For example, Lee (2011) shows that stocks from 50 different countries ~~in the world~~ are affected more by the change in U.S. market aggregate liquidity than by local market aggregate liquidity, ~~reflecting~~ underlining the predominant role of the U.S. market in a global stock market. The World Bank statistics show that the total market capitalization in the U.S. takes the lion's portion~~.~~, 42.40%, of the total market capitalization of all countries~~, which is 42.40%,~~ in 2016. In this section, therefore, we investigate whether U.S. stock market conditions have significant effect on aggregate short-selling by each investor type in Korean stock market ~~is affected by U.S. stock market conditions~~.

To examine the impact of U.S. market environment that is independent of local market environment, it is important to re-construct local or Korean market index return, net of U.S. market return. Specifically, considering the correlation between the KOSPI market index return and the U.S. market return, we first orthogonalize Korean stock market index return against the U.S. market return. In doing so, we regress cumulative return of KOSPI index for the past five-days on the cumulative return of S&P500 index for the past five days and take the residuals as

our local market index return (~~$Res.\bar{R}_{m,-5,-1}$~~$Res.R_{m,-5,-1}$~~,~~ independent of U.S. stock market. Similarly, we obtain residual market return of day *t*, ~~$Res.\bar{R}_{m,t}$~~$Res.R_{m,t}$, using market returns on day *t*. ~~At the next step~~Next, we include both Korean and U.S. market returns in the regression of our aggregate short-selling by investor type ~~both Korean and U.S. market returns~~ in order to ~~examine~~ assess the relative importance of ~~the~~ two market conditions on aggregate short-selling.

[INSERT TABLE 5 HERE]

Panel A of Table 5 ~~shows~~ presents some evidence that aggregate short-selling by foreign investors are affected by U.S. stock market index. Even after controlling for local market conditions such as market return, volatility, liquidity, and CDS premium, the coefficient on $R^{US}_{m,-5,-1}$ is negative and significant for all regression specifications in the panel. This evidence tells us that foreign investors reduce their short-selling in Korean stock market when the U.S. stock market ~~showed good performance~~ performed well for the past five days, implying the possibility that foreign investors ~~expect~~ anticipate short-term strong market in Korea after short-term U.S. market rallies. This significant impact is driven asymmetrically by positive cumulative U.S. market returns ($R^{US,Up}_{m,-5,-1}$), while past bearish markets in the U.S. does not affect aggregate short-selling in Korea. The table further ~~shows~~ finds that the large positive cumulative U.S. market return, $R^{US,Large\ Up}_{m,-5,-1}$, is significantly and negatively related to aggregate short-selling by foreign investors in Korean stock market. It is ~~worth noting~~ noteworthy that the Korean stock market return, now proxied by ~~$Res.\bar{R}_{m,-5,-1}$~~$Res.R_{m,-5,-1}$ and its (large) positive and negative components, is still significantly and negatively related to aggregate short-selling even after dropping the component that is correlated to the U.S. stock market. This is consistent with the results in Table 4, showing that the trading behavior of

foreign short-sellers is driven not just by the U.S. market condition, but also by the local market condition that is independent from the global component. With the inclusion of U.S. market return, other market conditions such as market volatility, illiquidity, VIX_{KR}, and CDS premium are no longer significant in any regressions in the panel.

~~Contrasting to the case of foreign short selling~~On the contrary, panels B and C show that the aggregate short-selling by individuals and by institutional investors are not linearly affected by the U.S. market condition. We do, ~~H~~however, find significant non-linear relation ~~is found to be significant~~ in some cases. Interestingly, individual ~~short sellers~~ investors tend to increase their short-selling after strong *and* weak U.S. stock market, as we can see from the positive and significant coefficient on $R_{m,-5,-1}^{US,Up}$ and negative and significant coefficient on $R_{m,-5,-1}^{US,Down}$. ~~The l~~Large changes in U.S. stock market returns, both positive and negative, are also significantly related to aggregate short-selling by individual investors. Panel C shows that it is only the positive U.S. market return that affects aggregate short-selling by institutional investors in Korea. In panel B, we see that local stock market return (~~$Res.R_{m,-5,-1}$~~$Res.R_{m,-5,-1}$) is negatively and significantly related to aggregate short-selling by individuals~~,~~ after controlling for the U.S. market, ~~the result being~~ consistent with ~~that~~ the findings in Table 4. Also consistent with the previous table, institutional short-selling is generally not significantly related to Korean stock market conditions.

III.4. Dynamic relation between aggregate short-selling and market return

In the previous section, we examine how aggregate short-selling is affected by stock market condition of both Korea and the U.S. The limitation of the analyses in the previous section is, however, that we set stock market returns as exogenous variables so that dynamic relation or the interaction between the aggregate short-selling and stock market returns cannot be ~~examined~~ accounted for. To overcome this limitation, we perform in this section the Vector

Auto-Regression (VAR), which provides a useful tool to examine the dynamic relation among variables of interest at macroeconomic level (Sims, 1996).

$$\boldsymbol{Y_t} = \boldsymbol{B}\boldsymbol{Y_{t-k}} + \boldsymbol{U} \quad (4)$$

where, $\boldsymbol{Y_t}$ is a vector of market return~~,~~ and three aggregate short-selling variables at day *t*, $\boldsymbol{Y_{t-k}}$ is a matrix for the variables of interest with up to *k* lags ~~upto *k*~~, $\boldsymbol{B}$ is a matrix for parameters, and $\boldsymbol{U}$ is a vector of error terms.[5]

[INSERT TABLE 6 HERE]

We see in Table 6 that aggregate short-selling is affected by the market, but not vice versa. That is, market return significantly affects but is not significantly affected by~~, but significantly affects,~~ aggregate short-selling variables. Consistent with the results in Table 4, the coefficient on the lagged market return is negative and highly significant for both aggregate short-selling by foreigners and individuals. ~~Interestingly, there are some i~~Intriguing patterns emerge in the interaction among aggregate short-selling by investor types. First, the table shows that institutional investors react differently to short-selling by foreigners and individuals. That is, institutional investors increase their short-selling following increased short-selling by foreign investors and the reduction of short-selling by individuals. The pattern of chasing foreign short-sellers is also present for individual investors. However, foreign investors are not affected by individual short-sellers. Lastly, both foreign and individual short-sellers are affected by the aggregate short-selling by institutional investors, with the impact being in ~~different~~ opposite direction. Following the increase in the aggregate short-selling by institutional

[5] ~~We~~ Results shown in this section ~~the results~~ are based on the lags up to two. ~~Our r~~Results are robust to alternative lag specifications of up to five, but we find the lags after two days are generally insignificant.

investors, foreign short-sellers also increase their short-selling, while individual investors reduce their short-selling position.

