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The Magnet Effect of Circuit Breakers and Its Interactions with Price Limits

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Abstract

Market-wide circuit breaker is one of typical market mechanisms in stock exchanges but little evidence exists on its impacts on stock returns. Using high frequency data during the four-day period which a circuit breaker was imposed in Chinese stock exchanges, this paper examines the magnet effect of market-wide circuit breakers and its interactions with the magnet effect of price limits. We provide evidences that magnet effect of circuit breaker exists in both market index returns and individual stock returns. Furthermore, magnet effect of price ceilings magnifies when a trigger of market-wide circuit breaker is more likely.

JEL: G10; G14; G18

Keywords: Circuit breaker; Price limits; Magnet Effect, High frequency stock data

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1. Introduction

Price limits and trading halts are two typical stock market mechanisms around the world. Price limits set the trading boundaries to restrict the daily security price changes. Trading halts, on the other hand, stop trading on the whole market for a pre-specified duration when the designated index reaches a pre-specified level. Unsurprisingly, many works have been done to study the effects of these mechanisms on volatility, price discovery, spillover effect and other market behaviors including Kim and Rhee (1997), Chen, Rui and Wang (2005) and Kim, Liu and Yang (2013) for price limits and Kim, Yagüe and Yang (2008), Jiang, McInish and Upson (2009) and Frino, Lecce and Segara (2011) for trading halts. Most existing literature on trading halt is focused on suspension of individual stocks triggered by the release of new information. Lauterbach and BEN- ZION (1993), on the other hand, investigate the effect of trading halts on stocks traded on the Israeli stock exchange during market crash. Furthermore, the single stock circuit breaker launched after the Flash Crash in the United States also add a few more studies such as Cui and Gozluklu (2016) to the literature on trading halts. Kim and Yang (2004) provide a comprehensive review for the studies on these trading mechanisms.

The magnet effect, among the others, is considered as one of the important unintended consequences of these mechanisms. Even though these mechanisms are designed to prevent excessive price movement, theoretical models such as Subrahmanyam (1994) suggest that the existence of price limits or trading halts could actually makes the price accelerates toward the boundaries when it gets closer to the limits. Using the high frequency transactions data, several recent studies including Cho, Russell, Tiao and Tsay (2003), Du, Liu and Rhee (2006) and Wong, Liu and Zeng (2009) provide evidences to support the existence of such magnet effect of price limits.

Empirical evidence for the magnet effect of trading halts, however, is nearly absence. This is especially true for trading halts at the market level, that is, the market-wide circuit breakers. One of the potential reasons for the missing evidence is that circuit breakers are rarely triggered by design. Since circuit breakers are designed to provide a cooling off period for market participants in exceptional circumstances, the circuit breaker levels are usually relatively high comparing to normal market volatility. For example, New York Stock Exchange requires a drop of 20% in the market index to trigger the market-wide circuit breaker.

The recent experience of China becomes a valuable exception in this sense. The market-wide circuit breaker was first implemented on the two main stock exchanges in China, Shanghai Stock Exchange (SSE) and Shenzhen Stock Exchange (SZSE) in 2016. Unlike circuit breakers in other countries, the mechanism was triggered twice shortly after it was in place, one in the first trading day of its implementation and again three day after. At the same night, the circuit breaker was called to an end by the regulator The short-lived circuit breaker therefore provides an unique and valuable opportunity to investigate the magnet effect of a market-wide circuit breaker.

We examine the magnet effect of the market-wide circuit breaker in Chinese stock markets during its four-day implementation period, using the high frequency transactions data at both market index level and individual stocks level. We also study whether the magnet effect of the market-wide circuit breaker interacts with the magnet effect of the existing price limits.

