Institutional trading in volatile markets:

Evidence from Chinese stock markets

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Abstract

We investigate daily stock returns of all firms 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 institutional trading and demonstrate that institutional trading behaviour consistently destabilizes both markets on extreme market movement days. We go on to highlight the conflating influence of regulator imposed daily limits to individual stocks' price movements. Specifically showing that when large institutional trades coincide with upper (lower) price limits being hit on extreme days, the prices of affected stocks continue to increase (decrease) significantly in subsequent days, such that institutional trades on extreme days help predict subsequent abnormal returns. We conclude that binding price limits act to exacerbate the destabilising effects of institutional trading in Chinese stock markets. Our results also provide policy implications for regulators in Chinese stock market that is supportive for the active steps towards financial liberalization of price limit in new launched Shanghai's Star Market.

(166 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 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 international risk sharing and portfolio diversification. However, the extreme price swings and apparent irrational behaviour experienced in Chinese stock markets have raised concerns amongst policy makers, regulators and global investors, particularly given the strong and growing dependence of the global economy on the Chinese economy (Tian *et. al.* 2018). Of particular concern is whether the trading activities that take place on extreme market movement days have the power to predict subsequent abnormal returns. There is increased interest in the answer to the question "who drives abnormal returns?"

In order 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 these ownership data is that they are only available on a quarterly basis, while the extreme market movements are captured on a daily basis. Dennis and Strickland (*op cit.*) is the first paper to investigate extreme market movement days experienced in the U.S. stock market; they find that firm level abnormal returns recorded on extreme days are positively correlated with the percentage of the relevant firms' shares that are owned by institutions. As a result, they argue that institutional ownership is destabilizing. 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, so conclude that institutional trading acts to stabilise the Chinese stock markets.

In our view, quarterly data on institutional holdings of each firm's stock is too restrictive and imprecise to appropriately proxy the influence of institutional traders on extreme market movement days (several of which sometimes occur within a given quarter in Chinese markets); we suggest that use of his proxy is likely to conceal important details about the shorter-term activities of the traders in question. As suggested, albeit in different contexts, by Campbell, *et al.* (2009) and Boehmer and Kelley (2009) among others, we argue that it is vital to seek an alternative, higher frequency, proxy for institutional trading in order to have a better chance of explaining whether institutional trading plays a role in generating and/or prolonging extreme market swings or alternatively to provide convincing evidence of market stabilizing effects.

In our study we exploit available daily cash flow data relating to individual firms' stocks to construct a more appropriate proxy for the daily trading activities of institutions. Such data has previously been

found to play an important role in explaining stock returns[1]. For example, Yang and Yang (2019) find that an index of inflow-outflow imbalances constructed from available cash flow data plays an important role in explaining excess stock returns in Chinese markets. Our proposed proxy relies on daily cash flow data on transactions by value, obtained from the RESSET database. From these data we focus purely on those transactions on a given trading day that have a value in excess of one million Chinese RMB, i.e. the largest category of transactions that has consistently been recorded in the database throughout our sample period. Given available data on the very low percentage of retail accounts for which the total market value of holdings exceeds one million RMB[2], it seems reasonable to assume that virtually all of these high value transactions will have been made by institutional investors. Specifically, our proxy is constructed as the net value of the total of the largest value category of inflows (purchases) and total of the largest value category of outflows (sales). Importantly, the utilization of daily cash flow data in our proxy allows us to investigate the impact of daily institutional trading behaviour on firm-level stock returns both on, and subsequent to, extreme market movement days.

In our empirical analysis we find that i) institutional investors tend to be net buyers (sellers) of stocks on extreme market up (down) days; ii) there is consistent and significant evidence, across both Chinese markets, of institutional trading having a destabilizing influence on abnormal stock returns. Our institutional trading proxy is also correlated with a reduction in abnormal turnover on extreme down days. These findings contrast with those of Tian *et al.* (*op cit.*), consistent with our belief that the quarterly proxy used in this prior research does not incorporate the necessary level of detail required to capture the impacts of daily institutional trading behaviour.

