

Reconsidering Price Limit Effectiveness

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Abstract

Most stock exchanges around the world impose daily price limits on stock prices. However, China is the only market that has experienced trading with and without price limits. We study China's experience with price limits by comparing a sub-period with price limits to a sub-period without price limits. We provide three major sets of findings. First, we find price limits moderate transitory volatility and mitigates abnormal trading activity. Second, for poor performing stocks, a tighter price limit also appears helpful in moderating volatility and not hurtful. Finally, we find some evidence that price limits can facilitate market recovery following crashes. Many prior studies criticize price limits. Our study is the first to show benefits of price limits.

JEL classifications: G10; G14

Keywords: price limits; China; stock markets; transitory volatility; trading volume

Reconsidering Price Limit Effectiveness

1. Introduction

Most stock exchanges around the world impose daily price limits.¹ For example, on any given trading day on the Chinese stock exchanges a stock price cannot change by more than 10 percent from its previous day's closing price. The rationale behind price limits varies. They are believed to moderate excessive volatility, mitigate panic behavior, and/or minimize price manipulation (e.g., see Kim and Rhee (1997), Kim (2001), Kim and Yang (2004), and Kim and Park (2010)). However, for more than a decade, researchers have criticized price limits.² According to many studies, price limits impede market efficiency, while showing no evidence of achieving their intended objectives. In this paper, we offer compelling and convincing evidence that shows benefits of price limits.

During 1992-1996, the Chinese stock markets did not use daily price limits (we refer to this period as the “no-PL-regime”). Other than this period, the Chinese markets have always imposed price limits. China is the only stock market in the world that has experienced trading with and without price limits. China's experience with price limits is extremely useful and fortuitous from a research standpoint. A major shortcoming of *all* existing price limit studies is they inherently study markets with price limits, but in doing so they cannot possibly ascertain if those markets would be better off without price limits.³ The Chinese markets, having had

¹ According to Kim and Park (2010), 23 out of the 43 largest stock exchanges around the world impose daily price limits on stock prices.

² Price limits have *not* been found to moderate volatility or panic, but instead, they have been found to delay price discovery (Kim and Rhee (1997), Chen (1998), Phylatkis, Kavussanos, and Manalis (1999), Kim and Limpaphayom (2000), Henke and Voronkova (2005), and Chan, Kim, and Rhee (2005)). Further, price limits can even exacerbate volatility as prices have been found to gravitate toward limit-prices (Cho et al. (2003), Du, Liu, and Rhee (2009), and Hsieh, Kim and Yang (2009)). See Kim and Yang (2004) for a literature review on price limits.

³ See Harris (1998) and Kim and Yang (2004) for critiques of price limit studies.

periods with and without price limits, provides a unique laboratory setting to assess price limit effectiveness.

Our study of China's experience with daily price limits yields three major sets of empirical findings. First, when we contrast a sub-period with price limits (i.e., the "PL-regime" sub-period) to a sub-period without price limits (the no-PL-regime), we find when stocks hit price limits during the PL-regime their volatility and trading activities return to "normal" faster compared to stocks that do not hit price limits *but* would have hit price limits had they been imposed during the no-PL-regime. These findings are in sharp contrast to prior price limit studies that argue price limits exacerbate volatility and delay trading activities. If firms are concerned about their stock price volatility and abnormal trading behavior, then our findings imply firms are better off when their stock prices are subject to daily price limits.

We also take advantage of another unique feature of China's price limit regulations to study price limit effectiveness. For firms suffering from poor performance, the stock exchange gives them a Special Treatment (ST) designation and imposes tighter price limits -- daily price limits on ST stocks are 5% instead of 10%. We find evidence these tighter price limits for ST stocks are helpful (i.e., when ST stocks hit upper price limits, their volatility returns to "normal" relatively quickly) and not hurtful (i.e., when ST stocks hit lower price limits, they do not behave much differently compared to non-ST stocks that hit lower price limits).

Third and finally, we also test whether price limits can facilitate overall market recovery following stock market crashes. In his study of the 1987 U.S. stock market crash, Schwert (1990) examines volatility on days following the crash to see how quickly the market goes back to normal. We also examine market volatility following "crashes" on Chinese stock markets. We find that market volatility returns to "normal" faster during the PL-regime than during the

no-PL-regime. If stock markets desire expeditious recoveries following crashes, then our findings show another benefit to price limits.

In general, price limits are easy to criticize. They literally restrict price movements and thus they are posited to impair market efficiency. So, previous literature that criticizes price limits has had, in our humble opinion, a relatively easy task. Yet, despite the numerous criticisms of price limits, most markets around the world use them, and even as these markets have matured they have not relinquished them. The Chinese markets did eliminate price limits only to reinstall them later. Some markets (e.g., Taiwan) use price limits as an active policy tool, changing their ranges on a regular basis (Kim (2001)). Given that price limits as a regulatory market mechanism have survived for so long, and given that they are ubiquitous, we believe they must provide some perceived and/or real benefits. In our paper, we are the first to uncover some of those benefits. This is not to say, however, that price limits are not without costs. Our study is not meant to challenge previous findings that criticize price limits. Those previously documented costs could very well be real. But, so too are the benefits we document in this paper. The challenge of policy makers is to weigh the costs of price limits against the benefits to decide if and how to use price limits. These discussions are especially important now, in the wake of the global financial meltdown. Can price limits moderate speculative excess, bubbles, and irrational exuberance? Should price limits be tighter for firms that have been hit especially hard by the financial crisis? Can price limits facilitate economic and market recovery and restore confidence in financial markets?

The rest of our paper proceeds as follows. In the next section, we provide a brief overview of Chinese stock markets. In section 3, we describe our data, sub-period designations,

and summary statistics on returns surrounding days when stocks hit price limits. Section 4 presents our primary empirical findings. The last section concludes.