We provide evidences for the magnet effect of the market-wide circuit breaker at both market index and individual stocks level. Our results show that returns accelerate toward the boundaries when it gets closer to the circuit breaker threshold with various distance proxies. At individual stocks level, the magnet effect of price limits is found to coexist with the magnet effect of the market-wide circuit breaker but of smaller magnitude. We further show that magnet effects of the two trading mechanisms not only coexist but also interact. In particular, the magnet effect of price ceilings becomes stronger when the market-wide circuit breaker approaches its suspension threshold.

This study contributes to the literature in two ways. First, we provide the empirical evidences on the magnet effect of a market-wide circuit breaker using both market index and individual stock returns. In this aspect, our study is mostly related to Goldstein and Kavajecz (2004) which study the trading strategies of market participants when the circuit breaker was triggered in the New York Stock Exchange on 27 October, 1997. Their study provides evidences on the choice of trading venue, order type and timing around the closure of the exchanges that are consistent with the magnet effect hypothesis. Different from Goldstein and Kavajecz (2004), we provide direct evidence on the magnet effect of the circuit breaker from the price movement. Moreover, we supplement the findings of Goldstein and Kavajecz (2004) obtained in a mature financial market with further evidences from one of the fast-growing emerging markets. Second, there are very few studies consider the coexistence of price limits and trading halts even though the two mechanisms are in place together in most financial markets. One exception is Kim, Yague and Yang (2008) which compare the performance of price limits and trading halts. Our study, on the other hand, shed light on their interactions.

The rest of the paper is organized as follow. We describe the institutional background of the two Chinese stock exchanges and data in Section 2. The research methodology is discussed in Section 3. In Section 4, we present the empirical findings using the high frequency data of the market index and individual stocks. Section 5 concludes.

2. Institutional Background and Data Description

2.1. Institutional Background

The Shanghai Stock Exchange (SSE) and the Shenzhen Stock Exchange (SZSE) are the two stock exchanges in China. By market capitalization, SSE and SZSE are the fifth and eighth largest stock markets in the world respectively. The two exchanges are operated independently under the supervision of China Securities Regulatory Commission (CSRC) but, unsurprisingly, the two exchanges follows essential the same set of trading mechanisms.

The two exchanges are typical order-driven markets without designated market makers or specialists. Orders are matches based on the price and time priority rules in the two trading sessions. The morning session runs from 9:30am to 11:30am and the afternoon runs from 1:00pm to 3:00pm. The tick size is 0.01 RMB, regardless of the stock price. Since 1998, poorly performing firms are required to have a ST (the short form of special treatment) designation. The ST firms are usually subject to stricter trading rules and mechanism such as a tighter price limit.

