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ABSTRACT

We use account-level data from the Shenzhen Stock Exchange to show that daily price limits, a widely adopted market stabilization mechanism, may lead to unintended, destructive market behavior: large investors tend to buy on the day when a stock hits the 10% upper price limit and then sell on the next day; and their net buying on the limit-hitting day predicts stronger long-run price reversal. We also analyze a sample of special treatment (ST) stocks, which face tighter 5% daily price limits, and provide a causal validation from comparing market dynamics before and after they are assigned the ST status.

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Daily price limit rules are widely used by stock markets across the globe.¹ These rules are particularly popular in emerging markets with a large fraction of inexperienced investors, as they give a time-out period during large price fluctuations and thus serve as a market stabilization mechanism. China's equity market (the second largest in the world by capitalization) imposes daily price limits of 10% on regular stocks and 5% on special treatment (ST) stocks. However, there is a growing concern that this rule might induce destructive trading behavior by some speculators to take advantage of other investors.

Of particular concern is a popular strategy, which is often discussed in the news media and also observed in some market enforcement cases, of certain speculators pushing up stock prices to the upper price limit and then taking profits by selling on the next day. This upper-price-limit strategy is reminiscent of the classic pump-and-dump strategy of market manipulation (e.g., De Long et al., 1990), yet with several important differences. First, after observing a stock hitting the daily upper price limit, it is natural for otherwise uninformed investors to infer that the stock's price has not fully incorporated all fundamental information and thus be willing to offer a higher price on the following day. This inference does not require any particular behavioral bias such as positive feedback trading and extrapolation; it requires only the naivety of failing to recognize the speculators' incentives to profit by pushing up the prices to the upper price limit. Second, the events of stock prices hitting the upper daily price limit often attracts the attention of new investors (e.g., Barber and Odean, 2008; Seasholes and Wu, 2007), which further exacerbates the price increase after the upper price limit is hit. Third, the publicly observed large price increase during a trading day also serves as a convenient device for unrelated speculators to coordinate to

¹ According to Deb, Kaley, and Marisetty (2010), out of 58 major countries, 41 countries have applied certain types of price limit rules in their equity exchanges.

push up the price together. In other words, the speculators do not need to plan a manipulation scheme as they can simply follow large price increases induced by fundamental news. The possibility of the daily price limit rule inducing these unintended effects motivates a systematic study of the impact of the daily price limit rule.

In this paper, we take advantage of account-level data from the Shenzhen Stock Exchange to analyze how daily price limit rules affect market dynamics and in particular whether the daily price limits may induce destructive trading behavior by a group of speculators against other investors. Specifically, we examine accounts pooled into six groups—one institution group, which includes all institutions, and five individual investor groups classified by the average stock balance in the previous year. We are particularly interested in the group of large investors, who have an average stock balance of over 10 million RMB. This group is particularly interesting because large investors tend to be more sophisticated and because the speculators involved in the news media coverage of the upper-price-limit strategy tend to be large investors.

We divide our study into two parts, one based on the sample of regular stocks and the other on ST stocks. In the first part, we analyze price dynamics and the trading of different investor groups subsequent to days when regular stocks hit the daily 10% upper price limit and when they experience large daily returns less than the 10% limit. We organize our analysis to test a central hypothesis that large investors push stocks that experience large price increases during a trading day to close at the upper price limit and then profit from selling at higher prices on the next day and, furthermore, their destructive trading behavior causes stock prices to overreact to the initial price shocks.

We find several results supporting this hypothesis. First, after a stock hits the 10% upper price limit, its price continues to rise on the next day and the price increase eventually reverses in the long run. Interestingly, the price increase occurs only after hitting the 10% price limit, mostly at the open price of the next day, but not after having a large daily return just below 10%. This pattern of continued price increase followed by long-run reversal indicates price overreactions around the events of hitting the upper price limit. Second, large investors tend to buy on the days when the upper price limit is hit and then sell on the next day. This finding suggests that large investors as a group indeed follow the hypothesized trading strategy. Interestingly, we also find that small and medium investors tend to trade on the opposite side by selling on the day of hitting the upper price limit and buying on the next day. Third, the net buying of large investors on the limit-hitting day predicts stronger long-run price reversal. Overall, these findings paint a clear picture that large investors as a group pursue a destructive strategy around the upper-price-limit-hitting days and their trading has significant market impacts.

To further separate the effect of the daily price limit rule from an alternative mechanism of the large investors simply front-running feedback traders on days of large price fluctuations, we also explore a sample of 119 ST stocks, which face tighter 5% daily price limits. In general, the ST status is given to a publicly listed firm if it reports negative profits for two consecutive years or a net asset value below the par value. While the ST status is announced by the exchange only after a firm formally releases its annual financial report, the market can well anticipate the ST assignment immediately after the firm reports its eighth consecutive negative quarterly earnings or a low net asset value, which is usually two or three months ahead of its annual report. During this interim period, the market

anticipate that the firm will be eventually labeled as ST but its stock is still trading under the regular 10% price limits.

By taking advantage of this period, we find several results induced by the more restrictive 5% price limits after the ST status is officially assigned: First, after the ST assignment, the long-run price reversal subsequent to days of hitting the 5% price limit becomes more pronounced relative to that subsequent to having large daily returns above 5% in the pre-ST period. Second, the trading of large investors displays the pattern of buying on the day of hitting the upper price limit and selling on the next after the ST assignment, but not before. Third, after the ST assignment, the net buying of large investors on the days of hitting the price limit has a stronger predictive power of the subsequent long-run price reversal. These findings thus specifically demonstrate that the tighter price limits of ST stocks exacerbate the destructive trading behavior of large investors around days with returns above 5%, and their trading is associated with price overreactions on these days. Finally, we also find that after the ST assignment, trading days with large positive returns above 4% become substantially more frequent, again confirming that by inducing the destructive behavior of large investors, the tighter price limits might amplify rather than mitigate extreme price fluctuations.

Overall, our analysis provides a set of empirical findings to show that the widely adopted daily price limit rules may induce large investors as a group to pursue a destructive trading strategy of pushing prices to the upper price limit and then profiting from selling on the next day. This unintended effect highlights the challenge in designing a trading system for emerging equity markets, which tend to have a mix of experienced and

inexperienced investors. Their different trading behaviors may render a market stabilization scheme, such as the daily price limits, counterproductive.

Some critics have pointed out that the price limit rules may impede the price discovery process, interfere with trading, and induce order imbalance and volatility spillover (e.g., Kim and Rhee, 1997; Chan, Kim, and Rhee, 2005). The prior studies have also documented the so-called "magnet effect"—a curious tendency for stock prices to accelerate toward the upper price limit and a similar, albeit weaker tendency, toward the lower limit as prices approach these limits (e.g., Cho et al., 2003; Hsieh et al., 2009). By identifying the destructive behavior of large investors, our analysis offers a sharp mechanism to understand these adverse effects. In particular, the active trading of large investors with the intent to push prices to the upper price limit explains the curious magnet effect.