An important factor omitted entirely from this previous study of 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. (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.) The Chinese stock market regulator imposes 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. To take just one 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 the upper limit is that no further trades that would involve further upward price movements are permissible until

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

[2] According to retail investors' holding value data from China Securities Depository & Clearing Corporation Limited, the percentage of retail accounts whose stock holding market value exceeding 1 million in 2011 and 2016 are only 0.82% and 2.75%.

the following (or subsequent) trading days. Given the frequent binding nature of these regulator imposed price limits, we argue that it is essential for a complete analysis of the impacts of institutional trading to allow for the potentially conflating impacts of binding price limits, and to incorporate information on what happens to abnormal returns in the days after price limits are hit. 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.

So, in our analysis of individual firms' abnormal stock returns on 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 days. 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. The regulators' stated objective with respect to the imposition of price limits is that they are intended to calm the markets, giving would-be active investors time to reflect on fundamentals. Subsequent price reversal would consistent with correction of a market whose participants come to the belief that traders had over-reacted. However, in rational markets, price limits delay adjustment that reflects changes in fundamentals. It's also possible that subsequent trading continues to be irrational and destabilizing and another feature of price limits being hit, and of large net trades in individual stocks by institutional investors, is that they can both grab the attention of large numbers of individual (retail) investors who are typically less well informed than institutional investors and engage in lower value trades which can nonetheless aggregate up to high values.

Our own post-extreme day analysis is closest to that of Chen *et al.* (2019), who examine the impact of trading behaviour of large investors in regular stocks that hit the 10% upper price limit in the Chinese stock markets; following their lead we investigate subsequent abnormal firm-level returns over a range of different horizons, from overnight and rising to a horizon of a maximum of 120 days. We find that firm-level abnormal returns on the days subsequent to extreme market movement days continue to be consistently positive (negative) for at least two subsequent days in the case of stocks that hit the +/-10% price limit during trading on the initial extreme market movement day. This evidence is consistent with the binding price limit acting to strengthen a delay in price discovery. We further find evidence of a longer-run price reversal effect for those stocks that hit the lower price limit on extreme market downward movement days, but that no such longer-run effects for stocks that hit the upper price limit on extreme market upward movement days.

Lastly we investigate whether the net purchases (sales) conducted by institutional investors on extreme market movement days are significant predictors of subsequent firm-level abnormal returns. Our results are consistent with a delayed price discovery effect that continues to destabilize markets. Interestingly,

we find that the high value net trades conducted by institutional investors are significant predictors of returns in days subsequent to 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 four ways: first, we improve on existing studies that have relied on quarterly data to proxy for the influence of institutional investors by constructing and using a new proxy that uses daily cash flow records on large transactions by value to better capture the daily trading activity of institutional investors. More importantly, different from Chen *et al.* (*op cit.*), the proxy of institutional trading in our study is sourced from open database, which facilitates the future study on the investigation of institutional trading behaviour. Second, we highlight the importance of price limits in influencing how extreme market swings impact on both the immediate and subsequent days performance of firm-level stock returns. Evidence suggests the different return patterns of post extreme market swings compared to the existing studies based on all trading-days investigation, which may be related to the high trading sentiment on and around extreme market movement days. 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 both the Chinese stock markets. Our findings suggest that previous research, which relied on quarterly institutional ownership data and ignored the impacts of price limits, was unable to capture important destabilising impacts of that can be attributed to shorter-term institutional trading activity. In short, we identify clear circumstances in which the activities of institutional investors drive abnormal returns. Lastly, our findings are supportive for the active steps the regulators are undertaking towards the financial liberalization of price limit such as the launch of Shanghai's Star Market[3] at July 22, 2019.

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 in section 4. Our key findings are summarised in section 5. Section 6 concludes. All the extreme movement days identified in the Shanghai and Shenzhen stock markets over our sample can be found in Appendix A, while detailed analysis of special treatment stocks can be found in and Appendix B.

[3] Shanghai's Star Market has been viewed as the testing ground of Chinese stock market reforms. There is no daily limit imposed for new listed stocks on the first five trading days, and after that a 20% daily limit was adopted, instead of the 10% daily limit for other boards of the A-share market. The increase of price limit level is thus expected to hinder institutional investors' destructive pump-and-dump trading behaviour through price limit hit (See Chen *et al.*, 2019).