2. Institutional details

2.1 Overview of Chinese stock markets

The two stock markets in China, the Shanghai Stock Exchange (SHSE) and the Shenzhen Stock Exchange (SZSE), were established in 1990. By the end of 2000, the last year of our study period, 1,060 stocks were listed on the two exchanges with a total market capitalization of 3,595 billion RMB (about \$500 billion).

There are two trading sessions on both stock exchanges. The morning session runs from 9:30am to 11:30am, and the afternoon session runs from 1:00pm to 3:00pm. The tick size is one cent, regardless of the stock price. Both markets are completely order-driven, with no specialists or market makers.

2.2 Price limit regulations

The Chinese stock markets currently impose a 10% daily price limit. When a stock hits a price limit, there is no special announcement; instead, this information is simply posted on the exchange's trading screens. Like most price limit systems, trading in the stock is allowed to continue after it hits a price limit, but only those orders at or within limit-prices get executed.

In the past, the two Chinese stock markets experimented with a variety of price limit ranges. Table 1 reports historical price limit regulations on each exchange. In the beginning, price limit regulations were different between the two exchanges. Price limits on the Shanghai exchange was initially set at a tight 3% while it was initially set at 10% on the Shenzhen exchange. Over the course of the following two years, price limit ranges varied quite a bit. Then, during 1992-1996, both markets eliminated price limits, but both markets later re-imposed

them at the end of 1996. The sub-periods before and after 1996 are the primary focus of our study.

[Insert Table 1 Here]

2.3 *Special Treatment designation*

Since April 22, 1998, the China Securities Regulatory Commission imposed a Special Treatment (ST) designation on poorly performing firms. A firm must satisfy a variety of conditions to be classified as an ST firm, but the primary condition is negative net profits for two consecutive fiscal years.⁴ The ST designation is believed to improve Chinese companies' corporate governance and to discipline managers by bringing attention to the firm. If an ST firm cannot improve its financial performance, then it will eventually be delisted. Most notably, for our study, ST firms have tighter price limit ranges than other firms: 5% for ST stocks versus 10% for other stocks.

Why do ST stocks have tighter price limits? We cannot find any explicit justification for it. However, from discussions with traders on these markets, it appears ST stocks are subject to much speculation. ST stocks have low prices, so a small price increase can represent a large percentage increase. Speculative trading by itself can cause transitory stock price volatility which is especially undesirable for poor performing firms. The conventional wisdom is that tight price limits for ST stocks restrict traders' abilities to cause excessive price volatility from their speculative trading.

⁴ Other conditions include (1) the shareholders' equity is lower than the par value, (2) certified accountants provide either no comment or negative views on recent financial statements, and/or (3) the exchange or the CSRC deems the financial condition abnormal.

3. Data, sub-period designations, and returns

We retrieve stock price data from the WIND database. The database contains daily opening, closing, high, and low prices on all individual shares. In addition, the database contains daily trading volume and daily shares outstanding for each firm. For some missing and questionable data, we obtain data and verify the accuracy of data from the Shanghai Grand Wisdom system.

We define two sub-periods: the no-PL-regime and the PL-regime. For the Shanghai exchange, it did not impose a daily price limit from May 21, 1992 to December 15, 1996. For the Shenzhen exchange, it did not impose a daily price limit from August 17, 1992 to December 15, 1996. In order to draw observations from the same time period while also eliminating any confounding effects due to a transition period associated with removing price limits, we define the no-PL-regime from September 1, 1992 to August 31, 1996. For the PL-regime sub-period, we wish to match the number of years between each of our sub-periods while again eliminating any confounding effects due to re-imposing price limits. Therefore, we define the PL-regime from January 1, 1997 to December 31, 2000.

Table 2 shows median daily returns surrounding days when stocks hit their daily price limits during the PL-regime. Day 0 is the day a stock hits its price limit, Day -1 is the day before, while Day 1 is the day after, and so forth. Of course, there are occurrences when stocks hit price limits on consecutive days. As Miller (1989) points out, there is no consensus about whether it is preferable to keep multiple hits or to take them out of the sample. We investigate samples both with and without multiple hits. Following Kim and Rhee (1997) and others, we report results without multiple hits (results with multiple hits are qualitatively similar to reported results and available upon request). In Table 2, we separately report median returns for upper

price limit hits and lower price limit hits. For all of our analyses, we focus on medians rather than means, as skew and outliers are a common problem during days of extreme price movements.⁵

[Insert Table 2 Here]

From Table 2, we see that the median return is 9.5% on days that stocks hit their upper price limit and -10.5% on days stocks hit their lower price limit. Price limits are 10% during the PL-regime, so the magnitude of our median returns is generally expected. We recognize the -10.5% median return on lower-hit days exceeds the 10% price limit, but this is due to issues related to the discrete tick size and also to limit-price rounding.

We now introduce a new category of stock events which we call “threshold-hits.” During the no-PL-regime, if a stock price moves 10% or more from its previous day’s closing price, then we define that event as a threshold-hit. From Table 2, we see that median returns on the threshold-hit day, i.e., Day 0, for upper and lower threshold hits is 12.9% and -13.5%, respectively.

4. Empirical findings

4.1 Volatility

To measure daily volatility, we adopt Grossman’s (1988) measure, which is calculated as follows:⁶

$$\text{Volatility} = \ln(H_t/L_t), \quad (1)$$

where H_t is the high price and L_t is the low price on day t , and \ln is the natural log operator. Volatility measures based on high and low prices are common in studies such as ours.

⁵ Mean results are often qualitatively similar to reported median results.

⁶ For the sake of robustness, we also measured volatility following Parkinson (1980) as follows: $(H_t - L_t)^2/4\ln 2$. Results using Parkinson’s volatility measure are qualitatively similar to our reported volatility results.