Our study is closely related to Seasholes and Wu (2007), who examine the effect of daily price limits in the Chinese stock market and emphasize that by attracting the attention of inexperienced new investors, the price-limit hitting events induce some smart traders to accumulate shares on the limit-hitting days and sell on the next. Our analysis provides stronger evidence to specifically relate the net buying of a group of large investors, which are classified by account size rather than any trading information, on the upper-price-limit-hitting days to the subsequent price reversal. More important, by comparing the price dynamics and the trading of large investors before and after the assignment of ST stocks, our analysis is able to isolate the effect of the price limits from effects induced simply by large daily returns.

The paper is organized as follows. Section I describes the institutional background and data, and Section II introduces empirical hypotheses. We then report the empirical

results from studying the sample of regular stocks in Section III, and report further evidence from analyzing the sample of ST stocks in Section IV. Finally, Section V concludes the paper. An online appendix also reports results from additional robustness analyses.

I. Institutional Background and Data

Daily price limit rules have been imposed on the two Chinese stock exchanges, the Shanghai Stock Exchange and the Shenzhen Stock Exchange (SZSE hereafter), since December 16, 1996. Within a single trading day, the price of an individual stock can only increase or decrease by a maximum percentage relative to the closing price on the previous trading day. This limit is set as 10% for regular stocks and 5% for ST stocks. After a stock hits the daily price limit, trading is still allowed as long as the transaction prices are within the upper and lower limits. As a result, it is possible for a stock to hit the upper or lower price limit during a trading day and then to close the day within the limits.

Our analysis cover all A-share stocks (shares issued to domestic investors) traded in the SZSE during the sample period of 2012 to 2015. As of January 31, 2015, the exchange lists 1,628 firms with a total market capitalization of 2,285 billion U.S. dollars, which ranks it as the eighth-largest stock exchange in the world.

We collect daily stock price data from the China Stock Market and Accounting Research (CSMAR) database. We consider capital distribution, such as dividends and stock splits, to adjust stock prices and use closing prices of each stock to identify price-limit-hitting events (as done by the exchange). We calculate returns of all stocks in our sample on the limit-hitting dates and their subsequent returns over different horizons from overnight up to 120 days. Other stock-level data include number of shares outstanding,

trading volume, and floating capitalization. We also collect firm-level accounting information such as the book equity, earnings, and ST status.

Price-limit-hitting events frequently occur in the Chinese stock markets. Table 1 shows that in 2012-2015, there were 21,005 (13,569) cases of regular stocks in the SZSE closing at the upper (lower) 10% price limits. On average, 2.05% (1.33%) of regular stocks close at the upper (lower) price limit per trading day. The fraction of ST stocks closing at the limits is higher due to their lower price limits: 7.9% (5.7%) for the upper (lower) limit. In addition, this ratio varies substantially over this period. The standard deviation of this fraction for regular (ST) stocks hitting the upper limit is 14.2% (27.0%).

We obtain account-level transaction data from the SZSE, which classifies all individual accounts into five categories every year based on the average stock balance during the previous year: 1) less than 100 thousand RMB; 2) between 100 thousand and 500 thousand RMB; 3) between 500 thousand and 5 million RMB; 4) between 5 million and 10 million RMB; and 5) larger than 10 million RMB. We are especially interested in the behavior of the last group. We also include institution accounts as a separate group in our study. This group includes mutual funds, insurance companies, security firms, and pension funds. We track the transactions by each group at the stock level. The key variable of interest is *NetBuy*, defined as the net purchase of shares of a stock by a specific group within a trading day scaled by the number of the stock's total tradable shares.

Table 2 reports the contributions of these groups to daily turnover of regular and ST stocks listed in the SZSE. For regular stocks, the average daily turnover (measured by the amount of purchases and sales divided by twice the floating capitalization of a stock during a day) is 3.1%, among which the five investor groups from small to large contribute to

7.7%, 23.5%, 38.0%, 7.5%, and 14.0%, respectively, and the institution group 9.4%. The number of accounts involved in trading a regular stock on a given day across the five investor groups is 1592, 1516, 767, 52, 44, respectively, and 40 for the institution group. For ST stocks, the average daily turnover is lower at 2.2%, with a small contribution of the institution group while the contributions of the five investor groups remain similar.

II. Empirical Hypotheses

Suppose that a piece of positive news hits a stock on one day and causes its price to hit the upper price limit. In the absence of other reasons, this event simply implies that the price impact of the news is larger than 10% and the stock price could have gone even higher without the price limit. Consequently, the price would continue to rise on the next day. However, this otherwise natural price pattern gives an incentive for speculators to push up the price to the upper limit even when the initial news does not necessarily justify a price increase of 10%. Suppose that the news justifies only an 8% price increase and its exact effect is not known by the market participants. Some speculators, who may or may not be informed of the exact news effect, may figure that as long as they can push up the stock price to close at the 10% price limit, then other uninformed investors would be willing to buy the stock at an even higher price on the next day and thus provide an exit for the speculators to sell at a profit. For this strategy to be profitable, it is necessary for the stock to close at the upper price limit. For this reason, we focus on studying the events of hitting the upper price limit at the close rather than at any time during the trading day.

This strategy can be profitable as long as some investors do not fully recognize that the stock price hitting the upper price limit might be partially caused by the speculators' destructive behavior rather than fully driven by the fundamental news. The literature has

pointed out the wide presence of this sort of naivety by some agents in failing to fully appreciate the incentives and strategic behavior of other agents.² This sort of naivety is different from the positive feedback bias that motivates the pump-and-dump strategy.

The price limit may also affect the market dynamics through several other channels. Seasholes and Wu (2007) show that as the price-limit-hitting events are widely covered by financial news media, they tend to attract the attention of new buyers on subsequent days. This attention effect further exacerbates the price increase on the next day.

Different from an outright price manipulation scheme, pursuing this strategy of pushing up stock prices to close at the upper price limit does not require a plot among a group of speculators. Instead, a large price movement during a day could already serve as a publicly observed signal sufficient to coordinate potential speculators to gather forces and further push up the price. Thus, another unintended effect of the price limit is that it serves as a coordination device for speculators.³

The objective of this study is not to identify manipulators, but rather to study the trading behavior of different investor groups around the upper-price-limit-hitting events. We classify the investor groups based on *ex ante* information—the average stock balance in the previous year. As large investors tend to be more sophisticated and the speculators involved in the news media coverage of the upper-price-limit strategy tend to be large investors, we examine the following hypothesis:

² For example, Malmendier and Shantikumar (2007) provide evidence to show that investors do not recognize the incentives of financial analysts to provide overly optimistic stock recommendations due to their incentives related to selling stocks. Hong, Scheinkman and Xiong (2008) develop a theoretical model to argue that this behavior can play an important role leading to price bubbles in new technology stocks.

³ Constrained by data availability, we do not aim to separately identify the different channels, such as investor naivety, the attention effect of limit-hitting events, and the coordination effect of large price increases, for the daily price limit rule to affect market dynamics. Instead, we design the analysis to study the overall effect.

Hypothesis 1: Large investors tend to buy on the day when a stock hits the upper price limit and sell on the next day. Furthermore, while the stock price continues to rise on the next day after hitting the upper price limit, the price increase eventually reverses over the longer run, and the long-run price reversal is more pronounced when the net buying by large investors on the limit-hitting day is greater.

