Institutional trading in volatile markets: evidence from Chinese stock markets

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Abstract

We investigate the daily stock returns of all A-shares listed on the Shanghai and Shenzhen stock exchanges over the period 2010-2017. Using daily cash flow data on the largest category of trades by value, we construct a proxy for high-value institutional trading activity. We demonstrate that high-value institutional transactions consistently exacerbate firm-level abnormal stock returns on extreme market movement days. We then highlight the conflating influence of regulator imposed daily limits on firm-level stock price movements and conclude that binding price limits act to exacerbate the destabilising effects associated with high-value institutional trades in Chinese stock markets.

(97 words)

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1. Introduction

Equity markets in China have expanded fast since the re-establishment of securities markets in Shanghai and Shenzhen in the early 1990s. The two Chinese stock exchanges combined now constitute the second largest capital market in the world by total stock capitalization after the U.S., having surpassed Japan in 2014. Chinese stocks have become increasingly popular with global investors who are seeking to benefit from portfolio diversification and international risk sharing. However, the extreme swings in stock market indices and the apparently irrational behaviour sometimes experienced in Chinese stock markets[1] have raised concerns amongst policymakers, regulators, and global investors; particularly given the strong and growing dependence of the global economy on the Chinese economy. Of particular interest is the answer to the question, does institutional trading drive abnormal returns during extreme market swings in Chinese stock markets?

When seeking to identify the sources of extreme swings in stock prices, two prior studies are key: Dennis and Strickland (2002) and Tian *et al.* (2018). Both these studies use institutional ownership data as a proxy that is intended to capture the influence of institutional traders. One disadvantage of this proxy is that the ownership data used is only available on a quarterly basis, while the extreme market movements are captured on a daily basis. Dennis and Strickland (*op cit.*) was the first paper to focus on the relationship between extreme stock market movements and institutional ownership, posing the question "Who blinks in volatile markets, individuals or institutions?". In particular, they present evidence that the absolute value of firm-level abnormal returns recorded on extreme market movement days is positively correlated with the percentage of the relevant firms' shares that are owned by institutions. They argue that this result is consistent with institutional trading having destabilizing impacts in a sharply falling (rising) market, driving stock prices below (above) their true values. In contrast, Tian et al. (2018), while using the identical approach applied to Chinese firm-level data, document a stabilizing effect of institutional ownership on firm-level abnormal returns, concluding that institutional trading acts to stabilize the Chinese stock markets.

However, we believe there are two limitations of Tian et al.'s analysis which are worth addressing. First, they rely on quarterly information on institutional holdings of each company's stocks, which may conceal important details institutional trading behaviour on a more active and timely basis. As suggested, albeit in different contexts, by Campbell et al. (2009) and Boehmer and Kelley (2009) among others, we believe that it is vital to seek an alternative, higher frequency, proxy for institutional trading activity, to capture better the impact of institutional trading behaviours in generating and prolonging extreme market swings or alternatively to provide convincing evidence of market stabilizing effects.

[1] For example, China's stock market had increased about 150% in a single year before reaching the ceiling at June 2015, and thereafter followed by the 2015-2016 market crash, in which 30% value of A-shares on the Shanghai Stock Exchange was lost within one month.

To be more specific, we exploit available daily cash flow data that relates to trades in individual firms' stocks to construct an appropriate proxy for the daily trading activities of institutional investors. Such data have previously been found to play an important role in explaining stock returns[2]. For example, Yang and Yang (2019) find that an index of inflow-outflow imbalances constructed from available cash flow data contributes to explaining excess stock returns in Chinese markets. Our proposed proxy relies on daily cash flow data on transactions by value, obtained from the free to access RESSET database. We focus on those transactions on a given trading day with a value in excess of one million Chinese RMB, i.e. the category of the highest value transactions consistently recorded in the database throughout our sample period. Given the available data on the very low percentage of retail accounts for which the total market value of holdings exceeds one million RMB[3], it seems reasonable to assume that the majority of these high value transactions are attributable to trading activities of institutional investors. Our proxy is constructed as the net value of the total of the highest value category of inflows (purchases) and a total of the largest value category of outflows (sales) that is recorded throughout our sample. The use of daily cash flow data in our proxy avoids the restrictions inherent in the use of quarterly data on institutional holdings of each firm's stock. Instead, these data allow us to investigate the impact of the highest-value trades, the vast majority of which will have been initiated by institutional investors, on firm-level stock returns on and after, extreme market movement days[4]. A similar proxy is used in a different context by Chi and Li (2019).

In our empirical analysis, we find that i) high-value net trades, mostly attributable to institutional investors, tend to be net-purchases (net-sales) on the extreme market up (down) days; ii) there is consistent evidence, across both Chinese markets, of high-value institutional trades having a destabilizing influence on abnormal stock returns. This influence is exerted, at least in part, via high-value purchases of rising stocks on the extreme market up days and high-value sales of falling stocks on the extreme market down days. Our institutional trading proxy also attracts a positive coefficient in regressions seeking to explain abnormal turnover on the extreme market up days; this is also consistent with destabilizing effects of high-value net trades of institutional investors. These findings contrast with

[2] See among others, Jotikasthira *et al.*, 2012; Kirchler *et al.*, 2015; Razena *et al.*, 2017; Jiang and Yuksel, 2017; Yang and Yang, 2019.

[3] According to retail investors' holding value data from China Securities Depository & Clearing Corporation Limited, retail accounts that have stock holdings with market values that exceed1 million RMB represent just only 0.82% of all retail accounts in 2011 and 2.75% in 2016, respectively.

[4] As noted above, our proxy is intended to capture high-value daily institutional trading activity in the Chinese stock market. Our selection of high-value transactions utilizes the largest value category that has been recorded consistently throughout our sample period. We are confident that the majority of these trades will have been instigated by institutional investors since only a tiny proportion of retail investors have shareholdings sufficient in value to execute trades of this size. These high-value trades capture only a fraction of institutional trading activity omitting lower value and split trades. We have not explored the use of lower transaction limits. To do so would be problematic for two reasons. The first is data availability: there is a lack of consistency in the lower-value splits for which transactions are recorded over our sample. The second is that incorporating lower value trades would progressively contaminate the proxy by adding trades that include more transactions made by retail investors.

those of Tian *et al.* (*op cit.*), consistent with our belief that the quarterly ownership-based proxy used in this prior research does not incorporate the necessary level of detail required to capture the impacts of daily institutional trading behaviour.

Secondly, an important factor omitted from the existing literature on extreme market swings in the Chinese stock market relates to the existence and role of regulator imposed limits on permitted stock price movements within a given trading day[5]. The Chinese stock market regulator enforces a (+/-)10% daily limit on price movements for regular stocks and a daily limit of +/-5% for special treatment stocks. Unsurprisingly, on extreme market movement days, a substantial number of Chinese stocks hit the upper (lower) price limit. For example, on 9th June 2015 when the day's market return on the Shanghai Composite Index reached 5.76%, as many as 87.7% of the tradeable A-shares hit the upper price limit. The consequence of hitting an upper (lower) price limit is that no further trades that would involve further upward (downward) price movements are permissible until the following or subsequent trading days. Given the frequent binding nature of these regulator imposed price limits, we argue that it is essential to conduct a more complete analysis of the impacts of institutional trading. More specifically we emphasise the need to take into account the potentially conflating impacts of binding price limits and information on what happens to abnormal returns in the days after price limits are hit is included. With this in mind, in contrast to the previous studies of extreme movement days, our investigation includes extensive analysis of abnormal stock returns on the days following extreme market movement days.

We analyse individual firms' abnormal stock returns in the days following extreme market movement days. We are particularly interested in what subsequently happens to the abnormal returns of those stocks that hit a regulator imposed price limit during trading on a given extreme market movement day. The existing literature provides mixed evidence on whether price limits lead to 'delayed price discovery' or to 'price reversal'. Evidence on this for Chinese stock markets includes Chen *et al.*, 2004; Wong *et al.* 2009 and Li *et al.*, 2014, Chen *et al.*, 2019, Li *et al.* (in press).

The regulators' stated objective in imposing price limits and temporary suspensions in trading is that they are intended to calm the markets, giving would-be active investors time to reflect on fundamentals. Subsequent price reversal would be consistent with the correction of a market whose participants come to the belief that traders had over-reacted. However, in rational markets, price limits delay an adjustment that reflects changes in fundamentals. It's also possible that subsequent trading continues to be destabilizing. Another feature of price limits being hit, and of high-value net trades in individual stocks by institutional investors, is that they can grab the attention of large numbers of retail (i.e. individual) investors. These retail investors are typically less well informed than institutional investors; they are

[5] This is not an issue for the Dennis and Strickland (*op cit.*) study, since there are no limits to daily stock price movements in use in the U.S. exchanges.

mainly likely to engage in relatively low-value trades, but the total value aggregating across retail investors can be high.

In this paper, we extend a Dennis and Strickland (*op cit.*) style analysis of destabilization effects to include analysis of days following extreme market movement days. In this extension, we draw on the approach of Chen *et al.* (2019), who examine the impact of the trading behaviour of large investors in regular stocks that hit the 10% upper price limit in the Shenzhen stock market. Following their lead, we investigate firm-level abnormal returns over a range of different horizons, from overnight and rising to a horizon of a maximum of 120 days. We find that in the case of stocks that hit the +/-10% price limit during trading on the initial extreme market movement day, abnormal returns on the days after extreme market movement days continue to be consistently positive (negative) for at least two subsequent days. This evidence is consistent with the binding price limit resulting in delays to price discovery. We further find evidence of a longer-run price reversal effect for stocks that hit the lower price limit on extreme market downward movement days. Although no such longer-run effects for stocks that hit the upper price limit on extreme market upward movement days.

Lastly, we investigate whether the high-value net purchases (sales) on extreme market movement days, which are mainly conducted by institutional investors, are significant predictors of subsequent firm-level abnormal returns. Our results are consistent with delayed price discovery, implying the continuing destabilization of the markets. Interestingly, we find that the high-value net trades conducted by institutional investors are significant predictors of abnormal returns in the days following extreme market movement days in both markets. We further show that this predictive power is strongest for regular, as opposed to special treatment, stocks.

In summary, this paper contributes to the existing literature in several ways. First, we improve upon the use of quarterly institutional ownership as an indirect proxy for institutional trading. We achieve this by constructing and using a new proxy at a daily frequency that makes use of cash flow records on high-value transactions in individual shares, which better captures important aspects of the trading activity of institutional investors. Second, we highlight the importance of price limits in influencing how extreme market swings impact both the immediate and subsequent days' performance of firm-level stock returns. Third, we investigate whether high-value net trades in individual shares on extreme market movement days are significant predictors of firm-level abnormal returns in the days following extreme market movement days in Chinese stock markets. Finally, we present our analysis for all Chinese A-shares listed on the Shanghai and Shenzhen stock exchanges over the extended period 2010-2017. Our findings also provide new evidence of the destabilizing effects of high-value institutional trading activity, and how these interact with regulator imposed price limits, in both the Shanghai and Shenzhen stock markets. These findings have considerable relevance to policymakers and market participants.

The rest of the paper is organized as follows. Section 2 develops the relevant testable hypotheses. Section 3 describes data sources and definitions of variables, and is followed by an explanation of our methodological approach and key findings in section 4. Section 5 concludes. All the extreme movement days identified in the Shanghai and Shenzhen stock markets over our sample are listed in Appendix A and our detailed analysis of special treatment stocks can be found in Appendix B.

2. Empirical hypotheses

2.1 The effects of institutional trading on extreme market movement days

Institutional trading behaviour has attracted considerable attention in the finance literature. Two well-documented types of trading behavior are herding and positive feedback trading. Herding refers to the propensity of investors to follow other institutional investors in their buy or sell decisions. Positive feedback trading relates to traders use available information on past performance to buy past winners and selling the past losers, see Lakonishok et al. (1992), Nofsinger and Sias (1999), Sias (2004). However, evidence in the existing literature on whether the actions of institutional investors stabilize or destabilize the stock market remains mixed and inconclusive. For example, Lakonishok et al. (1992) identify a destabilizing effect from herding and positive-feedback trading behaviours which they attribute to investment funds, while Dennis and Strickland (*op cit.*) provide results of a destabilizing effect of institutional trading behaviour on U.S. extreme market movement days. In contrast, others argue that the trading behaviors of institutional investors help to stabilize the stock market by i) speeding-up a necessary price-adjustment process (Wermers, 1999; Schuppli and Bohl, 2010); ii) reducing stock price volatility (Li and Wong, 2010); and iii) reducing the extent of abnormal returns that occur during market swings (Lipson and Puckett, 2010; Tian *et al*. (*op cit.*)).

Tian *et al*. argue institutional investors "provide a stabilizing influence on extreme market downturn days" p59. Their finding is based on Fama MacBeth style regressions for stock returns which yield a positive and significant estimated coefficient on the proportion of tradable shares in each company that is held by institutions. We suggest that their conclusion that institutional trading acts to stabilize Chinese stock market swings ought to be re-examined on two grounds. First, there is a need for a better proxy for daily institutional trading activity; and second, the existence of binding statutory price limits should not be ignored when examining Chinese data. In a more recent study, Chen *et al*. (2019) demonstrate the existence of destructive behaviour on the part of investors who appear to employ pump-and-dump trading strategies in those stocks that hit the regulators' upper-price-limit (i.e. record a price rise of 10% within a single trading day).

In this paper, we propose and utilize a different proxy international trading activity derived from the available daily cash flow data disaggregated by transaction value. More specifically, we focus on the

combined net value of individual trades that exceed 1 million RMB[6]. We then test the following hypothesis:

Hypothesis 1. High-value transactions, the majority of which are instigated by institutional investors, destabilize market swings by driving firms' abnormal returns on extreme-up (-down) market movement days, and/or by driving firms' abnormal turnover on extreme market movement days.

If hypothesis 1 holds, this implies that the high-value transactions conducted by institutional traders contribute to destabilizing Chinese stock markets on extreme market movement days, by driving firm-level stock returns.

2.2 The effects of institutional trading in the days following extreme market movement days

A notable characteristic in Chinese stock markets is that a substantial proportion of firms' shares hit the regulator's imposed price limit during extreme market movement days. The objective of regulators' in imposing price limits is to require investors to take a time-out to reflect on whether large movements reflect news about fundamentals or whether trading has become irrational. Statutory price limits are often used in emerging markets. However, whether the affected stock prices will continue to rise (fall) after the upper (lower) price limit hit is not clear *a priori*.

Chen et al. (2004) investigate the effects of price limits on Chinese listed A shares from 1996 to 2003. They provide evidence of a delayed effect on upward price movements, but the same is not true of downward price movements. Similarly, Wong et al. (2009) investigate the so-called magnet effects of price limits in the Shanghai Stock Exchange from Jan 2002 to Dec 2002 and again find evidence of delayed price discovery after stocks hit the price ceiling in a given trading day and, in contrast, find evidence of subsequent price reversal in stocks that hit the relevant price floor within a given trading day. On the other hand, Li et al. (2014) claim to present evidence that supports the conclusion that price limits are effective in preventing price movements from continuing when examining China's listed A shares as well as Chinese, Hong Kong (H shares) and New York (N shares). The period they focus upon includes new listings up to May 2011.