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 behaviour are herding, which refers to the propensity of investors to follow other institutional investors in their buy (sell) decisions, and positive feedback trading, which refers to using information on past winners and losers and buying the past winners while selling the past losers (Lakonishok *et al.*, 1992, Nofsinger and Sias, 1999, Sias, 2004). However, evidence in the existing literature on whether institutional investors stabilize or destabilize the stock market remains mixed and inconclusive. For example, Lakonishok et al. (1992) identify a destabilizing effect from the herding and positive-feedback trading behaviours that 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 behaviours of institutional investors help to stabilize the stock market through speeding-up a necessary price-adjustment process (Wermers, 1999); by reducing stock price volatility (Li and Wong, 2010); and by reducing the extent of abnormal returns that occur during market swings (Lipson and Puckett, 2010; Tian, *et al*. (*op cit.*)).

In Chinese stock markets, as discussed above, Tian *et al.* (*op cit.*) use firm-level quarterly data on institutional ownership as a proxy for the influence of institutional trading activity and we're concerned that their conclusion that institutional trading acts to stabilise Chinese stock market swings ought to be re-examined on two grounds i) that there is a need for a better proxy for daily institutional trading activity and ii) that the existence of binding statutory price limits should not be ignored when examining Chinese data.

A more recent study, Chen *et al.* (2019), demonstrates the existence of destructive market behaviour on the part of large scale investors who appear to employ pump-and-dump strategies in the case of stocks that hit the regulators' upper-price-limit, i.e. achieve a price rise of 10% within a single trading day. In this paper, we propose and utilise 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. We then test the following hypothesis:

Hypothesis 1. Institutional investors tend to perform high value net buy (sell) trades in individual firms' shares on extreme-up (-down) market movement days.

The daily trading represented in these high value trades exacerbate the volatility in Chinese firm-level stock returns. Hence, if hypothesis 1 holds, this implies that the large value transactions conducted by institutional traders contribute to destabilising the Chinese stock markets on extreme market movement days.

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 take 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 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 Shanghai Stock Exchange from Jan 2002 to Dec 2002 and again find evidence of delayed price discovery associated after stocks hit the price ceiling in a given trading day and, in contrast, find evidence of subsequent price reversal in stocks that hit 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 changes 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 listing data 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, which then often leads active individual investors to 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 number of firms' shares will hit the statutory price limit during the trading day, relative to the number of firms whose shares that 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. The prices of regular (and special treatment) stocks, after hitting the price limit of +/-10% on extreme market movement days (or +/-5% in the case of special treatment stocks), continue the same direction of movement in the days following the extreme days, although eventually these movements may be reversed in the longer run.

If empirical support is found for hypothesis 2, and if trading is rational, price discovery is delayed when stocks hit price limits. However, if stocks hit the statutory price limit during the trading day and trading has resulted in over-reaction relative to fundamentals, the movement is later reversed and the initial trading behaviour is destabilising. Rejection of hypothesis 2 would be consistent with the interpretation that the price limits 'cool-down' the kind of irrational trading behaviour that was previously driving share prices away from the level justified by their fundamentals, suggesting initial overreaction and subsequent correction.

There is a relative lack of research that examines the predictive power of institutional trading activity 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 from first to the 120th trading day after the price limit was hit. They find the evidence of price reversal in the days following binding upper price limits being hit and find that this effect is stronger when institutional investors are involved in high value firm-level net buy trades. Motivated by Chen *et al.* (*op cit.*), 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. High value net trades in individual firms' stocks conducted by institutional investors on extreme market movement days are significant predictors of firm-level stock returns in the days following extreme market movement days.

Empirical support for hypothesis 3 would imply that high value trades by institutional investors on extreme market movement days are important in driving returns on subsequent days, while rejection of this hypothesis would provide evidence against the trades of institutional investors driving firm level stock returns in the days following extreme market movement days.

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 the our institutional trading proxy (constructed from daily cash flow data that identifies transactions by value) for every firm whose shares are listed in the Shanghai and Shenzhen stock markets. The dataset spans every trading day over the period from January 2010 to December 2017. The daily market- and firm-level information has been collected from the China Stock Market & Accounting Research Database (CSMAR), while the daily cash flow data were obtained from the RESSET (www.resset.cn) database.

