Dynamic Short-Sales Constraints, Price Limits and Price Delays*

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Abstract

While short-sales constraints have been widely imposed due to the current credit crunch, theories disagree in their implications on the stock prices. This paper takes advantage of a natural experiment in Taiwan to test their effect on price delays. Since September 1998, short-selling is banned at a price below the close price of the previous trading day. The new rule creates unique daily dynamics of short-sales constraints. Unlike existing proxies, the dynamic constraints do not suffer from potential endogeneity or reverse causality. Moreover, the timely observable constraints are ideal for testing the rational expectation models, in which investors have to be aware of the tightness of the constraints. We extend the empirical methodology in Hou and Moskowitz (2005) and find no evidence of price delay. Our results are in line with Diamond and Verrechia (1987), who argue short-sales constraints do not necessarily bias the prices. We also study the effect of daily price limits on the price delay and find it increases significantly if stocks hit their price limits on the previous trading day.

JEL classification: G14, G18

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1 Introduction

> "Short selling is un-American. It is done by rogues, thieves, and especially pessimists, who are, or course, the worst of the lot. It is a terrible, terrible thing and must be stopped in our lifetime. We should halt it, restrict it, or at the very least revile those who make it their vocation. These sentiments are sadly not imaginary or rare. Rather, they genuinely reflect much of the investing public's view of short selling." *Short Selling: Strategies, Risks, and Rewards,* 2004, edited by Frank Fabozzi.

Imposing some form of short-sales constraints is a common response of regulators facing stock market downturns. The latest example is the global restrictions on short-selling in September/October 2008 due to the credit crunch.[1] Although widely adopted, the impact of short-sales constraints on stock prices is still debated. Miller (1977) argues that if short-sales constraints are imposed, stock prices are set only by optimistic investors and these stocks are thus overpriced. With a rational expectation model, however, Diamond and Verrechia (1987) argue that short-sales constraints do not necessarily bias prices upward. Investors rationally incorporate the constraints into prices. Bai, Cheng and Wang (2006) take the rational expectation model one step further. They argue that risk-averse investors ask a higher premium as compensation for bearing more risk due to less informative trades. In this paper, we shed light on the theories by providing a unique empirical strategy to study the effect of short-sales constraints on the prices.

We take advantage of a natural experiment in the Taiwan stock market. On 4th of September 1998, the Taiwanese Securities and Futures Bureau prohibited investors from short-selling a stock at a price below its close price of the previous trading day. It was a stability measure for the aftermath of the Asian financial crisis. The spirit of the rule is similar to the U.S. up-tick rule since both try to prevent short-sellers from driving stock prices further downward. The major difference is that the rule in Taiwan is stricter and clearer. Unlike the multiple reference prices in the up-tick rule, there is only one price

[1] See Appendix 1 for the details of the ban and restrictions in the world.

(determined and fixed before the market opening) in Taiwan per day. Therefore, investors are aware of whether short-selling is banned or not during the trading hours.[2] Consequently, this rule creates daily dynamics of short-sales constraints.

These dynamic constraints are ideal for testing the different implications of the theories. The theory of Miller (1977) implies that stocks are overpriced when short-selling is not feasible during trading hours and will be corrected after the restriction is lifted. Hence, we should see lower return following a constrained day. Diamond and Verrecchia (1987) argue that investors know that the short-sellers are excluded from the market during the constrained day. They rationally would incorporate it into prices, which on average would then be at the right level. Thus the returns would not be affected by the constraints. Investors in Bai et al. (2006) ask for an extra premium because of the information uncertainty in the market due to the absence of the short-sellers. Hence, stock prices could be on average too low during a ban day and will bounce back after the ban is lifted. These three models thus imply a positive, zero and negative price delay (or autocorrelation) in stock prices respectively.

