Short Selling and Price Pressures in the Korean Stock Market*

Sang Buhm Hahn (Kyonggi University)**

Yeongseop Rhee (Seoul National University)***

November 2012

(revised March 2014)

ABSTRACT

This paper examines short-selling activity focusing on its behavior during non-normal times of occasional excesses in the Korean stock market. Using the methodology explained by Brunnermeier and Pederson (2005) and Shkilko et al. (2009; 2012), we first examine whether short-selling is predatory on those event days of large price reversals. Overall there is little predatory abnormal short-selling in the pre-rebound phase and we can observe active contrarian short-selling in the post-rebound phase. When we compared aggressiveness between short-selling and non-short-selling using order imbalance variables, we found that non-short selling is much more aggressive than short selling in the Korean stock market. From the observation of market liquidity measured by quoted spreads, we could find that market liquidity is somewhat limited during price decline stages while it slightly improves during price reversal phases. Also, using dynamic panel model, we test the influences of those variables on stock price changes and disaggregate the compound effect of short-selling reflected in trading volume itself into differentiated ones not only through pure trading channel but also through other complicated channels such as market sentiment change. Main findings from the regression results are as follows: In the Korean stock market, short sellers seem to behave as a contrarian trader rather than a momentum trader; seller-initiated aggressive trading, whether it is by short-selling or non-short-selling, leads to negative order imbalance and price decline; market liquidity is limited by short-selling and further pressure on price decline is added in the pre-rebound stage; and stock prices are affected not only through pure selling (buying) channel but also through other channels in the Korean stock market.

Keywords: short selling, price reversals, order imbalance, aggressive trading

* The authors are grateful to the Institute for Research in Finance and Economics of the Seoul National University for its financial support.
** Corresponding author: Professor at department of economics, Kyonggi University, Korea; sbhahn@kgu.ac.kr
*** Professor at GSIS, Seoul National University, Korea; ysrhee@snu.ac.kr

I. Introduction

When the financial markets were severely turbulent right after the collapse of Lehman-Brothers in 2008, short-sellers were heavily blamed for that extreme volatility. In response, financial regulators around the world imposed temporary restrictions on short-selling. For example, the U.K's Financial Services Authority (FSA) banned short-selling on 32 stocks of financial services companies on September 18th 2008 , and the U.S.' Securities and Exchange Commission (SEC) restricted short-selling of 799 financial stocks on the next day. The Canadian securities administrators also banned short-selling of 13 shares of financial sector issuers which were inter-listed with the U.S. market on September 19th. In Korea, short-selling was banned on all stocks on October 1st 2008, following similar actions taken by U.S. and U.K. regulators. Korea lifted the rule from June 1st 2009, while keeping the ban for financial stocks, and temporarily reintroduced the ban for three months on all stocks on August 10th 2011 after the stock market index (KOSPI) slumped 17 percent in six days due to the Eurozone crisis.

The effect of banning short-selling has been a focus of intense debate,[1] and recently resurfaced at the core of policy debate when a series of new regulations were imposed in many countries during the global financial crisis. In general, the public and financial regulators seem to regard short sellers as conniving sharpies, spreading false rumors and victimizing innocent companies, and strongly support short-selling restrictions.[2] The SEC's chairwoman, Mary L. Schapiro, said at a roundtable after the Lehman-Brothers' bankruptcy, "The commission is concerned about abusive naked short selling and persistent fails to deliver and the potentially manipulative effect this activity can have on our markets."[3] The U.K. FSA also clearly says that it introduced temporary short selling measures because it was "concerned by heightened risks of market abuse and disorderly markets posed by short selling" (U.K. FSA 2009, p.3). A few financial companies who were fallen out during the crisis are also very strong proponents of short-selling ban: "What's happening out there? It's very clear to me — we're in the midst of a market controlled by fear and rumors, and short sellers are driving our stock down," fumed John Mack, CEO of Morgan Stanley, in a memo to employees.[4]

---

[1] Among others, see FSA (2009), ILSA (2009), and Lee and Wang (2012) and their references for overall summary of the debate.

[2] Additional supporting examples in mass media: "Almost everyone condemns naked short selling," by George Monbiot, The Guardian, February 15th 2011; "Restore the Uptick Rule, Restore confidence," by C. Schwab, The Wall Street Journal, December 9th 2008.

[3] Requoted from "Debate Heats Up Over Naked Short-Selling," New York Times, September 30th 2008.

[4] Requoted from "Are Short Sellers to Blame for the Financial Crisis?" TIME, September 18th 2008.

In contrast, most in the financial sector and most academic researchers are on the side of opposing group of short-selling ban, arguing that there is no evidence of abusive short-selling and that short-selling ban will result in exactly the opposite in what the regulators want to achieve. A president of a hedge fund company said, "We are very concerned that these emergency orders will not enhance long-term market integrity, nor will they address the fundamental economic issues that have been afflicting our financial sector," and "Simply put, short-selling is a vital investment strategy that responds to market fundamentals and contributes to the integrity of stock prices."[5] Also most economists believe that "The consensus view among economists is that nothing is wrong with short selling" (Brunnermeier and Oehmke 2008, p.1).

What's missing in the debate over the effect of short-selling ban, however, is whether short-selling is abusive and disorderly not in general but in non-normal times. When regulators put restrictions on short-selling, it was clearly stated that they introduced those restrictions "on an emergency basis" and "at a time of extreme market turbulence, manifested in the forms of high and prolonged price volatility and downward pressure on the prices of financial stocks in particular" (U.K. FSA 2009, p.3). Thus to discuss whether short-selling ban is justified, we need to focus on those non-normal days and show whether short-selling is really abusive and predatory at "times of stress" and at times of "occasional excesses" rather than during "normal times" (Brunnerweier and Oehmke 2008, p.1).

There is little literature that has analyzed short-selling behavior during those non-normal days with occasional excesses. Brunnermeier and Pederson (2005) and Brunnermeier and Oehmke (2008) theoretically show that "even though short-selling activity is beneficial during normal times, at times of stress short sellers can destabilize a financial institution." Shkilko et al. (2007; 2009; 2012) empirically identifies days with large intraday price reversals (event days), and shows that short sellers are abnormally aggressive and put substantially further pressure on price decline on those event days, even though short-selling enhances market efficiency during normal times. Still we have not found yet a study to analyze short-selling activity in a global market, in particular an emerging market, other than the U.S. market.

The main purpose of this paper is to examine whether short-selling is really predatory in the Korean market focusing on those event days of large price reversals.[6] Also this paper aims to analyze channels through which short-selling affects stock price. To identify event days with large

[5] Requoted from "Are short-sellers really to blame?" New York Times, September 23rd 2008. Also see ISLA (2009) for a position of an interest group.