If the stock prices are efficiently determined, we do not expect any reversal relative to either the price level after trading resumes on the next day or the price level when the upper price limit is initially hit. Thus, any evidence of price reversal subsequent to the price-limit-hitting days would indicate price overreactions when the price limit is hit. Thus, by linking the subsequent price reversal to the trading of large investors on limit-hitting days, we can associate the price overreactions to the destructive behavior of large investors.

Large investors face uncertainty regarding whether they can successfully push the price to the upper limit, such as uncertainty in the market's interpretation of the initial news, aggregate strength of the large investors involved in pushing up the price, and the number of other investors in the market who are eager to sell their shares. In other words, an initial price increase during the day may motivate some large investors to buy the shares, but they may not always succeed in pushing the price to close at the upper price limit. Thus, we also expect large investors to buy shares on days with large price increases even without closing at the upper price limit, albeit less than on upper-price-limit-hitting days.

While short sales of stocks are legally permitted after 2010 for a list of stocks designated by the China Securities Regulatory Commission (CSRC), short-selling is still difficult and costly.⁴ As a result, we do not expect large investors to pursue a similar

⁴ Short-selling was not allowed in the Chinese stock market until February 23, 2010, when the CSRC allowed 40 stocks on the SZSE and 50 stocks on the Shanghai Stock Exchange (SHSE) to be eligible for shorting. The

strategy around the days of hitting the lower price limit by short-selling stocks and then buying them back on the next day.

Examining Hypothesis 1 does not provide a forceful identification of the role served by the daily price limit in inducing the destructive behavior of large investors, as this hypothesis is also consistent with large investors trading to take advantage of feedback traders on days with large positive returns. To further isolate the effect of the daily price limit, we develop an additional identification strategy building on the fact that ST stocks face tighter daily price limits (5%) relative to the daily price limits of regular stocks (10%).

In general, the ST status is given to a publicly listed firm if it reports negative profits for two consecutive years or a net asset value below the par value (usually one yuan per share). This status is formally assigned by the stock exchange after firms release their annual financial reports, which is usually in March or April. As a result, the market can precisely anticipate whether a firm will obtain the ST status at the end of January after its fourth quarter earnings are announced. That is, if in January a firm reports negative earnings for the eighth consecutive quarter or a low net asset value, it will almost surely be assigned the ST status in March or April, and then be subject to the more restrictive 5% daily price limits. Thus, there is a period of 2 to 3 months during which market participants anticipate a stock to be labeled as ST, but the stock is still trading under the regular 10% price limits. This period allows us to identify the effects induced by the more restrictive 5% price limits after the ST status is officially assigned.⁵

list has been expanded several times and now includes 400 stocks on the SZSE and 500 stocks on the SHSE. The total short interest, however, has stayed at a very low level. For example, at the end of 2015, the short interest on the SZSE was less than 0.005% of tradable shares.

⁵ We illustrate the timeline using the example of Leshan Power (600644), which was assigned the ST status in 2014: 1) In December 2013, market news warned investors that Leshan Power might become a ST stock since it had reported negative profits for seven consecutive quarters. 2) On January 27, 2014, Leshan Power

Specifically, we examine the following hypothesis by comparing the price dynamics and large investors' trading behavior during the post-ST period right after a stock is officially assigned the ST status and during the pre-ST period when its ST status is anticipated but not yet officially assigned:

Hypothesis 2: Large investors pursue the destructive strategy of buying on the days of hitting the 5% upper price limit and selling on the next day in the post-ST period, although not around days with large daily returns above 5% in the pre-ST period; their aggressive buying on the days of hitting the 5% upper price limit predicts a more pronounced price reversal in the post-ST period; and as a result, the stock price reversal subsequent to hitting the 5% upper price limit in the post-ST period is more pronounced than its reversal subsequent to days with large returns above 5% in the pre-ST period.

III. Analysis of Regular Stocks

In this section, we report empirical results from using the sample of all regular stocks in the SZSE from 2012 to 2015 to analyze Hypothesis 1. We first examine stock price dynamics after hitting the upper price limit and having large daily returns below 10%. Then, we conduct a descriptive analysis of the trading behavior of different types of investors around these events. Finally, we verify whether the trading of large investors on the days when the upper price limit is hit has predictive power for the subsequent price reversal.

A. Continued Price Increase and Long-run Reversal

released its earnings for the fourth quarter of 2013, which were negative. 3) On March 6, 2014, after Leshan Power released its annual financial report, market news warned investors again of the firm's upcoming ST status. 4) On March 31, 2014, Leshan Power was officially assigned the ST status, and its daily price limits were reduced to 5%. In this example, market participants could anticipate Leshan Power's ST assignment well in advance of the official assignment, the ST assignment reduces the daily price limits but does not provide any additional information to the market.

We first document the price pattern subsequent to hitting the 10% upper and lower price limits. We compare the days when the closing price hits the upper or lower 10% limit with the days when the closing return falls into different inner ranges, such as 9% to 10%, 8% to 9%, ..., -10% to -9%. To make it comparable with our account-level analyses, we restrict the sample period to 2012 to 2015.⁶

Upon a stock's closing price hitting one of the limits, we track the stock's post-hit returns up to six months. To control risk characteristics that may drive a stock's returns, we use the characteristic-based adjustment method developed by Daniel, Grinblatt, Titman, and Wermers (DGTW, 1997). Specifically, we sort all stocks independently based on their float capitalization and market-to-book ratio at the end of each year into 5x5 groups. Then, in the following year, a stock's (daily) risk-adjusted return equals its raw return minus the average return of stocks in the stock's benchmark group. Through this adjustment, we obtain the abnormal returns of each individual stock, which have already removed market returns and other common return components related to size and market-to-book characteristics. We also calculate cumulative abnormal returns over longer windows. We use log returns in our main analysis, while the results from using percentage returns are similar and reported in the Online Appendix.⁷

Table 3 reports the abnormal returns subsequent to hitting the daily upper and lower price limits and other inner price ranges. We group all stock-day observations into 13 categories based on the magnitude of day-0 returns. For post-event returns, we adopt

⁶ The result using a longer sample from 1997 to 2015 is similar and reported in the Online Appendix.

⁷ We use stocks from both the Shenzhen and Shanghai Stock Exchanges to compute abnormal returns. The Shenzhen Stock Exchange lists mostly innovative private firms, which tend to be small, as opposed to the large state-owned enterprises listed in the Shanghai Stock Exchange. To ensure a balanced representation of stocks in the characteristics benchmark portfolios, we pool all stocks listed in both exchanges. The abnormal returns computed from this exercise are also used as the dependent variables in our later regression analysis.

different time windows up to 120 trading days. We decompose the first day return into close-to-open (i.e., overnight) and open-to-close returns, and report returns of day 2 to day 5 separately. We also report the cumulative returns over days 6 to 10, 11 to 20, 21 to 60, and 61 to 120. Standard errors are clustered by calendar date and the corresponding t -statistics are reported in parentheses with *, **, *** representing statistical significance at the 5%, 1%, and 0.1% levels, respectively.