[INSERT TABLE 7 HERE]

We ~~perform~~ conduct the zero-block exclusion test to examine Granger-causality among aggregate short-selling variables by investor type and market return in ~~a~~ the framework of Vector Auto-Regression system. Table 7 shows *p*-value from the *F*-test~~, which tests~~ of whether *X* Granger-causes *Y* under the null hypothesis~~ that *X* does not Granger cause *Y*~~ of no Granger causality. According to the table,~~The table shows that~~ there is a significant one side relation between ~~the change in aggregate short-selling by foreign investors (*Adjrelss*$_{fore}$) and~~ KOSPI market index return and the change in aggregate short-selling by foreign investors (*Adjrelss*$_{fore}$). The market return Granger-causes the aggregate short selling trades by foreigners, but not vice versa. Similarly, the aggregate short-selling by individuals (*Adjrelss*$_{indi}$) is affected by the market return, while the Granger-causality in reverse direction is not significant. Interestingly, interaction among three aggregate short-selling variables are all significant in the table.

In ~~a~~ further analysis to examine the dynamic relation among variables of interest, we also estimate the impulse-response functions over 10-day horizon after the impulse is given.[6] Figure 3 shows the results of impulse-response analyses among KOSPI index return, the adjusted aggregate short-selling by foreigners (*Adjrelss*$_{fore}$), individuals (*Adjrelss*$_{indi}$), and institutional investors (*Adjrelss*$_{inst}$).

[6] We use the variables in the order of market return, aggregate short-selling by foreigners, that by individuals, and that by institutions. The results are robust to alternative orderings.

[INSERT FIGURE 3 HERE]

The panels A, B, C, and D ~~show~~ plot the response of market return, aggregate short-selling by foreigners ($Adjrelss_{fore}$), aggregate short-selling by individuals ($Adjrelss_{indi}$), and aggregate short-selling by institutions ($Adjrelss_{inst}$), respectively. Panel A ~~shows that, consistent with~~ confirms the earlier results in the dynamic relation ~~between the market return and the aggregate short-selling,~~ that market return is not affected by any type of aggregate short-selling. Panel B shows that the response of the aggregate short-selling by foreigners ($Adjrelss_{fore}$) to a shock to a market return is significant for about a week before it decays out ~~after that~~. Consistent with the pattern of short-selling by foreigners shown in the earlier empirical analyses, the impulse-response test shows the highly significant initial negative response of $Adjrelss_{fore}$ to ~~an increase in~~ one standard deviation ~~of~~ increase in market return. The panel also shows that foreign investors increase their short-selling upon one standard deviation shock to the aggregate short-selling by institutional investors. The response is highly persistent in that the impact is significant in ten-days window in the graph. Similar~~ly~~ to the case of aggregate short-selling by foreigners, the response of $Adjrelss_{indi}$ to market return shock is negative and significant and the impact lasts significant for more than a week after the shock is given. Consistent with the result in Table 6, the panel also shows that individual short-sellers follow the short-selling by foreigners and are affected negatively by institutional investors' short-selling. Panel D shows that the aggregate short-selling by institutional investors are positively and negatively affected by the aggregate short-selling by foreigners and individuals, respectively. This is also consistent with the results in Table 6.

IV. Conclusion

We examine the time-variation of aggregate short-selling by foreigners, individuals, and institutional investors in Korean stock market in this paper. We reveal that the aggregate short-selling variables for all investor types have significant seasonal components as well as an increasing trend over time. ~~We find that the a~~Aggregate short-selling is significantly affected by the returns of both Korean stock market and the U.S. stock market. Furthermore, we find the significant and interesting dynamic relations among aggregate short-selling by each investor type and the market return. To the best of our knowledge, this paper is the first to study ~~on~~ the aggregate short-selling~~,~~ and to examine ~~examining~~ the dynamic interactions among short-selling variables and market return. Building on our research in this paper, we think that it will be interesting to examine the interaction among these aggregate short-selling variables by investor type in relation to market return in intra-daily frequency in the future.

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Figure 1. Aggregate short selling activity and KOSPI market index
Dotted line of the ~~The~~ figure shows the time-series of aggregate relative short-selling ($relss_{agg}$), ~~which is~~ defined as the number of shorted shares divided by the number of traded shares on a given day~~,~~ then averaged across sample stocks. The figure also shows the KOSPI index (right axis) in solid line. The sample period is from January 1, 2006 to December 31, 2015. The grey area denotes the two short-selling ban periods (October 1, 2008 to May 31, 2009 and August 10, 2011 to November 9, 2011).

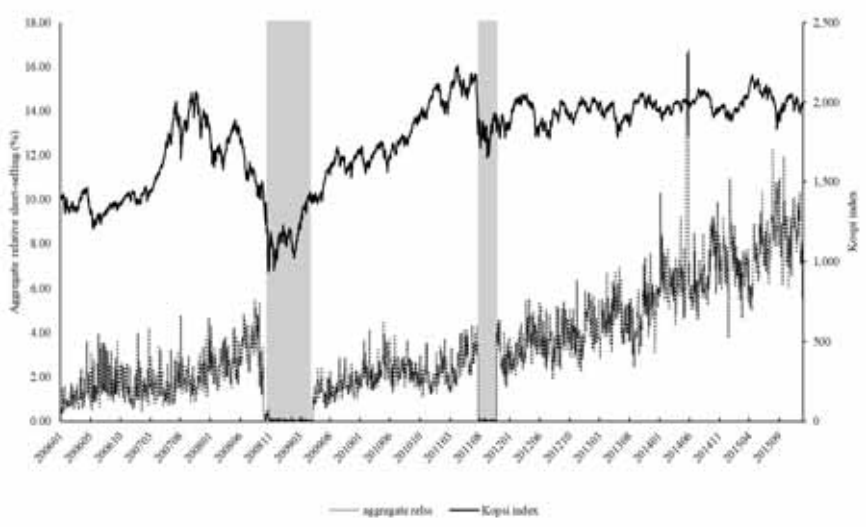


Figure 2. Adjusted aggregate short-selling

The figure shows the adjusted aggregate relative short-selling ($Adjrelss_{agg}$) over the sample period. ~~The adjusted aggregate relative short-selling,~~ $Adjrelss_{agg}$, is obtained from the residual in the regression of the aggregate relative short-selling ($relss_{agg}$) on the day-of-the-week dummies, month dummies, holiday dummy, dummies for short-selling ban periods and the time trend variable as specified in Eq. (3).~~, which~~ $relss_{agg}$ is defined as the number of shorted shares divided by the number of traded shares on a given day~~,~~ averaged across sample stocks~~, on the day-of-the-week dummies, month dummies, holiday dummy, dummies for short-selling ban periods and the time trend variable as specified in Eq. (3).~~ The sample period is from January 1, 2006 to December 31, 2015. The grey area denotes the two short-selling ban periods (October 1, 2008 to May 31, 2009 and August 10, 2011 to November 9, 2011)