More recent research by Chen *et al.* (2019) documents destructive market behaviour generated in response to shares hitting regulator imposed daily price limits during the period from 2012 to 2015. Specifically, they find that firm-level stock prices generally continue to increase on the day following the upper limit being hit but eventually reverse over the longer run. They assert that this probably reflects the attention-grabbing effect of a price limit being hit. Having had their attention grabbed,

[6] We have good reason to believe that few, if any, retail investors are represented in these high-value trades, see footnote 4.

active individual investors often purchase the affected firms' stocks, which they may well have never previously held (see for example, Seasholes and Wu (2007) and Barber and Odean (2018)). On extreme market movement days, it stands to reason that a greater proportion of shares will hit the relevant statutory price limit during the trading day, relative to the number of shares that hit the statutory price limits during other (non-extreme) trading days. This suggests that it will be worthwhile to investigate the effectiveness of price limits on and after extreme market movement days, and we do so through testing the following hypothesis:

Hypothesis 2. Stock prices continue to rise (fall) in the days after hitting the upper (lower) price limit on extreme-up (-down) market movement days. Although these movements may eventually be reversed in the longer run.

If empirical support is found for hypothesis 2, this implies that price discovery is delayed when stocks hit price limits. However, if trading results in over-reaction relative to fundamentals, we should expect to see movements are later reversed and can conclude that the initial trading behaviour was destabilizing. Rejection of hypothesis 2 would be consistent with the interpretation that the price limits 'cool-down' the kind of irrational trading behaviour that drives share prices away from the levels justified by their fundamentals.

There is a relative lack of research that examines the predictive power of institutional trading activity for firm-level stock returns on the days following extreme market movement days on which price limits were hit. Nonetheless, Chen *et al.* (2019) is the first study we are aware of that examines the predictive power of large trades in individual firms' stocks for firm-level abnormal returns over various horizons. They consider abnormal returns from first to the 120^{th} trading day after the price limit was hit and find evidence of price reversal in the days following upper price limits being hit. They further find that this effect is stronger when large investors are involved in high-value firm-level net-buy trades. Motivated by this study, we put forward the following hypothesis to examine whether high-value institutional trades in specific firms' stocks on extreme market movement days help to predict firm-level stock returns in the days following extreme market movement days.

Hypothesis 3. Firm-level abnormal stock returns experienced in the days after hitting an upper (lower) price limit are associated with high-value net trades on extreme-up (down) market movement days.

If hypothesis 3 holds, this implies that the high-value transactions that take place on extreme market movement days, the majority of which are attributable to institutional traders, contain information relevant to predicting stock price movements on the days after price limits are hit. We could then infer that the price discovery process is delayed. In short, the high-value trades by institutional investors on extreme market movement days may act as an indicator of a delayed price discovery process, leading stock prices to depart from their fundamentals for a more protracted period.

In summary, if both hypotheses 1 and 3 hold, we can conclude that binding price limits imposed by the stock market regulator act to exacerbate the destabilizing effects of high-value institutional trading activity in Chinese stock markets.

3. Data and measurement of variables

Our dataset includes daily market information in the form of firm-level stock returns and other firm-specific information, including our institutional trading proxy. Our proxy is constructed from daily cash flow data that identify transactions in each company's A-shares listed in either the Shanghai or Shenzhen stock markets by value. The dataset spans every trading day over the period from January 2010 to the end of December 2017. The daily market- and firm-level information has been collected from the China Stock Market & Accounting Research Database (CSMAR). Daily cash flow data were obtained from the RESSET (www.resset.cn) database.

We choose to analyze the Shanghai and Shenzhen markets separately. There are several reasons for this; the first is that the markets have different characteristics. According to the CSMAR data, the Shanghai exchange is the largest, with a market capitalization of 33.1 trillion RMB in December 2017 as compared to 18.4 trillion RMB in the Shenzhen exchange. Most companies listed on the Shanghai exchange are larger than those listed in the Shenzhen exchange, and many are state-owned companies (including PetroChina, the Industrial and Commercial Bank of China, the Bank of China, among others). The Shenzhen listings include smaller, more entrepreneurial companies. The second reason for separately analyzing the markets is that the Shenzhen exchange is typically more volatile. We choose to use exchange specific thresholds to identify extreme market movement days in each market. Lastly, the separate treatment of the two exchanges facilitates comparison of our findings with Tian et al. (2018) who focused solely on the Shanghai market and with Chen et al. (2019) who focused on the Shenzhen market.

3.1 Extreme market movement days

Following Dennis and Strickland (*op cit.*), we define extreme market movement days in the Shanghai and Shenzhen stock markets respectively as those trading days in which the absolute value of the market return exceeds two standard deviations above its full-sample mean. The thresholds surpassed in an extreme movement day, relative to the previous day's closing value of the relevant composite index, are therefore (+/-)2.90% and (+/-)3.44% in Shanghai and Shenzhen respectively. In all, our sample includes 106 extreme market movement days in Shanghai stock market, comprising 49 up- and 57 down-days, and 116 extreme market movement days in the Shenzhen stock market days, comprising 45 up- and 71 down-days. Notably, a large number (and proportion) of stocks hit the upper- (lower-) price limit in up- (down-) extreme days, particularly in the Shenzhen stock market. For example, there are three extreme up days and four extreme down days in our sample period on which in excess of 80%

of the listed firms in the Shenzhen market see their shares hit the respective upper or lower limit during trading.

All the extreme market movement days identified in our sample are listed in Appendix A, along with information on the relevant market's return expressed as the % change in the closing price on the extreme movement day relative to the closing price on the previous day; the number of stocks listed on the specific date; and information on the number of 'regular' and 'special treatment' shares. Also listed in Appendix A are the number and percentage of regular shares or special treatment shares that hit their respective price limits on the extreme market up days and likewise for extreme market down-days.

3.2 Key variables

As noted above, we obtain daily cash flow for each of the listed A-shares in the Shanghai and Shenzhen Stock Exchanges from the RESSET database. This database classifies all buy-initiated and sell-initiated trading transactions into four categories based on the value of each transaction. The categories available in the most recent data are individual transactions of i) less than 50 thousand RMB; ii) between 50 and 300 thousand RMB; iii) between 300 thousand and 1 million RMB and iv) in excess of 1 million RMB[7]. We are particularly interested in the trading information relating to this high-value category of transactions. We use the net of buy and sell transactions in this category as a proportion of total transactions in each firm's on each trading day as our proxy for daily institutional trading activity. Drawing inspiration from Chen *et al.* (*op cit.*), the key proxies we define for each listed firm, are i) *NETBUY*, defined as the total of buy transactions in excess of 1 million RMB less the total of individual sell transactions in excess of 1 million RMB divided by the total value of the firm's shares outstanding and ii) *NETSELL*, defined as the total of sell transactions in excess of 1 million RMB less the total of individual buy transactions in excess of 1 million RMB, divided by the total value of the firm's shares outstanding.

3.3 Dependent variables

Consistent with Dennis and Strickland (*op cit.*) and Tian *et al.* (*op cit.*), we begin by examining the performance of individual firm's A-shares on extreme market movement days as represented by abnormal firm-level daily returns and abnormal firm-level daily turnover. Abnormal daily returns (AR) are computed from a market model in which firm i's returns are compared to market returns over the time horizons from 250 to 50 days before each extreme market movement day (hereafter, [*t*-250, *t*-50]). Abnormal turnover (*ATURN*) is the difference between turnover in firm *i*'s shares on extreme market movement days relative to the median turnover in firm i's shares over the relevant time horizon [*t*-250,

[7] Transactions data were obtained from the RESSET Financial Research Database. Unfortunately, the reporting thresholds used prior to 2013 were different, leading us to focus on the one threshold that is available on a consistent basis throughout our full sample; that is transactions in excess of 1 million RMB.

t-50]. Turnover is defined as the trading volume on the extreme market movement day scaled by the total tradable shares outstanding.

We also examine the performance of listed firms' stocks in the days following extreme market movement days and pay particular attention to those firms whose stocks hit the statutory price limit during trading on the extreme market movement day.

Similar to Chen *et al.* (*op cit.*), we decompose the first-day return into i) *CTO*, the overnight component and ii) *OTC*, the 'open to close return'. *CTO* is calculated using the closing price on the extreme market movement day and the opening price on the next trading day. *OTC* is constructed using the opening and closing prices of the stocks on the first day of trading after the extreme market movement day. We then construct a set of abnormal returns using several different horizons, specifically abnormal returns achieved by the close of the 1st, 2nd, 3rd, 4th and 5th day relative to the extreme market movement day and cumulative abnormal returns from [6, 10], [11, 20], [21, 60] and [61, 120] trading days relative to on the extreme market movement day.

3.4 Control variables

We also include a set of control variables in our regressions, these are defined for as follows: i) *SIZE*, the natural logarithm of the market value of firm i's equity 50 days before each extreme market movement day; ii) *TURNOVER*, defined, for firm i on day t, as the ratio of shares traded to total shares outstanding; iii) *VARIANCE* and iv) *BETA*, defined as the residual variance and the beta of the firm's daily returns obtained from the estimation of the market model estimated for firm i, at time t, over the sample [t-250, t-50] in which market returns are represented by returns in the value-weighted Shanghai or Shenzhen Composite index.

These control variables are included to capture influences on daily firm-level returns that are unrelated to daily variation in institutional trading activity. The inclusion of *SIZE* controls for the fact that i) institutional investors generally prefer to invest in large firms (e.g. Lakonishok et al., 1992); and ii) firm size captures one dimension of systematic risk (see Banz, 1981; Fama and French, 1993). *TURNOVER* is included since institutional investors are generally found to have a preference for highly liquid stocks (Falkenstein, 1996; Gompers and Metrick, 2001). Relative to retail (individual) investors, institutional investors tend to be considered as informed investors (e.g. Wermers, 2000; Li and Wang, 2010), on this basis institutional holdings are expected to be negatively related to firm-level information asymmetry. The inclusion of *VARIANCE* is intended to capture the likelihood that institutional investors are averse to investing in stocks that experience fewer idiosyncratic shocks (Falkenstein, 1996). *BETA* is included as an additional, commonly used, a proxy for systematic risk. If institutional investors have a preference for holding stocks with a high beta, then regressions might otherwise be subject to omitted variable bias.

3.5 Descriptive statistics

Table 1 provides descriptive statistics for the key variables used in our analysis of extreme market movement days in the Shanghai and Shenzhen markets. Extreme market movement days are separated into up- or down-extreme days according to the sign of market return. In the Shanghai market, we capture a total of 38,740 firm-day observations on extreme up-days, and a larger number of firm-day observations, 45,411 on extreme-down days. The distribution shows an asymmetry toward the downside in the Shenzhen stock market over our sample period. There are a total of 48,173 firm-day observations on extreme up-days, which is far fewer than the 76,972 firm-day observations on extreme-down days.

The sign of *NETBUY (NETSELL)* is of particular interest in this study since this reflects the trading directions observed in the cash flow data for largest transactions by value, which is our proxy for the trading behaviour of institutional investors. The values of *NETBUY (NETSELL)* have been multiplied by 100 for convenience. The means and medians of firm-level *NETBUY* and *NETSELL* on extreme-up and extreme-down days are positive across both markets, suggesting that, on average, the high-value transactions are likely to be institutional trader instigated purchases (sales) on the extreme market up (down) days. The mean of *NETBUY* (after multiplying by 100) is 0.191 (0.258) on Shanghai (Shenzhen) extreme-up days, which is much higher than the mean of *NETSELL*, of 0.024 (0.008) on Shanghai (Shenzhen) extreme-down days[8]. We infer that high-value trades, mostly instigated by institutional investors, have a more pronounced effect in exacerbating movements on the extreme market up days relative to extreme market down days[9].

Regarding the discernible differences in four control variables in our study between two markets, Table 1 reports summary statistics that reveal *SIZE* is greater on average for firms in the Shanghai stock market relative to Shenzhen. At the same time, *TURNOVER*, *VARIANCE* and *BETA* tend to be lower.

Table 1 Descriptive statistics

The table records descriptive statistics of key variables used in our analysis of extreme market movement days in the Shanghai and Shenzhen stock markets (where extreme movement days are defined as those on which the absolute market return exceeds two standard deviations above mean). *RETURN* is the stock return on extreme days, and AR is abnormal stock return calculated from a simple CAPM model. *NETBUY* (*NETSELL*) refers to net values of large individual buy (sell) trades – our proxy for institutional trading behaviour is discussed in Section 3.2, its values have been multiplied by 100 for convenience. *SIZE*, *TURNOVER*, *BETA* and *VARIANCE* are control variables, as defined in section 3.4.

[8] We have repeated these estimates replacing our preferred institutional trading proxy with the aggregate and disaggregated institutional ownership proxy used in Tian et al. (*op cit.*) over our sample; we obtained results that are quantitatively and qualitatively similar to theirs, this suggests that the difference in the institutional trading proxies are the source of differences between our core results and theirs, not the different sample periods we examine (full results are available on request).

[9] Across all the extreme market movement days in our sample, the proportion of transactions that are identified as high-value institutional trades (whether buy-initiated or sell-initiated) is 24.65% on the Shanghai stock exchange and 17.16% on the Shenzhen stock exchange.