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 Shenzhen stock market. For example, there are three extreme up days and 4 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 listed 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[4]. We are particularly interested in the trading information of the largest value transactions, ie. those in excess of 1 million RMB, and use the net of buy and sell transactions in this category as a proportion of total transactions for each firm 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

[4] Transactions data have been provided in the RESET database for the value ranges stated above since 2013, but the thresholds used prior to 2013 are mostly different, which restricts our focusing on transactions in excess of 1 million RMB that are available on a consistent basis for our full sample.

individual buy transactions in excess of 1 million RMB, divided by the total value of the firm's shares outstanding[5].

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 simple CAPM model in which firm i's returns are compared to market returns over the time horizons from 250 to 50 prior to 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, *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 is the overnight component – calculated using the closing price on the extreme market movement day and the opening price on the next trading day; and ii) OTC is the 'open to close return' calculated using the opening and closing prices of the stock on first trading day after the extreme market movement day. We then construct a set of abnormal returns for each share based on 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 analysis, these are defined for as follows: i) SIZE, which is the natural logarithm of the market value firm *i*'s equity 50 days prior to each extreme market movement day; ii) TURNOVER, which is defined, for firm *i* on day *t*, as the ratio of shares traded to total shares outstanding; iii) VARIANCE and iv) BETA, which are defined as the residual variance and the beta of the firm's daily returns obtained from estimation of a CAPM (market model) estimated

[5] Although NETSELL is the negative value of NETBUY, the inclusion of both two variables facilitate the interpretation by identifying the positive direction of trading behaviour.

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 is intended to control for the fact that i) institutional investors generally prefer to invest in large firms (e.g. Lakonishok *et al.*, 1992); and ii) firm size is documented as a risk factor i.e. can capture a 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 ae 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, proxy for systematic risk. If institutional investors have a preference for holding stocks with a high beta then regressions might otherwise be subjected to omitted variable bias.

3.5 Descriptive statistics

Table 1 provides the 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 greater 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 on the of largest transactions by value, which is our proxy for the trading behaviour of institutional investors[6]. The values of NETBUY(NETSELL) have been multiplied by 100 for convenience. The means and median firm-level NETBUY and NETSELL on extreme-up and extreme-down days are all positive across both markets, suggesting that, on average,

[6] As suggested by Li and Fu (2017) and Tian *et al.* (2018), institutional investors in Chinese stock market can be categorized into four groups, which are Mutual Funds, Qualified Foreign Institutional Investors (QFII), Financial Institutions and 'other' Institutional Investors. During our sample period, the ownership of institutional investors accounts for, on average, 37.7% in all shares outstanding. The ownerships of mutual funds and QFII account for 6.7% and 0.2% respectively. The ownership of 'other' Institutional Investors, including such as legal person share and pension fund, accounts for 28.7%, see Tian *et al.* (2018) in more detailed discussion.

the largest individual transactions on extreme-up dates tend to institutional trader instigated purchases and tend to be institutional trader instigated sales on extreme-down days. The mean of NETBUY (after multiplying by 100) is 0.191 (0.258) on Shanghai (Shenzhen) extreme-up days, much higher than the mean of NETSELL, which is 0.024 (0.008) on Shanghai (Shenzhen) extreme-down days. This is suggestive of large trades instigated by institutional investors having a more pronounced effect in exacerbating extreme movements on extreme-up days relative to extreme- down days[7].

[7] On average, across all extreme market movement days in our sample, the proportions of institutional trading, including both buy-initiated and sell-initiated trades in extreme markets, are 24.65% (17.16%) on Shanghai (Shenzhen) stock exchanges.

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 of two standard deviations above mean). RETURN is the stock return on extreme day and AR is abnormal stock return calculated from a simple CAPM model. NETBUY (NETSELL) refer to net values of large individual buy (sell) trades – our proxy for institutional trading behaviour 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.

	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

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

4. Methodology

4.1 Analysis of extreme market movement days

Our main hypothesis is that the institutional investors exacerbate the volatility of the Chinese stock markets on extreme market movement days. We draw on the set-up used in Dennis and Strickland (*op*

cit.) but use our preferred proxy for institutional trading derived from daily cash flow data on transactions in excess of 1 million RMB. We investigate the effects of institutional trading on abnormal returns and on abnormal turnover on extreme market movement days in each of the Shanghai and Shenzhen markets.