The first row documents the abnormal returns subsequent to hitting the upper 10% price limit. On the first day, the close-to-open return on average is 2.44% (t -statistic of 20.3), and the price is reversed by a small amount during the trading hours with an average return of -0.30% and a t -statistic of 4.0. The price continues to rise on day 2 with an average return of 0.45% and a t -statistic of 4.1, but does not show any significant pattern on day 3 and day 4. The price pattern is significantly reversed starting from day 5, on which the average return equals -0.15% with a t -statistic of 3.6. Then, the price keeps decreasing: the average return from day 6 to 10 is -0.59% with a t -statistic of 6.4, -0.87% from day 11 to 20 with a t -statistic of 5.3, -1.31% from day 21 to 60 with a t -statistic of 4.7, and finally -0.97% from day 61 to 120 with a t -statistic of 7.1.

In other words, after hitting the 10% upper price limit at the close, the stock price continues to increase for another two days and eventually reverses afterward. It reaches the highest point on day 2 with a cumulative return of 2.59%. Summing up all the returns in the row provides the post-event accumulative abnormal return up to 120 days, which is negative and equals -1.21%. This number shows a long-term reversal pattern subsequent to hitting the 10% upper limit.

The middle row in the table shows that subsequent to days with modest closing returns in $(-5\%, 5\%)$, the average abnormal returns across all time windows up to 120 days are almost zero. This row thus provides a benchmark for the returns subsequent to other days with large closing returns.

We do not find a similar pattern of continued price increases subsequent to days with large returns but without hitting the price limit. Looking at the days with closing returns in $(9\%, 10\%)$, for example, the price drops by -0.51% at the open price of day 1, and then continues to drop on day 2. The long-term returns are also negative. Furthermore, the patterns subsequent to days with large returns in $(8\%, 9\%)$ and $(7\%, 8\%)$ appear to be similar—there is long-run price reversal but not any continued price increase right after the initial large return.

The bottom row of Table 3 presents the price pattern following lower-limit hits. Similar to upper-limit hits, the price significantly drops at the open of day 1 with an average return of -1.13% and a t -statistic of 8.7. The open-to-close return is moderately negative, and the price continues to drop significantly on day 2 and day 3. Nevertheless, the cumulative returns over days 6 to 10, days 11 to 20, and days 21 to 60 indicate a reversal pattern, with average returns of 0.34% (t -statistic of 2.2), 1.33% (t -statistic of 6.0), and 1.68% (t -statistic of 7.1), respectively. By comparison, this continuation-followed-by-reversal pattern does not appear subsequent to days with other large, interior negative returns, such as returns of $(-10\%, -9\%)$ and $(-9\%, -8\%)$.

In sum, Table 3 shows a pattern of stock prices continuing to increase for a couple of days subsequent to hitting the upper 10% price limit, but eventually reversing over a longer period. While this pattern is consistent with Hypothesis 1, it may be also consistent with

some traders pursuing positive feedback strategies and their price impact leading to subsequent price reversal. To sort out this possibility, we specifically examine the trading of large investors in the following subsections.

B. Trading around Upper-Price-Limit Hits

We now examine the behavior of different types of investors on the upper-price-limit-hitting day (day 0) and the following day (day 1). The first part of Hypothesis 1 posits that large investors tend to buy stocks on day 0 and then sell on day 1. To test this hypothesis, we compare the daily *NetBuy* by the six groups of investors on day 0 and day 1 in Panel A of Figure 1. For comparison, we also plot *NetBuy* by different investor groups on trading days with large closing returns in (8%, 9%) and (9%, 10%), which we hereafter refer simply to as having 8% and 9% returns, respectively.

Figure 1 shows a clear and distinctive strategy used by large investors (with stock balances above 10 million). Consistent with Hypothesis 1, large investors purchase these upper-price-limit-hitting stocks on day 0 and sell them on day 1—as a group they acquire 0.69% of the stock's floating shares on day 0 and sell 0.51% on day 1. These quantities are comparable to the average daily turnover rate of 3.1%, as reported in Table 2, and are particularly large relative to the group's average turnover of 0.44%. While the group trades in the same manner on days with large, interior closing returns of 8% or 9%, their *NetBuy* on day 0 and day 1 is substantially lower than around the upper-price-limit hits. The pattern of large traders quickly reversing their buying positions on the next day also shows that they are not simply following a positive-feedback strategy.

In contrast, small and median investors in the three groups with average stock balances lower than 5 million RMB all exhibit the opposite trading pattern—their *NetBuy*

is negative on day 0 while positive on day 1 of the upper-price-limit hits.⁸ The intermediate investor group with stock balances between 5 and 10 million RMB does not buy or sell any notable amount around the upper-price-limit-hitting days and large return days.⁹ The institution group acquires stocks on both day 0 and day 1 around these events.

Panel B of Figure 1 depicts the *NetBuy* of different investor groups on day 0 and day 1 of hitting the lower price limit and having large negative returns in (-9.99%, -9%) and (-8.99%, -8%). This plot clearly indicates that the large-investor group does not pursue any destructive strategy around either the lower-price-limit hitting events or the large negative return days—they tend to sell a large quantity on day 0 and then continue to sell another smaller quantity on day 1. This observation is consistent with our earlier argument that the difficulty of short-selling stocks makes pursuing a destructive strategy around the lower-price-limit-hitting events undesirable. For this reason, we focus our analysis on the upper price limit. The institution group has the same pattern with even stronger selling on these days. The three investor groups with stock balances less than 5 million RMB trade again in the exact opposite direction, buying large quantities on these days.

Finally, to further verify whether all accounts in one group trade similarly around the upper price limit hits, Panel C of Figure 1 plots the percentage of accounts in each group which bought shares on day 0 and then sold on day 1. Interestingly, 83.6% of large investors bought shares on day 0 and then sold on the next day, indicating homogeneous behavior among this group. In contrast, only a small fraction of small and median investors

⁸ This pattern is consistent with the disposition effect, i.e., current shareholders realize their gains on days when prices hit the upper limit, and the attention effect, i.e., new investors are attracted by the upper-price-limit-hitting events to buy the stocks on the following day.

⁹ The lack of notable buying and selling by this group might be caused by heterogeneity of investor behavior within this group, i.e., some behaving like the large investors in the group with stock balances larger than 10 million while some others behaving like those in the groups with balances less than 5 million.

adopted this type of strategy as the large investors. The pertinent percentage for investors with stock balances between 5 and 10 million RMB is larger than that of the small and median investors but it is still less than 20%. The institution group shows a more mixed picture, with 52.3% of them buying on day 0 and selling one day after.

C. Large Investors' Trading and Price Reversal

In this subsection, we proceed to examine whether the net buy of large investors on the upper-price-limit-hitting day has predictive power for the subsequent price reversal (i.e., the second part of Hypothesis 1). We pool all stock-day observations in our sample and run the following predictive regression:

$$\begin{aligned} \text{Ret}_{i,t+n \rightarrow t+m} = & \alpha + \beta_1 \text{LimitsHit}_{i,t} + \beta_2 \text{NetBuy}_{i,j,t} + \beta_3 \text{LimitsHit}_{i,t} * \text{NetBuy}_{i,j,t} \\ & + \sum_{k=1}^3 \delta_k \text{LargePrice}_{i,t}^k + \sum_{k=1}^3 \rho_k \text{LargePrice}_{i,t}^k * \text{NetBuy}_{i,j,t} \\ & + \psi X_{i,t} + \varepsilon_{i,j,t}, \quad n, m \in \{1, 2, 3, 4, 5, 10, 20, 60, 120\}, \end{aligned} \quad (1)$$

where the dependent variable $\text{Ret}_{i,t+n \rightarrow t+m}$ denotes the characteristics-adjusted abnormal returns on day 1, 2, 3, 4, 5, and cumulative abnormal returns over days 10 to 20, 21 to 60, and 61 to 120 for stock i after the upper-price-limit-hitting day t . $\text{LimitsHit}_{i,t}$ is a dummy variable that equals 1 if stock i hits the upper price limit on day t . $\text{NetBuy}_{i,j,t}$ denotes NetBuy of stock i on day t by investor group j . The variable of interest is the interaction term of LimitHit and NetBuy . Hypothesis 1 posits that this interaction term has a negative coefficient, indicating stronger price reversal after upper-price-limit hits with greater net buy by the large investors.