Economists generally identify two types of volatility: fundamental and transitory. Fundamental volatility occurs when there is uncertainty about underlying security values, while transitory volatility is caused by the trading process. Harris (1998) defines transitory volatility as the tendency of prices to bounce around their fundamental values. For market regulators concerned with excessive volatility, reducing transitory volatility takes precedence over reducing fundamental volatility. Garman and Klass (1980) and Parkinson (1980) argue and show volatility measures based on daily high and low prices capture transitory volatility better than volatility measures based on daily closing prices. Grossman (1988) further points out close-to-close returns are a market direction measure, not a volatility measure. Volatility varies across time (Schwert (1989)), so we report a standardized volatility measure so that measures from two different sub-periods can be compared directly to each other. For Days 0 to 10, we divide each day's volatility by the volatility on Day -1.⁷ Table 3 reports our volatility results.

[Insert Table 3 Here]

From Table 3, note that volatility on Day -1 is equal to 1.0 simply by design, as each day's volatility is standardized by volatility on Day -1. On Day 0, we see a dramatic increase (from Day -1) in standardized volatility for both limit-hits and threshold-hits samples, which is not surprising as stocks on Day 0 either hit a 10% price limit (during the PL-regime) or cross a 10% price threshold (during the no-PL-regime). The increase in standardized volatility is statistically significant at the 1% level. When comparing standardized volatility across Day 0 between limit-hits and threshold-hits, the volatility is lower for limit-hits than for threshold-hits (1.646 vs. 2.834 for upper hits and 1.422 versus 1.709 for lower hits). The “<<<” symbol shows

⁷ For the sake of robustness, we also standardized our volatility measures using the 5-day average volatility from day -15 to day -11 and from day -5 to day -1. The results are similar to our reported standardized volatility results.

the differences are statistically significant at the 1% level. However, this result is also not surprising as prices are censored at limit-prices on Day 0 during the PL-regime.

As in prior price limit studies, our focus is on days after Day 0.⁸ From Table 3, we see that for upper hits, volatility remains high (i.e., standardized volatility is statistically greater than 1) for stocks that hit price limits for six consecutive days, from Day 1 to Day 6. On Day 7, volatility of stocks resumes back to its Day -1 volatility level. Starting on Day 8, the standardized volatility level is lower than it was on Day -1. In contrast, for upper threshold-hits, volatility remains high all the way to Day 9. These results suggest volatility goes back to “normal” faster after stocks hit price limits. That is, price limits moderate long-run transitory volatility.

For the upper-hit sample, the reason we can confidently conclude price limits cause the quicker resumption back to “normal” volatility is because stocks from the limit-hits sample and threshold-hits sample are identical in almost every way, except the first group of stocks hit price limits while the other did not. Both groups of stocks experience extreme price movements on Day 0; they are listed on the same exchange with the same order execution mechanisms with same trader types and from nearly identical time periods. If there are any differences between the two samples that might lead to differences in volatility between samples then note those differences should cancel out when we standardize volatility by each stock’s Day -1 volatility. So, in effect, the only difference between the limit-hits sample and the threshold-hits sample is that stocks in the former group are bound by price limits on Day 0, while stocks in the latter group are not. Any observable difference in volatility between the two groups is therefore likely due to price limits. Previous price limit studies are not able to provide such a clean test to identify price limit effects.

⁸ For example, see Kim and Rhee (1997).

For stocks that experience lower hits, the results are similar to upper-hit results. For stocks that hit lower price limits, volatility reverts back to its Day -1 volatility level on Day 3. Starting on Day 4 and for every day thereafter, volatility is lower than it was on Day -1. In contrast, for stocks that experience lower threshold-hits, volatility remains high on Day 3. Volatility becomes significantly lower on Day 5. These results again suggest volatility goes back to “normal” faster when stocks hit price limits.

How do price limits moderate long-run transitory volatility? It could be that price limits are working as intended and is curbing overreaction and panic behavior. Without price limits, prices can fluctuate widely, thus exacerbating panic. If panic contributes to transitory volatility,⁹ then price limits could be a useful regulatory tool to moderate transitory volatility. Our study is the first to show a volatility-related benefit of price limits. Results using different volatility measures and different benchmark days for standardization yield qualitatively similar results.

4.2 *Trading activity*

Trading activity is measured by daily trading volume, which is the total number of shares traded on a given day. Similar to our volatility measure, we scale daily trading volume by the trading volume on Day -1.¹⁰ Table 4 shows standardized daily trading volume results surrounding days that prices experience limit-hits and threshold-hits.

[Insert Table 4 Here]

From Table 4, for upper hits, we see that standardized trading volume dramatically increases on Day 0 for both limit-hits and threshold-hits. For stocks that experience upper limit-hits, trading volume continues to be high from Day 1 to Day 6. On Day 7, trading activities

⁹ Schwert (1990) correlates panic trading to excessive volatility. There are also many papers that argue noise traders cause excessive (or destabilizing) volatility (e.g., French and Roll (1986) and DeLong, et al. (1990)).

¹⁰ For the sake of robustness, we also standardized our trading activity measures using the 5-day average trading volume from day -15 to day -11 and from day -5 to day -1. The results are similar to our reported standardized trading activity results.

return to “normal.” In contrast, for stocks that experience threshold-hits, their trading activities remains abnormally high all the way through Day 10. Kim and Rhee (1997) cite high trading volume on extended days following limit-hit days as evidence that price limits delay rational trading activities. However, from our findings, we see it is in the absence of price limits where trading volume continues to be high for a relatively long period of time.