[6] There are many studies on short-selling in the Korean stock market. But none of them is focused on short-selling behavior during non-normal cases. See Binh (2009), Choi and Lee (2010), Eom (2010), Kim (2010), Ko and Ahn (2006), Park (2011), Yi and Jang (2009), Yi et al. (2010) among others.

price reversals and examine how short-selling affects stock price, we methodologically follow Shkilko et al. (2007; 2009; 2012). Our paper is believed to be the first study that analyzes the behavior of predatory short-selling during non-normal times in an emerging market and that identifies various channels through which short-selling affects stock price on event days.

The remainder of the paper is structured as follows. Section II briefly explains the data used in the paper and provides very detailed explanation on the methodology to identify event days. After identifying those event days, the section also presents how price declines and rebounds during event days. In Section III we select a few important factors that affect stock prices and analyze how they behave during event days of large price reversals: short-selling trading volume; aggressive short-selling measured by order imbalance; and market liquidity measured by quoted spread. In Section IV, we estimate a multivariate model to test their influences on stock prices and draw a distinction among various channels through short-selling affects stock price. The conclusion is drawn in Section V with a brief summary of main findings.

II. Data and Methodology

1. Data

For the analysis in the paper, we use all intraday trades and quotes of stocks that are listed on the Korea Exchange (KRX) and involve short sale from January 3 to December 28, 2007. Trades and quotes, and short-selling data are collected from the Korea Capital Market Institute and the KRX. At the beginning stage, the total number of stocks and stock-day observations are 696 and 165,028, respectively. We exclude those stocks which are traded less than 100 trading days of short-selling on the KRX over the sample period. We additionally delete those stocks with price lower than 1,000 KRW at the beginning of the year and those with missing returns on a given trading day. After filtering the data, the sample size is reduced to 586 stocks and 144,029 stock-day observations.[7]

For the data analysis, we divide each trading day (regular trading hours from 9:00 am to 3:00 pm) into seventy two intervals with each five minute lengths ($j = 1$ *to* 72). For each interval j, continuously compounded five-minute returns r_{ij} of stock i are calculated using volume-weighted within-interval prices. Securities with less than 50 traded intervals on a given trading

[7] The sample size will further be reduced after the identification procedure of event days later.

day are deleted.

2. Identification of large price reversals

The first step to identify a trading day *d* as an event day (which is a day) with large price reversal is to set a historical intraday volatility of stock *i*'s five minute cumulative returns (r_{ijd}), σ_{id}. Following Shkilko et al. (2007; 2009; 2012), we also calculate σ_{id} as the average of daily standard deviations of stock *i*'s five minute cumulative returns during twenty trading days preceding day *d*.

The second step is to set the range of price reversals within a day. A price reversal consists of two stages: the pre-rebound stage with price decline and the post-rebound stage with price recovery. If a day *d* is to be an event day with large price reversal, it requires two conditions: the price decline should be large enough so that stock *i*'s cumulative intraday return decrease is equal to or more than $2 \times \sigma_{id}$ and at the same time the price should rebound so that the return recovers up to the range of 90% to 110% of the initial level by the end of the day. Figure 1 shows the identification procedure of an event day. Suppose the price is 100 at A and $\sigma_{id} = 1\%$. The first condition of large price decline requires that the daily minimum price at B should be equal to or lower than 98 (=100-2 x 1%). The second condition of price rebound implies that the price should recover so as for the closing price to stay between 99.8 (=100-(1.0-0.9) x 2%) at the level of p_1 and 100.2 (=100+(1.1-1.0) x 2%) at the level of p_2.[8]

(***Figure 1 here***)

This identification procedure can differentiate an event day from a non-event day. The first requirement of price decline can differentiate an event day with predatory short-selling from a day without short-selling or news. Without short-selling or news, the price can still fluctuate. However, it would not fluctuate a lot but a little bit around the initial price all day long. If there is predatory short-selling or bad new information instead, then the price decline will be large. Also the second requirement of the 90% to 110% recovery range can differentiate an event day influenced by predatory short-selling from a day with price reversal influenced by new information. "New information is likely to result in a new price level at the end of the day"

[8] This example assumes $|\Delta r| = 2\%$.

(Shkilko et al. 2012, p.350): higher level with good news and lower level with bad news. But if the price influenced only by predatory short-selling, it is likely end up with a similar level to the initial level of price. Thus this requirement can further eliminate the possibility of information influence.

After identifying event days, we further divide pre-rebound and post-rebound stages into 10 periods each. A benefit of this additional procedure is that we can detect the influence of short-selling over long time span: Some short-selling may affect price within a very short run while others may affect a little longer. But a cost is that it reduces the number of observations. After filtering all the above procedure, we have 1,649 stock-day observations in our final sample. In addition, price decline may be larger as short-selling grows more aggressive. To examine this possibility and get more information on price fluctuations, the whole sample is divided into four groups according to the magnitude of the pre-rebound price decline: $2 \times \sigma_{id} \leq |\Delta r| < 3 \times \sigma_{id}$; $3 \times \sigma_{id} \leq |\Delta r| < 4 \times \sigma_{id}$; $4 \times \sigma_{id} \leq |\Delta r| < 5 \times \sigma_{id}$; and $5 \times \sigma_{id} \leq |\Delta r|$. The sample sizes for each group are 828, 449, 195 and 177, respectively.

Table 1 shows large intraday price reversals on event days. The numbers in the table represent cumulative intraday returns. Panel A shows the total pre-rebound and post-rebound cumulative returns, and Panel B shows period-by-period cumulative returns. The table clearly shows that the price declines in the pre-rebound stage and rebounds in the post-rebound stage. Also it is confirmed that as price decline gets larger, the rebound grows larger. For example, in the first group with the smallest decline of -1.64%, the price rebounds by 1.99% from -1.64% to 0.35%, while in the last group with the biggest decline of -4.32%, the price rebounds by 4.62% from -4.32% to 0.30%.

(***Table 1 here***)

III. Short-selling and Price Reversals

1. Relation between short-selling and price reversals

To examine the basic relation between short-selling and price reversals, we first check whether short-selling is more active than usual on event days. Instead of using the magnitude of short-selling trading volume itself, we use the following measure of standardized short-selling.

$$av_{ijd} = \frac{v_{ijd} - \mu_v}{\sigma_v} \quad (1)$$

In the above equation (1), v_{ijd} is short trading volume of stock *i* during interval *j*, and μ_v and σ_v are respectively the mean and the standard deviation of short trading volume during twenty trading days preceding event day *d*. We will call this measure av abnormal short-selling because it shows whether the current short-selling is off the past normal trend or not.