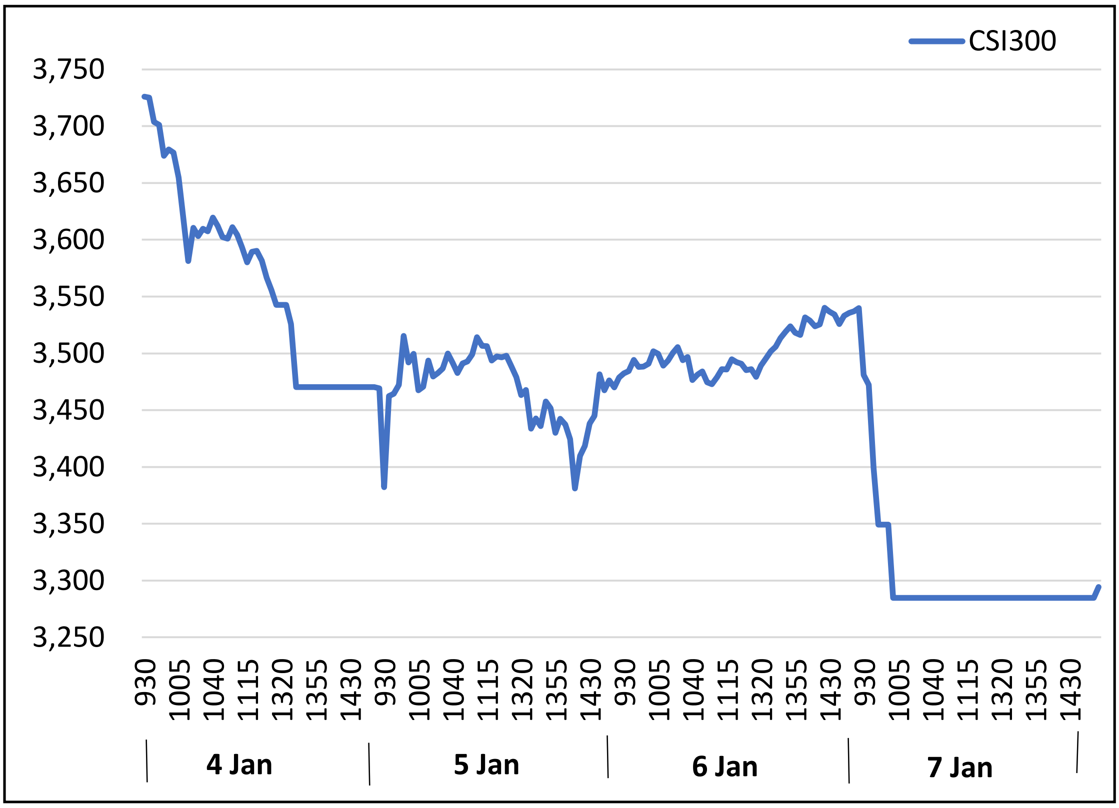
Price limit regulations have a long history in the two exchanges. Currently, the daily price limits for both markets is set at 10% from the previous closing price for individual stocks. Price limit hits are not uncommon, Wong et. al (2009) report that 463 out of the 705 stocks listed in SSE in their sample experienced limit hits in 2002. The Market-wide circuit breaker, compared to the price limits, has a much shorter history as discussed in the introduction. The market-wide circuit breaker became effective on the two stock exchanges on 1 January 2016 and was first imposed on 4 January, the first trading day of 2016. The CSI 300, the benchmark market index launched by the two exchanges together is used to measure the price movement. The circuit breaker has two thresholds, the exchanges would be closed for 15 minutes when there is a 5% drop of CSI 300 index before 2:45pm. Once the index declined 5%

after 2:45pm or 7% at any point of time during the trading session, the exchanges would suspend their trading for the rest of the day. The circuit breaker was triggered twice shortly after it was in place and the CSRC was forced to suspend the measure since 8 January.

2.2. Data Description

The transactions data used in this paper come from the GTA high frequency dataset. The dataset covers the 5-minute transactions data during the full sample period from 4 to 7 January 2016 when the market-wide circuit breaker was in place. Figure 1 presents the 5-minute movement of the market index, CSI 300 in this four-day period. At 4 January 2016, the first trading day of the year, the CSI 300 touched the first threshold of circuit breaker when it declined 5% at 1:12pm. Shortly after the exchanges resumed from a 15-minute trading halt, the index further dropped to the second threshold (i.e. a drop of 7%) at 1:33pm and the two exchanges were closed for the rest of the day. The index recovered about 2% in the next two days. At 7 January, however, another suspension was triggered shortly after the market opened at 10:00am.

Figure 1. CSI 300 from 4 to 7 January, 2016



In addition to the market index, the dataset contains 2,300 stocks listed in the SSE and SSZE. Removing stocks classified as ST and suspended for trading due to other reasons reduces the number of stocks to 1,603 in the empirical testing. Unsurprisingly, most stock prices dropped during the circuit breaker period following the market index. Among those stocks included in the empirical tests, 1,153 stocks hit their price floor limits during the circuit breaker period and most stocks experienced more than one hit. Meanwhile, there were also 89 stocks hit their price ceiling limits in the market downturn. A summary of data statistics is provided in the Table 1.