As with our volatility results, the difference in trading activity patterns between stocks that experience limit-hits versus those that experience threshold-hits can reliably be associated with the fact the former group of stocks hit price limits while the latter group does not. Why is trading volume abnormally high for a long period of time following threshold-hits? One possible explanation is that the high transitory volatility that persists on days after threshold-hits is correlated to noise or panic trading that occurs during times of uncertainty.¹¹ If noise or panic trading is deemed undesirable by markets, then it appears price limits can be employed to moderate it.

The trading volume results for lower hits, however, are unexpected. For lower limit-hits, trading volume reverts back to “normal” on Day 2, which we view as being rather quick in light of results from upper hits. However, for lower threshold-hits, trading volume is abnormally low on Days 0 and 1. One interpretation of this finding is that when prices are experiencing precipitous price free-falls in the absence of price limits, traders exit the market during these times of uncertainty and pessimism. These results also suggest traders behave differently between rising and falling markets. Prior studies have also found asymmetric results between upper and lower price limits (e.g., see Cho et al. (2003) and Kim and Yang (2008)).

¹¹ Schwert (1990) correlates the panic trading that occurred during the 1987 crash with excessive volatility. French and Roll (1986) and DeLong, et al. (1990) correlate noise trading with excessive volatility. See Karpoff (1987) for a review of the literature that relates price volatility to trading volume.

Overall, we view our trading activity results as being corroborative to our volatility results. Price limits appear to bring volatility and trading activities back to “normal” faster. When prices experience a large price movement on a given day, it appears useful if those prices are bound by price limits on that day. When prices are bound, there may be less panic and/or traders are less able to act on their panic. When panic is confined in this way, it appears markets are able to go back to “normal” faster.

4.3 *Price limits of Special Treatment stocks*

We obtain the information about ST firms and earnings of listed firms from the China Finance Online database. All ST firms are subject to 5% price limits, beginning on April 22, 1998 when the ST rule was established. We define two sub-periods: ST-regime and no-ST-regime. The ST-regime is one full year from January 1, 1999 to December 31, 1999. The no-ST-regime is one full year from January 1, 1997 to December 31, 1997. This way, each sub-period contains one year of data immediately surrounding the establishment of the ST designation.

Table 5 shows median daily returns surrounding Day 0 when ST stocks hit their 5% daily price limits during the ST-regime. As with the case with regular 10% price limits, there are occurrences when ST stocks hit 5% price limits on consecutive days. As before, we investigate samples both with and without multiple hits, but we only report results without multiple hits (results with multiple hits are qualitatively similar to reported results and available upon request). In Table 5, we separately report median returns for upper 5% price limit hits and lower 5% price limit hits.¹² From Table 5, we see that the median return is 5.0% on days that ST stocks hit their upper 5% price limit and -4.99% on days stocks hit their lower 5% price limit.

[Insert Table 5 Here]

¹² Mean results are often qualitatively similar to reported median results.

Table 6 reports standardized volatility surrounding days ST stocks hit their 5% price limit during the ST-regime. During the no-ST-regime, we identify firms we believe would have qualified as ST firms had the ST designation existed. These are firms with negative earnings during the prior fiscal year. For these firms, we report standardized volatility surrounding days they hit their 10% price limit during the no-ST-regime.

[Insert Table 6 Here]

From Table 6, we see that ST stocks that hit their 5% upper price limit on Day 0 revert back to their “normal” volatility on Day 1. For stocks that would have received the ST designation during the no-ST-regime, we see that when they hit their 10% upper price limit on Day 0 they continue to have high volatility on Day 1. These findings suggest that had these stocks been given the ST designation, their volatility would have returned back to normal as quickly as they did for ST stocks that hit their 5% upper price limit. If tighter price limits on ST stocks is meant to reduce transitory volatility that poorly performing or low priced stocks are especially vulnerable to, then these tight price limits appear to be working as intended.

For lower limit-hits, the results are unexpected. We see high volatility on Day 0 and Day 1 for ST stocks that hit their lower 5% price limit during the ST-regime, but for those stocks that would have qualified for ST designation during the no-ST-regime, we see that their volatility is “normal” on all days immediately surrounding Day 0, the day they hit their 10% price limit. However, note that these results suggest that a 10% lower price limit is not harmful for poorly performing stocks, so tightening price limits will unlikely yield an improvement in price limit effectiveness. We take a closer look at lower price limits for poor performing stocks in the next subsection.

4.4 *Lower price limits for poor performing firms*

Our previous analysis focused on the comparison between a tighter 5% limit and a regular 10% limit for firms with poor operating performance. A tight 5% up-limit seemed useful to constrain excessive volatility during times of upward price movements, but a tight 5% down-limit did not seem helpful to constrain volatility during times of downward price movements. We mentioned before that traders may behave differently between rising and falling markets. It appears lower-limits do not have to be tight to moderate excessive volatility for poorly performing firms. To verify this assertion, we conduct more tests. We specifically look at the performance of lower price limits for poorly-performing firms.

Following our earlier methodology, we compare the limit-hit sample to a threshold-hit sample. The limit-hit sample includes stocks that hit the 10% down-limit, while the threshold-hit sample includes stocks whose prices drop by more than 5% but do not hit the 10% lower limit. It should be noted that because both samples occur during the PL-regime, our analysis is similar to Kim and Rhee (1997) where they compare a limit-hit sample to a *near*-limit-hit sample to identify price limit effects. However, in contrast to Kim and Rhee (1997) who study price limits in general, our focus is on the effectiveness of lower price limits specifically for poor performing firms. Furthermore, our analysis is relevant to the ST rule in China given that those poor performing firms would have been designated as ST firms had the rule been imposed in 1997.