	Mean	Min	25th	Median	75th	Max	Std.
Panel A: Shanghai extreme-up days					(number of observations 38,740)		
RETURN	0.041	-0.100	0.021	0.037	0.059	0.106	0.031
AR	0.003	-0.159	-0.012	-0.002	0.020	0.109	0.031
NETBUY	0.191	-27.209	0.000	0.037	0.199	27.473	0.913
NETSELL	-0.191	-27.473	-0.199	-0.037	0.000	27.209	0.913
SIZE	22.543	19.081	21.736	22.355	23.133	28.374	1.185
TURNOVER	0.032	0.000	0.012	0.023	0.041	0.523	0.031
BETA	1.080	-0.545	0.838	1.116	1.338	2.687	0.361
VARIANCE	0.072	0.002	0.034	0.057	0.095	2.059	0.062
Panel B: Shanghai extreme-down days					(number of observations 45,411)		
RETURN	-0.056	-0.101	-0.093	-0.055	-0.033	0.101	0.037
AR	-0.009	-0.105	-0.03	-0.008	0.01	0.232	0.036
NETBUY	-0.024	-10.324	-0.167	-0.038	0.008	23.447	0.658
NETSELL	0.024	-23.447	-0.008	0.038	0.167	10.324	0.658
SIZE	22.556	19.081	21.736	22.388	23.185	28.429	1.212
TURNOVER	0.032	0.000	0.012	0.023	0.042	0.502	0.032
BETA	1.074	-0.275	0.833	1.104	1.342	3.971	0.353
VARIANCE	0.083	0.002	0.042	0.067	0.105	59.354	0.286
Panel C: Shenzhen extreme-up days					(number of observations 48,173)		
RETURN	*0.052*	*-0.1*	*0.033*	*0.047*	*0.069*	*0.102*	*0.028*
AR	*0.002*	*-0.192*	*-0.014*	*-0.002*	*0.016*	*0.134*	*0.026*
NETBUY	0.258	-15.405	0.000	0.080	0.287	21.932	0.67
NETSELL	-0.258	-21.932	-0.287	-0.080	0.000	15.405	0.67
SIZE	22.01	18.983	21.32	21.977	22.67	26.001	1.053
TURNOVER	0.041	0.000	0.017	0.031	0.054	0.604	0.036
BETA	1.226	-1.291	1.046	1.239	1.418	2.329	0.263
VARIANCE	0.117	0.003	0.043	0.073	0.112	375.562	3.295
Panel D Shenzhen extreme-down days					(number of observations 76,972)		
RETURN	*-0.059*	*-0.101*	*-0.096*	*-0.06*	*-0.037*	*0.102*	*0.037*
AR	*-0.001*	*-0.129*	*-0.021*	*-0.004*	*0.014*	*0.265*	*0.032*
NETBUY	-0.008	-13.74	-0.144	-0.012	0.024	27.578	0.655
NETSELL	0.008	-27.578	-0.024	0.012	0.144	13.74	0.655
SIZE	21.94	18.817	21.215	21.919	22.62	26.004	1.062
TURNOVER	0.038	0.000	0.015	0.029	0.05	0.591	0.036
BETA	1.196	-2.189	1.016	1.197	1.383	5.611	0.268
VARIANCE	0.098	0.003	0.038	0.063	0.099	353.624	1.881

4. Empirical Analysis

4.1 Extreme market movement days

Our central hypothesis (hypothesis 1) is that high-value transactions, the majority of which are instigated by institutional investors, destabilize the Chinese stock markets. We draw on the methodology used in Dennis and Strickland (*op cit.*), but use our preferred proxy. We expect our central hypothesis to be reflected in our institutional trading proxy exacerbating both firm-level abnormal returns and abnormal turnover on extreme market movement days. Specifically, we estimate the following regressions for all extreme market up days using a Fama and MacBeth (1973) approach:

$$AR_i = \gamma_{10} + \gamma_{11}NETBUY_i + \gamma_{12}SIZE_i + \gamma_{13}TURNOVER_i + \gamma_{14}VARIANCE_i + \gamma_{15}BETA_i + \varepsilon_{1i} \quad (1)$$

$$ATURN_i = \gamma_{20} + \gamma_{21}NEYBUY_i + \gamma_{22}SIZE_i + \gamma_{23}VARIANCE_i + \varepsilon_{2i} \quad (2)$$

where, AR_i denotes abnormal returns, and $ATURN_i$ abnormal turnover, of firm *i* on the extreme market up days; $NETBUY_i$ is defined as high-value net purchases as a proportion of the total value of firm *i*'s tradable shares outstanding. All other variables are as defined as set out in section 3.3.

Next, we estimate similar regressions for a sample of all extreme market down days, using the *NETSELL* variable as

$$AR_i = \gamma_{30} + \gamma_{31}NETSELL_i + \gamma_{32}SIZE_i + \gamma_{33}TURNOVER_i \quad (3)$$
$$+\gamma_{34}VARIANCE_i + \gamma_{35}BETA_i + \varepsilon_{3i}$$

$$ATURN_i = \gamma_{40} + \gamma_{41}NEYSELL_i + \gamma_{42}SIZE_i + \gamma_{43}VARIANCE_i + \varepsilon_{4i} \quad (4)$$

where, AR_i denotes abnormal returns and $ATURN_i$ abnormal turnover of firm *i* on extreme down days; $NETSELL_i$ is defined as high-value net sales as a proportion of the total value of firm *i*'s tradable shares outstanding, All other variables are defined as set out in section 3.3.

Taking the extreme market up day regressions by way of illustration: a significant estimated coefficient on the $NETBUY_i$ term in equations (1) and (2) would indicate that the high-value net purchase trades in individual firms' shares are associated with higher abnormal returns and higher abnormal turnover respectively, providing evidence that these high-value trades, the majority of which will have been instigated by institutional investors, exacerbate market swings providing evidence in support of Hypothesis 1.

Table 2 presents results of estimating equations (1) to (4) for each of the Shanghai and Shenzhen stock markets where the sample includes all listed companies and every extreme market up or down movement day over the period 2010-2017. The equations are estimated using the Fama-MacBeth (1973) approach. We focus on the estimated impact of institutional trading behaviour on firm-level stock returns on extreme market up (down) days. As explained previously, institutional trading is represented by the net of large net-buy (sell) transactions in individual firms' stocks as a percentage of the total value of the firm's stocks outstanding. The key coefficients of interest in columns (1) and (3) relate to the estimated relationship between firm-level abnormal stock returns and high-value net-buy transactions on the extreme market up days in each of the Chinese stock markets. Columns (2) and (4) similarly focus on the relationship between firm-level abnormal stock returns and large net-sell transactions on the extreme market down days. In each case, the coefficient on the high-value net-buy (net-sell) transactions has the expected positive (negative) sign and is significant at the 1% level. More specifically, the coefficient of *NETBUY* (*NETSELL*) in the Shanghai stock market is 1.898 (-2.809), which implies that a 1% increase in the high-value transactions as a share of total tradable shares outstanding is associated with an increase (decrease) of approximately 1.9% (2.8%) in abnormal stock

returns. From these results, we infer that the large trades attributable to institutional investors have a significant destabilizing effect on abnormal returns on extreme market movement days.

Furthermore, the estimated destabilizing impacts are greater in the Shanghai stock market relative to the Shenzhen stock market. These findings provide support for Hypothesis 1 but are contrary to the estimated stabilizing effect of institutional ownership reported in Tian *et al.* (*op cit.*). Nonetheless, we stress that their results rely on quarterly data on institutional ownership to proxy institutional trading activity. In contrast, our results rely on our more timely proxy for daily institutional trading activity. It seems likely that their quarterly proxy is simply not able to capture the shorter-term variation in institutional trading behaviour and that this distorts their results.

Column (5), (6), (7) and (8) in table 2 report the estimated impacts of institutional trading on abnormal turnover of firms' stocks on extreme market movement days. The results indicate that high-value transactions attributed to institutional investors (*NETBUY*) significantly exacerbate abnormal turnover on the extreme market up days, which is again consistent with Hypothesis 1. However, large net-sell transactions (*NETSELL)* are associated with a significant decrease in the abnormal turnover on the extreme market down days. More specifically, one percent increase in *NETBUY* is associated with an average increase of 1.981 (1.939) percent in abnormal turnover for shares listed in the Shanghai (Shenzhen) market on the extreme market up days. And on the extreme market down days, a one percent increase in *NETSELL* is associated with a decrease in abnormal turnover of 1.419 (1.137) percent in the Shanghai (Shenzhen) market.

It is interesting to note that these differential estimated impacts of *NETBUY* and *NETSELL* on abnormal turnover on the extreme market movement days are consistent with the so-called 'disposition effect' first put forward by Shefrin and Statman (1985). The disposition effect refers to the tendency for investors to sell assets that have increased in value, to realize the gain, while retaining assets that have fallen in value, in the hope of a reversal in their performance in the near future. Several researchers have formalized the disposition effect using prospect theory within behavioural finance. Prospect theory incorporates investors' perceptions of gains and losses, see for example see Kyle, Ou-Yang, Xiong (2006), Henderson (2012), and Li and Yang (2013) for more detailed discussions of related theories.

Table 2: Abnormal returns and abnormal turnover, Shanghai and Shenzhen stock market

This table reports regression results used to investigate the impacts of high-value trades conducted by institutional investors on abnormal stock returns and abnormal turnover, respectively. The sample includes all A-shares listed on the Shanghai and Shenzhen Stock Exchanges and all extreme market up or down movement days over the period 2010 to 2017. Results are for estimation of Equations (1)-(4) which are Fama-MacBeth (1973) style regressions. The dependent variables are stocks' abnormal returns (*AR*) on the extreme market movement day,

calculated from the market model over [t-250, t-50]; and abnormal turnover (*ATURN*), calculated from the difference between turnover on extreme days and the median turnover upon [t-250, t-50]. The key explanatory variables are *NETBUY* and *NETSELL* which are our proxies for institutional trading behaviour, referring to the net of large buy and sell transactions that take place on extreme market movement days. All variables are defined in section 3, t-values are shown in parenthesis. "***", "**" and "*" represent statistical significance at 1%, 5% and 10% levels respectively.

	Dependent variables: Abnormal returns				**Dependent variables: Abnormal turnover**			
	Shanghai stock market		Shenzhen stock market		Shanghai stock market		Shenzhen stock market	
	Up	Down	Up	Down	Up	Down	Up	Down
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
NETBUY	1.898***		1.406***		1.981***		1.939***	
	(10.0)		(9.54)		(19.0)		(13.2)	
NETSELL		-2.809***		-2.529***		-1.419***		-1.137***
		(-11.8)		(-16.2)		(-10.2)		(-6.88)
SIZE	0.000	0.003***	-0.001**	0.003***	-0.001***	-0.001**	-0.001*	-0.001
	(0.20)	(4.99)	(-2.19)	(6.18)	(-3.27)	(-2.56)	(-1.78)	(-1.05)
TURNOVER	-0.033*	0.128***	-0.046***	0.084***				
	(-1.86)	(5.72)	(-3.38)	(4.25)				
VARIANCE	0.007	-0.046***	0.012*	-0.025***	-0.047***	-0.060***	-0.065***	-0.052***
	(0.84)	(-5.00)	(1.70)	(-3.45)	(-4.65)	(-6.21)	(-6.09)	(-6.25)
BETA	-0.022***	0.023***	-0.021***	0.026***				
	(-12.3)	(8.74)	(-11.7)	(12.3)				
Constant	0.020	-0.094***	0.052***	-0.109***	0.040***	0.041***	0.032*	0.022
	(1.14)	(-6.23)	(3.97)	(-8.41)	(3.71)	(3.20)	(1.90)	(1.59)
No. Obs.	38,740	45,411	48,173	76,972	38,740	45,411	48,173	76,972
R^2	0.595	0.510	0.397	0.333	0.445	0.413	0.382	0.352

Our finding that institutional trading activity exacerbates abnormal turnover on the extreme market up days, yet decreases abnormal turnover on the extreme market down days is perhaps surprising. However, a plausible explanation for this finding that draws on the existing literature is that actions of institutional traders on the extreme market down days can often instigate panic selling by large numbers of individual (retail) investors. Panic selling is likely to result in more shares hitting the regulator imposed price limits during the trading day. Once a limit is hit, this prevents any further transactions occurring that would depress the price of a limit-hitting stock any further, until the next trading day. Such temporary suspensions in trading depress the liquidity of the affected stocks (e.g. Kim and Rhee, 1997) and could explain the estimated negative impact on abnormal turnover. More generally, the potential for regulator imposed price limits to conflate the impacts of institutional trading on, and following extreme market movement days motivates our analysis of post-extreme day performance.

4.2 Post-extreme day performance

We now turn to explain how we test Hypothesis 2, i.e. whether stock prices continue to rise (fall) in the days immediately after hitting the applicable price limit on extreme market movement days. Given that different price limits apply, we analyze regular stocks and special treatment stocks separately. In what follows, we describe our approach to the analysis of regular stocks.

We first group all stock-day observations into nine categories based on the magnitude of day-0 excess returns, i.e. the magnitude of the return recorded on each extreme market up day and on each extreme market down day, respectively. In the case of the extreme market up days, the first group consists of stocks that hit the price limit of +10%; the next group of stocks are those that rise by at least 9% but less than 10%; and four other groups capture stocks that move within one percentage point bands. Three more bands capture those stocks that rise by <5% or fall up to 5%; those that fall more than 5% but less than 10%; and finally, those that hit the lower limit. For trading following the extreme market down days we look in most detail at the price falls: the first group consists of stocks that hit the lower limit of -10%; then those that fall by at least 9% but less than 10%, those that fall by at least 8% but less than 9% and so on. The final three groups capture stocks that see their prices change by up to 5% in either direction; that rise by more than 5% but less than 10%; and finally those that hit the upper limit on extreme market down days. Our next step is to decompose the first-day abnormal return for each group of stock-days into i) CTO (i.e. the overnight return), calculated from the closing price on the extreme market movement day and the opening price on the following trading day and ii) OTC, which refers to the return calculated from the opening and closing price on the first trading day following the extreme market movement day. We also report the abnormal returns for the stocks in each group over the 2nd, 3rd, 4th and 5th trading days following each extreme market movement day and cumulative abnormal returns over days 6 to 10, 11-20, 21-60 and 61-120. The results of this analysis will allow us to infer whether or not abnormal returns continue to increase (decrease) in the days following extreme market up (down) days. We shall also check whether there are clear differences in the subsequent direction of movements in abnormal returns for i) stocks that hit a statutory price limit during trading on the extreme market movement day, as distinct from ii) stocks that experienced price changes within the permitted limits during trading on extreme days.

Finally, our investigation turns to hypothesis 3: whether the high-value net trades on extreme market movement days, which are in the main instigated by institutional investors, are significant predictors of subsequent movements in firm-level abnormal stock returns. Our investigation again pays particular attention to those stocks that hit the price limit on extreme market movement days. Following Chen *et al.* (*op cit.*) we pool all the stock-day observations in our sample. We then analyze regular and special treatment stocks separately due to differences in the applicable price limits. However, while Chen *et al.* focus on daily data for the Shenzhen market over the full period 2012-2015, our analysis spans extreme market up and down days over the period 2010-2017, and is conducted separately for the Shanghai and Shenzhen stock markets. We set out the details of our analysis on regular stocks below, while the analysis of special treatment stocks is set out in Appendix B.

The regressions estimated for regular stocks on extreme market up days and for extreme market down days are specified as follows:

$$RET_{i,t+n\to t+m} = \gamma_{50} + \gamma_{51}UPPER_{i,t} + \gamma_{52}NETBUY_{i,t} + \gamma_{53}UPPER_{i,t} * NETBUY_{i,t} + \gamma_{54}EIGHT_{i,t} + \gamma_{55}EIGHT * NETBUY_{i,t} + \gamma_{56}SIX_{i,t} + \gamma_{57}SIX * NETBUY_{i,t} + \gamma_{58}FOUR_{i,t} + \gamma_{59}FOUR * NETBUY_{i,t} + \gamma_{510}SIZE_{i,t} + \gamma_{511}TURNOVER_{i,t} + \gamma_{512}VARIANCE_{i,t} + \gamma_{513}BETA_{i,t} + \varepsilon_{i,t}$$

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

$$RET_{i,t+n\to t+m} = \gamma_{60} + \gamma_{61}LOWER_{i,t} + \gamma_{62}NETSELL_{i,t} + \gamma_{63}LOWER_{i,t} * NETSELL_{i,t} + \gamma_{64}NEIGHT_{i,t} + \gamma_{65}NEIGHT * NETSELL_{i,t} + \gamma_{66}NSIX_{i,t} + \gamma_{67}NSIX * NETSELL_{i,t} + \gamma_{68}NFOUR_{i,t} + \gamma_{69}NFOUR * NETSELL_{i,t} + \gamma_{610}SIZE_{i,t} + \gamma_{611}TURNOVER_{i,t} + \gamma_{612}VARIANCE_{i,t} + \gamma_{613}BETA_{i,t} + \varepsilon_{i,t}$$

where $n, m \in \{1,2,3,4,5,10,20,60,120\}$ (6)

where, $RET_{i,t+n\to t+m}$ is the dependent variable, defined as the market-adjusted abnormal returns for stock *i* on days 1, 2. 3. 4 and 5 (previously denoted $AR_{i,t+n,t+n+1}$), and cumulative abnormal returns over various time windows subsequent to extreme market up day *t*, specifically over days [6, 10], [11, 20], [21, 60] and [61, 120].