Institutional investors tend to conduct net buying trading on extreme market up days and net selling trading behaviour on extreme market down days, we further use NETBUY and NETSELL in up and down extreme days respectively to test the Hypothesis 1. We then specify the following regressions for all extreme market up days using a Fama and MacBeth (1973) approach:

$$AR_i = \gamma_0 + \gamma_1 NETBUY_i + \gamma_2 SIZE_i + \gamma_3 TURNOVER_i + \gamma_4 VARIANCE_i + \gamma_5 BETA_i + \varepsilon_i, \quad (1)$$

$$ATURN_i = \gamma_0 + \gamma_1 NEYBUY_i + \gamma_2 SIZE_i + \gamma_3 VARIANCE_i + \varepsilon_i, \quad (2)$$

where, AR_i are abnormal returns, and $ATURN_i$ abnormal turnover, of firm *i* on extreme market up days; $NETBUY_i$ is institutional traders' 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.

We then specify the regression estimated for all firms, over all extreme market down days, using the NETSELL variable as

$$AR_i = \gamma_0 + \gamma_1 NETSELL_i + \gamma_2 SIZE_i + \gamma_3 TURNOVER_i + \gamma_4 VARIANCE_i + \gamma_5 BETA_i + \varepsilon_i, \quad (3)$$

$$ATURN_i = \gamma_0 + \gamma_1 NEYSELL_i + \gamma_2 SIZE_i + \gamma_3 VARIANCE_i + \varepsilon_i, \quad (4)$$

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

4.2 Post-extreme market movement day analysis

We now turn to explaining how we test the whether or not stocks that hit the price limit during extreme market movement days generally continue to experience significant positive (negative) returns on subsequent trading days (Hypothesis 2), and whether they are more prone to do so than stocks that experience price movements within the permitted limits on extreme market movement days.

Given that different price limits that apply, we analyse regular 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 9 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. In the case of up days, the first group consists of stocks that hit the price limit of +10%; the next group consists of stocks that rise by at least 9% but less than 10%; and four further groups capture stocks that move within

one percentage point bands. Three more bands capture stocks that rise by <5% or fall by up to 5%; those that fall by more than 5% but by less than 10%; and finally, those that hit the lower limit. For trading following extreme market down days we look in most detail at the price falls: the first group consist of stocks that hit the lower limit of -10%; the next, those that fall by at least 9% but less than 10%, then 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 at 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. 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 follow 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, and will allow us to check whether or not there are clear differences in the subsequent direction of movements in abnormal returns for those stocks that hit a statutory price limit during trading on the extreme market movement day as distinct from those stocks that experienced price changes within the permitted limits during trading on extreme days.

Finally, our investigation turns to of hypothesis 3, whether the large net trades conducted by institutional investors on extreme market movement days are significant predictors of subsequent movements in firm level abnormal stock returns. Following Chen *et al.* (*op cit.*) we pool all stock-day observations in our sample then analyse regular and special treatment stocks separately due to differences in the applicable price limits, though while they look at daily data for both markets over the full period 2012-2015, our analysis focuses on 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:

$$\begin{aligned} RET_{i,t+n\to t+m} = {} & \gamma_0 + \gamma_1 UPPER_{i,t} + \gamma_2 NETBUY_{i,t} + \gamma_3 UPPER_{i,t} * NETBUY_{i,t} + \gamma_4 EIGHT_{i,t} \\ & + \gamma_5 EIGHT * NETBUY_{i,t} + \gamma_6 SIX_{i,t} + \gamma_7 SIX * NETBUY_{i,t} + \gamma_8 FOUR_{i,t} \\ & + \gamma_9 FOUR * NETBUY_{i,t} + \gamma_{10} SIZE_{i,t} + \gamma_{11} TURNOVER_{i,t} + \gamma_{12} VARIANCE_{i,t} \\ & + \gamma_{13} BETA_{i,t} + \varepsilon_{i,t} \end{aligned}$$