Table 7 presents daily volatility from Day -1 to Day 10 for both samples. The standardized volatility on Day 0 is not different from Day -1 volatility for the limit-hit sample, but the volatility on Day 0 is significantly high for the threshold-hit sample. Lower limit-hits are associated with less volatility than threshold-hits on event days. Furthermore, in contrast to Kim

and Rhee (1997), we do not find high volatility on Days 1 to 3 for the 10% down-hit sample. Lower price limits do not appear to exacerbate volatility for poor performing firms.

[Insert Table 7 Here]

Trading volume results are more illuminating. Kim and Rhee (1997) in their criticisms of price limits find evidence of constrained trading activity on limit-hit days followed by intensified trading on subsequent days. For our sample of poor-performing firms, we report daily trading volume for both the 10% down-hit sample and the threshold-hit sample in Table 8. From this table, we do not see any evidence of constrained trading activity on the limit-hit day or intensified trading activities following the limit-hit day. Interestingly, for the threshold-hit sample, trading volumes on Days 0 to 10 are all significantly lower than the Day -1 level. Investors seem reluctant to trade stocks of poorly performing firms following days they experience a large price drop. However, they appear more willing to trade these stocks following days after they hit a 10% lower price limit. One possible explanation for these results is that price limits may be providing a certain degree of protection from price free-falls, which, in turn, keeps traders in the markets.

[Insert Table 8 Here]

4.5 *Evidence surrounding stock market crashes*

Price limits became a hot topic in the wake of the 1987 stock market crash when it was being considered as a policy tool to prevent precipitous price free-falls (e.g., see the Brady Report (1988)). Some scholars believe panic contributed to the crash (e.g., Blume, MacKinlay, and Terker (1989) and Greenwald and Stein (1988)). Price limits put a cap on price declines and so traders cannot sell stocks below limit-prices. When traders cannot act on their panic-induced desires, it essentially extends the length of the overnight non-trading period thus giving these

initially panicked traders more time to assess the situation. As a result, these traders may return the next day less panicked. As stated by Kim and Rhee (1997), price limits are “supposed to give frenzied traders time to cool off” and this is also the same rationale used by the Tokyo Stock Exchange for its price limit system. Panic trading is well-known to be correlated with excessive stock price volatility (e.g., Schwert (1990)). In his study of the 1987 crash, Schwert (1990) examines market volatility following the day of the crash to see how quickly the market goes back to normal. To see whether price limits have a cooling-off effect, we also examine the overall volatility of the markets following “crashes” on the Chinese stock markets.

A crash is defined as a drop in market index by 3% or more from its previous day’s closing index value. Crash days are designated as Day 0. We again use equation (1) to measure volatility where we take the natural log of the ratio of the market index daily high value to its daily low value, and we standardize each day’s market volatility by its Day -1 volatility. The way we measure recovery speed is the same as before. We count the number of days it takes for the market to revert back to its Day -1 volatility. Table 9 reports the number of days it takes markets to recover from crashes during the PL-regime and during the no-PL-regime.¹³

[Insert Table 9 Here]

In Table 9, we report results separately for the two stock exchanges as each exchange can experience crashes on different days. For the Shanghai exchange, there were three occasions where the market index dropped by 8% or more during the PL-regime, while there were 18 such occasions during the no-PL-regime. For the three crash events during the PL-regime, the median market volatility spiked on Day 0, but on Day 1 the volatility was not statistically different from what it was on Day -1. That is, it only took one day to recover from the crash. In contrast, for

¹³ For the sake of space, we do not report standardized volatility statistics for each day, but they are available from us upon request.

the 18 crash events during the no-PL-regime, the median market volatility was statistically higher on Day 0, Day 1, and Day 2, than it was on Day -1. On Day 3, volatility reverted back to “normal” (i.e., Day 3 volatility is not statistically different from Day -1 volatility). That is, it took three days for the market to recover from the crash during the no-PL-regime. These results suggest markets recover faster when they impose daily price limits. Results for the Shenzhen exchange are similar. It took only one day on average for the market to recover from four crash events during the PL-regime, but it took two days on average to recover from 8 crashes during the no-PL-regime. When we use more liberal definitions of crashes, the results are consistent. Markets usually recover more or just as quickly from crashes during the PL-regime than they do during the no-PL-regime.

In Panel B of Table 9, we define crashes by their magnitudes rather than by thresholds. Again, the results are similar to what is reported in Panel A. For example, it took only 3 (2) days on average for the Shanghai (Shenzhen) exchange to recover from a 3-4% crash during the PL-regime while it took a longer 9 (3) days to recover from 3-4% crashes during the no-PL-regime. During each regime, the stocks, traders, market mechanisms, and economic conditions are nearly identical. If there are any differences between regimes that could lead to differences in volatility, then those differences should cancel out when we standardize daily market volatility by each crash events’ market volatility from the day before the crash. Therefore, any differences in recovery rates should therefore be reliably associated with the fact one regime imposed price limits while the other regime did not.

5. Conclusion

Many securities markets impose daily price limits on individual securities to explicitly restrict price movements on a day-to-day basis. Daily price limits are used in most stock markets

around the world, and for almost all of these markets they have been in place since the markets' inception. The rationales for price limits vary. Because price limits prevent wide swings in prices, they are supposed to reduce excessive volatility and moderate the adverse effects of speculative or panic trading behavior. Following the 1987 market crash, the merits of price limits as a regulatory tool was heavily debated. The recent global economic crisis has renewed regulators' interests in market mechanisms that can prevent market meltdowns and that can facilitate recovery. In our paper, we revisit price limits and their effectiveness as a regulatory tool.

Are price limits effective in achieving their intended goals? Existing literature has not been able to answer this question in convincing fashion. The biggest challenge faced by empirical studies is to observe price behaviors both with and without price limits in order to identify the effects of price limits. Of course, we can observe price behavior from a market with price limits and compare it to price behavior from another market without price limits (e.g., see Roll (1989)). However, this kind of study ignores many other differences between markets. Most price limit studies examine only price behavior from markets with price limits, but those studies are subject to the criticism that we do not know what would have happened without price limits. Empirical results and conclusions from those studies are thus questionable.