$UPPER_{i,t}$ is a dummy variable which is equal to one if the price of stock *i* on day *t* rises by 10% during the trading, so the upper price limit is hit, and is zero otherwise. $LOWER_{i,t}$ is a dummy variable which is equal to one if the price of stock *i* on day *t* falls by 10% during trading, so the lower price limit is hit, and is zero otherwise. To allow comparison of price dynamics on days following extreme market movements of stocks that hit price limits with those of stocks that did not hit the price limits, we also include three further dummy variables in each regression, for equation (5) we define $EIGHT_{i,t}$, $SIX_{i,t}$ and $FOUR_{i,t}$ which set to 1 for stocks that experience within limit price rises in three 2% intervals (<10% but ⩾8%, <8% but ⩾6%, <6% but ⩾4% respectively) and zero otherwise, while $NEIGHT_{i,t}$, $NSIX_{i,t}$ and $NFOUR_{i,t}$ for equation (6), for similarly defined within limit price falls. All other variables are defined as previously.

Our key interest is in the estimated coefficients on the interaction term *UPPER * NETBUY* on extreme market up days and *LOWER * NETSELL* on extreme market down days. More specifically, significant positive estimates of the coefficients on these interaction terms, γ_{53} and γ_{63} in Equations (5) and (6) respectively, would be consistent with delays in the price adjustment of stocks in the days following extreme market movement days, for those stocks that hit the upper-price-limit (lower-price-limit) and sustained high-value net-buy (net-sell) transactions on the extreme market movement day.

Tables 3 and 4 report the abnormal returns and cumulative abnormal returns of regular stocks over periods that follow each of the extreme market movement days over the period 2010 and 2017. The

regressions cover all A-shares listed on the Shanghai and Shenzhen stock exchanges respectively. As explained in section 4.2, we group the stocks by the magnitude of their day-0 price changes, i.e. the price change recorded on the extreme market movement day. This approach allows us to explore whether subsequent price dynamics differ for stocks that hit price limits during trading on the extreme market movement day relative to those stocks that experience lesser, within the limit, price changes.

The first row records abnormal returns and cumulative abnormal returns on days after extreme market movement days for those regular stocks that hit the 10% upper price limit during trading on the extreme market movement day. It is striking that abnormal returns for this group of stocks continue to be positive and significant over horizons of up to two subsequent days in both markets. This pattern is not evident in stocks that record substantial within limit rises on the extreme up days (compare Panel A row 1 with rows 2 onwards). More specifically, the first row of Panel A in Table 3 (Table 4) report the close-to-open (CTO) return is on average 2.64% (2.59%), and abnormal returns continue to be positive during trading on the first day following the extreme movement day, on average at 1.52% (0.8%). Our results further indicate that stock prices continue to rise by 1.31% (0.46%) on average on the second subsequent day of trading. We can see a pattern of partial price reversal occurs on days 3 and 4. However, the estimated cumulative abnormal returns show no evidence of significant longer-run price reversal (as indicated in the absence of significant negative cumulative abnormal returns in the rightmost columns of Panel A).

Likewise, the abnormal returns of regular stocks that hit the lower price limit during trading on the extreme market down days continue to be negative and significant for horizons of up to two subsequent days, in both markets. Again, though, there is no clear pattern in the subsequent abnormal returns of shares that recorded lesser (within-limit) falls on the extreme market movement days (compare Panel B final row with the rows above).

More specifically, the final rows of Panel B in Tables 3 and 4 show the pattern of subsequent abnormal returns and cumulative abnormal returns for those stocks that hit the lower price limit during trading during extreme market down days in the Shanghai and Shenzhen markets respectively. The close-to-open return (CTO) of -2.49% (-2.92%) indicates significant drops in the stock prices when the market opens for trading on the first day following the extreme down day. A more moderate average drop of -0.24% (-0.49%) is recorded during trading, as indicated in the open-to-close (OTC) return. These groups of stocks continue to record negative abnormal returns on average on days 2 through to 4 in the Shanghai market (though only to day 2 for the Shenzhen market).

It is notable that over the longer-term, there is evidence of subsequent price reversal of the stocks that hit lower price limits during trading on the extreme market down days. For example, the table records significant positive cumulated abnormal returns over the horizon [61, 120] days of on average 1.86% (2.09%) in the Shanghai and Shenzhen samples. In contrast, there is no evidence of significant longer

run price reversal for stocks that hit upper price limits during trading on extreme market up days. This result is revealed by contrasting the significant positive coefficients from the rightmost columns of Panel B with the lack of significance and more variable negative estimates shown in the rightmost columns of Panel A. Although note the strong reversal found in the Shanghai samples over the horizon [11, 20] days of, on average, -2.94%.

That the patterns referred to above are clear among shares that hit statutory price limits during extreme market movement days. They are not evident among stocks that traded within the price limits. Together, this provides clear evidence of the importance of stocks hitting binding price limits in determining post-extreme day performance. These results are similar to those reported in Chen *et al.* (*op cit*) although ours indicate more pronounced price dynamics of stocks that hit price limits on days following extreme market movement days than theirs. However, note that their results relate to days on which individual stocks hit upper price limits in the Shenzhen market only, while our analysis covers the extreme up or down market movement days across both the Shenzhen and Shanghai stock markets, over a longer period. It seems entirely plausible that binding price limits would have a greater influence on subsequent price dynamics in days following the extreme market movement days than after a small number of individual stock prices record large upward movements (on non-extreme market movement days). Another distinction between Chen et al.'s work and our own is that their institutional trading variable is sourced from a proprietary database; our data on high-value net trades are constructed from free-to-access data.

Our comparable analysis of special treatment stocks is reported in Appendix B, in Tables B.1 and B.2. Note first that the number of observations used in this analysis is necessarily far smaller, which is likely to impact the precision of the estimates. Nonetheless, following extreme market up days, those special treatment shares that hit the upper price limit in trading show significant and positive subsequent abnormal returns (from open to close on the day after the extreme movement day and on the subsequent day in the Shanghai market, and at the opening of trading after the extreme market movement day and over the next two days in the Shenzhen market. Likewise, special treatment stocks that hit lower price limits on the extreme market down days show negative CTO returns and negative abnormal returns for several subsequent days of trading in both the markets, more persistently so than in the case of regular stocks. Cumulative abnormal returns show now indication of significant price reversals in the case of

Table 3 Post-extreme day performance of regular stocks in the Shanghai stock market

The table records log abnormal returns and logged cumulative abnormal returns at various horizons following extreme market movement days. The sample includes all stocks listed in Shanghai stock market during 2010 to 2017. Stocks are separated into groups according to the extent of the price rise/fall recorded on the extreme market movement day (day 0), as indicated in the first column. The numbers of shares in each group are indicated in the far right column (Obs.). CTO refers to the return calculated from the closing price on day 0 and the open price on the subsequent trading day, day 1. OTC refers to the return calculated from the opening and closing price on day 1. Columns headed day 2, 3, 4 and 5 refer to the abnormal return on the 2nd, 3rd, 4th and 5th day relative to day 0. [6, 10], [11, 20], [21, 60] and [61, 120] refer to the cumulative abnormal return from time window over 6th to 10th, 11th, to 20th, 21st to 60th, and 61st to 120th day relative to day 0. Abnormal returns are calculated using stock's daily return minus the expected return from a market model. "***", "**" and "*" represent statistical significance at 0.1%, 1% and 5% levels respectively.

	CTO	OTC	Day 2	Day 3	Day 4	Day 5	[6, 10]	[11, 20]	[21, 60]	[61, 120]	Obs.
Panel A (Abnormal) returns of regular stocks in Shanghai stock market following extreme market up days											
Upper Hit	2.64%***	1.52%***	1.31%***	-0.78%***	-0.41%***	1.06%***	2.06%***	-2.94%***	1.69%***	0.06%	3300
[9%, 10%)	-0.06%	-0.16%	-0.45%**	-0.24%	0.51%***	0.54%***	0.49%	-5.00%***	1.09%*	0.52%	1050
[8%, 9%)	-0.59%***	-0.38%**	-1.08%***	-0.39%**	0.73%***	-0.02%	0.31%	-3.14%***	1.83%***	-0.99%**	1139
[7%, 8%)	-0.27%***	0.30%**	-0.53%***	-0.36%***	0.38%***	-0.04%	0.17%	-2.61%***	1.03%**	-0.66%*	1542
[6%, 7%)	-0.25%***	0.49%***	-0.47%***	-0.06%	0.02%	-0.18%*	0.55%*	-1.42%***	1.22%***	0.05%	2310
[5%, 6%)	-0.21%***	0.80%***	-0.30%***	0.17%**	-0.01%	0.07%	1.23%***	-0.86%***	1.02%***	0.87%***	3249
[-5%, 5%)	-0.16%***	0.55%***	0.03%	0.05%**	-0.42%***	0.08%***	1.22%***	0.29%***	1.76%***	0.95%***	24770
(-10%,-5%)	-1.35%***	0.80%	-2.21%***	-2.22%***	-3.2%***	-0.12%	-4.03%	-3.38%	2.74%	-1.96%	64
Lower Hit	-7.54%***	5.43%**	-5.52%***	-4.28%**	-5.01%**	-1.33%	-8.78%	-5.69%	3.27%	3.68%	18
Panel B (Abnormal) returns of regular stocks in Shanghai stock market following extreme market down days											
Upper Hit	0.09%	1.53%**	-0.22%	-0.65%	-1.11%**	-0.82%*	2.02%	-1.55%	-1.76%	3.5%**	180
[5%, 10%)	-2.18%***	2.01%***	0.01%	-1.19%***	-0.87%**	-1.33%***	0.18%	-0.56%	0.41%	1.10%	280
[-5%, 5%)	-0.51%***	0.67%***	-0.17%***	-0.17%***	-0.50%***	-0.30%***	0.76%***	0.37%***	0.72%***	1.19%***	18362
[-6%, -5%)	-0.46%***	0.23%***	0.00%	-0.15%**	-0.42%***	-0.09%*	0.59%**	0.76%***	0.85%***	1.11%***	4139
[-7%, -6%)	-0.56%***	0.25%***	-0.09%	-0.21%***	-0.45%***	-0.08%	0.65%**	0.31%	0.38%*	1.06%***	3389
[-8%, -7%)	-0.66%***	0.42%***	-0.05%	-0.47%***	-0.42%***	0.09%	0.86%**	0.66%*	0.8%***	0.81%***	2768
[-9%, -8%)	-0.45%***	0.3%**	-0.07%	-0.70%***	-0.51%***	0.34%***	0.71%*	0.8%**	0.65%**	0.91%***	2368
(-10%, -9%)	-0.66%***	0.63%***	-0.02%	-0.42%***	-0.39%***	0.04%	0.76%**	0.61%*	0.11%	1.28%***	3528
Lower Hit	-2.49%***	-0.24%**	-0.86%***	-0.94%***	-0.81%***	-1.25%***	-3.56%***	2.93%***	-0.13%	1.86%***	8678

Table 4 Post-extreme day performance of regular stocks in Shenzhen stock market

The table records log abnormal returns and logged cumulative abnormal returns at various horizons following extreme market movement days. The sample includes all stocks listed in Shenzhen stock market during 2010 to 2017. Stocks are separated into groups according to the extent of the price rise/fall recorded on the extreme market movement day (day 0), as indicated in the first column. The numbers of shares in each group are indicated in the far right column (Obs.). CTO refers to the return calculated from the closing price on day 0 and the open price on the subsequent trading day, day 1. OTC refers to the return calculated from the opening and closing price on day 1. Columns headed day 2, 3, 4 and 5 refer to the abnormal return on the 2nd, 3rd, 4th and 5th day relative to day 0. [6, 10], [11, 20], [21, 60] and [61, 120] refer to the cumulative abnormal return from time window over 6th to 10th, 11th, to 20th, 21st to 60th, and 61st to 120th day relative to day 0. Abnormal returns are calculated using stock's daily return minus the expected return from a market model. "***", "**" and "*" represent statistical significance at 0.1%, 1% and 5% levels respectively.

	CTO	OTC	Day 2	Day 3	Day 4	Day 5	[6, 10]	[11, 20]	[21, 60]	[61, 120]	Obs.
Panel A (Abnormal) returns of regular stocks in Shenzhen stock market subsequent to extreme market up days											
Upper Hit	2.59%***	0.80%***	0.46%***	-0.15%**	-0.09%	0.44%***	1.46%***	0.36%	1.41%***	1.63%***	5925
[9%, 10%)	-0.15%	-0.40%***	-0.41%***	-0.38%***	0.43%***	0.01%	1.56%***	0.51%	1.19%**	1.12%**	1460
[8%, 9%)	-0.51%***	0.02%	-0.27%***	-0.25%**	0.46%***	0.00%	1.91%***	0.67%	1.53%***	0.84%**	1848
[7%, 8%)	-0.57%***	0.30%***	-0.24%***	0.09%	0.35%***	0.04%	2.68%***	0.96%***	1.87%***	0.48%*	2612
[6%, 7%)	-0.24%***	0.60%***	-0.10%*	-0.03%	0.16%***	-0.01%	2.15%***	0.92%***	1.28%***	1.11%***	3868
[5%, 6%)	-0.11%***	0.74%***	-0.07%	-0.01%	0.16%***	0.15%***	1.98%***	0.96%***	1.39%***	1.27%***	5772
[-5%, 5%)	-0.14%***	0.81%***	-0.09%***	-0.11%***	-0.07%***	-0.03%*	1.46%***	1.12%***	1.43%***	1.46%***	25993
(-10%,-5%)	-2.06%***	-1.11%	-2.13%***	-1.93%**	-3.01%***	-0.37%	-3.19%	-0.17%	3.20%	0.18%	44
Lower Hit	-9%***	1.67%*	-5.42%***	-3.54%***	-1.04%	-1.00%	2.58%	-0.68%	1.60%	2.92%*	56
Panel B (Abnormal) returns of regular stocks in Shenzhen stock market subsequent to extreme market down days											
Upper Hit	-0.14%	3.25%***	0.89%**	0.33%	0.30%	-0.79%***	1.05%	2.79%**	1.48%*	2.31%***	393
[5%, 10%)	-1.98%***	2.65%***	-0.71%***	-0.67%***	-0.53%**	-0.74%***	-0.54%	0.06%	2.06%**	1.52%**	485
[-5%, 5%)	-0.79%***	1.14%***	0.02%	-0.12%***	-0.20%***	-0.08%***	0.90%***	0.96%***	1.02%***	1.11%***	28513
[-6%,-5%)	-0.57%***	0.72%***	0.13%***	0.08%**	0.02%	0.02%	1.21%***	1.06%***	1.16%***	1.09%***	7857
[-7%,-6%)	-0.67%***	0.65%***	0.11%***	0.03%	0.02%	0.11%***	1.50%***	1.30%***	1.26%***	1.27%***	6848
[-8%,-7%)	-0.72%***	0.76%***	0.15%***	0.00%	0.04%	0.11%**	1.76%***	1.30%***	1.25%***	1.32%***	5401
[-9%,-8%)	-0.92%***	0.87%***	0.21%***	-0.01%	0.12%**	0.13%**	2.18%***	1.24%***	1.01%***	1.27%***	4403
(-10%,-9%)	-0.86%***	0.85%***	0.32%***	0.23%***	0.13%**	0.20%***	2.29%***	1.43%***	1.45%***	1.69%***	5238
Lower Hit	-2.92%***	-0.49%***	-0.19%***	0.02%	0.16%***	0.12%***	2.28%***	2.90%***	1.36%***	2.09%***	16653

those special treatment stocks that hit upper price limits during trading on the extreme market up days. Only the Shenzhen market data provides evidence of a small longer-run price reversal among stocks that hit the lower price limit during extreme market down days.