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

$$RET_{i,t+n\rightarrow t+m} = \gamma_0 + \gamma_1 LOWER_{i,t} + \gamma_2 NETSELL_{i,t} + \gamma_3 LOWER_{i,t} * NETSELL_{i,t} + \gamma_4 NEIGHT_{i,t} + \gamma_5 NEIGHT * NETSELL_{i,t} + \gamma_6 NSIX_{i,t} + \gamma_7 NSIX * NETSELL_{i,t} + \gamma_8 NFOUR_{i,t} + \gamma_9 NFOUR * NETSELL_{i,t} + \gamma_{10} SIZE_{i,t} + \gamma_{11} TURNOVER_{i,t} + \gamma_{12} VARIANCE_{i,t} + \gamma_{13} BETA_{i,t} + \varepsilon_{i,t}$$

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

where, $RET_{i,t+n\rightarrow t+m}$ 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. In order 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 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 this interaction term, γ_3 in Equation (5) (Equation (6)), would be consistent with a stronger delay to the price adjustment of stocks being generated in the days following extreme market movement days, for those stocks that hit the upper-price-limit (lower-price-limit) and experienced high value net buy (net sell) transactions on the extreme market movement day.

5. Results

5.1 Extreme market movement days

Table 2 presents the results of estimation of 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 years 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 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 large net buy transactions on extreme market up days in each of the Chinese stock markets, while columns (2) and (4) similarly focus on the relationship between firm-level abnormal stock returns and large net sell transactions on extreme market down days. In each case the coefficient on the large 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 Shanghai stock market is 1.898 (-2.809), which implies that a 1% increase in the net value of large 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 extreme market movement days, and further that the estimated destabilising greater in the Shanghai stock market relative to Shenzhen stock market. This finding is contrary to the estimated stabilizing effect of institutional ownership reported in Tian *et al.* (*op cit.*), although we stress that their results rely on quarterly data on institutional ownership to proxy institutional trading activity, while 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 large purchase transactions attributed to institutional investors (NETBUY) significantly exacerbate abnormal turnover on extreme market up days whereas large net sell transactions (NETSELL) significantly decrease abnormal turnover on extreme market down days. More specifically, one percent increase in NETBUY generates, on average, an increase of approximately 1.981 (1.939) percent in abnormal turnover for shares listed in the Shanghai (Shenzhen) market on extreme market up days, while on extreme market down days, a one percent increase of NETSELL tends to decrease abnormal turnover by approximately 1.419 (1.137) percent in the Shanghai (Shenzhen) market.

Our finding that institutional trading activity exacerbates abnormal turnover on extreme market up days, yet decreases abnormal turnover on extreme market down days is perhaps surprising, although a plausible explanation that draws on the existing literature is that the actions of institutional traders on extreme market down days can often instigate panic selling by large numbers of individual (retail) investors, potentially leading more shares to hit the regulator imposed downward price limits during the trading day; this then results prevents any further transactions that would depress the price of a limit-hitting stock any further until the next trading day. Such temporary suspensions in trading decrease the liquidity of the affected stocks (e.g. Kim and Rhee, 1997) which could explain the negative impact on abnormal turnover. More generally, the potential for regulator imposed price limits to conflate the

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

This table reports regression results used to investigate the impacts of large trades conducted by institutional investors on abnormal stock returns and abnormal turnover respectively. The sample includes of all A-shares listed on the Shanghai and Shenzhen Stock Exchanges and all extreme market up or down movement days over the years 2010 to 2017. Results are for estimation of Equations (1)-(4) which are Fama-MacBeth (1973) style regressions. The dependent variables are stock abnormal return (AR) on extreme day, calculated from market model over [*t*-250, *t*-50]; and abnormal turnover (ATURN), calculated from 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

impacts of institutional trading on and following extreme market movement days motivates our analysis of post-extreme day performance.

5.2 Post-extreme day performance

Tables 3 and 4 report the estimated abnormal returns and cumulative abnormal returns of regular stocks over periods that follow each of the extreme market movement days that occurred between 2010 and 2017, for all stocks 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 a the extreme market movement day. This allows us to explore whether subsequent price dynamics differ for stocks that hit price limits during trading relative to those stocks that experience lesser, within limit, price changes on the extreme market movement days.

The first row records abnormal returns and cumulative abnormal returns on days subsequent to 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 that a pattern of partial price reversal occurs on days 3 and 4 but note that the estimated cumulative abnormal returns show no evidence of significant longer run price reversal shown (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 extreme market down days in both markets continue to be negative and significant for horizons of up to two subsequent days, but again 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 on during trading during on 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 downward price limits during trading on 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, compare the significant positive coefficients take from the rightmost columns of Panel B with the more variable figures and particularly the lack of any significant negative coefficients in the rightmost columns in Panel A.