The two Chinese stock markets provide a great opportunity to study the performance of price limits. Price limits were initially imposed in those markets, but then they were removed during 1992-1996, and then re-imposed since December 16, 1996. Using the Chinese experience with price limits, we can test the performance of price limits by examining stock price behaviors during periods with and without price limits from the same market. Furthermore, firms that have negative earnings over two consecutive years are under "special treatment" and subject to

narrower price limits. We can further provide evidence on the performance of tight price limits for poor performing firms.

We provide three major sets of findings. First, we find price limits moderate transitory volatility and mitigates abnormal trading activity. Second, for poor performing stocks, a tighter price limit also appears helpful in moderating volatility and not hurtful. Finally, we find some evidence that price limits can facilitate market recovery following crashes. Although many prior studies criticize price limits, our study is the first to show convincing evidence of some benefits of price limits. Our results should shed important considerations to policy makers that continue to weigh the benefits and costs of price limits. For policy makers that endorse price limits, our results should shed some light on when and how price limits should be used. As to the broader question of whether or not price limits can prevent financial collapses or help our markets to recover from them, is something we leave to policy makers.

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Table 1
Price Limits in Shanghai and Shenzhen Stock Exchanges

This table reports daily price limit regulations that have been imposed on the Shanghai and Shenzhen Stock Exchanges since inception of both exchanges. For example, since December 16, 1996, the maximum allowable daily stock price change from its previous day's closing price is 10%, both upward and downward, on both stock exchanges.

<u>Price limits in Shanghai Stock Exchange</u>	
<u>Time period</u>	<u>Price limits</u>
07/27/90 - 12/18/90	±3.0%
12/19/90 - 12/26/90	±5.0%
12/27/90 - 01/06/91	±1.0%
01/07/91 - 04/25/91	±0.5%
04/26/91 - 05/20/92	±1.0%
05/21/92 - 12/15/96	No limits
12/16/96 - present	±10%
<u>Price limits in Shenzhen Stock Exchange</u>	
<u>Time period</u>	<u>Price limits</u>
05/30/90 - 06/17/90	±10%
06/18/90 - 06/25/90	±5.0%
06/26/90 - 11/20/90	+ 1%, -5%
11/21/90 - 12/13/90	±5.0%
12/14/90 - 01/01/91	+ 5%, -2%
01/02/91 - 08/16/92	±0.5%
08/17/92 - 12/15/96	No limits
12/16/96 - present	±10%

Table 2
Daily Returns Following Price Limit-Hits and Threshold-Hits

This table shows close-to-close median daily stock returns following days (i.e., day 0) when stocks experience price limit-hits or threshold-hits. Since December 16, 1996, the Shanghai and Shenzhen Stock Exchanges have imposed a daily 10% price limit (both upward and downward) on individual stock's daily price movements. From May 21, 1992 to December 15, 1996, the Shanghai and Shenzhen Stock Exchanges did not impose price limits. For this period where there is no price limit, a threshold-hit is when a stock price moves at least 10% from its previous day's closing price. Our sample periods are from September 1, 1992 to August 31, 1996 and from January 1, 1997 to December 31, 2000. Day -1 is the day before the hit day, day 1 is the day after the hit day, etc. ***, **, * (^^^, ^^, ^) indicate the median return is significantly greater (lower) than zero at the 1, 5, and 10 percent levels, respectively.

Upper hits			Lower hits		
Day	Limits-hits	Threshold-hits	Day	Limit-hits	Threshold-hits
-1	0.0083***	0.0090***	-1	-0.0167^^^	-0.0148^^^
0	0.0953***	0.1286***	0	-0.1054^^^	-0.1354^^^
1	0.0146***	-0.0088^^^	1	0.0128***	-0.0072^^^
2	-0.0004^^	-0.0053^^^	2	0.0000	0.0000
3	0.0003**	0.0075***	3	0.0054***	-0.0110^^^
4	0.0000	-0.0063^^^	4	0.0059***	0.0044***
5	-0.0012^^^	-0.0033^^^	5	0.0031***	0.0000
6	-0.0013^^^	-0.0020^^^	6	0.0028***	0.0000
7	0.0000	0.0000	7	0.0000	0.0025***
8	0.0041^^^	-0.0047^^^	8	-0.0033^^^	-0.0087^^^
9	0.0000	0.0000	9	0.0063***	0.0020***
10	0.0030^^^	-0.0035^^^	10	0.0018***	0.0000
	n = 5,979	n = 3,102		n = 2,923	n = 1,844

Table 3
Daily Volatility Following Price Limit-Hits and Threshold-Hits

This table shows standardized median daily volatility following days (i.e., day 0) when stocks experience price limit-hits or threshold-hits. Daily volatility is measured as log of the ratio of day's high price to its low price. Each day's volatility is standardized by volatility on day -1, the day before the hit day. Since December 16, 1996, the Shanghai and Shenzhen Stock Exchanges have imposed a daily 10% price limit (both upward and downward) on individual stock's daily price movements. From May 21, 1992 to December 15, 1996, the Shanghai and Shenzhen Stock Exchanges did not impose price limits. For this period where there is no price limit, a threshold hit is when a stock price moves at least 10% from its previous day's closing price. Our sample periods are from September 1, 1992 to August 31, 1996 and from January 1, 1997 to December 31, 2000. ***, **, * (^^^, ^^, ^) indicate median standardized volatility is significantly greater (lower) than one at the 1, 5, and 10 percent levels, respectively. <<<. <<, < (>>>, >>, >) indicate the left-hand volatility is significantly lesser (greater) than the right-hand volatility at the 1, 5, and 10 percent levels, respectively.