4.3 Is institutional trading a significant predictor of subsequent abnormal returns?

In this subsection, we examine whether the high-value net-buy (net-sell) transactions conducted by institutional investors on extreme market movement days have predictive power for subsequent abnormal stock returns. Panel A in Tables 5 and 6 reports the results of estimating equations (5) and (6) for regular stocks following extreme market up days in the Shanghai and Shenzhen stock markets respectively. Panel B in each table reports equivalent results for extreme market down days.

The key variable of interest in Panel A is the interaction term *UPPER*NETBUY*. That this term attracts significant positive coefficients in the abnormal returns regressions in the first three columns indicates strong support for Hypothesis 3. Specifically, that the high-value net trades in individual firms' stocks on extreme market movement days, which are dominated by the trades of institutional investors, are significant predictors of continued positive firm-level abnormal stock returns. This result applies to each of the three (four) days following the extreme market movement days, for stocks that hit the 10% upper price limit on the extreme market movement day, in the Shanghai and Shenzhen markets, respectively. Note that the significant negative coefficients on *NETBUY* in the Shenzhen results act to partially offset the effect of *UPPER*NETBUY*, but not sufficiently to generate a price reversal. In comparison, the coefficient of *UPPER*NETBUY* is 1.413 in Shenzhen stock market is higher than that of 0.468 in Shanghai stock market. There is relatively less trading by institutional investors (as a proprortion of total trades, in the Shenzhen stock market as compared to the Shanghai stock market[10]. The higher estimated coefficient on *UPPER*NETBUY* in Shenzhen stock market is likely to be attributable to the stronger attention-grabbing effect of hitting the price limit in Shenzhen stock market (e.g. Seasholes *et al.*, 2007).

These results contrast with those reported in table 4 of Chen *et al*. (op cit) p258: they estimated negative coefficients on similar interaction terms for firm-day samples over the period 2012-2015. They concluded that there was evidence of strong price reversal, associated with greater net-buys of institutional investors after upper-price limits were hit. We again suggest that the main explanation for these differences in results is that binding price limits have a distinctive influence on the subsequent price dynamics, after the extreme market movement days. In Chen *et al*.'s study, they look at all trading days in their sample in which one or more firms' stocks hit the upper price limit. The distinction is

[10] In our extreme up days samples, the average shares held by institutional investors in Shanghai and Shenzhen stock market are 45.5% and 35.8% respectively.

likely to derive from the fact that we focus on high-value transactions in specific companies' shares, which are mostly instigated by institutional investors, take place on the extreme *market* movement days. These trades are more likely to attract the attention of (less informed) retail investors.

Clear patterns are absent in the subsequent firm-level abnormal returns for stocks which recorded within limit returns on extreme market movement days. This fact again supports our conclusion that distinctive and significant subsequent price dynamics look to be concentrated in those stocks that hit the upper price on the extreme market movement days.

We now turn to our analysis of abnormal returns in regular stocks in the days following the extreme market down days. We find clear results in the Shenzhen market (Panel B in Table 6). The estimated coefficients on the interaction term LOWER**NETSELL* are positive and significant in the abnormal returns regressions, for three trading days following the extreme market down days in the Shenzhen market. This finding is consistent with significant price reversal for stocks that hit the lower price limit during trading on the extreme down days which is positively associated with the share of high-value net-sell transactions attributed to institutional investors on the extreme market down day. However, the corresponding estimates for the Shanghai stock market do not show any clear pattern. Nonetheless, the coefficient on *NETSELL* in the Shenzhen regressions, on the first day after the extreme market movement day, is 0.167. This estimate implies that a 1 unit increase in the share of high-value net-sell transactions, which are mostly instigated by institutional investors, is associated with an average increase of 0.167% in the abnormal returns of stocks in the first trading day following an extreme market down day. Our interpretation of these results is that high-value net-sell transactions on the extreme market down days tend to reflect panic selling and help to predict positive abnormal returns in the days that follow.

Table 5 Regression analysis of abnormal returns on regular stocks in Shanghai Stock Exchange

The table reports the results of estimating equations (5) and (6) to explain the abnormal returns or cumulative abnormal returns of regular stocks in the days following extreme market movement days that occurred in the Shanghai stock market over the period 2010 to 2017. Panel A reports the results for extreme up days, in which the key variable UPPER refer to regular stocks hitting 10% upper price limit and *NETBUY* refers to large net-buy transactions of institutional investors on the extreme market up days. Panel B reports the regression results for abnormal returns on regular stocks following extreme market down days, where LOWER refers to regular stocks that hit the -10% price limit and *NETSELL* to the large net-sell transactions of institutional investors on extreme market down days. Control variables in each regression include *SIZE*, *TURNOVER*, *VARIANCE* and *BETA*. All variables are as defined in section 3. Standard errors are clustered by firm and t-statistics are reported in parentheses. ***, ** and * indicate statistical significance at 1%, 5% and 10% levels respectively.

Panel A Abnormal returns in Shanghai stock market subsequent to extreme market up days

	AR Day1	AR Day2	AR Day3	AR Day4	AR Day5	CAR [6,10]	CAR [11,20]	CAR [21,60]	CAR [61,120]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
UPPER	0.035***	0.011***	-0.008***	0.004***	0.010***	0.005	-0.031***	-0.006*	-0.008***
	(25.6)	(9.96)	(-7.37)	(3.43)	(11.0)	(1.30)	(-7.83)	(-1.85)	(-2.60)
NETBUY	0.056	-0.140***	0.017	0.088**	-0.030	0.145	-0.482***	-0.292*	-0.070
	(1.08)	(-3.27)	(0.47)	(2.11)	(-0.84)	(0.94)	(-2.63)	(-1.69)	(-0.60)
UPPER *	0.468***	0.497***	0.192**	-0.397***	-0.111*	0.008	1.252***	0.762***	0.256
NETBUY	(4.61)	(6.16)	(2.46)	(-4.99)	(-1.70)	(0.04)	(4.26)	(3.39)	(1.27)
[8%, 10%)	-0.010***	-0.009***	-0.003***	0.012***	0.001	-0.007*	-0.041***	-0.008**	-0.014***
	(-8.05)	(-8.38)	(-2.75)	(11.5)	(0.86)	(-1.72)	(-9.50)	(-2.22)	(-4.52)
[8%, 10%)*	0.661***	0.669***	0.110	-0.423***	-0.028	-0.842	1.389**	1.483***	0.893**
NETBUY	(3.83)	(4.80)	(0.92)	(-3.14)	(-0.25)	(-1.35)	(2.43)	(3.16)	(1.98)
[6%, 8%)	0.000	-0.004***	-0.001*	0.007***	-0.002***	-0.009***	-0.020***	-0.006***	-0.012***
	(-0.01)	(-5.97)	(-1.72)	(9.375)	(-3.36)	(-3.38)	(-7.26)	(-2.82)	(-5.64)
[6%, 8%)*	-0.035	0.408***	-0.027	-0.304***	-0.206**	-0.005	1.229***	0.176	0.694**
NETBUY	(-0.32)	(3.19)	(-0.19)	(-3.50)	(-2.49)	(-0.01)	(4.23)	(0.51)	(2.55)
[4%, 6%)	0.006***	-0.001***	0.001	0.003***	-0.001**	0.001	-0.008***	-0.008***	-0.002
	(10.5)	(-2.77)	(1.38)	(6.01)	(-2.55)	(0.54)	(-4.59)	(-5.29)	(-1.43)
[4%, 6%)*	-0.494***	0.555***	0.315***	0.188*	-0.026	0.779**	0.879**	0.549	-0.080
NETBUY	(-4.35)	(5.72)	(2.89)	(1.90)	(-0.23)	(2.02)	(1.97)	(1.52)	(-0.25)
Control variables	yes	yes	yes	yes	yes	yes	yes	yes	yes
Constant	0.04***	0.031***	0.014***	-0.017***	0.012***	-0.002	-0.032**	0.079***	0.034***
	(11.5)	(9.74)	(4.61)	(-6.43)	(4.41)	(-0.18)	(-2.37)	(7.50)	(2.88)
No. Obs.	37409	37408	37408	37408	37408	37405	37394	37349	37240
Adjusted R^2	0.082	0.039	0.013	0.015	0.011	0.003	0.020	0.002	0.002

Panel B Abnormal returns in Shanghai stock market subsequent to extreme market down days

LOWER	-0.027***	-0.006***	-0.005***	0.000	-0.007***	-0.04***	0.034***	-0.008***	0.006***
	(-34.3)	(-9.09)	(-8.43)	(0.24)	(-11.3)	(-14.9)	(14.5)	(-4.32)	(4.04)
NETSELL	0.167**	0.033	0.071	-0.025	-0.080	-0.154	-0.197	0.108	-0.010
	(2.54)	(0.62)	(1.33)	(-0.52)	(-1.61)	(-0.76)	(-1.05)	(0.75)	(-0.11)
*LOWER**	-0.273	-0.128	-0.837***	-0.733***	0.127	-2.450***	-1.926***	0.626	0.024
NETSELL	(-1.58)	(-1.13)	(-6.38)	(-5.63)	(1.06)	(-5.54)	(-5.32)	(1.52)	(0.10)
(-10%,-8%]	-0.005***	0.002***	-0.003***	0.002***	0.005***	0.002	0.006**	-0.003	0.000
	(-6.29)	(3.27)	(-5.07)	(3.01)	(7.41)	(0.81)	(2.36)	(-1.60)	(0.08)
(-10%,-8%]*	-0.214	-0.433***	-0.664***	-0.672***	0.138	-1.864***	-0.541	-0.537	-0.373
NETSELL	(-0.99)	(-3.18)	(-4.21)	(-4.50)	(0.89)	(-3.30)	(-1.07)	(-1.17)	(-1.01)
(-8%,-6%]	-0.006***	0.001***	-0.002***	0.001***	0.003***	0.001	0.000	-0.003*	-0.003*
	(-7.96)	(2.89)	(-2.87)	(2.64)	(6.46)	(0.51)	(0.04)	(-1.69)	(-1.65)
(-8%,-6%]*	-0.568***	-0.257*	-0.166	-0.310**	-0.093	-0.728	1.090*	1.034*	0.097
NETSELL	(-2.77)	(-1.72)	(-1.04)	(-2.18)	(-0.59)	(-1.32)	(1.92)	(1.84)	(0.23)
(-6%,-4%]	-0.004***	0.002***	0.000	0.002***	0.002***	0.001	0.004**	-0.001	0.000
	(-7.29)	(5.28)	(0.40)	(3.90)	(4.01)	(0.72)	(1.97)	(-0.53)	(-0.37)
(-6%,-4%]*	-0.588**	-0.387**	-0.017	-0.205	-0.062	-0.096	-0.206	0.535	-0.050
NETSELL	(-2.33)	(-2.51)	(-0.10)	(-1.34)	(-0.44)	(-0.22)	(-0.39)	(1.47)	(-0.20)
Control variables	yes	yes	yes	yes	yes	yes	yes	yes	yes
Constant	-0.025***	-0.026***	-0.024***	-0.04***	-0.022***	-0.029**	0.067***	0.036***	0.068***
	(-5.30)	(-8.25)	(-8.13)	(-11.4)	(-5.78)	(-2.34)	(5.90)	(3.85)	(8.00)
No. Obs.	43629	43628	43627	43626	43625	43620	43604	43535	43395
Adjusted R^2	0.068	0.012	0.022	0.021	0.034	0.014	0.012	0.002	0.001

Table 6 Regression analysis of abnormal returns on regular stocks in Shenzhen Stock Exchange

The table reports the results of estimating equations (5) and (6) to explain the abnormal returns or cumulative abnormal returns of regular stocks in the days following extreme market movement days that occurred in the Shenzhen stock market over the period 2010 to 2017. Panel A reports the results for extreme up days, in which the key variable *UPPER* refers to regular stocks hitting 10% upper price limit and *NETBUY* refers to large net-buy transactions of institutional investors on the extreme market up days. Panel B reports the regression results for abnormal returns on regular stocks following extreme market down days, where LOWER refers to regular stocks that hit the -10% price limit and *NETSELL* to the large net-sell transactions of institutional investors on extreme market down days. Controls included in each regression include *SIZE*, *TURNOVER*, *VARIANCE* and *BETA*, as defined in section 3. Standard errors are clustered by firm, t-statistics are reported in parentheses. ***, ** and * indicate statistical significance at 1%, 5% and 10% levels respectively.