메모 포함[KL2]: Shu-Feng, please draw this line in the picture

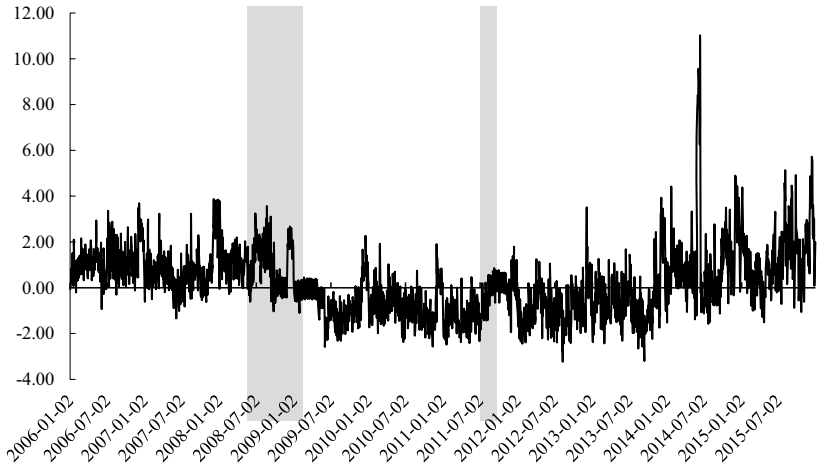
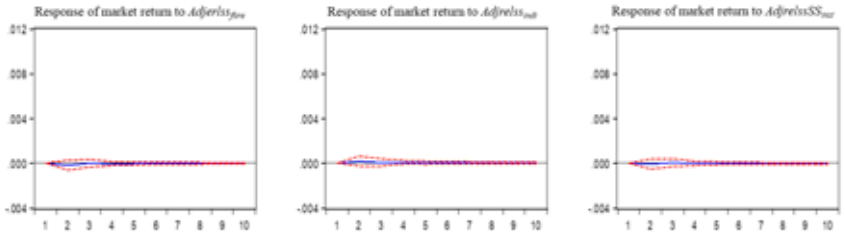


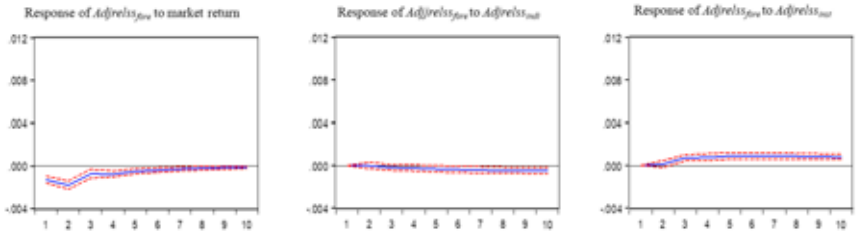
Figure 3. Impulse response analysis

The figure shows the results of the impulse-response analyses among KOSPI index return, $Adjrelss_{fore,}$ $Adjrelss_{indi}$, and $Adjrelss_{inst}$, in which the latter three variables denote adjusted aggregate short-selling by foreigners, domestic individual investors and domestic institutional investors, respectively. Adjusted aggregate short-selling variables are obtained from the residual in the regression of the aggregate relative short-selling by each type on the day-of-the-week dummies, month dummies, holiday dummy, dummies for short-selling ban periods and the time trend variable as specified in Eq. (3). Aggregate relative short-selling~~, which~~ is defined as the number of shorted shares by investor type divided by the number of traded shares on a given day~~,~~ averaged across sample stocks~~, on the day of the week dummies, month dummies, holiday dummy, dummies for short-selling ban periods and the time trend variable as specified in Eq. (3).~~ Market return is daily KOSPI index return. The figure shows the decay of response variables over 10-day horizon after an impulse of one standard deviation shock. The 90% confidence level bands are drawn in a dotted line. The sample period is from January 1, 2006 to December 31, 2015, excluding the two short-selling ban periods (October 1, 2008 to May 31, 2009 and August 10, 2011 to November 9, 2011).

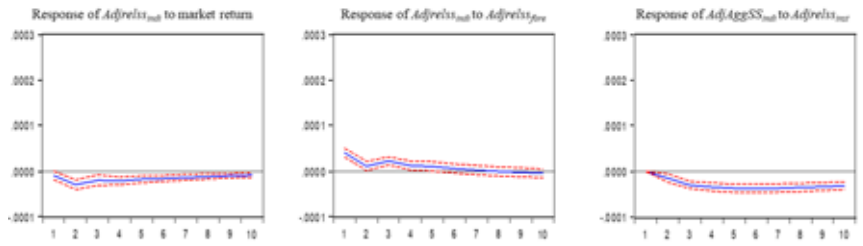
Panel A. Response of Market return to $Adjrelss_{fore}$, $Adjrelss_{indi}$, and $Adjrelss_{inst}$



Panel B. Response of $Adjrelss_{fore}$ to market return, $Adjrelss_{indi,}$ and $Adjrelss_{inst}$



Panel C. Response of $Adjrelss_{indi}$ to market return, $Adjrelss_{fore}$, and $Adjrelss_{inst}$



Panel D. Response of $Adjrelss_{inst}$ to market return, $Adjrelss_{fore}$, and $Adjrelss_{indi}$

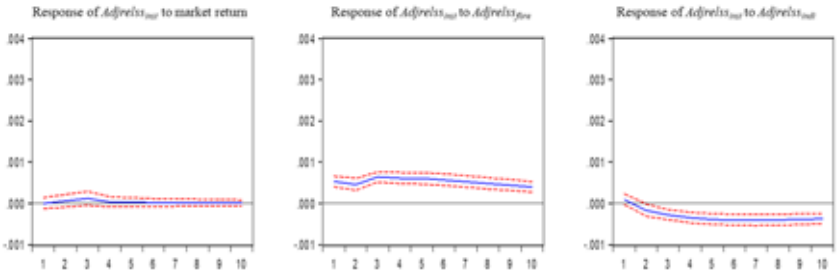


Table 1. Distribution of average relative short-selling (*relss*)

The table shows the distribution of relative short-selling (*relss*) for all stocks listed in KOSPI market. *relss* (%) is the daily number of shorted shares divided by the daily number of traded shares for a given stock. Panels A and B represent the distribution in terms of stock-day observations and firm observations, respectively. In panel A, we first calculate the *relss* for each stock each day and then count the number of stock-days that belongs to the range shown in the first column. In panel B, we average the daily *relss* for a given stock over the sample period and count the number of firms that belongs to the range shown in the first column. The panel also reports the cross-sectional average across firms within a given range of average market capitalization over the sample period (in billions of Korean won). The sample period is from January 1, 2006 to December 31, 2015, excluding the two short-selling ban periods (October 1, 2008 to May 31, 2009 and August 10, 2011 to November 9, 2011).