3. Methodology

We examine the magnet effects using returns of CSI 300 and individual stocks in this paper. To address the seasonal pattern of intraday volatility for high frequency returns documented in the literature, the returns of market index and individual stocks are handled in the same way following Cho et al. (2003) and Wong et al. (2009). For the market index and each stock, the standard deviation for each 5-minute interval is computed and the 5-minutes returns are then divided by the corresponding standard deviation. The autocorrelation and heteroscedasticity of the 5-minute returns are further removed with the following AR(3)-GARCH(2,2) model:

$$r_t = \mu + a_1 r_{t-1} + a_2 r_{t-2} + a_3 r_{t-3} + u_t \tag{1}$$

where $u_t = z_t h_t^{1/2}$, z_t is the i.i.d. standardized random variable and

$$h_t = \alpha_0 + \alpha_1 u_{t-1}^2 + \alpha_2 u_{t-2}^2 + \beta h_{t-1} + \beta h_{t-2} \tag{2}$$

The standardized returns, z_t are used to estimate the magnet effect with the following baseline model using market index:

$$z_t = \gamma + \delta CB_t + \varepsilon_t \tag{3}$$

and a slightly modified specification using individual stock returns:

$$z_{it} = \gamma + \delta CB_t + \beta_1 Ceiling_{it} + \beta_2 Floor_{it} + \beta_3 (CB_t x\ Ceiling_{it}) + \beta_4 (CB_t\ x\ Floor_{it}) + \varepsilon_{it}. \quad (4)$$

The only difference between two specifications rests on the proximity to price limits and their interactions with the proximity to the circuit breaker level are included in the later one using individual stock returns. These variables, obviously, are only available at individual stocks level. To address the concern on unobserved individual effect, fixed effect model is estimated for the panel data of individual stock returns.

Proximity to the circuit breaker level, which is set at the 5% drop from the closing price in the last trading day[1], is measured by CB_t and the magnet effect of circuit breaker is estimated by δ. Several methods are used to proxy the distance from the circuit breaker threshold to ensure robustness. First, a dummy variable which is equal to 1 when the last 5-minute price is within certain percentage of the circuit breaker threshold is used following Cho et al. (2003). In the estimations, 3% and 1% from the circuit breaker level are used. Second, a variable from 1 to 6 is used to indicate the time distance prior to the trigger of the circuit breaker following Wong et al. (2009) and Du et al. (2006). For example, CB_t= 6 refers to the 5-minute interval just before the trigger of circuit breaker and CB_t= 1 refers to the sixth 5-minute interval before the break. In all other cases, CB_t= 0. To address the nonlinearity of magnet effect, square of the time distance is also used as an alternative in the estimation. Finally, the inverse of the percentage difference between the last 5-minute closing price and the circuit breaker level, P_{CB} is computed as below:

$$CB_t = \frac{1}{(P_{t-1} - P_{CB})/P_{t-1}}$$

Using the inverse could make the interpretation of the coefficient more straight forward on the one hand. On the other hand, the inverse of the percentage difference could also address the nonlinearity of magnet effect. In total, five measures for the proximity to the circuit breaker level are used for the empirical tests.

For the specification estimated for the individual stock returns, proximities to the price

[1] There are two thresholds of circuit breaker in China. As described in the introduction, however, the second threshold is always triggered shortly after the market reached the first threshold. In view of this, the circuit breaker level used in the empirical testing is set at the 5% decline of the market index.

limits and their interactions with the circuit breaker are included. $Ceiling_{it}$ and $Floor_{it}$ are the proximity to the price ceiling limit and price floor limit of the stock *i* respectively. For brevity, we use the integer distance of stock *i* at time prior to the limit hit as defined in Wong et al. (2009) and Du et al. (2006) to measure the proximity to the price limits . Similar to the same measure for the proximity to the circuit breaker level, the variables have the value from 1 to 6. The variable, $Ceiling_{it}$ $(Floor_{it}) = 6$ referes to the 5-minute interval just before the stock price hits the price ceiling (price floor) while a value of 1 refers to the sixth closest 5-minute interval before the limit hit. The square of the time distance is used in the estimation to address for the nonlinearity of the magnet effect of price limits. The findings reported in this paper, however, remain robust when a linear model is used for the magnet effect.