Each event day *d* is divided into two phases of $[r_{max,pre}\ ,\ r_{min}]$ and $[r_{min}\ ,\ r_{max,post}]$ where $r_{max,pre}$ is the maximum r_{ijd} during the pre-rebound phase on the event day *d* of stock *i*, $r_{max,post}$ is the maximum r_{ijd} during the post-rebound phase, and r_{min} is the minimum r_{ijd} on the given day. We split further each of the two phases into 10 periods, and get a total of twenty time periods per event day. This adjustment benefits subsequent analysis, as it allows for standardization of price reversals that, naturally, vary in length; however, it restricts the sample to event days with pre- and post-rebound stages lasting at least 50 minutes each. This restriction does not significantly reduce the number of event days, as the vast majority of large reversals take longer than 50 minutes to unfold.

Figure 2 shows the relation between short-selling and price reversals on event days. From the figure we can find a couple of features. First, the short-selling activity increases as price decline becomes larger. The magnitude of abnormal short-selling represented by bar in Figure 2 is the largest in Group 4. Second, overall there is little abnormal short-selling in the pre-rebound stage but it increases in the post-rebound stage. Only in the case of the largest price decline (Group 4), we can observe active short-selling in the pre-rebound stage. This is also confirmed in Table 2, which provides more detailed information on price decline and abnormal short-selling volume. In all groups, most short-selling estimates are not statistically significant in the pre-rebound stage; but only in Group 4, short-selling estimates with positive signs are statistically significant in the post-rebound stage.

This result is quite different from Shikilko et al. (2009). From the analysis of short-selling activities in the U.S. market, they found that "Overall, *abnormal short-selling* gradually increases early in the pre-rebound stage and then begins to decline mid-stage" (Shikilko et al. 2009, p.13) but it is still significantly different from zero in the post-rebound stage. Intense short-selling in the pre-rebound stage implies predatory activities while intense short-selling in the post-rebound stage implies contrarian activities. Thus they conclude that in the case of the U.S., "whereas aggressive activities may cease by the time prices reach a reversal point, a contrarian activity may

replace it" (Shikilko et al. 2009, p.14). However, in Korea we couldn't find predatory short-selling in the pre-rebound stage but only contrarian short-selling in the post-rebound stage.

(***Figure 2 here***)
(***Table 2 here***)

2. Aggressiveness of short-selling

Although the above short-selling volume hints short-seller's aggressiveness, we need a separate measure to differentiate pure aggressiveness of short-selling from others. If short-sellers are speculative, they will aggressively place sell-orders when price declines. Thus in the pre-rebound stage of price decline, the seller-initiated trading volume will be much larger than the buyer-initiated one. In contrast, when price rebounds, buy-orders will consume all sell-orders and the seller-initiated trading volume will be smaller than the other. Thus as a measure of short-selling aggressiveness, we use the following order imbalance.

$$iv_{ijd} = \frac{buyer\ initiated\ volume - seller\ initiated\ volume}{total\ trading\ volume} \qquad (2)$$

Table 3-A shows order imbalances in the pre-rebound and the post-rebound stages for the four groups on event days. According to the table, sellers do not dominate in the pre-rebound stage of price decline unlike our expectation. Estimates of order imbalances are positive in many cases and are not statistically significant. In contrast, in the post-rebound stage of price reversals, buyers are dominant and order imbalance becomes positive and statistically significant as expected. This implies that in the Korean market, short-selling is not predominantly seller-initiated and short-sellers are not so aggressive when price declines.

Order imbalances may be caused not only by short-selling but also by non-short-selling (Brunnermeier and Pederson 2005). To compare aggressiveness between short-selling and non-short-selling, we also show the estimates of order imbalances for non-short-selling in Table 3-B. The table clearly shows that as price declines, sellers dominate and order imbalances are largely negative. This dominance remains very strong until price begins to rebound. Once price reveals start in the post-rebound stage, order imbalances become positive. In the case of non-short-selling, order imbalances both in the pre-rebound and in the post-rebound stages are consistent with our expectation. This result shows that non-short selling is much more aggressive than short selling in the Korean stock market.

3. Short-selling and liquidity

Short-selling may also affect stock price through its influence on market liquidity. If short-selling increases potential sellers in the market, market liquidity can be increased and market efficiency can also be improved through increased trading volumes and reduced transaction costs (FSA 2009, p.10). Conversely, if short-selling reduces market liquidity as Madrigal (1996) and Cai et al. (2006) posit, it will discourage potential sellers, increase transaction costs and worsen market efficiency. In particular, when short sellers are intentionally putting excessive pressure on prices, they "may be actively promoting withdrawals of liquidity on the bid side or inducing additional short selling by contacting other traders" (Shkilko et al. 2009, p.23) and amplify price decline in the pre-rebound stage.

A widely used measure of liquidity is that of Amihud (2002), which is the daily ratio of absolute stock return to its trading volume, averaged over time. But it has some limit to apply to our data, and we use the percentage quoted spreads as a proxy measure of market liquidity, following Shikilko et al. (2009).

$$sp = \frac{best\ ask\ quote - best\ bid\ quote}{0.5 \times (best\ ask\ quote + best\ bid\ quote)} \qquad (3)$$

Table 4 shows that quoted spreads are a little wider in the pre-rebound stage of price decline than in the post-rebound stage of price reversals. This implies that liquidity is somewhat limited during price decline stages while it slightly improves during price reversal stages. On the other hand, no clear pattern is observed between quoted spreads and the magnitude of price decline. As price decline becomes larger in the pre-rebound stage, quoted spreads also become larger until Group 3. But for Group 4 with the largest price decline, quoted spreads are smaller than those of Group 3.

(***Table 4 here***)

IV. Determinants of Intraday Pre-rebound Price Changes

1. The model

In the previous section, we examined behaviors of various factors, abnormal short-selling, order imbalance, and liquidity, which are believed to affect price decline in the pre-rebound phase on event days with large price reversals. To test their influences on price changes, we specify a multivariate model by including all of them. In addition, we include non-short-selling volume av^n and order imbalance of non-short volume iv^n because the results in the previous section suggest they strongly affect price declines in the pre-rebound phase. We also include lags of all variables.

$$r_{ij} = \beta_0 + \beta_1 av_{ij} + \beta_2 av_{ij-1} + \beta_3 av_{ij}^n + \beta_4 av_{ij-1}^n + \beta_5 iv_{ij} + \beta_6 iv_{ij-1} + \beta_7 iv_{ij}^n + \beta_8 iv_{ij-1}^n + \beta_9 sp_{ij} + \beta_{10} sp_{ij-1} + \beta_{11} r_{ij-1} + \varepsilon_i \qquad (4)$$

where r_{ij} is pre-rebound or post-rebound the 5-minute return for stock *i* during interval *j* used to identify price reversals in Section II. av and av^n are abnormal volumes of short-selling and non-short-selling respectively calculated using equation (1). They are expected to have a negative effect on prices because sale orders will put downward pressure on prices. iv and iv^n are order imbalances of short-selling and non-short-selling respectively based on equation (2). They are also expected to have a negative effect on prices because aggressive sale orders further move prices down. sp is quoted spreads from equation (3), and is expected to have a negative sign because as short-selling is more aggressive, predatory short sellers may actively promote withdrawals of liquidity on the bid side and price declines further. Since the lag of the dependent variable r_{ij-1} is included, to get the consistent estimates we estimate this dynamic panel model using system GMM estimation method by Blundell and Bond (1998).