Upper hits			Lower hits		
Day	Limit-hits	Threshold-hits	Day	Limit-hits	Threshold-hits
-1	1.000	1.000	-1	1.000	1.000
0	1.646***	2.834***	0	1.422***	1.709***
1	1.395***	2.173***	1	1.281***	1.267***
2	1.210***	1.849***	2	1.055***	1.298***
3	1.178***	1.544***	3	0.932	1.121***
4	1.114***	1.434***	4	0.818^^^	0.847
5	1.050***	1.280***	5	0.766^^^	0.774^^^
6	1.023**	1.222***	6	0.745^^^	0.998
7	0.993	1.238***	7	0.760^^^	0.978
8	0.961^^^	1.122***	8	0.756^^^	0.813
9	0.939^^^	1.038*	9	0.722^^^	0.741^^^
10	0.976^^	0.965^	10	0.814^^^	0.764^^^
	n = 5,979	n = 3,102		n = 2,923	n = 1,844

Table 4
Daily Trading Volume Following Price Limit-Hits and Threshold-Hits

This table shows standardized median daily trading volume following days (i.e., day 0) when stocks experience price limit-hits and threshold-hits. Daily trading volume is measured as number of shares traded. Each day's trading volume is standardized by trading volume on day -1, the day before the hit day. Since December 16, 1996, the Shanghai and Shenzhen Stock Exchanges have imposed a daily 10% price limit (both upward and downward) on individual stock's daily price movements. From May 21, 1992 to December 15, 1996, the Shanghai and Shenzhen Stock Exchanges did not impose price limits. For this period where there is no price limit, a threshold hit is when a stock price moves at least 10% from its previous day's closing price. Our sample periods are from September 1, 1992 to August 31, 1996 and from January 1, 1997 to December 31, 2000. ***, **, * (^^^, ^^, ^) indicate median standardized trading volume is significantly greater (lower) than one at the 1, 5, and 10 percent levels, respectively. <<<, <<, < (>>>, >>, >) indicate the left-hand trading volume is significantly lower (greater) than the right-hand trading volume at the 1, 5, and 10 percent levels, respectively.

Upper hits			Lower hits				
Day	Limits-hits		Threshold-hits	Day	Limits-hits		Threshold-hits
-1	1.000		1.000	-1	1.000		1.000
0	2.262***	<<<	3.748***	0	1.198***	>>>	0.923^^^
1	2.660***	<<<	3.792***	1	1.060***	>>>	0.784^^^
2	1.620***	<<<	2.437***	2	0.974		1.061***
3	1.418***	<<<	2.242***	3	0.933^^^		0.958^
4	1.215***	<<<	2.069***	4	0.925^^^		0.829^^^
5	1.127***	<<<	1.690***	5	0.895^^^	>>	0.781^^^
6	1.027*	<<<	1.577***	6	0.824^^^	>>	0.812^^^
7	0.991	<<<	1.436***	7	0.854^^^		0.803^^^
8	0.928^^^	<<<	1.286***	8	0.816^^^	>>	0.659^^^
9	0.931^^^	<<<	1.214***	9	0.803^^^	>>>	0.652^^^
10	0.935^^^	<<<	1.092***	10	0.872^^^	>>>	0.620^^^
	n = 5,979		n = 3,102		n = 2,923		n = 1,844

Table 5
Daily Returns Following Price Limit-Hits for Special Treatment Stocks

This table shows close-to-close median daily stock returns following days (i.e., day 0) when stocks experience price limit-hits for Special Treatment (ST) Stocks. All ST firms are subject to 5% price limits, beginning on April 22, 1998 when the ST rule was established. Our sample period is from January 1, 1999 to December 31, 1999. Day -1 is the day before the hit day, day 1 is the day after the hit day, etc. ***, **, * (^^^, ^^, ^) indicate the median return is significantly greater (lower) than zero at the 1, 5, and 10 percent levels, respectively.

<u>Day</u>	<u>Price limit-hits for ST stocks</u>	
	<u>Upper hits</u>	<u>Lower hits</u>
-1	0.0000	0.0014
0	0.0500***	-0.0499^^^
1	0.0188***	-0.0051^
2	-0.0022	0.0012
3	0.0068***	0.0000
4	0.0000	0.0037**
5	-0.0020	0.0070***
6	0.0012	0.0081***
7	0.0015	0.0064
8	0.0037**	0.0061***
9	0.0000	0.0000
10	0.0012	0.0042**
	n = 434	n = 288

Table 6
Daily Volatility Following 5% Limit-Hits for Special Treatment Stocks and
10% Limit-Hits for Poorly Performing Firms

This table shows standardized median daily volatility following days (i.e., day 0) when Special Treatment stocks experience 5% price limit-hits or when other stocks experience 10% price limit-hits. Daily volatility is measured as log of the ratio of day's high price to its low price. Each day's volatility is standardized by volatility on day -1, the day before the hit day. Special Treatment designation is assigned by exchanges to firms that experience netative earnings for two consecutive years. The sample period is year 1999 for ST firms and year 1997 for poorly performing firms. ***, **, * (^^^, ^^, ^) indicate median standardized volatility is significantly greater (lower) than one at the 1, 5, and 10 percent levels, respectively. <<<, <<, < (>>>, >>, >) indicate the left-hand volatility is significantly lesser (greater) than the right-hand volatility at the 1, 5, and 10 percent levels, respectively.