The coefficient, β_1 and β_2 measure the magnet effect of price ceiling limit and price floor limit respectively. The effects of the proximity to the circuit breaker level on the magnet effects of price limits (the magnet-on-magnet effect) are estimated by β_3 and β_4 respectively. In particular, a positive (negative) sign of $\beta_3(\beta_4)$ suggests the magnet effect of the price ceiling (floor) limit increases when the market index approaches the circuit breaker level, vice versa. Table 1 provides the statistics under various measures of proximity to the circuit breaker threshold.

Table 1. Summary Statistics

	within 3%	*within 1%*	*time distance*	*Squared time distance*	*% distance inverse*	*Total Observations*
Market Index						
No. of observations	20	1	8	8	124	124
Individual Stocks						
No. of observations	31623	1496	12505	12505	196954	196954
No. of stocks	1602	1496	1602	1602	1602	1602
of which						
Price ceiling hits	18	-	-	-	705	705
No. of stocks	18	-	-	-	89	89
Price floor hits	2469	661	4066	4066	5811	5811
No. of stocks	771	661	1149	1149	1153	1153

4. Empirical Results

4.1. Magnet Effect of Circuit Breaker on Market Index Returns

The magnet effects estimated with the market index returns using various measures for the proximity to the circuit breaker level are reported in the first two columns of Table 2. To provide better understandings of the results, we also estimate the same model using the data of four trading days with similar market downturn in the period which market-wide circuit breaker did not exist. In particular, the four trading days are 24, 25 August 2015, 26 January and 25 February 2016. The largest daily declines of the CSI 300 in these days were about 6% to 8%. In these days, we set a hypothetical circuit breaker level and remove observations after the market index first hit the 5% threshold.

Table 2. The Magnet Effect of Circuit Breaker on Market Index Returns

		Sample period with Circuit Breaker in place (N= 124)		Sample period without Circuit Breaker in place (N =109)	
		γ	δ	γ	δ
Measure for the Proximity to the Circuit Breaker	Dummy = 1 if last closing price is within 3% of the circuit breaker level	-0.007 (0.097)	-0.265 (0.264)	0.109 (0.143)	-0.201 (0.190)
	Dummy = 1 if last closing price is within 1% of the circuit breaker level	-0.037 (0.089)	-1.620*** (0.089)	-0.010 (0.105)	0.087 (0.170)
	Time distance from the circuit breaker being triggered	0.021 (0.089)	-0.274*** (0.050)	0.068 (0.101)	-0.107** (0.048)
	Square of the time distance from the circuit breaker being triggered	0.017 (0.090)	-0.055*** (0.008)	0.036 (0.102)	-0.013 (0.008)
	Inverse of the percentage difference between the last closing price and the circuit breaker level	0.171 (0.125)	-0.828** (0.358)	0.008 (0101)	-0.014 (0.034)

Dependent variable is the 5-minute standardized returns of the CSI300 after removing the autocorrelation and heteroscedasticity using the AR(3)-GARCH(2,2) model. Robust standard errors are reported. *, **, and *** denote estimates that are significant at 10%, 5%, and 1%, respectively.

The estimations using the circuit breaker period data support the existence of magnet effect. The magnet effect is found to be significant in all measures of proximity to the circuit breaker level but one. Magnet effect of the hypothetical circuit breaker in the non-circuit breaker period, as shown in the last two columns of Table 2, is only significant when the time distance is used as proximity measure. Moreover, the estimated effect are much smaller, economically and statistically, in the non-circuit breaker period.