Panel A Abnormal returns in Shenzhen stock market subsequent to extreme market up days

	AR Day1	AR Day2	AR Day3	AR Day4	AR Day5	CAR [6,10]	CAR [11,20]	CAR [21,60]	CAR [61,120]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
UPPER	0.026***	0.008***	0.000	0.001**	0.006***	0.005*	-0.001	0.000	0.002
	(22.2)	(10.7)	(-0.61)	(1.96)	(8.61)	(1.80)	(-0.45)	(-0.10)	(0.77)
NETBUY	-0.969***	-0.167**	-0.342***	-0.413***	-0.054	1.325***	-0.388*	0.154	0.122
	(-6.84)	(-2.43)	(-4.61)	(-5.83)	(-0.82)	(3.27)	(-1.85)	(0.68)	(0.480)
*UPPER**	1.413***	0.182**	0.451***	0.308***	-0.038	-1.56***	-0.129	-0.020	-0.254
NETBUY	(8.547)	(2.149)	(5.192)	(3.662)	(-0.50)	(-3.53)	(-0.45)	(-0.07)	(-0.873)
[8%, 10%)	-0.011***	-0.001	0.000	0.007***	0.001	0.007**	-0.005	-0.001	-0.007***
	(-8.395)	(-1.073)	(-0.62)	(10.531)	(1.26)	(2.19)	(-1.60)	(-0.28)	(-2.903)
[8%,10%)*	1.524***	0.210	0.195	-0.043	-0.107	-1.772***	0.425	0.121	0.249
NETBUY	(5.092)	(1.635)	(1.317)	(-0.377)	(-0.98)	(-3.46)	(1.30)	(0.36)	(0.66)
[6%, 8%)	-0.005***	0.001**	0.002***	0.004***	0.000	0.011***	0.000	0.004**	-0.008***
	(-5.068)	(1.974)	(3.499)	(9.239)	(0.49)	(4.90)	(0.06)	(2.11)	(-3.846)
[6%, 8%)*	1.39***	0.101	0.469***	0.064	0.057	-1.478***	-0.168	-1.293***	0.172
NETBUY	(5.323)	(0.949)	(4.226)	(0.586)	(0.58)	(-2.56)	(-0.45)	(-2.86)	(0.42)
[4%, 6%)	0.001*	0.001***	0.002***	0.002***	0.001**	0.004**	0.000	-0.001	-0.003**
	(1.797)	(2.56)	(6.325)	(5.63)	(2.08)	(2.35)	(-0.08)	(-0.65)	(-2.14)
[4%, 6%)*	1.33***	0.214	0.174*	0.206	0.219*	-0.131	-0.288	0.396	1.239
NETBUY	(6.197)	(1.496)	(1.666)	(1.476)	(1.84)	(-0.21)	(-0.65)	(1.04)	(1.42)
Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes
Constant	0.066***	0.029***	0.01***	0.007**	0.009***	0.06***	0.017	0.029**	0.044***
	(15.592)	(10.523)	(3.764)	(2.455)	(3.501)	(4.45)	(1.362)	(2.484)	(3.805)
No Obs.	47534	47533	47533	47532	47530	47523	47508	47363	47000
R^2	0.047	0.017	0.004	0.007	0.006	0.003	0.001	0.001	0.001

Panel B Regular stocks from Shenzhen down extreme days

LOWER	-0.043***	-0.001***	0.002***	0.004***	0.002***	0.014***	0.020***	0.003***	0.01***
	(-64.9)	(-2.93)	(4.97)	(13.3)	(6.51)	(7.85)	(13.5)	(2.61)	(7.62)
NETSELL	0.033	0.056*	-0.014	-0.03	0.091***	-0.043	-0.048	-0.172*	-0.214
	(0.61)	(1.79)	(-0.38)	(-0.876)	(2.93)	(-0.37)	(-0.51)	(-1.73)	(-1.42)
*LOWER**	1.124***	0.189***	0.158**	-0.168**	-0.06	-0.012	0.020	0.388*	-0.017
NETSELL	(9.37)	(2.87)	(2.04)	(-2.40)	(-0.87)	(-0.04)	(0.07)	(1.69)	(-0.08)
(-10%,-8%]	-0.009***	0.004***	0.003***	0.004***	0.003***	0.014***	0.005***	0.003*	0.004***
	(-12.3)	(9.84)	(7.70)	(10.2)	(7.00)	(8.25)	(3.50)	(1.74)	(2.81)
(-10%,-8%]*	0.347**	-0.249**	0.027	0.081	0.002	-0.336	-0.345	0.162	0.006
NETSELL	(1.98)	(-2.34)	(0.27)	(0.94)	(0.03)	(-0.98)	(-1.05)	(0.52)	(0.02)
(-8%,-6%]	-0.007***	0.002***	0.002***	0.003***	0.002***	0.009***	0.004***	0.002*	0.001
	(-10.7)	(5.55)	(5.34)	(8.29)	(7.01)	(6.29)	(2.78)	(1.66)	(0.87)
(-8%,-6%]*	-0.194	0.078	0.033	0.032	-0.109	-0.886***	0.035	0.617**	0.34
NETSELL	(-1.05)	(0.91)	(0.33)	(0.46)	(-1.36)	(-2.87)	(0.11)	(2.05)	(0.94)
(-6%,-4%]	-0.005***	0.002***	0.002***	0.002***	0.001***	0.004***	0.002	0.001	-0.001
	(-8.92)	(6.86)	(7.77)	(6.95)	(3.65)	(3.70)	(1.47)	(0.71)	(-1.41)
(-6%,-4%]*	-0.253*	-0.231**	0.008	0.116	0.028	-0.295	-0.04	0.387	0.000
NETSELL	(-1.88)	(-2.44)	(0.08)	(1.52)	(0.34)	(-0.93)	(-0.13)	(1.51)	(0.00)
Controls	yes	yes	yes	yes	yes	yes	yes	yes	yes
constant	-0.035***	-0.008***	-0.011***	-0.003	0.003	-0.033***	0.054***	0.030***	0.067***
	(-8.73)	(-3.59)	(-4.87)	(-1.62)	(1.49)	(-3.12)	(5.93)	(3.49)	(8.45)
No. Obs.	75678	75672	75663	75661	75653	75634	75589	75342	73219
Adjusted R^2	0.074	0.005	0.006	0.006	0.002	0.003	0.004	0.000	0.002

4.4 Robustness checks

Up to this point, we have followed Dennis and Strickland (*op cit.*), in defining extreme market movements as occurring on days when the absolute value of the market return (as expressed in the relevant composite stock price index) exceeds two standard deviations from the mean. We have repeated our analysis with the alternative definition of extreme market movements exceeding 2.5 standard deviations from the mean. This change necessarily results in the identification of fewer extreme market movement days over our full sample. We now identify 19 extreme up days and 32 extreme down days in the Shenzhen stock market and 12 up, 40 down extreme market movement days in the Shenzhen stock market over the period 2010-2017. But importantly, the results that use this definition are qualitatively and quantitatively very similar to the core results discussed above,

5. Conclusions

Using daily stock returns of all stocks listed in the Shanghai and Shenzhen Stock Exchanges over the period 2010 to 2017, we have identified the highly volatile extreme market movement days in each market. We have further investigated the impacts of aspects of institutional trading activity on these days. Our approach contrasts with the existing literature on extreme market movement days, in which researchers have so far used a quarterly proxy for institutional trading based on the proportion of each firm's shares held by institutions. We employ a daily proxy that captures a key aspect of daily institutional trading activity. More specifically, our proxy for institutional trading activity is derived from the high-value transactions that take place in individual firms' shares on the extreme market movement days. We have referred to evidence that supports our view that the vast majority of these trades will have been initiated by institutional investors. To the best of our knowledge, the analysis presented in this paper is the first in which daily transactions data have been used in the context of extreme market movement days. Our descriptive statistics suggest that, on average, the high-value net-buy (net-sell) activity occurs on extreme market up (down) days. Our regression results provide strong evidence that the high-value net trades in individual firm-level stocks on extreme maket movement days have a significant destabilizing effect on firm-level abnormal returns in both Chinese stock markets. Since these trades are mostly instigated by institutional investors, we infer that this aspect of institutional trading activity destabilises the markets. The fact that our results contrast with those of Tian *et al.* (*op cit.*) suggests the quarterly institutional ownership data used in prior extreme day studies experiences insufficient variation to capture the most influential daily institutional trading behaviour.

We are also able to show that high-value net trades exacerbate abnormal turnover on the extreme market up days, while in contrast, abnormal turnover falls on the extreme market down days. We suggest that

the interaction of high-value institutional trades and the propensity of stocks hitting binding price limits on the extreme market down days may explain the latter result. This suggestion motivates us to incorporate consideration of daily price limits imposed by the Chinese stock market regulator into our analysis, which is one of the main contributions of this paper. By doing this, we can investigate whether the high-value net trades, mostly attributable to institutional trading activity, have distinctive impacts on the subsequent price dynamics of individual stocks that hit the upper (lower) binding price limits during extreme market up (down) days. Specifically, we focus on whether or not high-value net trades in shares that hit price limits on extreme market movement days can help to predict abnormal returns in subsequent days.

Our analysis of post-extreme day abnormal returns provides strong evidence that high-value trades have predictive power. Specifically, high-value trades in those stocks that hit price limits during the extreme market movement are significant predictors of abnormal returns in the days after extreme market movement days. We can also infer that when price limits bind, they delay price discovery. In summary, we conclude that the high-value institutional trades in price-limit-hitting stocks on extreme market movement days not only exacerbate the volatile market on those days; they also continue to predict abnormal returns, which continue in the same direction, for several subsequent days.

These findings do not necessarily mean that institutional trading is to blame for stock price movements after the extreme market movement days. Instead, we point out that is it possible the high-value net trades that have taken place, along with the news that price limits have been hit, draw the attention of large numbers of retail investors, and that this attention-grabbing effect results in further trades.

Such clear patterns of destabilizing impacts are absent in the post-extreme day firm-level abnormal returns of those stocks that remain within the permitted price limits on extreme market movement days. We believe that these results provide further support to our conclusion that distinctive and significant post-extreme day price dynamics are concentrated among stocks that: i) are initially the focus of high-value institutional trades; and ii) hit the stock market regulator imposed price limits on the extreme market movement days. It is hoped that the findings contained in this paper will be of interest to finance practitioners who want to understand the sources and patterns of market swings and also to policymakers who want to evaluate the effectiveness of imposed price limit rules on and after extreme market movement days.

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Appendix A. Extreme days in Shanghai and Shenzhen Stock Exchange

Table A.1 Extreme days in Shanghai and Shenzhen Stock Exchange

The table reports all extreme days in Shanghai (Shenzhen) stock market when the absolute value of the market return calculated from the relevant composite price index exceeds two standard deviations above mean. Specifically, we report the extreme market movement date, the market return, the numbers of regular A shares, and the number of regular A shares that hit the +10% price limit on the extreme day, the numbers of special treatment (ST) shares, of ST shares that hit the +5% price limit and the percentage of all A-shares that hit their upper price limit.

Panel A: Shanghai Up Extreme days

date	market return (%)	no. A-Shares	no. regular shares	no. regular shares that hit +10% price limit	no. of ST shares	no. ST shares that hit the +5% price limit	% of A- shares that hit the upper price limit
24/05/2010	3.48	832	755	26	77	20	5.5%
21/06/2010	2.90	831	752	4	79	7	1.3%
08/10/2010	3.13	843	767	18	76	6	2.8%
15/10/2010	3.18	835	760	14	75	3	2%
13/12/2010	2.88	844	770	12	74	4	1.9%
25/08/2011	2.92	877	801	8	76	2	1.1%
12/10/2011	3.04	887	808	11	79	4	1.7%
09/01/2012	2.89	891	818	24	73	19	4.8%
17/01/2012	4.18	887	815	53	72	19	8.1%
07/09/2012	3.70	924	885	31	39	1	3.5%
05/12/2012	2.87	921	880	17	41	5	2.4%
14/12/2012	4.32	919	879	23	40	3	2.8%
14/01/2013	3.06	920	881	23	39	4	2.9%
11/07/2013	3.23	907	879	16	28	1	1.9%
09/09/2013	3.39	917	891	23	26	0	2.5%
18/11/2013	2.87	905	877	17	28	1	2%
02/12/2014	3.11	890	870	27	20	1	3.1%
04/12/2014	4.31	889	869	34	20	1	3.9%
08/12/2014	2.81	897	877	52	20	1	5.9%
10/12/2014	2.93	906	885	46	21	2	5.3%
25/12/2014	3.36	908	886	26	22	4	3.3%
05/01/2015	3.58	915	891	51	24	1	5.7%
15/01/2015	3.54	917	893	11	24	0	1.2%
21/01/2015	4.74	919	895	25	24	2	2.9%
27/04/2015	3.04	941	919	52	22	4	6%
11/05/2015	3.04	938	913	79	25	8	9.3%
19/05/2015	3.13	940	918	57	22	9	7%
22/05/2015	2.83	938	917	107	21	11	12.6%
25/05/2015	3.35	934	913	122	21	10	14.1%
01/06/2015	4.71	933	912	159	21	8	17.9%
30/06/2015	5.53	947	925	103	22	0	10.9%
09/07/2015	5.76	661	640	576	21	4	87.7%
10/07/2015	4.54	694	673	587	21	14	86.6%
17/07/2015	3.51	926	905	151	21	8	17.2%
29/07/2015	3.44	941	919	156	22	2	16.8%
04/08/2015	3.69	932	911	204	21	7	22.6%
10/08/2015	4.92	934	911	119	23	7	13.5%
27/08/2015	5.34	907	886	110	21	0	12.1%
28/08/2015	4.82	909	888	218	21	13	25.4%

08/09/2015	2.92	912	890	104	22	7	12.2%
16/09/2015	4.89	920	898	334	22	8	37.2%
08/10/2015	2.97	917	894	47	23	2	5.3%
12/10/2015	3.28	917	894	43	23	3	5%
04/11/2015	4.31	922	900	54	22	3	6.2%
19/01/2016	3.22	998	972	54	26	15	6.9%
29/01/2016	3.09	1006	979	26	27	3	2.9%
16/02/2016	3.29	1003	976	50	27	6	5.6%
02/03/2016	4.26	990	964	72	26	11	8.4%
31/05/2016	3.34	1013	990	24	23	1	2.5%

Panel B: Shanghai Down Extreme days

date	market return (%)	no. A-Shares	no. regular shares	no. regular shares that hit -10% price limit	no. of ST shares	no. ST shares that hit the -5% price limit	% of A-shares that hit the lower price limit
13/01/2010	-3.09	839	769	0	70	3	0.4%
20/01/2010	-2.93	834	767	0	67	12	1.4%
19/04/2010	-4.79	823	752	18	71	40	7%
06/05/2010	-4.11	840	761	7	79	13	2.4%
17/05/2010	-5.07	834	758	97	76	49	17.5%
29/06/2010	-4.27	817	746	28	71	43	8.7%
10/08/2010	-2.89	834	759	1	75	9	1.2%
12/11/2010	-5.16	831	755	66	76	54	14.4%
16/11/2010	-3.98	842	766	15	76	13	3.3%
17/01/2011	-3.03	858	779	7	79	15	2.6%
20/01/2011	-2.92	849	771	2	78	8	1.2%
23/05/2011	-2.93	859	784	6	75	38	5.1%
25/07/2011	-2.96	877	802	5	75	25	3.4%
08/08/2011	-3.79	866	792	20	74	43	7.3%
30/11/2011	-3.27	882	809	4	73	19	2.6%
21/02/2013	-2.97	918	887	0	31	1	0.1%
04/03/2013	-3.65	912	882	37	30	3	4.4%
28/03/2013	-2.82	914	887	3	27	1	0.4%
13/06/2013	-2.83	898	870	5	28	7	1.3%
24/06/2013	-5.30	901	872	69	29	14	9.2%
10/03/2014	-2.86	915	894	6	21	0	0.7%
09/12/2014	-5.43	902	881	61	21	13	8.2%
23/12/2014	-3.03	906	883	12	23	3	1.7%
19/01/2015	-7.7	920	896	99	24	5	11.3%
05/05/2015	-4.06	935	909	12	26	10	2.4%
28/05/2015	-6.5	934	912	225	22	11	25.3%
16/06/2015	-3.47	929	909	27	20	15	4.5%
18/06/2015	-3.67	932	911	33	21	11	4.7%
19/06/2015	-6.42	934	913	381	21	18	42.7%
25/06/2015	-3.46	947	925	28	22	5	3.5%
26/06/2015	-7.40	951	929	736	22	21	79.6%
29/06/2015	-3.34	947	925	471	22	19	51.7%
01/07/2015	-5.23	946	924	318	22	19	35.6%
02/07/2015	-3.48	942	920	526	22	20	58%
03/07/2015	-5.77	933	911	536	22	22	59.8%
08/07/2015	-5.90	710	690	494	20	18	72.1%
15/07/2015	-3.03	928	906	563	22	21	62.9%
27/07/2015	-8.48	939	918	720	21	17	78.5%