2. Results

Table 5 shows the regression results with pre-rebound returns and post-rebound returns as dependent variables. We ran regressions of equation (4) with three different specifications in the pre-rebound stages: Model (1), Model (2) and Model (3).

Model (1) includes only trading variables with excluding order imbalance variables. Since order imbalance variables are not included, av variables reflect the compound effect of short-selling on stock price not only through selling (buying) pressure of market trading but also through other complicated channels such as market sentiment change. The regression result of Model (1)

shows that the coefficient of av variable is positive[9] while that of av^n is negative and larger than that of av variable in absolute terms. This indicates that overall selling of stocks moves prices down but short sellers behave as a contrarian trader rather than a momentum trader in the Korean stock market. This is consistent with Lee and Wang (2012) who found that short-sellers are contrarian traders in Korea. Also the contemporaneous quoted spread variable (sp) has a negative and significant coefficient, which implies that short-sellers limit liquidity and put further pressure on price decline.[10] The lagged quoted spread shows slightly significant positive sign, but total effect of this liquidity variable on the price changes is negative. The coefficient for the lagged term of dependent variable is negative, indicating that prices are negatively correlated in the pre-rebound phase.

Model (2) additionally includes order imbalances of only short-selling, still excluding those of non-short-selling. This is to analyze a separate effect of short-selling on price through pure selling (buying) pressure from that through other channels. If the effect of short-selling is purely through selling (buying) pressure, then the addition of order imbalances of short-selling (iv) significantly reduce the effect of av. Otherwise, some part of av's influence on stock price should still remain even after the addition of iv. The regression result of Model (2) is basically the same as that of Model (1). But one thing to note is that the effect of additional variable iv on stock price is positive and significant and that av is also still significant. This implies that the pure selling (buying) channel is important in influencing stock price and that seller-initiated aggressive short-selling leads to negative order imbalance and price decline. At the same time, the result also implies that there are other channels besides pure selling (buying) one through which short-selling affects price.

Model (3) adds order imbalances of both short-selling and non-short-selling to Model (1). This is to identify various channels not only for short-selling but also for non-short-selling. As we saw in the previous section, non-short selling is much more aggressive than short selling in the Korean stock market. Thus this examination of whether non-short-selling (av^n) affects price through other channels than pure selling (buying) channel is very important. The regression result of Model (3) again looks very similar to that of Model (2). The only additional result is that the coefficient of order imbalances of non-short-selling (iv^n) is positive and very significant, indicating that aggressive seller-initiated trading leads to negative order imbalance and prices further decline. Even though the effect of order imbalances of non-short-selling is very strong,

[9] The coefficients for lagged ones are negative but mostly insignificant.
[10] Lee and Wang (2012) found that liquidity provision by investors is not supported through their short-selling activity in the Korean stock market.

the variable of non-short-selling (av^n) is still statistically significant. This again implies that non-short-selling also affects price through other channels.

Table 5 also shows the regression result for the post-rebound phase in the last column, which is somewhat different from those for the pre-rebound phase. The short-selling variable has the same positive sign as in the case of the pre-rebound phase, indicating that short-selling is contrarian in the Korean stock market. But the coefficient of non-short-selling volume is positive while they were negative in the pre-rebound phase. This positive sign implies that non-short-sellers sell stocks to realize capital gains when price recovers in the post-rebound phase. The contemporaneous quoted spread has, however, statistically significant same negative sign as the pre-rebound phase. Meanwhile the lagged term of this liquidity variable does not have significant effects on returns, suggesting that short-selling demands liquidity in the market. The coefficient for order-imbalances of both short-selling and non-short-selling is positive. Thus order imbalances of short-selling and non-short-selling have same effects on price change in the post-rebound phase. But the variables of short-selling volume (av and av^n) are still significant even after adding order imbalance variables (iv and iv^n), implying that short-selling and non-short-selling affect price through other channels in the post-rebound phase as well.

In Table 6, we disaggregate the pre-rebound stage into four different groups by the magnitude of price decline, and show dynamic panel regression results of model with only pre-rebound returns as dependent variables only using Model (3). This is to examine whether the effect of short-selling becomes stronger as the magnitude of price decline grows larger in the pre-rebound stage. A few things are noteworthy. First, the effect of short-selling does not grow larger as the initial price decline becomes larger: The coefficients for av and iv are not significant for Group 4, unlike our expectation. Second, but the aggressiveness of non-short-selling represented by order-imbalances of non-short-selling (iv^n) has stronger effect as the price decline becomes larger in the pre-rebound stage: The coefficient for Group 4 is almost twice that for Group 1. Third, as we expect, the more active short-selling, the more limited market liquidity and the more pressure on price decline: The coefficient of quoted spread variable (sp) gets larger (in absolute terms), and that for Group 4 is almost six times that for Group 1.

Overall, the regression results of the dynamic panel model in this section are consistent with the results in the previous section. In the Korean stock market, short sellers seem to behave as a contrarian trader rather than a momentum trader. Also, seller-initiated aggressive short-selling and non-short-selling both lead to negative order imbalance and price decline. Short-sellers seem to limit liquidity and put further pressure on price decline in the pre-rebound stage. Even though the effects of order imbalances of both short-selling and non-short-selling are very strong, the

trading volume variables of short-selling and non-short-selling are still significant, suggesting that there are other channels besides pure selling (buying) one through which short-selling and non-short-selling affect price.

V. Conclusion

In this paper, we have examined short-selling activity focusing on its behavior not during normal times but during non-normal times of occasional excesses in the Korean stock market. Using the methodology explained by Brunnermeier and Pederson (2005) and Shkilko et al. (2009; 2012), we first identified event days of large price reversals. Also it is confirmed that as price decline gets larger at the initial stage, the rebound grows larger in the later stage.