Table 3. Effects of Circuit Breaker on Trade Volume and Volatility

		Trade Volume		Volatility	
		w Circuit Breaker	w/o Circuit Breaker	w Circuit Breaker	w/o Circuit Breaker
Proxy for the Proximity to the Circuit Breaker	Dummy = 1 if last closing price is within 3% of the circuit breaker level	0.732*** (0.258)	0.586** (0.254)	0.663** (0.325)	0.637*** (0.163)
	Dummy = 1 if last closing price is within 1% of the circuit breaker level	1.422*** (0.162)	0.308 (0.347)	0.478*** (0.157)	-0.028 (0.309)
	Time distance from the circuit breaker being triggered off	0.129** (0.059)	0.094 (0.081)	0.061 (0.073)	0.053 (0.072)
	Square of the time distance from the circuit breaker being triggered off	0.028** (0.011)	0.021 (0.012)	0.019 (0.012)	0.007 (0.014)
	Inverse of the percentage difference between the last closing price and the circuit breaker level	1.413*** (0.266)	0.095 (0.066)	1.025** (0.416)	-0.001 (0.082)

Dependent variable is the trade volume standardized by its mean and standard deviation during the same interval in the first two columns. In the last two columns, the dependent variable is the standardized volatility measured by the high-low price difference in the 5-minute interval. Robust standard errors are reported. *, **, and *** denote estimates that are significant at 10%, 5%, and 1%, respectively.

To shed light on the effect of circuit breaker on the dynamics of other market variables, the baseline model is also estimated for the standardized trade volume and volatility. The volatility is measured by the high-low price difference. Trade volume and volatility are then standardized with their means and standard deviations during the same time interval across the sample following Lee et al. (1994), Du et al. (2005) and Wong et al. (2009). The estimated results are presented in Table 3. In general, the results are consistent with the findings on price limits in the existing literature. Greater trading intensity is observed when the market index approaches to its circuit breaker level during the sample period with circuit breaker in place. Such effect, however, is not found near the hypothetical circuit breaker level when the circuit breaker is absent. The effect of circuit breaker on volatility is relatively mixed. Increased volatility is only found in three of five proximity measures in the circuit breaker period. Meanwhile, the results obtained from the non-circuit breaker period are not significant in four out of five cases.

4.2. Magnet Effects of Circuit Breaker, Price Limits and their Interactions

The findings in the previous section support the magnet effect of circuit breaker on market index returns. To further study the interaction between the magnet effect of circuit breaker and the magnet effect of price limits, however, we need to turn to the individual stock returns. In the upper panel of Table 4, the findings on the magnet effect of circuit breaker are replicated using the individual stock returns. In the lower panel, proximities to the price limits are included in the model. The magnet effect of circuit breaker in general remains even though the magnet effect is now marginally rejected when proximity is measured by the inverse of the percentage distance from the circuit breaker level. On the other hand, the magnet effect of price limits is found to be highly significant across all measures.

In the fourth column of Table 4, proximities to the circuit breaker level and price limits are both measured with the squared time distance. This sheds light on the relative magnitude of magnet effect of the market-wide circuit breaker and price limits on individual stocks. In this case, the magnet effects of the price ceiling limit and price floor limit are found to be relatively symmetric similar to the findings in Wong et al. (2009). The magnet effect of the circuit breaker, however, is found to be much stronger than the magnet effect of price floor limit. Moving from 35 minutes to 30 minutes before the trigger of trading mechanism, the additional drop in standardized return of an individual stock is 0.014% for the case of price floor limit while 0.038% for the case of market-wide circuit breaker. Since the result is obtained with the squared time distance, this also suggests that the magnet effect of circuit breaker also accelerates at a faster rate than the magnet effect of price floor limit. One of the possible explanations rests on the different consequences of the two mechanisms. Unlike price limits which only restrict the trading boundaries, the market-wide circuit breaker also suspends the trading for all stocks. This could lead to substantial concern on liquidity and magnify the magnet effect.