18/08/2015	-6.15	928	905	621	23	18	68.9%
20/08/2015	-3.42	930	907	61	23	5	7.1%
21/08/2015	-4.27	931	908	90	23	16	11.4%
24/08/2015	-8.49	924	903	787	21	21	87.4%
25/08/2015	-7.63	918	897	708	21	19	79.2%
15/09/2015	-3.52	921	898	227	23	17	26.5%
21/10/2015	-3.06	899	876	284	23	17	33.5%
27/11/2015	-5.48	950	927	91	23	14	11.1%
04/01/2016	-6.86	983	960	382	23	21	41%
07/01/2016	-7.04	989	964	422	25	22	44.9%
11/01/2016	-5.33	987	962	378	25	24	40.7%
15/01/2016	-3.55	994	968	29	26	3	3.2%
21/01/2016	-3.23	1002	976	35	26	8	4.3%
26/01/2016	-6.42	1001	975	270	26	19	28.9%
28/01/2016	-2.92	1005	979	67	26	9	7.6%
25/02/2016	-6.41	990	964	436	26	21	46.2%
29/02/2016	-2.86	987	961	139	26	21	16.2%
06/05/2016	-2.82	1004	979	9	25	13	2.2%
13/06/2016	-3.21	1019	993	41	26	14	5.4%

Panel C: Shenzhen Up Extreme days

date	market return (%)	no. A-Shares	no. regular shares	no. regular shares that hit +10% price limit	no. of ST shares	no. ST shares that hit the +5% price limit	% of A- shares that hit the upper price limit
24/05/2010	4.28	906	855	33	51	19	5.7%
12/10/2011	3.5	1299	1253	21	46	4	1.9%
09/01/2012	3.72	1336	1295	27	41	14	3.1%
10/01/2012	3.85	1345	1304	40	41	9	3.6%
17/01/2012	5.14	1342	1300	46	42	14	4.5%
07/09/2012	3.75	1471	1427	34	44	2	2.4%
05/12/2012	3.78	1478	1441	26	37	2	1.9%
14/12/2012	4.12	1481	1441	20	40	3	1.6%
14/01/2013	3.63	1471	1431	37	40	2	2.7%
10/12/2014	3.5	1412	1399	68	13	2	5%
20/01/2015	3.39	1402	1389	69	13	3	5.1%
21/04/2015	3.88	1392	1381	112	11	8	8.6%
08/05/2015	4.17	1414	1400	198	14	2	14.1%
11/05/2015	4.48	1421	1407	203	14	4	14.6%
21/05/2015	3.59	1419	1404	276	15	5	19.8%
26/05/2015	3.58	1399	1384	248	15	8	18.3%
01/06/2015	4.79	1385	1371	286	14	4	20.9%
02/06/2015	3.52	1381	1366	297	15	4	21.8%
30/06/2015	4.8	1388	1375	180	13	1	13%
09/07/2015	3.76	678	667	645	11	7	96.2%
10/07/2015	4.09	701	690	660	11	7	95.1%
13/07/2015	4.18	842	831	753	11	7	90.3%
17/07/2015	4.98	1223	1210	356	13	2	29.3%
29/07/2015	4.13	1322	1308	245	14	3	18.8%
04/08/2015	4.77	1333	1319	439	14	6	33.4%
10/08/2015	4.49	1333	1320	183	13	7	14.3%
28/08/2015	5.4	1366	1353	347	13	5	25.8%
08/09/2015	3.83	1386	1372	232	14	1	16.8%
16/09/2015	6.52	1405	1391	728	14	4	52.1%

21/09/2015	3.55	1411	1396	170	15	3	12.3%
08/10/2015	4	1427	1411	138	16	1	9.7%
12/10/2015	4.18	1433	1416	138	17	7	10.1%
22/10/2015	3.71	1435	1420	169	15	2	11.9%
04/11/2015	5.12	1471	1453	144	18	2	9.9%
14/01/2016	3.81	1561	1541	108	20	2	7%
19/01/2016	3.57	1556	1536	91	20	13	6.7%
29/01/2016	3.71	1549	1529	77	20	3	5.2%
02/02/2016	3.42	1550	1530	91	20	7	6.3%
16/02/2016	4.1	1557	1538	124	19	7	8.4%
02/03/2016	4.7	1553	1536	118	17	8	8.1%
14/03/2016	3.56	1553	1537	80	16	5	5.5%
17/03/2016	3.56	1555	1538	76	17	1	5%
18/03/2016	3.65	1553	1536	103	17	1	6.7%
30/03/2016	3.6	1536	1522	82	14	0	5.3%
31/05/2016	4.09	1540	1523	72	17	2	4.8%

Panel D: Shenzhen Down Extreme days

date	market return (%)	no. A-Shares	no. regular shares	no. regular shares that hit -10% price limit	no. of ST shares	no. ST shares that hit the -5% price limit	% of A-shares that hit the lower price limit
20/01/2010	-3.67	814	768	8	46	6	1.7%
19/04/2010	-4.42	879	828	17	51	22	4.4%
06/05/2010	-3.65	891	837	6	54	10	1.8%
17/05/2010	-5.97	888	838	105	50	30	15.2%
18/06/2010	-3.61	929	876	26	53	12	4.1%
29/06/2010	-5.44	934	885	42	49	30	7.7%
12/11/2010	-6.12	1048	1001	78	47	32	10.5%
16/11/2010	-3.49	1051	1002	16	49	9	2.4%
17/01/2011	-4.25	1111	1062	23	49	11	3.1%
20/01/2011	-3.4	1119	1072	1	47	4	0.4%
23/05/2011	-3.63	1192	1143	14	49	30	3.7%
25/07/2011	-3.75	1249	1204	6	45	13	1.5%
08/08/2011	-4.43	1259	1215	46	44	28	5.9%
30/11/2011	-4.01	1315	1275	23	40	19	3.2%
05/01/2012	-3.52	1329	1288	73	41	16	6.7%
13/01/2012	-3.52	1331	1290	34	41	4	2.9%
14/03/2012	-4.09	1370	1332	3	38	21	1.8%
28/03/2012	-4.06	1370	1328	31	42	23	3.9%
16/07/2012	-3.63	1448	1402	83	46	9	6.4%
04/03/2013	-3.54	1482	1430	32	52	13	3%
20/06/2013	-3.39	1461	1436	4	25	3	0.5%
24/06/2013	-6.1	1460	1435	96	25	15	7.6%
08/07/2013	-3.57	1455	1434	18	21	6	1.6%
02/12/2013	-4.96	1431	1409	334	22	14	24.3%
25/02/2014	-3.96	1466	1446	69	20	3	4.9%
10/03/2014	-3.47	1464	1446	37	18	1	2.6%
09/12/2014	-4.31	1410	1397	122	13	6	9.1%
22/12/2014	-3.64	1414	1400	200	14	6	14.6%
19/01/2015	-3.39	1403	1391	36	12	1	2.6%
15/04/2015	-3.68	1383	1372	85	11	3	6.4%
28/05/2015	-5.52	1401	1386	321	15	7	23.4%
16/06/2015	-3.59	1395	1384	101	11	9	7.9%

18/06/2015	-3.57	1390	1377	109	13	5	8.2%
19/06/2015	-5.88	1393	1380	593	13	13	43.5%
25/06/2015	-3.76	1400	1387	106	13	3	7.8%
26/06/2015	-7.87	1409	1396	1232	13	11	88.2%
29/06/2015	-6.05	1401	1388	1024	13	12	73.9%
01/07/2015	-4.79	1396	1383	540	13	11	39.5%
02/07/2015	-5.55	1378	1365	900	13	12	66.2%
03/07/2015	-5.3	1336	1323	818	13	11	62.1%
07/07/2015	-5.34	1135	1122	982	13	12	87.6%
15/07/2015	-4.22	1167	1154	637	13	12	55.6%
27/07/2015	-7	1312	1299	1021	13	11	78.7%
18/08/2015	-6.58	1364	1351	915	13	11	67.9%
21/08/2015	-5.39	1373	1360	248	13	11	18.9%
24/08/2015	-7.7	1376	1363	1304	13	11	95.6%
25/08/2015	-7.09	1379	1366	1166	13	10	85.3%
01/09/2015	-4.61	1377	1363	718	14	9	52.8%
14/09/2015	-6.65	1395	1381	968	14	10	70.1%
15/09/2015	-4.97	1399	1385	466	14	11	34.1%
25/09/2015	-3.44	1414	1398	49	16	2	3.6%
21/10/2015	-5.94	1427	1414	549	13	12	39.3%
27/11/2015	-6.09	1511	1493	210	18	5	14.2%
04/01/2016	-8.22	1563	1545	906	18	16	59%
07/01/2016	-8.24	1564	1546	939	18	16	61.1%
11/01/2016	-6.6	1556	1537	865	19	16	56.6%
13/01/2016	-3.46	1563	1543	129	20	11	9%
15/01/2016	-3.4	1565	1545	53	20	1	3.5%
21/01/2016	-4.01	1556	1536	78	20	6	5.4%
26/01/2016	-7.12	1559	1540	734	19	13	47.9%
28/01/2016	-4.18	1555	1535	180	20	10	12.2%
25/02/2016	-7.34	1549	1533	907	16	12	59.3%
29/02/2016	-5.37	1548	1533	449	15	10	29.7%
20/04/2016	-4.43	1518	1501	58	17	7	4.3%
06/05/2016	-3.65	1541	1519	16	22	8	1.6%
09/05/2016	-3.59	1536	1514	84	22	14	6.4%
13/06/2016	-4.76	1545	1528	189	17	10	12.9%
27/07/2016	-4.45	1605	1583	72	22	7	4.9%
12/12/2016	-4.86	1701	1673	169	28	10	10.5%
16/01/2017	-3.62	1737	1706	57	31	17	4.3%
17/07/2017	-4.28	1810	1792	361	18	9	20.4%

Appendix B. Analysis of Special Treatment (ST) stocks

We first outline the methodology employed in the analysis of abnormal returns and abnormal turnover in ST stock, then report on post-extreme day findings for ST stocks.

The regression of ST samples in extreme up days and extreme down days are specified as follows:

$$RET_{i,t+n\to t+m} = \gamma_{70} + \gamma_{71}UFIVE_{i,t} + \gamma_{72}NETBUY_{i,t} + \gamma_{73}UFIVE_{i,t} * NETBUY_{i,t} + \gamma_{74}SIZE_{i,t} + \gamma_{75}TURNOVER_{i,t} + \gamma_{76}VARIANCE_{i,t} + \gamma_{77}BETA_{i,t} + \varepsilon_{7i}, n, m \in \{1,2,3,4,5,10,20,60,120\} \quad (7)$$

$$RET_{i,t+n\to t+m} = \gamma_{80} + \gamma 8_1 LFIVE_{i,t} + \gamma_{82}NETSELL_{i,t} + \gamma_{83}LFIVE_{i,t} * NETBUY_{i,t} + \gamma_{84}SIZE_{i,t} + \gamma_{85}TURNOVER_{i,t} + \gamma_{86}VARIANCE_{i,t} + \gamma_{87}BETA_{i,t} + \varepsilon_{8i}, n, m \in \{1,2,3,4,5,10,20,60,120\} \quad (8)$$

where $RET_{i,t+n\to t+m}$ is the dependent variable, referring to the market-adjusted abnormal returns on day 1,2,3,4,5 and cumulative abnormal returns over days [6, 10], [11, 20], [21, 60] and [61, 120] for stock i after up extreme day t. $UFIVE_{i,t}$ ($LFIVE_{i,t}$) is dummy variable with the value one if ST stock i hits the upper (lower) price limit of 5% on extreme market movement day t and is zero otherwise. All other variables are defined in section 3.

Our key interest here are the estimated coefficients on the interaction terms involving *UFIVE* and *NETBUY* on extreme market up days and involving *LFIVE* and *NETSELL* on extreme market down days. More specifically, a positive coefficient of γ_3 in Equation (7) (Equation (8)) indicates a stronger price delay effect after shares hit the upper price limit (lower price limit) after being subjected to large net-buy (net-sell) transactions attributable to institutional investors on extreme market up (down) days.

ST stocks

In Appendix B, Panel A and Panel B in Table B.3 (Table B.4) report the regression results of estimating equations (7) and (8). The Shanghai results again reveal significant positive coefficients on *NETBUY* for a further two days following extreme market movement days, which indicates that *NETBUY* has predictive power on returns subsequent returns for ST. The coefficients of the interaction term, however, are mostly insignificant.

On the extreme down days, the positive coefficient of interaction term *LFIVE*NETSELL* in the regression for abnormal returns on the first trading day after the extreme movement day suggests that the price reversal effect is stronger for ST stocks that hit the lower price limit after being subjected to large net-sell transactions in the Shanghai market. However, we do not find equivalent evidence in the Shenzhen regressions. In summary, the predictive power of net-buy or net-sell in extreme days on subsequent days is less clear for ST stocks as compared to regular stocks.

Table B.1 Post-extreme day performance of ST stocks in Shanghai stock market

This table records the log abnormal returns and logged abnormal cumulative returns of ST stocks at various horizons after to extreme market movement days. The sample includes all ST stocks listed in the Shanghai stock market during the period 2010 to 2017. Stocks are separated into groups according to the extent of the price rise/fall recorded on the extreme market movement day (day 0). The numbers of shares in each group are reported in the column on the far right. CTO refers to the return calculated from the closing price on day 0 to the opening price on day 1. OTC refers to the return calculated from the opening price and the closing price day 1. Day 2, 3, 4 and 5 refer to the abnormal return on the 2nd, 3rd, 4th and 5th relative to day 0. [6, 10], [11, 20], [21, 60] and [61, 120] refer to the cumulative abnormal returns for time windows spanning the 6th to 10th, 11th, to 20th, 21st to 60th, and 61st to 120th day relative to extreme day. Abnormal returns are calculated as each stock's daily return minus the expected return derived from the market model. The table reports log returns. "***", "**" and "*" represent the significance level at 0.1%, 1% and 5% respectively.