Secondly, we examined whether short-selling is predatory on those event days of large price fluctuation. For the purpose, we analyzed behaviors of some important variables which are believed to strongly affect stock price: short-selling trading volume itself, order imbalance, and market liquidity. Overall there is little predatory abnormal short-selling in the pre-rebound phase and we can observe active contrarian short-selling in the post-rebound phase. When we compared aggressiveness between short-selling and non-short-selling using order imbalance variables, we found that non-short selling is much more aggressive than short selling in the Korean stock market. From the observation of market liquidity measured by quoted spreads, we could find that market liquidity is somewhat limited during price decline stages while it slightly improves during price reversal phases.

Also, using dynamic panel model, we tried to test the influences of those variables on stock price changes and disaggregate the compound effect of short-selling reflected in trading volume itself into differentiated ones not only through pure trading channel but also through other complicated channels such as market sentiment change. Overall, the regression results of the dynamic panel model again confirm those findings in the previous section. In the Korean stock market, short sellers seem to behave as a contrarian trader rather than a momentum trader. Also, seller-initiated aggressive trading, whether it is by short-selling or non-short-selling, leads to negative order imbalance and price decline. Market liquidity is limited by short-selling and further pressure on price decline is added in the pre-rebound stage. Finally stock prices are affected not only through pure selling (buying) channel but also through other channels in the Korean stock market.

References

Allen, Franklin and Douglas Gale (1992), "Stock-price Manipulation," Review of Financial Studies 5, pp.503-529.

Amihud, Y. (2002), "Illiquidity and Stock Returns: Cross-section and Time-series Effects," *Journal of Financial Markets* 5, pp.51-56.

Binh, Ki-Beom (2009), "Do Foreign Investors' Short Selling Destabilize Stock and Foreign Exchange Markets?" KCMI *Capital Market Perspective* 1(1), pp.46-69. (in Korean)

Blundell R. and S. Bond, 1998, "Initial conditions and moment restrictions in dynamic panel-data models," *Journal of Econometrics* 87, pp.115-143.

Boehmer, E., C. Jones, and X. Zhang, 2009, "Shackling Short Sellers: The 2008 Shorting Ban," University of Oregon, Columbia University, and Purdue University, Working paper.

Boehmer, E. and J. Wu, 2010, "Short Selling and the Price Discovery Process," University of Oregon and University of Georgia, Working paper.

Boulton, T. and M. Braga-Alves, 2010, "The Skinny on the 2008 Naked Short-Sale Restrictions," *Journal of Financial Markets* 13, pp.397-421.

Brunnermeier, M. and L.H. Pederson (2005), "Predatory Trading," *Journal of Finance* 60, pp.1825-1863.

Brunnermeier, Markus K. and Martin Oehmke (2008), "Predatory Short Selling," *mimeo*, Princeton University.

Cai, Jinghan, Yuming Li and Le Xia (2006), "Liquidity, Information Asymmetry and Short Sales Constraints: Evidence from the Hong Kong Stock Market," California State University, Fullerton, *Working Paper*.

Choi, Hyuk and Hyo-Jung Lee (2010), "Effects of Short Sale Ban on Market Information on Liquidity and Price," *mimeo*, Seoul National University, Business School. (in Korean)

Diether, K., Kuan-Hui Leee and I. Werner (2009), "Short-sale Strategies and Return Predictability," *Review of Financial Studies* 22, pp.575-607.

Eom, Kyong-Shik, Ki-Beom Binh and Joon-Seok Kim, "Foreign Investors` Short Sales and Individual Stock Prices in the Korean Stock Market," *Financial Management Review* 28(3), pp.139-187. (in Korean)

Financial Services Authority (2009), "Short Selling," *Discussion Paper* 09/1.

Goldstein, Itay and Alexendar Gümbel (2008), "Manipulation and the Allocational Role of Prices," *Review of Economic Studies* 75, pp.133-164.

ISLA (International Securities Lending Association) (2009), "Securities Lending and Short

Selling," *mimeo*.

Kim, Joon-Seok (2010), "Analysis on the Effect of Short Sale Ban on the Korean Stock Market," KCMI *Capital Market Perspective* 2(1), pp.49-59. (in Korean)

Ko, Bongchan and Soo-Kyung Ahn (2006), "Empirical Analysis on Short Sale's Predictability of Future Return," *mimeo*, Seoul National university, Business School. (in Korean)

Lee, Kuan-Hui and Shu-Feng Wang (2012), "Are Short-Sellers to Blame? Evidence from Korea Stock Exchange," *mimeo*, Seoul National University.

Liu, Xuewen (2011), "Predatory Short-selling and Self-fulfilling Crises: When Morris-Shin meets Diamond-Dybvig," *mime*o, Hong Kong University of Science and Technology.

Madrigal, V. (1996), "Non-fundamental Speculation," *Journal of Finance* 51, pp.553-578.

Park, Kee-Bong (2011), "How Does the Restriction of Shortsale Affect the Motives to Do Shortsale?" *Korea Management Review* 24(2), pp.723-741. (in Korean)

SEC (2006), "Economic Analysis on the Short Sale Price Restrictions under the Regulation SHO Pilot."

Shkilko, Andriy, Nonnie Van Ness and Robert Van Ness (2007), "Predatory Short Selling," *mimeo*, University of Mississippi.

Shkilko, Andriy, Nonnie Van Ness and Robert Van Ness (2009), "Aggressive Short Selling and Price Reversals," *mimeo*, University of Mississippi.

Shkilko, Andriy, Nonnie Van Ness and Robert Van Ness (2012), "Short Selling and Intraday Price Pressures," *Financial Management*, 41(2), pp.345-370.

Yi, Junesuh, Ki-Beom Binh and Gwangik Jang (2010), "The Causal Relationship between Stock price and Short Sales: Evidence from the Korean Stock Market," *Korean Journal of Financial Studies* 39(3), pp.449-489. (in Korean)

Yi, Junesuh and Gwangik Jang (2009), "Analysis on the Causation between Short Sale and Stock Price," presented at the joint conference of finance related associations. (in Korean)