Table 4. The Magnet Effect of Circuit Breaker and Price Limits on Individual Stock Returns

	Proximity to the Circuit Breaker				
	within 3%	*within 1%*	*time distance*	*Squared time distance*	*% distance inverse*
			Circuit Breaker only		
Circuit Breaker	-0.121	-0.946***	-0.203***	-0.040***	-0.480*
	(0.195)	(0.067)	(0.058)	(0.010)	(0.275)
Observations	196,954	196,954	196,954	196,954	196,954
R^2	0.002	0.007	0.046	0.050	0.007
			Circuit Breaker and Price Limits		
Circuit Breaker	-0.010	-0.822***	-0.191***	-0.038***	-0.415
	(0.194)	(0.092)	(0.056)	(0.010)	(0.273)
Ceiling	0.017***	0.018***	0.016***	0.016***	0.016***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.003)
Floor	-0.040**	-0.037**	-0.016***	-0.014***	-0.035**
	(0.016)	(0.016)	(0.005)	(0.005)	(0.016)
Observations	196,954	196,954	196,954	196,954	196,954
R^2	0.012	0.016	0.047	0.051	0.018

Fixed effect model is estimated. Standard errors are clustered by both stock and time.

*, **, and *** denote estimates that are significant at 10%, 5%, and 1%, respectively.

To explore how the market-wide circuit breaker interacts with the price limits of the individual stocks, we estimate the model with their interactions and report the results in Table 5. The model is estimated with the various proximity measures to the circuit breaker as before. Unfortunately, there are no observations for the interactions between price ceiling hit and circuit breaker proximity measure when *within 1%*

dummy, *time distance* and *squared time distance* variables are used. The results in Table 5 generally replicate the previous findings on the magnet effects of circuit breaker and price limits. The sign of the coefficient of *Ceiling* is negative in the last column when the inverse of the percentage distance from the circuit break level is used to measure the proximity. However, the magnet effect of price ceiling limit is always positive in practice since the inverse variable has a minimum value of 0.14 in the dataset.

Table 5. The Magnet Effect of Circuit Breaker, Price Limits and Their Interactions

	Proximity to the Circuit Breaker				
	within 3%	*within 1%*	*time distance*	*Squared time distance*	*% distance inverse*
Circuit Breaker	-0.116	-0.968***	-0.190***	-0.038***	-0.454
	(0.196)	(0.066)	(0.052)	(0.010)	(0.291)
Ceiling	0.016***	0.018***	0.016***	0.016***	-0.027*
	(0.004)	(0.004)	(0.004)	(0.004)	(0.015)
Floor	-0.050**	-0.050**	-0.014*	-0.014*	-0.051**
	(0.022)	(0.017)	(0.008)	(0.008)	(0.025)
Circuit Breaker x Ceiling	0.098***	-	-	-	0.246***
	(0.028)				(0.083)
Circuit Breaker x Floor	0.030	0.045***	-0.000	0.000	0.032
	(0.023)	(0.016)	(0.003)	(0.000)	(0.024)
Observations	196,954		196,954	196,954	196,954
R^2	0.013		0.047	0.051	0.019

Fixed effect model is estimated. Standard errors are clustered by both stock and time.

*, **, and *** denote estimates that are significant at 10%, 5%, and 1%, respectively.

The results on the interaction terms suggest that the circuit breaker does not only have magnet effect on the stock returns directly but also have a magnet effect on the magnet effect of price ceiling limits. For example, the magnet effect of the price ceiling limits is found to be 0.098% higher when the market index is within 3% of the circuit breaker level. The magnet-on-magnet effect is consistently found across estimations using various measures of proximity. Similar effect, however, is not found for the case of price floor limit. An explanation for this result may rest on the prohibition of short selling in the two exchanges. This trading rule could restrict circuit breaker to create additional magnet effect on price floor limit.