Panel A: Distribution of stock-day observations

Range	*N* of stock-day obs.	*Freq.* (%)
relss = 0%	983,898	61.90
0%< *relss* ≦10%	551,087	34.67
0%< *relss* ≦1%	250,885	15.78
1%< *relss* ≦2%	94,347	5.94
2%< *relss* ≦3%	59,022	3.71
3%< *relss* ≦4%	41,179	2.59
4%< *relss* ≦5%	30,336	1.91
5%< *relss* ≦6%	23,180	1.46
6%< *relss* ≦7%	17,753	1.12
7%< *relss* ≦8%	13,863	0.87
8%< *relss* ≦9%	11,282	0.71
9%< *relss* ≦10%	9,240	0.58
10%< *relss* ≦20%	40,960	2.58
20%< *relss* ≦30%	10,088	0.63
relss >30%	3,561	0.22
Total	1,589,594	100

Panel B: Distribution of stock observations

Range	Firm size	*N* of stocks	*Freq.* (%)
relss = 0%	189.28	25	3.04
0%< *relss* ≦1%	175.03	475	57.72
1%< *relss* ≦2%	946.77	119	14.46
2%< *relss* ≦3%	3,301.72	83	10.09
3%< *relss* ≦4%	7,906.70	35	4.25
relss >4%	4,647.33	86	10.45
Total		823	100

서식 있음: 글꼴: 10 pt

서식 있음: 간격 단락 뒤: 0 pt

서식 있음: 글꼴: 기울임꼴

서식 있음: 글꼴: 기울임꼴 없음

Table 2. Summary statistics of short-selling activity by investor type

The table reports the time-series statistics of cross-sectional averages of short-selling activity by investor type and subperiods. Shorted shares and shorted valu the number ~~of shorted shares~~ (in thousands of shares) and the amount (in millions of Korean won) of shorted shares ~~(in millions of Korean won)~~. *relss* (%) is t number of shorted shares divided by the daily number of traded shares for a given stock. We classify investors into three groups: foreign investors (foreigner), d individual investors (individual) and domestic institution investors (institution). The sample period is from January 1, 2006 to December 31, 2015, excluding short-selling ban periods (October 1, 2008 to May 31, 2009 and August 10, 2011 to November 9, 2011).

		Shorted shares			Shorted value			*relss* (%)		
		Mean	Median	Stdev	Mean	Median	Stdev	Mean	Median	St
All	2006:01:01-2015:12:31	29.03	7.68	61.75	1,427.06	457.04	2,687.26	6.26	4.18	
	2006:01:01-2008:09:30	22.15	3.42	50.95	1,198.79	244.45	2,506.96	3.50	1.29	
	2009:06:01-2011:08:09	25.80	4.86	67.91	1,548.15	350.20	3,342.45	3.82	2.21	
	2011:11:10-2015:12:31	35.33	12.02	65.58	1,513.00	655.58	2,453.21	9.41	7.15	
Foreigner	2006:01:01-2015:12:31	23.25	5.11	53.31	1,169.94	314.55	2,381.55	4.90	2.89	
	2006:01:01-2008:09:30	20.27	2.56	48.87	1,092.74	191.32	2,393.53	3.19	1.05	
	2009:06:01-2011:08:09	22.44	3.47	61.66	1,332.82	260.02	3,022.26	3.33	1.72	
	2011:11:10-2015:12:31	25.67	7.68	51.74	1,133.22	425.64	2,027.89	6.89	4.74	
Individual	2006:01:01-2015:12:31	0.46	0.01	1.62	22.56	0.45	67.86	0.06	0.00	
	2006:01:01-2008:09:30	0.21	0.01	0.63	10.78	0.45	29.91	0.02	0.00	
	2009:06:01-2011:08:09	0.89	0.02	2.76	49.69	1.26	126.37	0.10	0.01	
	2011:11:10-2015:12:31	0.38	0.00	1.66	15.72	0.00	61.45	0.07	0.00	
Institution	2006:01:01-2015:12:31	5.32	0.60	14.93	234.56	35.15	606.93	1.30	0.35	
	2006:01:01-2008:09:30	1.67	0.03	6.75	95.27	1.44	373.98	0.29	0.01	
	2009:06:01-2011:08:09	2.46	0.13	9.16	165.64	8.83	549.77	0.39	0.05	
	2011:11:10-2015:12:31	9.28	1.23	23.48	364.07	71.69	792.17	2.45	0.74	

Table 3. Calendar effect in aggregate short-selling

The table reports the regression results of aggregate short-selling by investor type on calendar-related variables. The aggregate short-selling (%) is the number of shorted shares by all investor types ("All"), by foreign short-sellers ("Foreigner"), by individual investors ("Individual"), or by institutional investors ("Institution"), divided by the number of traded shares on a given day~~,~~ averaged across sample stocks. Monday, Tuesday, Wednesday and Thursday are the dummy variables that is equal to one if a trading day is the named day and zero otherwise. January through November are dummy variables that is equal to one if the trading day belongs to ~~each~~ the named month, and zero otherwise. Holiday is a dummy variable that is equals to one if a trading day is one day before and one day after the given holiday. If a holiday is on Monday then only the following Tuesday is set to one and if a holiday is on Friday then only the preceding Thursday is set to one. Ban1 and Ban2 are dummy variables for short-selling ban periods from October 1, 2008, to May 31, 2009 and from August 10, 2011, to November 9, 2011, respectively. Year equals ~~to~~ the difference between current year and 2009. We multiply 100 for all coefficients. The sample period is from January 1, 2006 to December 31, 2015. The *t* values are in the parentheses and significance level at 1%, 5%, and 10% are presented by asterisks of ***, **, and *, respectively.

	All	Foreigner	Individual	Institution
Day of the week				
Monday	0.659***	0.568***	0.012***	0.079***
	(7.83)	(8.48)	(5.74)	(2.72)
Tuesday	0.797***	0.675***	0.013***	0.109***
	(9.44)	(10.03)	(6.13)	(3.76)
Wednesday	0.872***	0.779***	0.012***	0.081***
	(10.29)	(11.54)	(5.70)	(2.78)
Thursday	0.812***	0.713***	0.012***	0.086***
	(9.59)	(10.59)	(5.99)	(2.95)
Month				
January	1.600***	1.297***	0.027***	0.275***
	(14.24)	(14.50)	(9.97)	(7.12)
February	1.534***	1.279***	0.034***	0.221***
	(13.16)	(13.77)	(12.00)	(5.51)
March	1.480***	1.191***	0.028***	0.260***
	(13.29)	(13.44)	(10.32)	(6.79)
April	1.516***	1.248***	0.026***	0.242***
	(13.58)	(14.04)	(9.54)	(6.28)
May	1.882***	1.544***	0.037***	0.301***
	(16.32)	(16.81)	(12.95)	(7.59)
June	2.297***	1.868***	0.044***	0.385***
	(20.38)	(20.81)	(16.12)	(9.92)
July	1.888***	1.556***	0.040***	0.292***
	(17.22)	(17.83)	(14.75)	(7.74)
August	2.244***	1.888***	0.037***	0.319***
	(20.04)	(21.17)	(13.43)	(8.28)
September	2.061***	1.731***	0.033***	0.297***
	(17.80)	(18.77)	(11.64)	(7.44)
October	2.128***	1.684***	0.030***	0.414***
	(18.64)	(18.53)	(10.67)	(10.54)
November	2.152***	1.777***	0.040***	0.335***
	(19.27)	(19.99)	(14.58)	(8.70)
Holiday	0.512***	0.434***	0.003	0.076*
	(4.08)	(4.34)	(0.82)	(1.76)
Short-Selling Ban				
Ban1	-1.852***	-1.592***	-0.035***	-0.225***
	(-15.58)	(-16.81)	(-12.09)	(-5.50)
Ban2	-4.128***	-3.256***	-0.055***	-0.817***
	(-21.63)	(-21.43)	(-11.80)	(-12.43)
Year	0.691***	0.464***	0.006***	0.221***
	(68.30)	(57.59)	(23.65)	(63.51)