<Table 1> Identification of large price reversals

Group		1	2	2	4
Range		[2; 3)	[3; 4)	[4; 5)	[5; ∞)
Panel A: Pre- and post-rebound cumulative returns					
Pre		-1.61	-2.44	-3.18	-4.25
Post		0.35	0.32	0.23	0.30
Panel B: Pre- and post-rebound statistics, by period					
PRE PERIOD	-10	0.08	-0.21	-0.26	-0.36
	-9	-0.27	-0.55	-0.98	-0.98
	-8	-0.49	-0.85	-1.19	-1.33
	-7	-0.64	-1.09	-1.44	-1.73
	-6	-0.74	-1.25	-1.70	-2.06
	-5	-0.86	-1.45	-1.81	-2.23
	-4	-1.01	-1.61	-2.16	-2.63
	-3	-1.15	-1.84	-2.43	-3.14
	-2	-1.36	-2.06	-2.74	-3.48
	-1	-1.61	-2.44	-3.18	-4.25
POST PERIOD	1	-1.64	-2.40	-3.09	-4.32
	2	-1.42	-2.16	-2.88	-3.80
	3	-1.28	-1.99	-2.56	-3.47
	4	-1.23	-1.85	-2.40	-3.22
	5	-1.13	-1.75	-2.29	-3.01
	6	-1.03	-1.57	-2.02	-2.72
	7	-0.92	-1.37	-1.91	-2.40
	8	-0.78	-1.16	-1.58	-1.92
	9	-0.54	-0.81	-1.11	-1.49
	10	0.35	0.32	0.24	0.30
Panel C: Number of events					
Total: 1649		828	449	195	177

<Table 2> Short selling during large price reversals: *av*

Group		1	2	3	4
Range		[2; 3)	[3; 4)	[4; 5)	[5; ∞)
Panel A: Pre- and post-rebound aggregate statistics					
Pre		-0.02	0.01	0.04	0.15***
Post		0.04***	0.10***	0.11***	0.20***
Panel B: Pre- and post-rebound statistics, by period					
PRE PERIOD	-10	0.07**	0.11**	0.07	0.27***
	-9	0.02	0.02	0.04	0.10*
	-8	0.02	0.00	0.02	0.12**
	-7	-0.02	-0.02	0.06	0.19***
	-6	-0.03	-0.05	0.04	0.09
	-5	-0.06***	-0.02	-0.04	0.04
	-4	-0.05*	-0.05	0.03	0.08
	-3	-0.05**	-0.02	0.03	0.14*
	-2	-0.04*	-0.05	0.08	0.15**
	-1	-0.02	0.05	0.10	0.17**
POST PERIOD	1	-0.06**	0.05	0.14**	0.24***
	2	-0.02	-0.02	0.02	0.13**
	3	0.00	0.04	0.01	0.16**
	4	-0.01	0.08**	0.08	0.11*
	5	0.01	0.06	0.13**	0.22***
	6	0.04	0.08**	0.11*	0.22***
	7	0.08***	0.10**	0.14**	0.17***
	8	0.05*	0.15***	0.12**	0.15**
	9	0.10***	0.15***	0.06	0.17***
	10	0.22***	0.27***	0.24***	0.34***

<Table 3-A> Order imbalance: short selling: *iv*

Group		1	2	3	4
Range		[2; 3)	[3; 4)	[4; 5)	[5; ∞)
Panel A: Pre- and post-rebound aggregate statistics					
Pre		-0.009	0.004	-0.033	-0.049
Post		0.276***	0.287***	0.258***	0.255***
Panel B: Pre- and post-rebound statistics, by period					
PRE PERIOD	-10	0.117	0.150	0.219	0.088
	-9	0.024	0.026	0.033	0.058
	-8	0.041	0.016	0.124	-0.041
	-7	0.058	0.074	-0.047	-0.001
	-6	0.067	0.020	-0.016	-0.053
	-5	0.055	0.012	-0.039	-0.084
	-4	0.077	0.010	-0.010	-0.171
	-3	0.004	-0.044	-0.125	-0.007
	-2	0.053	0.017	-0.009	-0.217
	-1	-0.044	-0.094	-0.158	-0.046
POST PERIOD	1	0.253	0.203	0.102	0.145
	2	0.155	0.144	0.100	0.251
	3	0.170	0.128	0.236	0.094
	4	0.142	0.157	0.238	0.165
	5	0.238	0.165	0.136	0.118
	6	0.245	0.158	0.216	0.224
	7	0.206	0.209	0.243	0.189
	8	0.241	0.207	0.187	0.225
	9	0.300	0.270	0.211	0.234
	10	0.454	0.440	0.438	0.441

<Table 3-B> Order imbalance: non-short volume: iv^n

Group		1	2	3	4
Range		[2; 3)	[3; 4)	[4; 5)	[5; ∞)
Panel A: Pre- and post-rebound aggregate statistics					
Pre		-0.336***	-0.371***	-0.398***	-0.381***
Post		0.167***	0.177***	0.199***	0.185***
Panel B: Pre- and post-rebound statistics, by period					
PRE PERIOD	-10	-0.069	-0.053	-0.109	-0.193
	-9	-0.234	-0.237	-0.349	-0.303
	-8	-0.262	-0.284	-0.226	-0.307
	-7	-0.233	-0.269	-0.303	-0.318
	-6	-0.234	-0.256	-0.364	-0.299
	-5	-0.253	-0.296	-0.300	-0.312
	-4	-0.296	-0.304	-0.434	-0.323
	-3	-0.346	-0.380	-0.412	-0.336
	-2	-0.362	-0.369	-0.377	-0.371
	-1	-0.391	-0.450	-0.466	-0.449
POST PERIOD	1	0.003	0.006	-0.030	-0.004
	2	0.029	-0.006	-0.047	0.083
	3	0.031	-0.009	0.112	-0.005
	4	-0.007	-0.014	0.010	0.073
	5	0.042	-0.001	0.012	0.014
	6	0.065	0.008	0.046	0.012
	7	0.053	0.103	0.054	0.048
	8	0.113	0.056	0.133	0.095
	9	0.167	0.218	0.234	0.147
	10	0.453	0.474	0.435	0.421

<Table 4> Liquidity: *quoted spreads*

Group	1	2	3	4
Range	[2; 3)	[3; 4)	[4; 5)	[5; ∞)
quoted spreads (% *qsp*, bps)				
Pre	0.2356	0.2477	0.2648	0.2427
Post	0.2265	0.2330*	0.2548	0.2363

(*앞의 표처럼 시간대별로도 보여줄 것***)**

<Table 5> Determinants of intraday returns

	pre-rebound			*post-rebound*
Model	(1)	(2)	(3)	(3)
av_t	0.012***	0.032***	0.022***	0.015***
	(0.004)	(0.005)	(0.005)	(0.004)
av_{t-1}	-0.003	-0.001	-0.003	-0.003
	(0.004)	(0.005)	(0.005)	(0.004)
av^n_t	-0.081***	-0.057***	-0.050***	0.053***
	(0.004)	(0.006)	(0.006)	(0.005)
av^n_{t-1}	0.027***	0.030***	0.028***	0.008*
	(0.004)	(0.006)	(0.006)	(0.005)
sp_t	-0.262***	-0.482***	-0.448***	-0.347***
	(0.040)	(0.081)	(0.077)	(0.067)
sp_{t-1}	0.068*	-0.121	-0.126*	-0.090
	(0.037)	(0.080)	(0.076)	(0.064)
r_{t-1}	-0.164***	-0.132***	-0.144***	-0.169***
	(0.004)	(0.007)	(0.007)	(0.006)
iv_t		0.234***	0.090***	0.066***
		(0.011)	(0.012)	(0.010)
iv_{t-1}		0.029**	0.032***	0.042***
		(0.012)	(0.012)	(0.012)
iv^n_t			0.502***	0.453***
			(0.018)	(0.012)
iv^n_{t-1}			-0.060***	-0.010
			(0.019)	(0.013)
Const.	-0.037***	-0.064***	-0.027***	0.032***
	(0.003)	(0.005)	(0.005)	(0.004)