4.3.Sensitivity Tests for Interaction Effects

The magnet effect of circuit breaker is consistently supported by the market index return and individual stock returns using various proximity measures. Evidences on the interaction effects between price limits and circuit breaker, unfortunately, are limited by the absence of observations in some proximity measures for circuit breaker. To ensure our findings on interaction effects are robust, we estimate the model with various sub-samples. Five firm characteristics used in the sensitivity tests are market capitalization, standardized trading volume, beta, book to market ratio and CSI300 constituents. Two sub-samples are constructed for each firm characteristics based on the median. To avoid endogeneity, firm characteristics at the year-end of 2015 are used.

Table 6. Sensitivity Tests for Interaction Effects

Proximity to the Circuit breaker	**within 3%**		**% distance inverse**	
	Circuit Breaker x Ceiling	*Circuit Breaker x Floor*	*Circuit Breaker x Ceiling*	*Circuit Breaker x Floor*
Large Market Cap.	0.095***	0.029	0.283***	0.029
	(0.028)	(0.024)	(0.089)	(0.026)
Small Market Cap.	0.119***	0.030	0.171**	0.033
	(0.016)	(0.022)	(0.081)	(0.024)
High Trading Vol.	0.095***	0.025	0.231***	0.028
	(0.030)	(0.020)	(0.086)	(0.022)
Low Trading Vol.	0.113***	0.037	0.276***	0.038
	(0.015)	(0.028)	(0.087)	(0.028)
High Beta	0.149***	0.031	0.311***	0.031
	(0.020)	(0.023)	(0.094)	(0.026)
Low Beta	0.067***	0.028	0.136*	0.032
	(0.015)	(0.022)	(0.071)	(0.023)
High Book-to-Market	0.086***	0.052	0.216***	0.051
	(0.002)	(0.035)	(0.080)	(0.037)
Low Book-to-Market	0.159***	0.0216	0.319***	0.024
	(0.033)	(0.018)	(0.100)	(0.020)
CSI300	0.280***	0.091***	0.604***	0.048
	(0.026)	(0.023)	(0.171)	(0.038)
Non-CSI300	0.043	0.029	0.207***	0.031
	(0.031)	(0.023)	(0.079)	(0.024)

Fixed effect model for the equation (4) is estimated. Standard errors are clustered by both stock and time. *, **, and *** denote estimates that are significant at 10%, 5%, and 1%, respectively.

The results reported in Table 6 suggest that the interaction effects vary with firm characteristics. In particular, the interaction effect between circuit breaker and price ceiling becomes stronger for stocks with high beta and low book-to-market. This result could imply that growth stocks with higher market risk have a stronger interaction effects. This is also true for the CSI constituents. Apart from the variations, the interaction effect between circuit breaker and price ceiling is consistently found to be significant positive across all sub-samples. The interaction effect between circuit breaker and price floor, on the other hand, remains insignificant.

5. Conclusion

Circuit breakers and price limits are the two typical trading mechanisms in the stock markets. However, evidence on the magnet effect of a market-wide circuit breaker is rare since it is seldom triggered by design. Furthermore, the interactions of the two mechanisms are unexplored in the literature. Using high-frequency data in the four-day period which a market-wide circuit breaker was imposed in China, this paper examines the magnet effect of circuit breaker and its interactions with the existing price limits.

In this paper, we provide evidences on the magnet effect of circuit breaker based on returns of market index and individual stocks. The magnet effect is consistently found with various proximity measures. Such effect is not found with most proximity measures in a control sample period which circuit breaker is not in place.

Our empirical tests using the individual stock returns also suggest that magnet effect of circuit breaker does not only coexist but also interacts with the magnet effect of price limits. In particular, the magnet effect of price ceiling accelerates when a trigger of market-wide circuit breaker is more likely. This finding would surely open the door for future studies on the interactions between various stock exchanges trading mechanisms.

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