Table 4. Regression of aggregate short-selling by investor type

The table shows the regressions of adjusted aggregate short-selling ($Adjrelss^{agg}$) on market-related variables by investor type in separate panels. The adjusted aggregate short-selling variables are obtained from the residual in the regression of the aggregate relative short-selling by each type on the day-of-the-week dummies, month dummies, holiday dummy, dummies for short-selling ban periods and the time trend variable as specified in Eq. (3). Aggregate relative short-selling, ~~which~~ is defined as the number of shorted shares divided by the number of traded shares on a given day~~,~~ averaged across sample stocks~~, on the day-of-the-week dummies, month dummies, holiday dummy, dummies for short-selling ban periods and the time trend variable as specified in Eq. (3)~~. We classify investors into three groups: foreign investors (foreigner), domestic individual investors (Individual) and domestic institution investors (institution). $R_{m,-5,-1}$ is cumulative market return from day t - 5 to t - 1. $R_{m,t}$ is market return on day t. $R^{Up}_{m,-5,-1}$ ($R^{Down}_{m,-5,-1}$) is equal to $R_{m,-5,-1}$ if $R_{m,-5,-1}$ is positive (negative), and zero otherwise. $R^{Up}_{m,t}$ ($R^{Down}_{m,t}$) is equal to $R_{m,t}$ if $R_{m,t}$ is positive (negative) and zero otherwise. $R^{Large\ Up}_{m,-5,-1}$ ($R^{Large\ Down}_{m,-5,-1}$) is equal to $R_{m,-5,-1}$ if $R_{m,-5,-1}$ is ~~larger (smaller) by~~ more than one standard deviation above (below) the average market return over the sample period~~,~~ and zero otherwise. $R^{Large\ Up}_{m,t}$ ($R^{Large\ Down}_{m,t}$) is equal to $R_{m,t}$ if $R_{m,t}$ is ~~larger (smaller) by~~ more than one standard deviation above (below) the average market return over the sample period~~,~~ and zero otherwise. *MktVol* is market volatility of day t, which is defined as the difference between the daily high and the low prices of the index~~and~~ scaled by the daily high price ~~of index~~. *Mktill* is an equally-weighted average of Amihud (2002) illiquidity measure across all stocks listed in KOSPI at day t~~of illiquidity measure at day t proposed by Amihud (2002)~~. ΔVIX_{KR} is a daily percentage change in the volatility index, which is similar to US VIX but based on KOSPI200 option (obtained from KRX). $\Delta CDS\ prem.$ is a daily percentage change of credit default swap (CDS) spread for five-year Korean government bond. We multiply 100 for coefficient of ~~*MktIll*~~*Mktill*, ΔVIX_{KR}, and $\Delta CDS\ prem.$ The sample period is from January 1, 2006 to December 31, 2015, excluding the two ban periods (October 1, 2008 to May 31, 2009 and August 10, 2011 to November 9, 2011). The t values are in the parentheses and calculated based on Newey-West standard error with a lag of 12 days. Significance level at 1%, 5%, and 10% are presented by asterisks of ***, **, and *, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Panel A: Foreigner						
Intercept	0.002**	0.001	0.001	0.001*	0.001*	0.001	0.000
	(2.27)	(1.15)	(1.28)	(1.81)	(1.80)	(1.64)	(0.55)
$R_{m,-5,-1}$	-0.095***			-0.094***	-0.094***	-0.091***	-0.136***
	(-5.33)			(-5.24)	(-5.24)	(-5.03)	(-5.63)
$R_{m,t}$	-0.134***			-0.140***	-0.140***	-0.183***	-0.165***
	(-5.50)			(-4.68)	(-4.69)	(-4.77)	(-3.12)
$R^{Up}_{m,-5,-1}$		-0.056*					
		(-1.87)					
$R^{Down}_{m,-5,-1}$		-0.132***					
		(-4.59)					
$R^{Up}_{m,t}$		-0.168***					
		(-3.85)					
$R^{Down}_{m,t}$		-0.105**					
		(-2.55)					
$R^{Large\ Up}_{m,-5,-1}$			-0.023				
			(-0.82)				
$R^{Large\ Down}_{m,-5,-1}$			-0.103***				
			(-4.12)				
$R^{Large\ Up}_{m,t}$			-0.125***				
			(-3.41)				
$R^{Large\ Down}_{m,t}$			-0.125***				
			(-3.04)				
MktVol.				0.031	0.032	0.057	-0.042
				(0.41)	(0.41)	(0.70)	(-0.38)
Mktill×100					0.020	0.009	0.020

					(0.11)	(0.05)	(0.11)
$\Delta VIX_{KR}\times 100$						-1.249	-1.246
						(-1.50)	(-1.22)
$\Delta CDS\ prem.\times 100$							2.150***
							(2.74)
R^2	5.281	5.531	2.680	5.295	5.295	5.455	8.532
Obs.	2,253	2,253	2,253	2,253	2,253	2,252	1,768
	Panel B: Individual						
Intercept	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	(1.30)	(-0.31)	(0.45)	(0.07)	(0.06)	(-0.11)	(0.87)
$R_{m,-5,-1}$	-0.002***			-0.002***	-0.002***	-0.002***	-0.002***
	(-2.97)			(-2.73)	(-2.73)	(-2.61)	(-2.62)
$R_{m,t}$	0.000			-0.001	-0.002	-0.003**	-0.006***
	(-0.52)			(-1.46)	(-1.48)	(-2.47)	(-3.14)
$R^{Up}_{m,-5,-1}$		-0.001					
		(-0.98)					
$R^{Down}_{m,-5,-1}$		-0.002**					
		(-2.00)					
$R^{Up}_{m,t}$		0.003*					
		(1.67)					
$R^{Down}_{m,t}$		-0.003**					
		(-1.97)					
$R^{Large\ Up}_{m,-5,-1}$			0.000				
			(-0.40)				
$R^{Large\ Down}_{m,-5,-1}$			-0.002*				
			(-1.68)				
$R^{Large\ Up}_{m,t}$			0.003*				
			(1.87)				
$R^{Large\ Down}_{m,t}$			-0.002				
			(-1.32)				
MktVol.				0.006*	0.006**	0.007**	0.015***
				(1.95)	(1.96)	(2.25)	(4.52)
Mktill×100					0.002	0.001	0.002
					(0.29)	(0.22)	(0.23)
$\Delta VIX_{KR}\times 100$						-0.053***	-0.071***
						(-3.13)	(-3.33)
$\Delta CDS\ prem.\times 100$							-0.006
							(-0.29)
R^2	1.687	2.228	1.149	2.133	2.138	2.439	4.898
Obs.	2,253	2,253	2,253	2,253	2,253	2,252	1,768
	Panel C: Institution						
Intercept	0.000	0.001	0.000	0.001	0.001	0.001	0.000
	(0.66)	(1.56)	(0.98)	(1.38)	(1.43)	(1.41)	(0.19)
$R_{m,-5,-1}$	-0.002			-0.004	-0.004	-0.004	-0.013
	(-0.31)			(-0.60)	(-0.61)	(-0.62)	(-1.55)
$R_{m,t}$	-0.005			0.008	0.010	0.011	0.039**
	(-0.61)			(0.86)	(1.01)	(0.87)	(2.46)
$R^{Up}_{m,-5,-1}$		-0.020					
		(-1.46)					
$R^{Down}_{m,-5,-1}$		0.007					
		(0.63)					
$R^{Up}_{m,t}$		-0.046**					