To compare market dynamics after the upper-price-limit hits and after days with large daily price movements, we include a series of dummies $k = 1, 2, 3$, denoting the three 2% intervals from 4% to 10% of daily closing returns. We also include the interaction terms of

these dummies with *NetBuy*. We further control several covariates $X_{i,t}$, such as market-to-book ratio, float capitalization, and past 30-trading-day return. Finally, we use robust standard errors throughout and cluster by calendar date, which controls for the clustering of price-limit hits on certain dates.¹⁰

Table 4 reports the regression results. Panel A reports the results using the *NetBuy* for large investors with stock balances above 10 million. Consistent with Hypothesis 1, the coefficients of the key interaction term of *LimitHit* and *NetBuy* indicate that the net buying of large investors on day 0 of upper-price-limit hits consistently predicts significantly negative returns throughout different time windows subsequent to the upper-price-limit-hitting events, except that the coefficient of the day-1 return is insignificant. In other words, when large investors acquire more shares on the day of hitting the upper price limits, the subsequent stock returns are lower throughout the period from day 1 up to day 120.¹¹ These lower returns indicate stronger reversal of the price increase immediately after hitting the upper price limit. Summing up the coefficient of the interaction term *LimitHit*NetBuy* across the return intervals gives a total of -3.296, which, after multiplying by the average *NetBuy* of 0.69% by large investors on day 0 of hitting the upper price limit, further implies a total price reversal of -2.27% from day 1 to day 120. This magnitude is comparable to the total price increase of 2.59% during the first two days after the price limit is hit.

Also note several other observations from Panel A. First, the coefficient of *NetBuy* of large investors is significantly positive across all return intervals, suggesting that on a

¹⁰ In Table A6 of the Online Appendix, we also report results from including calendar-day fixed effects to further control for the clustering of price-limit hitting events. The results remain robust.

¹¹ We also estimate the same regressions replacing net buying of large investors on day 0 with either the net selling of large investors or the net buying of small investors on day 1 after the event. This estimation yields a similarly significant effect on long-term stock returns up to day 120, which gives further support to Hypothesis 1. The results are reported in Table A7 of the Online Appendix.

normal day with daily returns below 4%, the trading of large investors consistently and positively predicts subsequent returns. This finding strongly supports a key premise of our hypotheses that large investors are the "smart money" in the market. The sharp contrast of their trading negatively predicting returns subsequent to hitting the upper price limit makes their destructive behavior around these events even more striking.

Second, *NetBuy* of large investors also has a similar effect on the price reversal subsequent to large daily returns within the price limit, albeit with smaller significance and magnitude. The coefficients of the interaction term of *NetBuy* with the dummy of daily returns in (8%, 9.99%) are all negative, especially for the short-term returns within 10 days. The interaction terms with the dummies of daily returns in (6%, 7.99%) and (4%, 5.99%) are mostly insignificant. The negative predictive power of the trading of large investors subsequent to the days of large positive returns is consistent with their possibly failed attempt to push up prices to the upper limit on these days.¹²

Panel B of Table 4 also reports the results from using the *NetBuy* by each of the five other groups to predict the subsequent returns. This panel reports only the coefficients of the key interaction term of *NetBuy* with the dummy of hitting the upper price limit. Consistent with our earlier observation of the institution group and the group with intermediate stock balances between 5 and 10 million RMB behaving differently from the large-investor group, the trading of these two groups on the days of hitting the upper price limit has no predictive power for the subsequent returns.

¹² As our dependent variable in these regressions is abnormal return that already has been adjusted for market-to-book and stock float characteristics, the coefficients of the control variables, market-to-book ratio, and float capitalization are insignificant. The coefficient of return in the past 30 days is negative and is significant except for returns in two intervals AR Day 5 and CAR[6,10]. The R-squared from these predictive regressions of (un-grouped) individual stock returns is low, as is well known from the empirical asset pricing literature.

In contrast to large investors, trading of the three small and medium investor groups with stock balances below 5 million on the days of hitting the upper price limit has a positive predictive power for the subsequent returns throughout the various return intervals between day 2 and 120. This finding again confirms our earlier discussion that small and medium investors tend to trade exactly on the opposite side of large investors around the days of hitting the upper price limit.

In sum, consistent with Hypothesis 1, Table 4 provides strong and robust evidence confirming that the net buy of large investors on the days of hitting the upper price limit is associated with more pronounced price reversal over the subsequent periods.¹³

IV. Analysis of ST Stocks

The results reported in the previous section show a significant relationship between the net buying of large investors on days of hitting the upper price limit and the subsequent price reversal. To further identify the role played by the daily price limit, as opposed to simply large daily returns, in inducing the destructive behavior of large investors, we now turn to testing Hypothesis 2 by exploiting ST assignments in an event study of a sample of ST stocks as these stocks face tighter 5% daily price limits than the 10% limits imposed on regular stocks. There are 119 stocks, which were assigned the ST status on the Shenzhen Stock Exchange in our sample period of 2012 to 2015.¹⁴

As discussed in Section II, market participants can anticipate the ST assignment two or three months in advance. Thus, the official assignment offers no new information about

¹³ As a robustness check, we also examine whether the net buy by large investors on the days of hitting the lower price limit has the same negative effect on subsequent stock returns. The results reported in Table A8 of the Online Appendix confirm that there is no such effect for the lower price limit hits.

¹⁴ There is only a very small sample of firms whose ST status was removed during this period, which prevents us from studying the effects of ST removal.

the firm's fundamental. The key change around the ST assignment is the tightened daily price limit from 10% to 5%, which offers a suitable setting to identify the effect of the tighter 5% price limits on large investors' trading behavior and market dynamics.

A. Price Reversal Before and After ST Assignment

We first compare the stock returns subsequent to hitting the 5% upper price limit in the post-ST period relative to having large daily returns above 5% in the pre-ST period in the sample of 119 ST stocks. Specifically, we run the following regression:

$$Ret_{i,t+n \rightarrow t+m} = \alpha + \beta_1 ST_{i,t} + \beta_2 Five_{i,t} + \beta_3 ST_{i,t} * Five_{i,t} + \psi X_{i,t} + \alpha_t + \varepsilon_{i,j,t},$$

$$n, m \in \{1, 2, 3, 4, 5, 10, 20, 60, 120\}, \quad (2)$$

where $t \in [-60, 60]$ is a date before or after the ST assignment of a stock, measured by the number of days to the ST assignment, and the dependent variable is the abnormal return subsequent to each stock-day in the sample.¹⁵ Like before, the abnormal return is adjusted for the stock's float capitalization and market-to-book ratio.¹⁶ $ST_{i,t}$ is a dummy variable that equals one if stock i has the ST status on date t and zero otherwise. $Five_{i,t}$ is also a dummy variable that equals one if stock i hits the 5% limit on date t in the post-ST period or has daily return larger than 5% in the pre-ST period. The key variable of interest is the interaction term of $ST_{i,t}$ and $Five_{i,t}$, which gives an estimate of the effect of the reduced price limit after the ST assignment on the stock return. As posited by Hypothesis 2, we expect a stronger price increase right after hitting the 5% upper price limit in the post-ST

¹⁵ As a robustness check reported in the Online Appendix, instead of using the time window of $[-60, 60]$, we define the pre-ST period as the exact period between the announcement of a stock's fourth quarter earnings and the official assignment of its ST status and the post-ST period as an equally long period after the ST assignment. The results are similar.