That the patterns referred to above are clear among shares that hit statutory price limits during extreme market movement days but are not evident among stocks that traded within the price limits 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 our results indicate more pronounced price dynamics of price limit hitting stocks on days subsequent to extreme

market movement days than those that they reported. However, it is important to note that Chen *et al.* (i) focus on all stock-days that recorded large upward price movements, rather than on extreme market movement days; ii) examine only data for Shenzhen A shares; iii) use a different proxy for net trading behaviour of large investors with stock balances above 10 million RMB; and iv) investigate these movements for stock-day observations over a somewhat shorter window from 2012-2015. We suggest that the main explanation for the differences in our results is that binding price limits have a greater influence on subsequent price dynamics after extreme market movement days than on stock-days in which large upward movements are recorded in individual stock prices.

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 on 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 following the extreme movement day and on the subsequent day in the Shanghai market, and at the opening of trading following the extreme market day and for the next two days in the Shenzhen market. Likewise stocks that hit lower price limits on extreme market down days show negative CTO returns further negative abnormal returns in several subsequent days of trading in both the markets, more persistently so than for regular stocks. Cumulative abnormal returns indicate no significant price reversals in the case of the special treatment stocks that hit upper price limits during trading on extreme market up days, and only the Shenzhen market data gives evidence of a small longer run price reversal among stocks that hit the lower price limit during extreme market down days.

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

In this subsection we examine whether the large 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 that the high value net trades in individual firms' stocks conducted by institutional investors on extreme market movement days are significant predictors of continued positive firm-level abnormal stock returns in each of the next three (four) days following the extreme market movement days in the case of stocks that hit the 10% upper price limit on the extreme market

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

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 result in price reversal. 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 and concluded that there was evidence of strong price reversal, associated with greater net buys of institutional investors after upper-price limit hits. We again suggest that the main explanation for these differences in results is that binding price limits have a distinctive influence on subsequent price dynamics after extreme market movement days as opposed to on (the wider range of) days subsequent to individual stocks hitting the upper price limit. The distinction is likely to derive from the fact that high value institutional trades in the shares of specific companies that take place on extreme *market* movement days are more likely to attract the attention of (less informed) retail investors.

The fact that clear patterns are absent in the subsequent firm level abnormal returns for those stocks that recorded within limit returns on extreme market movement days 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.

Turning to our analysis of abnormal returns in regular stocks following extreme market down days, we find clear results in the Shenzhen market (Panel B in Table 6) in that 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 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 of NETSELL in the Shenzhen regressions on the first subsequent day of trading is 0.167, implying that an increase in the share of high value net sell transactions by institutional investors is associated with an average increase of 0.167% in the abnormal returns of stocks in the first trading day that follows an extreme market down day. Our interpretation of these results is that large net sell transactions on extreme market down days mainly reflect panic selling and help to predict positive abnormal returns in subsequent days.

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 "*" represent 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	CAR	CAR	CAR
	(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 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. 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 "*" represent 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	CAR	CAR	CAR
	(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)
Control	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

	AR Day1	AR Day2	AR Day3	AR Day4	AR Day5	CAR	CAR	CAR	CAR
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
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)
Control	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

5.4 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 market return (as expressed in the relevant composite stock price index) exceeds two standard deviations above mean. We have repeated this analysis with the alternative definition of extreme market movements exceeding three standard deviations from the mean. Over our full sample, 2010-2017 this obviously results in fewer extreme market movement days (13 up and 24 down days in the Shenzhen stock market and 4 up and 25 down extreme market movement days in the Shenzhen stock market). Given the much reduced sample for the Shenzhen up days we omit analysis of these but can report that the remainder of the results are quantitatively and qualitatively very similar to the core results discussed above.