		(-2.39)					
$R^{Down}_{m,t}$		0.030*					
		(1.80)					
$R^{Large\ Up}_{m,-5,-1}$			-0.011				
			(-1.03)				
$R^{Large\ Down}_{m,-5,-1}$			0.004				
			(0.38)				
$R^{Large\ Up}_{m,t}$			-0.029*				
			(-1.84)				
$R^{Large\ Down}_{m,t}$			0.018				
			(1.07)				
MktVol.				-0.069**	-0.070**	-0.071**	-0.169***
				(-2.16)	(-2.19)	(-2.12)	(-3.86)
Mktill×100					-0.117***	-0.117**	-0.122***
					(-2.53)	(-2.54)	(-2.70)
ΔVIX_{KR}×100						0.031	0.062
						(0.13)	(0.21)
Δ*CDS prem.*×100							0.624*
							(1.77)
R^2	0.022	0.552	0.253	0.363	0.465	0.466	1.902
Obs.	2,253	2,253	2,253	2,253	2,253	2,252	1,768

Table 5. Aggregate short-selling in Korea in relation to U.S. stock market environment

The table shows the regressions of adjusted aggregate short-selling by each investor type on market-related variables by investor type in separate panels. The adjusted aggregate short-selling variables are obtained from the residual in the regression of the aggregate relative short-selling by investor type, which is defined as the number of shorted shares by investor type divided by the number of traded shares on a given day, averaged across sample stocks, on the day-of-the-week dummies, month dummies, holiday dummy, dummies for short-selling ban periods and the time trend variable as specified in Eq. (3). We classify investors into three groups: foreign investors (foreigner), domestic individual investors (Individual) and domestic institution investors (institution). $Res.R_{m,-5,-1}$ ($Res.R_{m,t}$) is a residual from the regression of five days cumulative (day t) KOSPI index return, $R_{m,-5,-1}$ ($R_{m,t}$) on $R^{US}_{m,-5,-1}$ ($R^{US}_{m,t}$), where $R_{m,-5,-1}$ is cumulative KOSPI index return from day t-5 to t-1, $R_{m,t}$ is KOSPI index return on day t, $R^{US}_{m,-5,-1}$ is cumulative S&P500 index return from day t-5 to t–1, and $R^{US}_{m,t}$ is S&P500 index return on day t. $Res.R^{Up}_{m,-5,-1}$ ($Res.R^{Down}_{m,-5,-1}$) is equal to $Res.R_{m,-5,-1}$ if $Res.R_{m,-5,-1}$ is positive (negative), and zero otherwise. $Res.R^{Up}_{m,t}$ ($Res.R^{Down}_{m,t}$) is equal to $Res.R_{m,t}$ if $Res.R_{m,t}$ is positive (negative) and zero otherwise. $R^{US,Up}_{m,-5,-1}$ ($R^{US,Down}_{m,-5,-1}$) is equal to $R^{US}_{m,-5,-1}$ if $R^{US}_{m,-5,-1}$ is positive (negative) and zero otherwise. $R^{US,Up}_{m,t}$ ($R^{US,Down}_{m,t}$) is equal to $R^{US}_{m,t}$ if $R^{US}_{m,t}$ is positive (negative) and zero otherwise $Res.R^{Large\ Up}_{m,-5,-1}$ ($Res.R^{Large\ Down}_{m,-5,-1}$) is equal to $Res.R_{m,-5,-1}$ if $Res.R_{m,-5,-1}$ is larger (smaller) by more than one standard deviation above (below) the average market return over the sample period. $Res.R^{Large\ Up}_{m,t}$ ($Res.R^{Large\ Down}_{m,t}$) is equal to $Res.R_{m,t}$ if $Res.R_{m,t}$ is larger (smaller) by more than one standard deviation above (below) then average market return over the sample period. $R^{US,Large\ Up}_{m,-5,-1}$ ($R^{US,Large\ Down}_{m,-5,-1}$) is equal to $R^{US}_{m,-5,-1}$ if $R^{US}_{m,-5,-1}$ is larger (smaller) by more than one standard deviation above (below) then average market return over the sample period. $R^{US,Large\ Up}_{m,t}$ ($R^{US,Large\ Down}_{m,t}$) is equal to $R^{US}_{m,t}$ if $R^{US}_{m,t}$ is larger (smaller) by more than one standard deviation above (below) then average market return over the sample period. $\Delta\ VIX_{US}$ is a daily percentage change in the CBOE volatility index. *MktVol* is daily change in market volatility of day t, which is defined as the difference between the daily high and the low prices and scaled by the daily high price of index. *Mktill* is an equally-weighted average across all stocks listed in KOSPI of illiquidity measure at day t proposed by Amihud (2002). $\Delta Res.VIX_{KR}$ is a daily percentage change in residual volatility index, which is obtained from the regression of VIX_{KR} on VIX_{US}, where VIX_{KR} is the volatility index, which is similar to US VIX but based on KOSPI200 option (obtained from KRX). $\Delta CDS\ prem.$ is a daily change of credit default swap spread for five-year Korean government bond. We multiply 100 for coefficients of $\Delta\ VIX_{US}$, *Mktill*, $\Delta Res.VIX_{KR}$, and $\Delta CDS\ prem.$ The sample period is from January 1, 2006 to December 31, 2015, excluding the two ban periods (October 1, 2008 to May 31, 2009 and August 10, 2011 to November 9, 2011). The t values are in the parentheses and calculated based on Newey-West standard error with a lag of 12 days. Significance level at 1%, 5%, and 10% are presented by asterisks of ***, **, and *, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
				Panel A: Foreigner			
Intercept	0.002**	0.002	0.001	0.002***	0.002***	0.002***	0.002*
	(2.38)	(1.61)	(1.56)	(2.71)	(2.69)	(2.94)	(1.78)
$Res.R_{m,-5,-1}$	-0.086***			-0.087***	-0.087***	-0.082***	-0.123***
	(-4.21)			(-4.22)	(-4.21)	(-3.99)	(-4.27)
$Res.R_{m,t}$	-0.093***			-0.056	-0.056	-0.027	-0.006
	(-3.83)			(-1.51)	(-1.52)	(-0.63)	(-0.11)
$R^{US}_{m,-5,-1}$	-0.075***			-0.079***	-0.079***	-0.080***	-0.110***
	(-3.72)			(-3.85)	(-3.85)	(-3.74)	(-4.62)
$R^{US}_{m,t}$	-0.132***			-0.138***	-0.138***	-0.151***	-0.135***
	(-4.87)			(-3.82)	(-3.83)	(-3.97)	(-3.03)
$Res.R^{Up}_{m,-5,-1}$		-0.043					
		(-1.34)					
$Res.R^{Down}_{m,-5,-1}$		-0.134***					
		(-3.99)					
$Res.R^{Up}_{m,t}$		-0.157***					