¹⁶ Again, we follow DGTW (1997) to control risk characteristics: abnormal returns are calculated using a stock's daily return minus the average return of the stock's ST benchmark group, which is formed at every year's end based on stocks' float capitalization and market-to-book ratio using the sample of all ST stocks. Due to the small sample size of 119 ST stocks, we sort them into 2x2 ST benchmark groups.

period than after having daily returns above 5% in the pre-ST period, as well as a more pronounced price reversal afterward. In other words, we expect the coefficient of this interaction term to be positive for return periods right after the upper-price-limit hits and negative for return periods long after the hits.

We further control several covariates $X_{i,t}$, such as market-to-book ratio, float capitalization, and past 30-trading-day return. We also incorporate a set of fixed effects α_t for each date around the ST assignment to capture any potential deterministic effect associated with the ST assignments. For example, certain institutions may not hold ST stocks and need to unload their holdings around the ST assignment events, while some investors might prefer to invest in ST stocks and may gradually enter the market. As the ST assignments are well anticipated, these effects can be captured by including a set of fixed effects based on the number of days to the ST assignments. Finally, we use robust standard errors throughout and cluster them by calendar date, which controls for the clustering of price-limit hits on certain dates.

Table 5 reports the coefficient estimate of the key interaction term of $ST_{i,t}$ and $Five_{i,t}$ in regression (2). Panel A does not include the fixed effects associated with the number of days to the ST assignment, while Panel B includes these fixed effects. In column (1) of Panel A, the coefficient of the interaction term of $ST_{i,t}$ and $Five_{i,t}$ indicates that in the post-ST period, the stock open price on the next day of hitting the 5% upper price limit tends to rise 1.6% more relative to the open price after having a large daily return above 5% in the pre-ST period. In addition, column (2) shows that the open to close return on the next day is lower by 0.4% in the post-ST period than in the pre-ST period, while column (3) shows that the return on day 2 is significantly higher by 1.1%. Overall, the returns in the two days

right after hitting the 5% upper price limit in the post-ST period are significantly higher than right after having large daily returns above 5% in the pre-ST period.

More important, there is also more pronounced price reversal in the post-ST period. Columns (8), (9), and (10) show that the price reversal in days [11, 20], [21, 60], and [61, 120] subsequent to hitting the 5% upper price limit in the post-ST period is significantly stronger by 4.5%, 7.7%, and 5.2%, respectively, than subsequent to having large returns above 5% in the pre-ST period. Adding these numbers gives a total of 17.4% in the strengthened price reversal from day 11 to day 120. Panel B reports very similar results after including the fixed effects associated with the number of days to the ST assignment as Panel A. Overall, Table 5 shows a more pronounced price pattern of continued price increases and subsequent reversal after having large daily returns above 5% in the post-ST period than in the pre-ST period, consistent with Hypothesis 2.

B. Large Investors' Trading of ST Stocks

We now compare the large investors' trading behavior around the days with large returns in the pre-ST and post-ST periods. Figure 2 depicts the net buy of the 119 ST stocks in our sample by different investor groups around the days with large positive returns in (3%, 3.99%), (4%, 4.99%), and above 5% with Panel A representing the pre-ST period and Panel B representing the post-ST period. Panel A shows that in the pre-ST period, large investors (with stock balance above 10 million RMB) tend to buy on both day 0 and day 1 of having these large daily returns, just like institutions. Specifically, on average, large investors buy 0.11% of the tradable shares on day 0 of having returns above 5% and buy another small amount on day 1. The three groups of small and medium investors with stock balances less than 5 million RMB tend to sell on these days.

Interestingly, Panel B presents a sharp change in the net buy of large investors in the post-ST period around hitting the 5% upper price limit—instead of buying on both day 0 and day 1, large investors buy on day 0 and then sell on day 1, the same way they trade regular stocks upon hitting the 10% upper price limit. Specifically, on average, they buy 0.15% of the tradable shares on day 0 and then sell 0.05% on day 1. Not only do they buy more aggressively on day 0, but also, more curiously, they switch the direction of their trading from buy to sell on day 1.

Around days that have returns in (4%, 4.99%), the net buy of large investors also displays a similar pattern of buying on day 0 and then selling on day 1, again in contrast to the pattern in the pre-ST period. As we discussed in the previous section, large investors face uncertainty in pushing the stock prices to the upper price limit. Thus, this pattern might reflect their failed attempt to push up the stock prices.

Institutions tend to sell a small quantity on both day 0 and day 1 after hitting the 5% upper price limit and having large returns in (4%, 4.99%), which help highlight the stark behavior of large investors. The net buy of the three groups of small and medium investors with stock balances below 5 million RMB is exactly the opposite to that of the large investors. Overall, Figure 2 shows that after the ST assignment, there is a sharp change in the trading behavior of large investors around the days of hitting the upper price limit or having large positive returns.

C. Large Investors' Trading and Price Reversal of ST Stocks

After showing the strengthened price reversal subsequent to hitting the 5% upper price limit and the sharp change in the trading behavior of large investors around the days of hitting the upper price limit after the ST assignment, we now connect these two phenomena.

We again pool the sample of the 119 ST stocks for the period 60 days before and after their ST assignments and run the following predictive regression:

$$\begin{aligned} \text{Ret}_{i,t+n \rightarrow t+m} = & \alpha + \beta_1 \text{NetBuy}_{i,t} + \beta_2 \text{ST}_{i,t} + \beta_3 \text{Five}_{i,t} + \beta_4 \text{NetBuy}_{i,t} * \text{ST}_{i,t} + \\ & \beta_5 \text{NetBuy}_{i,t} * \text{ST}_{i,t} + \beta_6 \text{NetBuy}_{i,t} * \text{Five}_{i,t} + \beta_7 \text{NetBuy}_{i,t} * \text{ST}_{i,t} * \text{Five}_{i,t} \\ & + \eta' X_{i,t} + \alpha_t + \varepsilon_{i,t}, \quad n, m \in \{1, 2, 3, 4, 5, 10, 20, 60, 120\}, \end{aligned} \quad (3)$$

where the dependent variable is the abnormal return for various time windows subsequent to a given date $t \in [-60, 60]$.¹⁷ $\text{NetBuy}_{i,t}$ is the net buying of stock i by large investors with stock balances above 10 million RMB on date t , $\text{ST}_{i,t}$ is a dummy indicating whether date t is in the post-ST period, and $\text{Five}_{i,t}$ is a dummy indicating whether the stock return on date t is above 5% in the pre-ST period or whether the stock has hit the upper price limit in the post-ST period. The key variable of interest is the triple interaction term $\text{NetBuy}_{i,t} * \text{ST}_{i,t} * \text{Five}_{i,t}$. Hypothesis 2 posits that a stronger price reversal is associated with more buying by large investors on the day of hitting the upper price limit in the post-ST period. That is, we expect the coefficient of the triple interaction term β_7 to be negative for long-term returns. We control for the same list of covariates $X_{i,t}$ as before. We also incorporate a set of fixed effects α_t for each date around the ST assignment to capture any potential deterministic effect associated with the ST assignment and use robust standard errors throughout and cluster by calendar date.