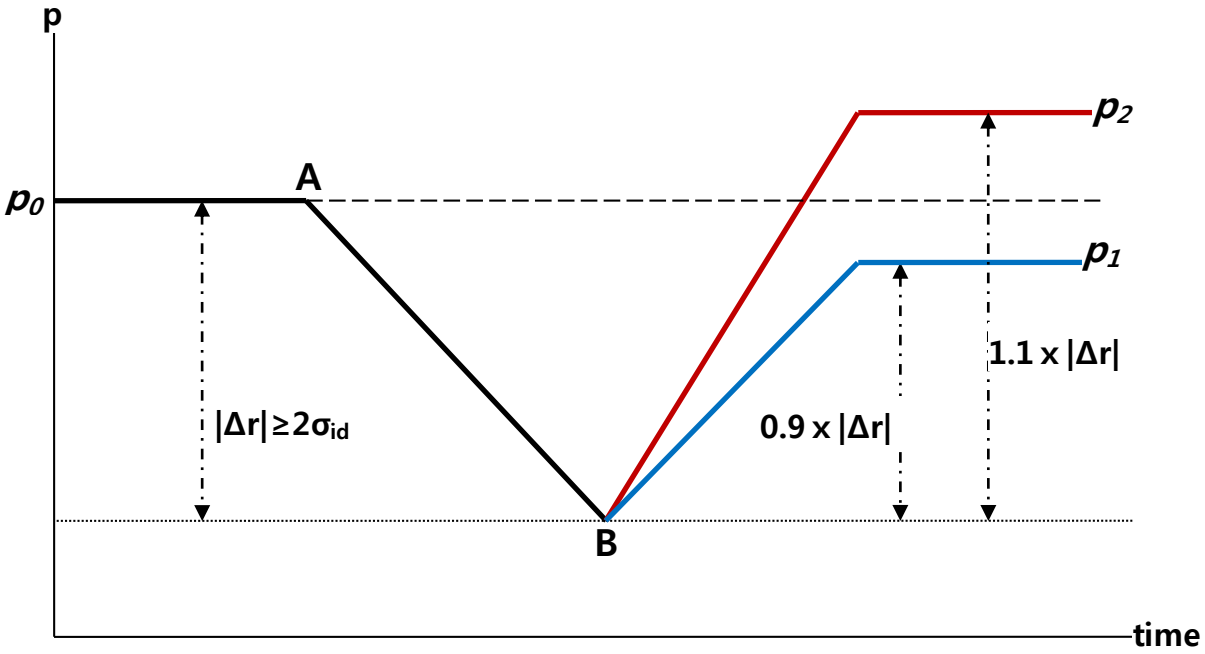
Note: 1. *av* and av^n are abnormal short-selling and non-short-selling respectively. *iv* and iv^n are order imbalance of short-selling and non-short-selling. *sp* is quoted spread.
2. Standard errors are reported in parentheses.
3. ***, ** and * denote significance at 1%, 5%, and 10% level, respectively.

<Table 6> Determinants of intraday returns: by group

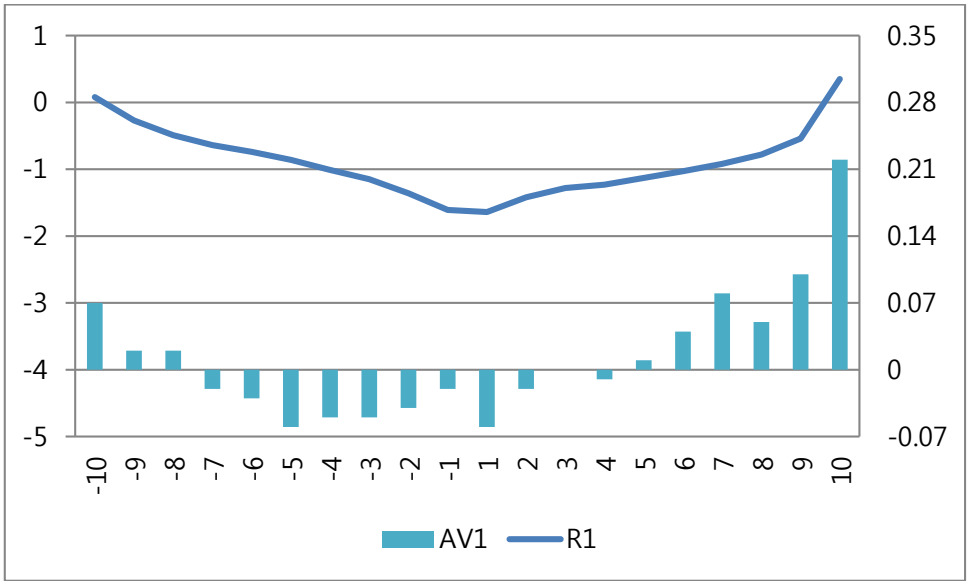
	pre-rebound			
Group	1	2	3	4
Range	[2; 3)	[3; 4)	[4; 5)	[5; ∞)
av_t	0.015***	0.029***	0.029***	0.011
	(0.004)	(0.006)	(0.009)	(0.010)
av_{t-1}	-0.005	-0.005	0.003	0.002
	(0.004)	(0.006)	(0.008)	(0.010)
av^n_t	0.005	-0.009	0.012	-0.011
	(0.004)	(0.007)	(0.010)	(0.011)
av^n_{t-1}	0.014***	0.031***	0.026***	0.016
	(0.004)	(0.007)	(0.010)	(0.011)
sp_t	-0.333***	-0.360***	-0.224*	-2.034***
	(0.078)	(0.077)	(0.129)	(0.095)
sp_{t-1}	0.094	-0.098	-0.054	0.804***
	(0.068)	(0.082)	(0.131)	(0.085)
r_{t-1}	-0.182***	-0.170***	-0.164***	-0.177***
	(0.006)	(0.009)	(0.012)	(0.013)
iv_t	0.078***	0.077***	0.076***	0.007
	(0.009)	(0.015)	(0.023)	(0.029)
iv_{t-1}	0.032***	0.055***	0.066***	0.0066**
	(0.009)	(0.015)	(0.023)	(0.029)
iv^n_t	0.392***	0.543***	0.669***	0.858***
	(0.012)	(0.020)	(0.031)	(0.041)
iv^n_{t-1}	-0.018	-0.025	-0.019	0.065
	(0.012)	(0.021)	(0.033)	(0.043)
Const.	-0.002	0.013**	0.014	0.014
	(0.004)	(0.006)	(0.009)	(0.015)