6. 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 and have focused on the impacts of institutional trading on these days. In contrast to the existing literature, we employ a daily proxy for institutional trading activity derived from open data source for the first time. Our proxy is based on of high value net trades in individual stocks as opposed to the quarterly proxy based on institutional share ownership employed used by others. Our descriptive statistics suggest that on average, institutional investors engage in net buy (sell) behaviour on extreme up (down) days. Regression results provide strong evidence that the large net trades in firm-level stocks attributable to institutional investors have a significant destabilizing effect on firm-level abnormal returns on extreme market up and down days, in both Chinese stock markets. The fact that our results contrasts with those of Tian *et al.* (*op cit.*), suggests that the quarterly institutional ownership data used in prior extreme day studies does not provide sufficient variation to capture daily institutional trading behaviour.

We are also able to show that abnormal turnover is also exacerbated by institution trading activity on extreme market up days although it seems that abnormal turnover falls on extreme market down days. We suggest that the interaction of institutional trading and the propensity of stocks hitting binding price limits on extreme down days may explain the latter result. This motivates us to incorporate consideration of the daily price limits imposed by the Chinese stock market regulator into our analysis, again this is a novel contribution to the literature on extreme market movement days which allows for the possibility that institutional trading activity has 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 institutional trades in shares that hit

price limits on extreme market movement days can help to predict abnormal returns in subsequent days. In doing so we draw on the work of Chen *et al.* (2019), though note that while they found evidence of destabilizing behaviour following stocks hitting upper price limits, they did not focus purely on extreme market up days and nor did they extend their analysis to include days in which stocks hit lower price limits.

Our analysis of post-extreme day abnormal returns provides strong evidence that high value institutional trades in price limit hitting stocks on extreme market movement days does indeed have significant predictive power for these abnormal returns in these stocks in the days subsequent to extreme market movements. More specifically we find that the price limit results in delayed price discovery particularly when it binds, the delayed effect is much stronger than that in all trading-days investigation (Chen *et al.*, 2019). So, high value institutional trades in price-limit-hitting stocks on extreme market movement days not only exacerbate the volatile market on these extreme market movement days, they continue to predict abnormal returns, in the same direction, for several subsequent days. We note that this does not necessarily mean that institutional trading is to blame for the subsequent movements, rather it may be the trades of large numbers of individual (retail) investors who are less well informed yet have their attention drawn to the affected stocks as a result of large net institutional trades and the binding price limits.

The fact that these clear patterns of destabilizing impacts are absent in the subsequent firm-level abnormal returns for stocks that recorded within limit price movements on extreme market movement days adds support to our conclusion that distinctive and significant subsequent price dynamics look to be concentrated in those stocks that are the focus of high value institutional trades and hit the stock market regulator imposed price limits on the 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 A-shares, regular shares, regular 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
Date	Mean Return (%)	Number	Regular	Lower Hit (Regular)	ST	Lower Hit (ST)	Total Lower Hit
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 firstly 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:

$$RET_{i,t+n\to t+m} = \gamma_0 + \gamma_1 UFIVE_{i,t} + \gamma_2 NETBUY_{i,t} + \gamma_3 UFIVE_{i,t} * NETBUY_{i,t} + \gamma_{10} SIZE_{i,t} + \gamma_{11} TURNOVER_{i,t} + \gamma_{12} VARIANCE_{i,t} + \gamma_{13} BETA_{i,t} + \varepsilon_{i,t}, n, m \in \{1,2,3,4,5,10,20,60,120\} \text{ (B.1)}$$

$$RET_{i,t+n\to t+m} = \gamma_0 + \gamma_1 LFIVE_{i,t} + \gamma_2 NETBUY_{i,t} + \gamma_3 LFIVE_{i,t} * NETBUY_{i,t} + \gamma_{10} SIZE_{i,t} + \gamma_{11} TURNOVER_{i,t} + \gamma_{12} VARIANCE_{i,t} + \gamma_{13} BETA_{i,t} + \varepsilon_{i,t}, n, m \in \{1,2,3,4,5,10,20,60,120\} \text{ (B.2)}$$

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 as 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 (B.1) (Equation (B.2)) 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 (B.1) and (B.2). 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 interaction term, however, are mostly insignificant.

On 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 subsequent to extreme market movement days. The sample includes all ST 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). The numbers of shares in each group are reported in 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 individual stock's daily return minus the expected return derived from 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 subsequent to extreme market movement days. The sample includes all ST 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). The numbers of shares in each group are reported in 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 individual stock's daily return minus the expected return derived from 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