Table 6 reports the results from estimating regression (3) with Panel A not including the fixed effects associated with the number of days to the ST assignment and Panel B including these fixed effects. The coefficient of the triple interaction term is significantly

¹⁷ We again provide a robust check in the Online Appendix by defining the pre-ST period as the exact period between the announcement of a stock's fourth quarter earnings and the official assignment of its ST status and the post-ST period as an equally long period after the ST assignment. The results are similar.

negative for all return periods from day 6 to day 120 subsequent to hitting the 5% upper price limit, indicating that in the post-ST period the trading of large investors on the days of these hits makes the subsequent price reversal more pronounced.¹⁸ Panel B reports very similar results. Overall, Table 6 indeed shows that the destructive trading behavior of large investors on the day of hitting the 5% upper price limit in the post-ST period is associated with the strengthened price reversal, strongly supporting Hypothesis 2.

D. Frequency of Large Returns

Finally, we give a visual illustration of the change in the frequency of large returns before and after the ST assignment. Specifically, Figure 3 depicts the fraction of the 119 ST stocks in our sample on a given day with large daily returns above 4%. The figure shows a visible increase in this fraction in the post-ST period. This increase highlights the effect of the tighter daily price limit—the destructive trading behavior of large investors induced by the tighter daily price limit makes the occurrence of large daily returns above 4% more frequent rather than less frequent. Admittedly, the cutoff choice of 4% is ad hoc. We choose a cutoff lower than 5% because large investors pursue the destructive trading strategy not only on days hitting the 5% price limit but also on days with large returns close to the price limit, as shown by Figure 2.

V. Conclusion

In this paper, we study the effects of the widely used daily price limit rule on the dynamics of stock prices and the trading behavior of different investor groups. We find a set of results indicating that the daily price limits may have an unintended effect of inducing

¹⁸ Note that the coefficient of this triple interaction term may appear larger than that in Table 4. This is due to the smaller quantity of the net buy of ST stocks by large investors on the days of hitting the price limit (Panel B of Figure 2) relative to that of regular stocks on average (Panel A of Figure 1).

large investors to pursue a destructive strategy of pushing up stock prices to the upper price limit and then selling on the next day. This unintended effect highlights the challenge in designing the trading system for emerging equity markets, which tend to have a mix of experienced and inexperienced investors. The interactions between them may render a market stabilization scheme, such as the daily price limits, counterproductive.

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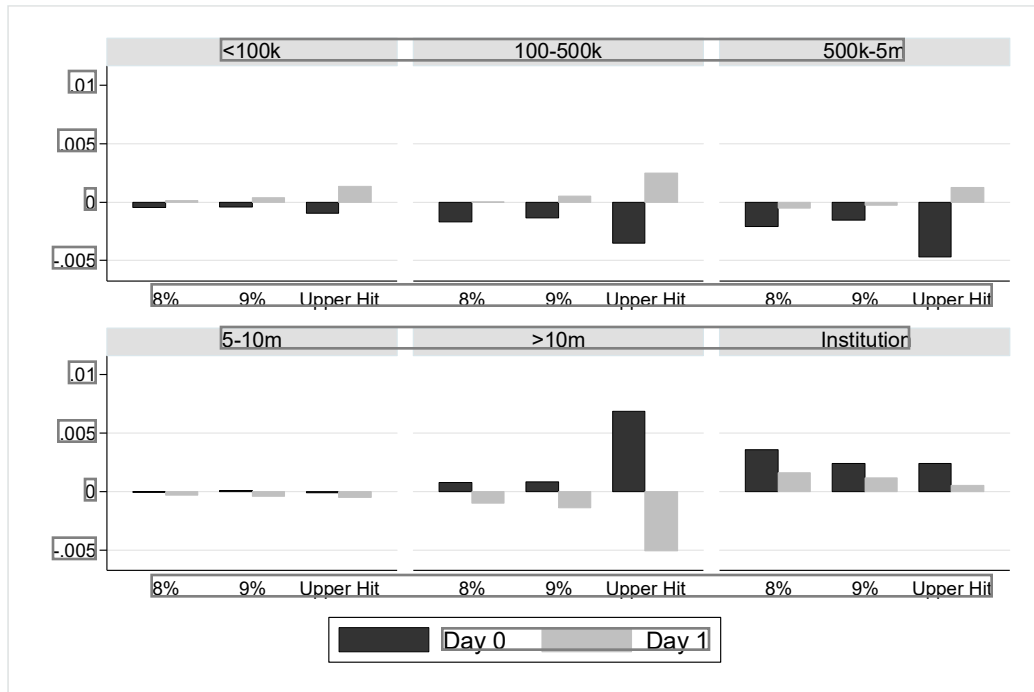
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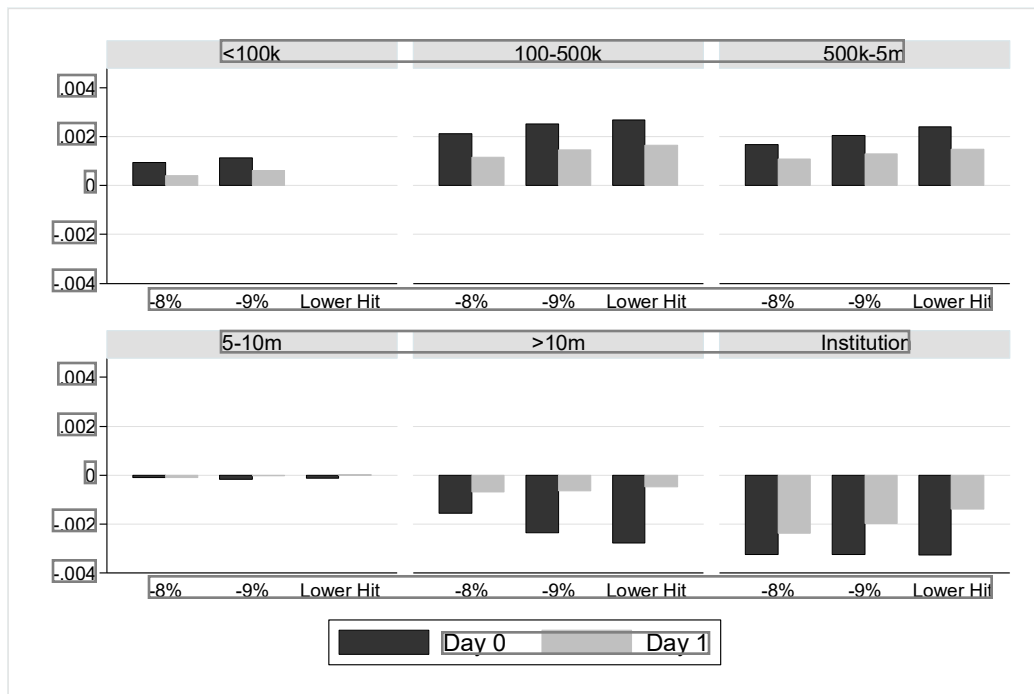
Figure 1. Trading around Days with Large Price Fluctuations by Investor Groups

This figure plots the *NetBuy* of different investor groups on the day (Day 0) and the following day (Day 1) of large price fluctuations.