	CTO	OTC	Day 2	Day 3	Day 4	Day 5	[6, 10]	[11, 20]	[21, 60]	[61, 120]	No.
Panel A ST stocks in Shanghai up extreme days											
Upper Hit	0.84%	0.38%*	0.54%**	0.30%	0.02%	0.04%	0.58%	-0.95%	0.80%	0.41%	213
[4%, 5%)	0.03%	0.73%***	0.34%	0.50%*	0.49%*	0.11%	0.39%	1.22%*	0.35%	-0.56%	148
[3%, 4%)	0.04%	0.88%***	0.33%*	0.38%*	-0.08%	0.31%	1.38%**	0.70%	1.34%**	0.54%	176
[2%, 3%)	-0.17%**	0.71%***	0.42%**	0.62%***	-0.14%	0.00%	1.34%*	0.62%	0.56%	1.22%*	240
[-2%, 2%)	-0.11%*	0.09%	0.12%	0.07%	-0.58%***	0.07%	-0.36%	-0.51%	0.60%	0.05%	477
(-5%, -2%)	0.14%	-1.14%*	-0.46%	-1.02%*	-1.51%**	-0.72%	-1.41%	-1.28%	-0.12%	-2.23%	45
Lower Hit	-2.28%***	-0.34%	-2.38%***	-2.06%***	-2.46%***	-0.44%	-1.17%	0.43%	-0.09%	0.56%	31
Panel B ST stocks in Shanghai down extreme days											
Upper Hit	1.68%*	0.10%	0.30%	-0.08%	-1.79%	-0.78%	-0.94%	-0.24%	0.60%	3.1%	26
[2%, 5%)	-0.18%	0.24%	-0.61%	-0.37%	-1.07%*	-0.75%	0.59%	0.80%	-1.01%	0.33%	50
[-2%, 2%)	-0.54%***	0.92%***	-0.07%	0.04%	-0.67%***	-0.38%*	0.79%*	0.39%	0.98%*	0.5%	265
[-3%, -2%)	-0.18%	0.55%**	0.08%	-0.18%	-0.45%*	-0.7%***	0.03%	0.4%	-0.06%	0.94%	159
[-4%, -3%)	-0.51%***	1.03%***	-0.08%	-0.13%	-0.25%	-0.24%	0.91%*	1.31%**	0.94%*	0.29%	179
(-5%, -4%)	-1.06%***	0.37%**	-0.18%	-0.48%***	-0.51%***	-0.19%	-0.42%	0.22%	1.00%*	1.45%**	305
Lower Hit	-2.46%***	0.10%	-0.86%***	-0.81%***	-0.89%***	-0.52%***	-1.17%***	0.24%	-0.06%	0.35%	796

Table B.2 Post-extreme day performance of ST stocks in Shenzhen stock market

This table records the log abnormal returns and logged abnormal cumulative returns of ST stocks at various horizons after extreme market movement days. The sample includes all ST stocks listed in the Shenzhen stock market during the period 2010 to 2017. Stocks are separated into groups according to the extent of the price rise/fall recorded on the extreme market movement day (day 0). The numbers of shares in each group are reported in the column on the far right. CTO refers to the return calculated from the closing price on day 0 to the opening price on day 1. OTC refers to the return calculated from the opening price and the closing price day 1. Day 2, 3, 4 and 5 refer to the abnormal return on the 2nd, 3rd, 4th and 5th relative to day 0. [6, 10], [11, 20], [21, 60] and [61, 120] refer to the cumulative abnormal returns for time windows spanning the 6th to 10th, 11th, to 20th, 21st to 60th, and 61st to 120th day relative to extreme day. Abnormal returns are calculated as each stock's daily return minus the expected return derived from the market model. The table reports log returns. "***", "**" and "*" represent the significance level at 0.1%, 1% and 5% respectively

	CTO	OTC	Day 2	Day 3	Day 4	Day 5	[6, 10]	[11, 20]	[21, 60]	[61, 120]	No.
Panel A ST stocks in Shenzhen up extreme days											
Upper Hit	1.24%***	0.26%	0.81%***	0.47%*	0.44%	0.59%*	1.08%	0.23%	0.01%	1.62%	148
[4%, 5%)	-0.19%	0.95%***	0.24%	0.28%	0.18%	0.36%	0.69%	1.68%	1.21%	-0.13%	97
[3%, 4%)	-0.24%*	0.63%**	0.17%	0.43%*	0.42%	0.23%	0.77%	1.78%**	1.45%*	0.76%	96
[2%, 3%)	-0.12%	0.62%***	0.29%	0.38%*	0.10%	0.26%	0.57%	0.80%	1.39%*	0.52%	138
[-2%, 2%)	-0.12%	0.58%**	0.54%*	0.03%	0.59%**	0.49%*	1.06%	-1.11%	2.25%**	0.55%	142
(-5%,-2%)	-1.06%	-3.45%**	0.71%	1.30%	-0.05%	0.11%	-5.12%	-5.86%	-0.06%	0.21%	8
Lower Hit	-3.25%*	1.51%	-2.76%	-0.74%	-0.33%	-0.97%	1.76%	0.49%	7.39%	9.39%	8
Panel B ST stocks in Shenzhen down extreme days											
Upper Hit	-0.38%	0.67%	-1.03%	-1.73%	-0.24%	-0.03%	-1.18%	-0.01%	1.79%	-2.2%	17
[4%, 5%)	-1.11%***	0.82%	-1.35%**	-0.85%	-0.91%*	-0.88%*	-3.42%**	-1.43%	0.03%	-0.35%	39
[3%, 4%)	-0.67%***	0.60%**	-0.17%	-0.4%*	-0.34%*	-0.47%**	-0.44%	-0.22%	0.23%	0.93%	170
[2%, 3%)	-0.49%***	0.80%**	0.36%*	-0.09%	-0.12%	-0.12%	-0.08%	0.92%	0.32%	0.95%	105
[-2%, 2%)	-0.54%***	0.62%**	0.37%*	0.02%	-0.11%	-0.25%	-0.03%	0.14%	-0.16%	0.49%	139
(-5%,-2%)	-0.86%***	0.21%	0.08%	0.02%	0.04%	0.04%	0.20%	0.52%	1.22%**	0.77%	254
Lower Hit	-2.23%***	0.07%	-0.52%***	-0.29%**	-0.26%*	-0.02%	-0.09%	-0.06%	0.59%	0.99%**	564

Table B.3 Regression analysis for abnormal returns on ST stocks on the Shanghai Stock Exchange

This table reports the results of estimating equations (B.1) and (B.2) regression to explain abnormal returns of special treatment (ST) stocks estimated on extreme market movement days in the Shanghai stock market over the period 2010 to 2017. Panel A reports the regressions for extreme market up days, in which the key variable UFIVE identifies regular stocks that hit the +5% price limit and *NETBUY* refers to the large net-buy transactions of institutional investors on the extreme market up days. Panel B reports the regressions for extreme down days, in which the key variable *LFIVE* identifies regular stocks that hit -5% price limit and *NETSELL* refers to the large net-sell transactions attributed to institutional investors on the extreme market down days. Control variables in each regression include *SIZE*, *TURNOVER*, *VARIANCE* and *BETA*, all variables are as defined in section 3. Standard errors are clustered by firm and t-statistics are reported in parentheses. "***", "**" and "*" represent statistical significance at 1%, 5% and 10% levels respectively.

Panel A Abnormal returns on ST stocks following Shanghai extreme market up days									
	AR Day1	AR Day2	AR Day3	AR Day4	AR Day5	CAR [6,10]	CAR [11,20]	CAR [21,60]	CAR [61,120]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
UFIVE	0.007	0.005***	0.002	0.006***	0.001	-0.004	-0.006	0.006	0.008
	(1.40)	(2.96)	(0.89)	(2.85)	(0.26)	(-0.95)	(-0.90)	(0.78)	(0.81)
NETBUY	0.607***	0.206	-0.055	-0.336**	-0.676***	0.027	0.164	0.902**	-0.079
	(3.49)	(1.46)	(-0.34)	(-2.42)	(-6.21)	(0.05)	(0.38)	(2.17)	(-0.20)
UFIVE*	0.267	-0.201	0.075	-0.103	0.344	0.976*	-0.682	-0.770	-0.636
NETBUY	(0.68)	(-1.32)	(0.34)	(-0.53)	(1.08)	(1.82)	(-1.01)	(-1.21)	(-0.83)
Control variables	yes	yes	yes	yes	yes	yes	yes	yes	yes
constant	0.005	0.068***	-0.005	-0.01	-0.055***	-0.077	0.122**	0.086	0.137**
	(0.21)	(3.21)	(-0.24)	(-0.45)	(-2.82)	(-1.00)	(2.16)	(1.20)	(2.18)
No. Obs.	1330	1330	1330	1330	1329	1328	1326	1313	1286
Adjusted R^2	0.016	0.016	0.026	0.025	0.027	0.004	0.008	0.012	0.004
Panel B Abnormal returns on ST stocks following Shanghai extreme market down days									
	AR Day1	AR Day2	AR Day3	AR Day4	AR Day5	CAR [6,10]	CAR [11,20]	CAR [21,60]	CAR [61,120]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
LFIVE	-0.023***	-0.006***	-0.005***	-0.002*	0.000	-0.010**	-0.003	-0.008**	-0.005
	(-16.8)	(-5.07)	(-4.67)	(-1.67)	(-0.17)	(-2.53)	(-0.85)	(-2.29)	(-1.46)
NETSELL	-0.331	0.299**	0.360***	-0.267	-0.347***	-0.020	0.561*	0.238	-0.028
	(-1.36)	(2.29)	(2.97)	(-1.37)	(-2.93)	(-0.07)	(1.71)	(0.70)	(-0.08)
LFIVE*	0.701***	0.007	-0.181	0.013	0.137	0.003	-1.701***	-0.175	-0.055
NETSELL	(2.67)	(0.04)	(-1.22)	(0.05)	(0.57)	(0.01)	(-3.57)	(-0.41)	(-0.12)
Control variables	yes	yes	yes	yes	yes	yes	yes	yes	yes
constant	0.091***	0.052***	0.036**	0.016	-0.003	0.158***	0.025	0.012	-0.049
	(3.88)	(3.16)	(2.24)	(1.19)	(-0.17)	(2.76)	(0.65)	(0.23)	(-0.76)
No. Obs.	1780	1779	1779	1779	1779	1775	1767	1751	1725
Adjusted. $R^{2.}$	0.138	0.036	0.017	0.010	0.015	0.021	0.003	0.001	-0.001

Table B.4 Regression analysis for abnormal returns on ST stocks on the Shenzhen Stock Exchange

This table reports the regression evidence of special treatment (ST) stocks estimated from Eq. (B.1) and (B.2) on extreme market movement days in Shenzhen stock market over 2010 to 2017, while samples are further separated into up or down extreme days. Panel A reports the regressions for ST stocks on extreme up days, in which the key variable *UFIVE* refers to regular stocks hitting 5% price limit and *NETBUY* refers to the large net-buy transactions of institutional investors on the extreme market up days. Panel B reports the regressions for ST stocks on extreme down days, in which the key variable LFIVE refers to regular stocks hitting -5% price limit and *NETSELL* refers to the large net-sell transactions attributed to institutional investors on the extreme market down days. Control variables in each regression include *SIZE*, *TURNOVER*, *VARIANCE* and *BETA*, all variable are as defined earlier. Standard errors are clustered by firm and t-statistics are reported in parentheses. "***", "**" and "*" represent statistical significance at 1%, 5% and 10% levels respectively.

Panel A Abnormal returns on ST stocks following Shenzhen extreme market up days									
	AR Day1	AR Day2	AR Day3	AR Day4	AR Day5	CAR [6,10]	CAR [11,20]	CAR [21,60]	CAR [61,120]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
UFIVE	0.012***	0.007***	0.005**	0.005**	0.005*	0.004	0.008	-0.011	0.019
	(3.77)	(2.58)	(2.28)	(2.10)	(1.75)	(0.57)	(1.14)	(-1.20)	(1.46)
NETBUY	0.030	-0.160	-0.130	0.208	-0.100	-0.093	1.418**	-1.196***	0.442
	(0.09)	(-0.52)	(-0.89)	(0.97)	(-0.27)	(-0.18)	(2.23)	(-3.68)	(0.94)
UFIVE *	-0.269	-0.157	-0.619***	-0.904***	-0.363	0.770	-2.666**	-0.204	-2.62***
NETBUY	(-0.35)	(-0.29)	(-2.90)	(-4.11)	(-0.54)	(1.11)	(-2.20)	(-0.44)	(-2.88)
Control variables	yes	yes	yes	yes	yes	yes	yes	yes	yes
constant	-0.010	0.111***	0.005	-0.004	0.000	0.142**	0.034	0.307***	0.089
	(-0.39)	(6.33)	(0.19)	(-0.15)	(0.00)	(2.25)	(0.34)	(3.25)	(0.87)
Number	637	637	637	637	637	637	636	627	609
Adjusted R^2	0.015	0.028	0.036	0.021	0.002	0.003	0.021	0.021	0.001
Panel B Abnormal returns on ST stocks following Shenzhen extreme market down days									
	AR Day1	AR Day2	AR Day3	AR Day4	AR Day5	CAR [6,10]	CAR [11,20]	CAR [21,60]	CAR [61,120]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
LFIVE	-0.019***	-0.006***	-0.002	-0.001	0.001	-0.001	-0.002	-0.000	0.002
	(-9.97)	(-4.41)	(-1.18)	(-0.83)	(0.90)	(-0.18)	(-0.56)	(-0.10)	(0.51)
NETSELL	0.245	0.409***	-0.036	-0.438**	0.128	3.198***	0.214	0.418	0.445
	(0.83)	(3.61)	(-0.15)	(-2.56)	(1.03)	(2.79)	(0.61)	(1.01)	(1.16)
LFIVE *	-0.962	0.347	0.840*	0.545	-0.130	-2.899*	0.610	-0.903	-0.516
NETSELL	(-0.69)	(0.84)	(1.95)	(1.56)	(-0.39)	(-1.79)	(0.44)	(-1.05)	(-0.56)
Control variables	yes	yes	yes	yes	yes	yes	yes	yes	yes
Constant	0.068***	0.043***	-0.006	-0.035*	-0.058***	0.078	0.025	-0.083	0.043
	(3.18)	(3.06)	(-0.354)	(-1.95)	(-3.48)	(1.56)	(0.42)	(-1.38)	(0.67)
No. Obs.	1288	1288	1288	1287	1287	1286	1285	1276	1242
Adjusted R^2	0.114	0.042	0.005	0.006	0.013	0.033	-0.003	-0.003	0.000