		(-3.06)					
$Res.\ R_{m,t}^{Down}$		-0.045					
		(-0.99)					
$R_{m,-5,-1}^{US,Up}$		-0.120***					
		(-3.35)					
$R_{m,-5,-1}^{US,Down}$		-0.028					
		(-0.87)					
$R_{m,t}^{US,Up}$		-0.086*					
		(-1.81)					
$R_{m,t}^{US,Down}$		-0.169***					
		(-2.92)					
$Res.\ R_{m,-5,-1}^{Large\ Up}$			-0.043				
			(-1.54)				
$Res.\ R_{m,-5,-1}^{Large\ Down}$			-0.106***				
			(-3.31)				
$Res.\ R_{m,t}^{Large\ Up}$			-0.121**				
			(-2.48)				
$Res.\ R_{m,t}^{Large\ Down}$			-0.057				
			(-1.39)				
$R_{m,-5,-1}^{US,Large\ Up}$			-0.097***				
			(-2.80)				
$R_{m,-5,-1}^{US,Large\ Down}$			-0.042				
			(-1.40)				
$R_{m,t}^{US,Large\ Up}$			-0.037				
			(-0.82)				
$R_{m,t}^{US,Large\ Down}$			-0.165***				
			(-2.95)				
$\Delta\ VIX_{US}\times 100$				0.002	0.002	0.001	0.007
				(0.38)	(0.38)	(0.25)	(1.00)
$MktVol.$				-0.122	-0.122	-0.152	-0.267*
				(-1.23)	(-1.23)	(-1.39)	(-1.92)
$Mktill\times 100$					0.024	0.047	0.057
					(0.14)	(0.25)	(0.32)
$\Delta Res.VIX_{KR}\times 100$						0.000	0.000
						(1.30)	(1.42)
$\Delta CDS\ prem.\times 100$							1.090
							(1.08)
R^2	5.699	6.295	3.550	5.846	5.847	5.592	8.858
Obs.	2,186	2,186	2,186	2,186	2,186	2,043	1,606
			Panel B: Individual				
Intercept	0.000	0.000*	0.000	0.000	0.000	0.000	0.000
	(1.26)	(-1.74)	(-0.52)	(-0.24)	(-0.25)	(-0.25)	(0.28)
$Res.\ R_{m,-5,-1}$	-0.002***			-0.002***	-0.002***	-0.002***	-0.003***
	(-2.85)			(-2.82)	(-2.81)	(-2.63)	(-2.61)
$Res.\ R_{m,t}$	0.000			-0.002	-0.002	-0.003*	-0.005***
	(0.09)			(-1.54)	(-1.55)	(-1.83)	(-3.04)
$R_{m,-5,-1}^{US}$	-0.001			0.000	0.000	0.000	-0.001
	(-1.03)			(-0.67)	(-0.68)	(-0.62)	(-1.05)
$R_{m,t}^{US}$	0.000			-0.001	-0.001	0.000	0.001
	(-0.47)			(-0.46)	(-0.47)	(-0.32)	(0.69)
$Res.\ R_{m,-5,-1}^{Up}$		-0.002*					

		(-1.78)					
$Res.\ R^{Down}_{m,-5,-1}$		-0.002					
		(-1.45)					
$Res.\ R^{Up}_{m,t}$		0.002					
		(1.20)					
$Res.\ R^{Down}_{m,t}$		-0.002					
		(-1.06)					
$R^{US,Up}_{m,-5,-1}$		0.003**					
		(2.27)					
$R^{US,Down}_{m,-5,-1}$		-0.003**					
		(-2.14)					
$R^{US,Up}_{m,t}$		0.005***					
		(2.72)					
$R^{US,Down}_{m,t}$		-0.005**					
		(-2.56)					
$Res.\ R^{Large\ Up}_{m,-5,-1}$			-0.001				
			(-1.23)				
$Res.\ R^{Large\ Down}_{m,-5,-1}$			-0.002				
			(-1.57)				
$Res.\ R^{Large\ Up}_{m,t}$			0.003				
			(1.45)				
$Res.\ R^{Large\ Down}_{m,t}$			-0.002				
			(-0.88)				
$R^{US,Large\ Up}_{m,-5,-1}$			0.003***				
			(2.74)				
$R^{US,Large\ Down}_{m,-5,-1}$			-0.002*				
			(-1.74)				
$R^{US,Large\ Up}_{m,t}$			0.005***				
			(2.85)				
$R^{US,Large\ Down}_{m,t}$			-0.004**				
			(-2.02)				
$\Delta\ VIX_{US}\times 100$				0.000	0.000	0.000	0.000
				(-1.47)	(-1.47)	(-1.41)	(-1.01)
MktVol.				0.007**	0.007**	0.008**	0.018**
				(1.96)	(1.96)	(2.08)	(4.36)
Mktill×100					0.002	-0.001	-0.001
					(0.26)	(-0.20)	(-0.24)
$\Delta Res.VIX_{KR}\times 100$						0.000	0.000
						(1.57)	(-0.29)
$\Delta CDS\ prem.\times 100$							-0.002
							(-0.06)
R^2	1.896	4.091	3.431	2.468	2.473	2.358	5.035
Obs.	2,186	2,186	2,186	2,186	2,186	2,043	1,606
			Panel C: Institution				
Intercept	0.000	0.001**	0.001	0.001*	0.001*	0.001*	0.001
	(0.70)	(2.01)	(1.33)	(1.80)	(1.84)	(1.83)	(0.92)
$Res.\ R_{m,-5,-1}$	0.003			0.002	0.002	0.005	0.000
	(0.37)			(0.24)	(0.24)	(0.53)	(-0.01)
$Res.\ R_{m,t}$	-0.003			0.032**	0.033**	0.039**	0.077***
	(-0.36)			(2.22)	(2.29)	(2.48)	(4.19)
$R^{US}_{m,-5,-1}$	-0.008			-0.012	-0.011	-0.014	-0.021**