Upper limit hits			Lower limit hits		
Day	5% limit-hits	10% limit-hits	Day	5% limit-hits	10% limit-hits
-1	1.000	1.000	-1	1.000	1.000
0	1.166***	1.235**	0	1.186***	0.969
1	0.999	1.267***	1	1.158***	1.131
2	1.050	1.032	2	0.980	1.012
3	1.075**	0.989	3	1.016	0.932
4	1.001	0.910	4	0.937	0.796^^
5	1.035	0.875	5	0.925	0.843^
6	1.021	0.765^^^	6	0.945	0.789^^^
7	0.966	0.899	7	1.008	0.805^^^
8	0.945	0.866^^	8	1.017	0.827^^
9	1.002	0.878	9	0.945	0.775^^^
10	0.996	0.884	10	0.952	0.734^^^
	n = 434	n = 101		n = 288	n = 60

Table 7
Daily Volatility Following Price Limit-Down-Hits and Threshold-Down-Hits
for Poor Performing Firms when there is No Special Treatment Designation

The sample is restricted to stocks that would have been designated as Special Treatment stocks during the period from January 1 to December 31, 1997 when there is no such designation. This table shows standardized median daily volatility following days (i.e., day 0) when these stocks' prices hit their 10% down limit and when these stocks' prices drop by more than 5% of their previous day's closing price but do not hit their 10% down limit (i.e., threshold down-hits). Daily volatility is measured as log of the ratio of day's high price to its low price. Each day's volatility is standardized by volatility on day -1, the day before the hit day. ***, **, * (^^^, ^^, ^) indicate median standardized volatility is significantly greater (lower) than one at the 1, 5, and 10 percent levels, respectively. <<<, <<, < (>>>, >>, >) indicate the left-hand volatility is significantly lesser (greater) than the right-hand volatility at the 1, 5, and 10 percent levels, respectively.

<u>Day</u>	<u>10% limit down-hits</u>		<u>Threshold down-hits</u>
-1	1.000		1.000
0	0.969	<<<	1.297***
1	1.131		1.063
2	1.012		0.993
3	0.932		0.926
4	0.796^^		0.850^^^
5	0.843^		0.844^^^
6	0.789^^^		0.852^^^
7	0.805^^^		0.832^^^
8	0.827^^		0.849^^^
9	0.775^^^		0.792^^^
10	0.734^^^	<	0.821^^^
	n = 60		n = 357

Table 8
Daily Trading Volume Following Lower Hits of Poor Performing Firms
when there is No Special Treatment Designation

The sample is restricted to stocks that would have been designated as Special Treatment stocks during the period from January 1 to December 31, 1997, when there is no such designation. This table shows standardized median daily trading volume following days (i.e., day 0) when these stocks' prices hit their 10% down limit and when these stocks' prices drop by more than 5% of their previous day's closing price but do not hit their 10% down limit (i.e., threshold down-hits). Daily trading volume is measured as number of shares traded. Each day's trading volume is standardized by trading volume on day -1, the day before the hit day. ***, **, * (^^^, ^^, ^) indicate median standardized trading volume is significantly greater (lower) than one at the 1, 5, and 10 percent levels, respectively. <<<, <<, < (>>>, >>, >) indicate the left-hand trading volume is significantly lesser (greater) than the right-hand trading volume at the 1, 5, and 10 percent levels, respectively.

<u>Day</u>	<u>10% limit down-hits</u>		<u>Threshold down-hits</u>
-1	1.000		1.000
0	0.957		0.894^^
1	0.899	>>	0.777^^^
2	0.918		0.811^^^
3	0.982	>>	0.750^^^
4	0.772^		0.711^^^
5	0.763^^		0.712^^^
6	0.711^^		0.660^^^
7	0.716	>	0.597^^^
8	0.815	>	0.682^^^
9	0.928		0.760^^^
10	0.954	>>	0.733^^^
	n = 60		n = 357

Table 9
Number of Days to Recovery Following Stock Market Crashes

This table shows the number of days it takes the Shanghai and Shenzhen Stock Exchanges to recover from stock market crashes. A crash is defined as a drop in market index by 3% or more of its previous day's closing index value. We focus on market index daily volatility, where daily volatility is measured as the log of the ratio of the index daily high to its low. A recovery occurs on the first day when stock index volatility is no longer larger than its volatility on the day before the crash. We separate our crash events into subperiods where price limits were imposed and not imposed (i.e., after and before December 16, 1996, respectively). Panel A reports crashes greater than different thresholds, such as 3% or more, 4% or more, 5% or more, and so forth. Panel B reports crashes by their magnitude, such as 3-4%, 4-5%, and so forth.

Panel A: Crashes defined by thresholds

	Shanghai Stock Exchange											
	8% crash		7% crash		6% crash		5% crash		4% crash		3% crash	
Price limits: Y/N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
# events	3	18	6	24	8	40	11	63	19	89	28	128
# days to recovery	1	< 3	2	2	2	< 3	2	< 3	2	< 3	3	3

	Shenzhen Stock Exchange											
	8% crash		7% crash		6% crash		5% crash		4% crash		3% crash	
Price limits: Y/N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
# events	4	8	5	11	11	13	16	23	23	45	38	90
# days to recovery	1	< 2	1	< 2	2	2	2	2	3	> 2	3	3

Panel B: Crashes defined by magnitudes

	Shanghai Stock Exchange											
	8% crash		7%-8% crash		6%-7% crash		5%-6% crash		4%-5% crash		3%-4% crash	
Price limits: Y/N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
# events	3	18	3	6	2	16	3	23	8	26	9	39
# days to recovery	1 < 3		1 1		2 < 3		1 < 2		2 2		3 < 9	

	Shenzhen Stock Exchange											
	8% crash		7%-8% crash		6%-7% crash		5%-6% crash		4%-5% crash		3%-4% crash	
Price limits: Y/N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
# events	4	8	1	3	6	2	5	10	7	22	15	45
# days to recovery	1 < 2		1 1		1 1		1 1		2 > 1		2 < 3	