Panel A: Trading around Days with Large Positive Returns



Panel B: Trading around Days with Large Negative Returns



Panel C: Percentage of Accounts Buying on Day 0 and Selling on Day 1 of Upper Limit
Hits

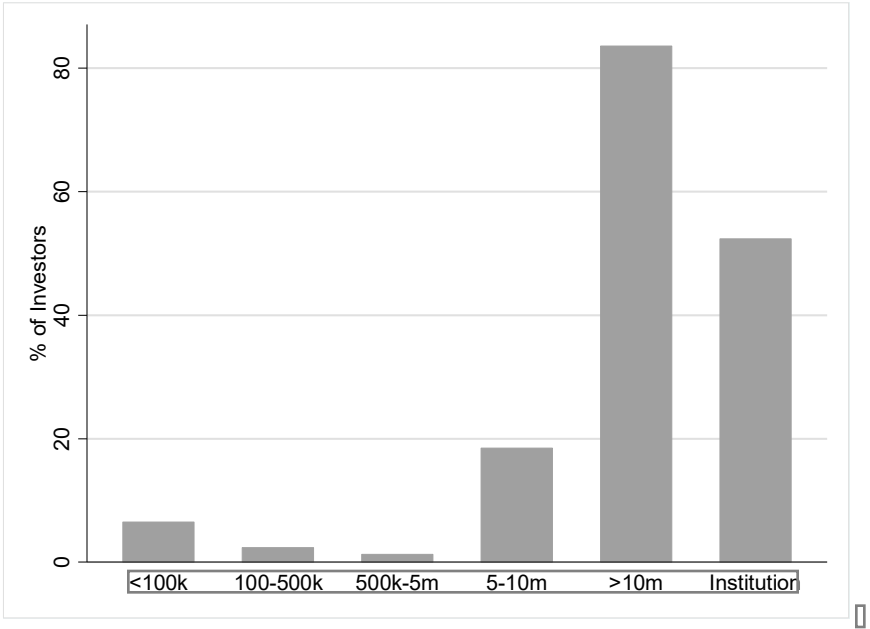
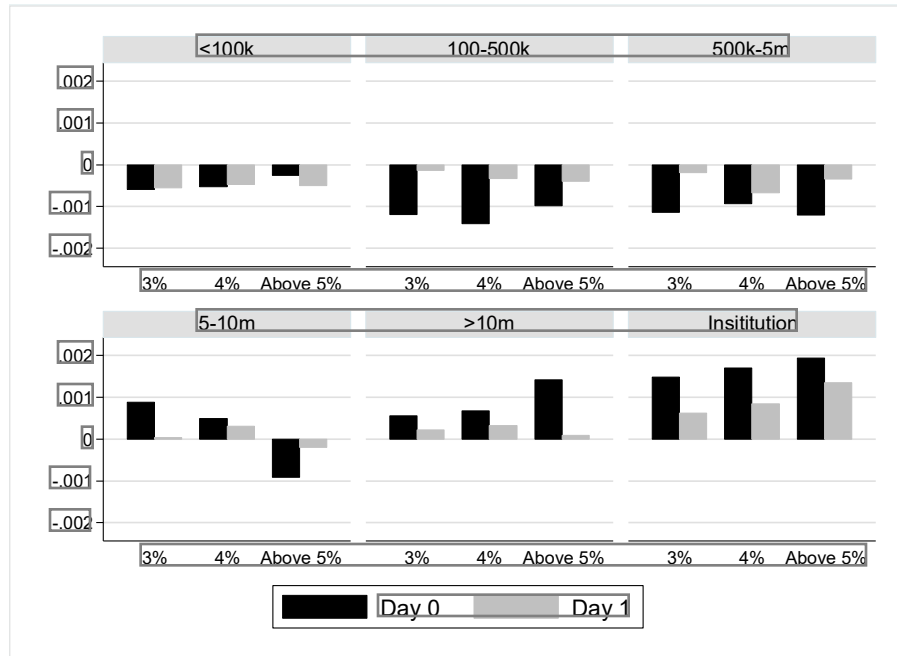


Figure 2. Trading of ST Stocks around Days with Large Positive Returns by Different Investor Groups

This figure plots the *NetBuy* by different investor groups of ST stocks around days with large positive returns: (3%, 3.99%), (4%, 4.99%), and hitting the 5% upper price limit (or above 5% in the pre-ST period).

Panel A: ST Stocks in Pre-ST Period



Panel B: ST Stocks in Post-ST Period

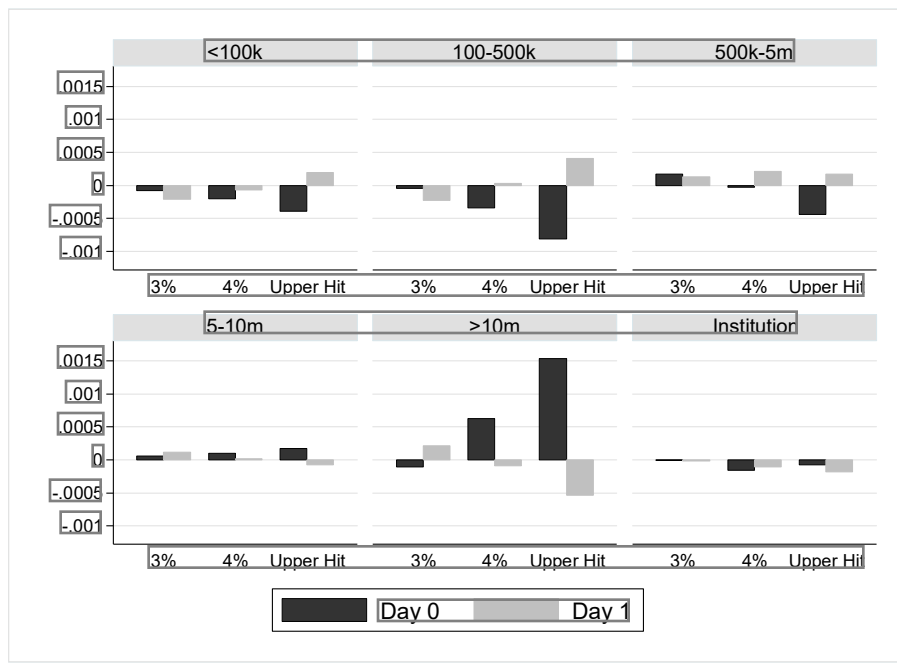


Figure 3. Distribution of Large Daily Returns Before and After ST Assignment

This figure shows the fraction of stocks with daily returns larger than 4% 60 days before and after the assignment of the ST status for 119 ST stocks.