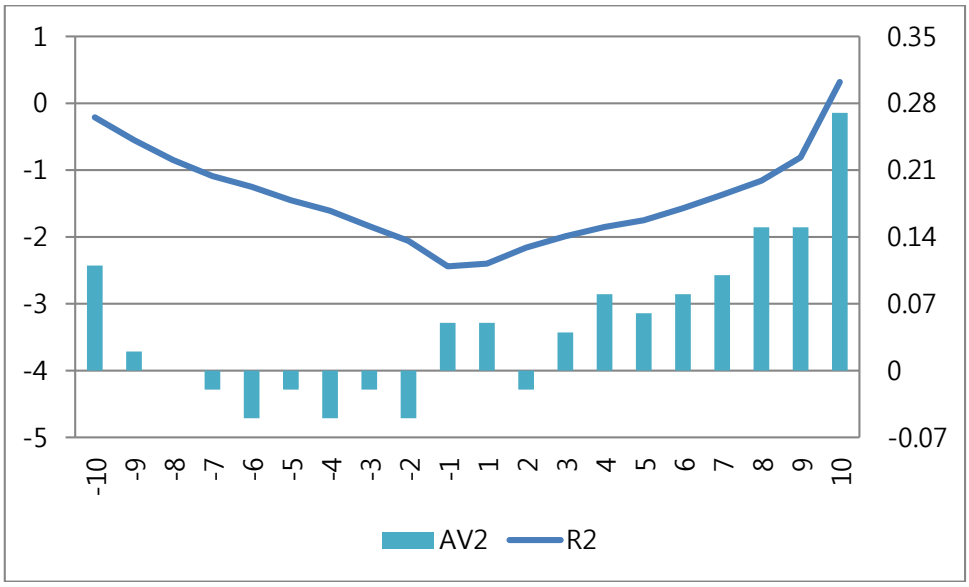
Note: 1. *av* and av^n are abnormal short-selling and non-short-selling respectively. *iv* and iv^n are order imbalance of short-selling and non-short-selling. *sp* is quoted spread.
2. Standard errors are reported in parentheses.
3. ***, ** and * denote significance at 1%, 5%, and 10% level, respectively.

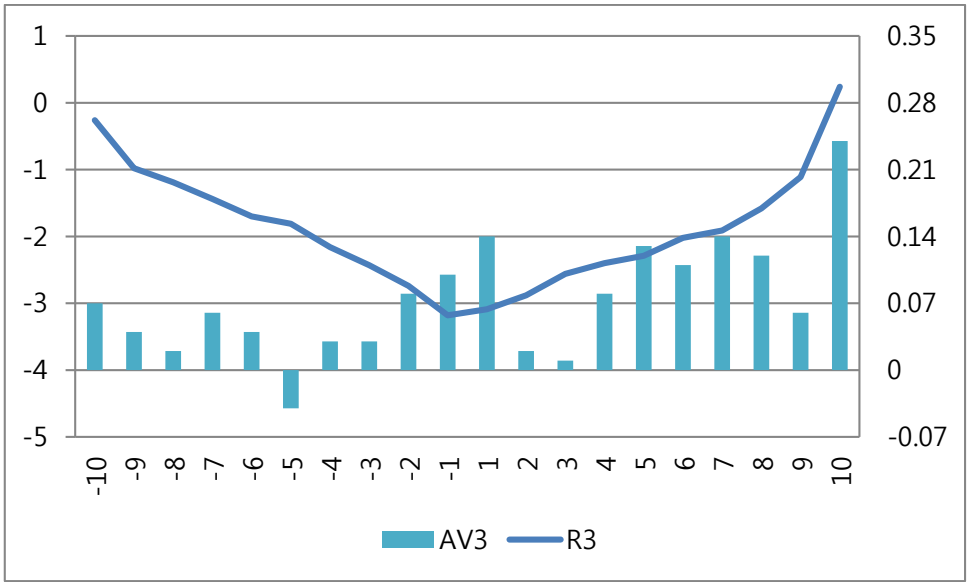
<Figure 1> Identification of large price reversals

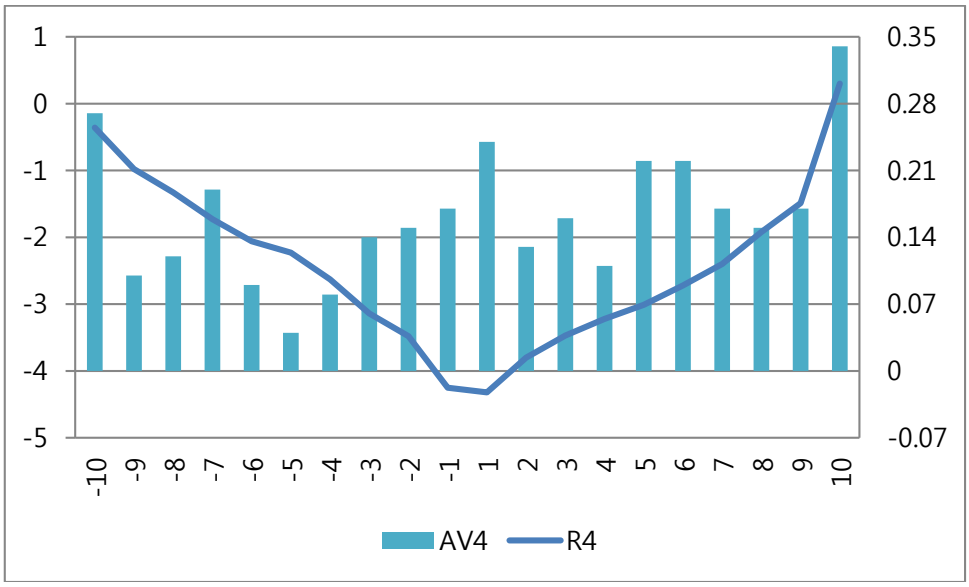


<Figure 2> Short-selling and price reversals









Note: *av* and av^n are abnormal short-selling and non-short-selling respectively