	(-0.82)			(-1.24)	(-1.23)	(-1.45)	(-2.01)
$R^{US}_{m,t}$	-0.010			-0.016	-0.015	-0.022	-0.042**
	(-1.02)			(-1.00)	(-0.94)	(-1.20)	(-2.08)
$Res.\ R^{Up}_{m,-5,-1}$		-0.003					
		(-0.15)					
$Res.\ R^{Down}_{m,-5,-1}$		0.005					
		(0.36)					
$Res.\ R^{Up}_{m,t}$		-0.035					
		(-1.55)					
$Res.\ R^{Down}_{m,t}$		0.025					
		(1.24)					
$R^{US,Up}_{m,-5,-1}$		-0.043***					
		(-2.84)					
$R^{US,Down}_{m,-5,-1}$		0.015					
		(0.84)					
$R^{US,Up}_{m,t}$		-0.038**					
		(-2.02)					
$R^{US,Down}_{m,t}$		0.013					
		(0.75)					
$Res.\ R^{Large\ Up}_{m,-5,-1}$			0.001				
			(0.10)				
$Res.\ R^{Large\ Down}_{m,-5,-1}$			0.014				
			(1.10)				
$Res.\ R^{Large\ Up}_{m,t}$			-0.014				
			(-0.73)				
$Res.\ R^{Large\ Down}_{m,t}$			0.029				
			(1.44)				
$R^{US,LargeUp}_{m,-5,-1}$			-0.032**				
			(-2.23)				
$R^{US,Large\ Down}_{m,-5,-1}$			0.005				
			(0.33)				
$R^{US,LargeUp}_{m,t}$			-0.035**				
			(-2.11)				
$R^{US,Large\ Down}_{m,t}$			0.009				
			(0.57)				
$\Delta\ VIX_{US}\times 100$				0.002	0.002	0.001	0.000
				(0.87)	(0.87)	(0.55)	(0.07)
$MktVol.$				-0.117***	-0.117***	-0.120***	-0.245***
				(-2.66)	(-2.67)	(-2.59)	(-4.38)
$Mktill\times 100$					-0.117***	-0.097**	-0.094**
					(-2.61)	(-2.38)	(-2.50)
$\Delta Res.VIX_{KR}\times 100$						0.000*	0.000
						(-1.71)	(-0.81)
$\Delta CDS\ prem.\times 100$							-0.010
							(-0.02)
R^2	0.135	1.151	0.873	0.829	0.933	1.040	2.942
Obs.	2,186	2,186	2,186	2,186	2,186	2,043	1,606

Table 6. Vector Auto-Regression

The table reports the Vector Auto-Regression (VAR) results for market return, $Adjrelss_{fore,}$ $Adjrelss_{indi}$, and $Adjrelss_{inst}$, in which the latter three variables denote adjusted aggregate short-selling by foreigners, domestic individual investors and domestic institutional investors, respectively. Adjusted aggregate short-selling variables are obtained from the residual in the regression of the aggregate relative short-selling by each type, which is defined as the number of shorted shares by investor type divided by the number of traded shares on a given day, averaged across sample stocks, on the day-of-the-week dummies, month dummies, holiday dummy, dummies for short-selling ban periods and the time trend variable as specified in Eq. (3). Market return is daily KOSPI index return. The sample period is from January 1, 2006 to December 31, 2015, excluding the two ban periods (October 1, 2008 to May 31, 2009 and August 10, 2011 to November 9, 2011). The *t* values are in the parentheses. Significance level at 1%, 5%, and 10% are presented by asterisks of ***, **, and *, respectively.

	Market ret	$Adjrelss_{fore}$	$Adjrelss_{indi}$	$Adjrelss_{inst}$
Intercept	0.000	0.000**	0.000	0.000
	(0.87)	(2.20)	(1.56)	(0.24)
Market ret (-1)	-0.006	-0.108***	-0.002***	0.008
	(-0.28)	(-7.03)	(-5.37)	(1.24)
Market ret (-2)	0.011	0.039**	0.000	0.013**
	(0.49)	(2.48)	(-0.32)	(2.05)
$Adjrelss_{fore}$ (-1)	-0.026	0.482***	-0.001	0.027***
	(-0.86)	(22.57)	(-1.36)	(3.17)
$Adjrelss_{fore}$ (-2)	0.011	0.240***	0.002***	0.029***
	(0.38)	(11.36)	(2.77)	(3.46)
$Adjrelss_{indi}$ (-1)	0.808	-0.070	0.492***	-0.975***
	(0.81)	(-0.10)	(23.98)	(-3.42)
$Adjrelss_{indi}$ (-2)	-0.201	-0.760	0.281***	-0.458
	(-0.20)	(-1.07)	(13.78)	(-1.62)
$Adjrelss_{inst}$ (-1)	-0.027	0.047	-0.005***	0.539***
	(-0.36)	(0.90)	(-3.01)	(25.58)
$Adjrelss_{inst}$ (-2)	0.035	0.184***	-0.005***	0.179***
	(0.48)	(3.49)	(-3.18)	(8.48)
R^2	0.103	54.571	61.061	62.303

Table 7. Dynamic relation between aggregate short-selling activity and market return

The table reports the Granger-causality between short-selling activity by investor type, market return, and market volatility. $Adjrelss_{fore}$, $Adjrelss_{indi}$, and $Adjrelss_{inst}$ are adjusted aggregate short-selling ($Adjrelss^{agg}$) by foreigners, domestic individual investors and domestic institution investors, respectively. $Adjrelss^{agg}$ is the residual from the regression of aggregate short-selling ($relss^{agg}$) on variables to capture calendar effect as specified in Eq. (3), where $relss^{agg}$ is the number of shorted shares divided by the number of traded shares on a given day, averaged for fifty sample stocks. The arrows in the table show the direction of Granger-causality together with *p*-value from the F-test for the null hypothesis of non-existence of Granger-causality relation. The sample period is from January 1, 2006 to December 31, 2015, excluding the two ban periods (October 1, 2008 to May 31, 2009 and August 10, 2011 to November 9, 2011).

Hypothesis	*p*-value
$Adjrelss_{fore}$ → Market ret	0.263
Market ret → $Adjrelss_{fore}$	0.000
$Adjrelss_{indi}$ → Market ret	0.953
Market ret → $Adjrelss_{indi}$	0.000
$Adjrelss_{inst}$ → Market ret	0.306
Market ret → $Adjrelss_{inst}$	0.584
$Adjrelss_{fore}$ → $Adjrelss_{indi}$	0.003
$Adjrelss_{indi}$ → $Adjrelss_{fore}$	0.000
$Adjrelss_{fore}$ → $Adjrelss_{inst}$	0.000
$Adjrelss_{inst}$ → $Adjrelss_{fore}$	0.003
$Adjrelss_{indi}$ → $Adjrelss_{inst}$	0.009
$Adjrelss_{inst}$ → $Adjrelss_{indi}$	0.000