Our main contribution is to evaluate the influence of these dynamic short-sales constraints on stock price delays. Using these constraints has several advantages over the existing proxies discussed below. First, the dynamic constraints are imposed by the regulators rather than determined by the lending supply and demand. This specific feature alleviates the concern of endogeneity or reverse causality. This is because the tightness of the constraints is not related to firm-specific characteristics, which might also affect the lending market equilibrium. In addition, for rational expectation to work, investors have to be clearly aware of the tightness of the constraints to incorporate them into the prices. In contrast to the lending market data, our dynamic constraints are observed by all investors and thus provide an ideal environment to test the implications. Second, unlike a one-time-only natural experiment, the daily constraints are spread across stocks and different points in time for the sample period. The effects from concurrent confounding macroeconomics

[2]For example, if the close price of a stock on the previous trading day is 20, short-sellers are banned to short at a price below 20 today. That is to say, if the price today is never higher than 20, short-selling is banned for today.

events are thus minimized. Last, Taiwan did not have an option market for individual stocks until 2003.[3] Therefore, short-selling is supposedly the only way to express investors' private negative information.[4] This offers a cleaner testing field.

Since the dynamics of short-sales constraints are at daily frequency, we have to take another trading restriction in Taiwan stock exchange into account. In our sample period, Taiwan has daily price limits of 7% for both sides based on the close price of the previous trading day. Proponents argue that investors are prone to overreact to new information. Price limits can provide a cooling-off effect and reduce volatility. Opponents, however, argue that price limits merely delay price discovery and generate the volatility spillover to the subsequent day. Incorporating the price limits into our empirical tests is thus crucial to isolate the effects of short-sales constraints. Taiwan has one of the tightest price limits among the world stock markets. That also makes it one of the few markets that has price limits frequently reaching high enough to allow for empirical tests with sufficient statistical power. Given price limits are still imposed by U.S. futures market and by many other stock exchanges, the second contribution of this paper is to shed light on the impact of these limits on stock prices.[5]

Our empirical methodology is as follows. We extend the empirical methodology in Hou and Moskowitz (2005) to incorporate the dynamic short-sales constraints and the price limits directly. We run a regression of daily stock returns on the contemporaneous returns of Taiwan stock index and its one-day lag. Specifically, we model the lagged coefficient on market returns as a function of a constant, a short-sales constraints dummy and a price limits dummy. In theory, the lagged coefficient should not differ from zero if price discovery process is not delayed. However, once the short-sales constraints are effective after September 1998 (the constrained period, while before September 1998 is referred to as the unconstrained period hereafter), short-selling is not always permitted. Especially when

[3] The number of stocks issuing options started with 5 and only increased to 30 in 2008. Our sample period ends in January 2003.

[4] Literature has shown that option trading tends to reduce the tightness of short-sales constraints and the effects on stock prices (see Diamond and Verrecchia (1987), Senchack and Starks (1993) and Figlewski and Webb (1993)).

[5] For example, the price limits are applied in Athens, China, Japan, Korea, Malaysia, Mexico, Thailand and others. For details, see Roll (1989).

the highest price within a day is below the close price of the previous trading day, negative private information possessed by short-sellers can only be revealed on the subsequent day. The lagged coefficient might not be zero in this situation. Hence, under the new short-selling rule, the coefficient of short-sales constraints dummy should be informative about whether these constraints have any effect on price reactions. However, it may also capture firm-specific characteristics in a down market. By comparing the difference between coefficients of the unconstrained and constrained periods, we can disentangle the two. Intuitively, other confounding firm-specific features are largely cancelled out by the paired-test. Our setup does not suffer from potential omitted variables problem that often shows up in the cross-sectional regression used in the short-selling literature.

The impact of short-sales constraints on price reactions could also be captured by an autoregressive model. Following this logic, we run an AR regression with the autoregressive term as a function of a constant, a short-sales constraints dummy and a price limits dummy. We then compare the difference between the coefficients of the unconstrained and constrained periods. Both methods mentioned above incorporate the daily dynamics into the regressions directly. To facilitate comparison with the existing literature, we also estimate the price delay measures in Hou and Moskowitz (2005). Relating the difference between the measures of the unconstrained and constrained periods to the short-sales constraints and price limits also sheds light on the issue.

Our main finding is that imposing constraints on short-selling prices does not significantly change the lagged coefficient on market returns or the autoregressive term. The difference between the loadings on short-sales constraints dummies of the unconstrained and constrained periods is insignificant in all regression specifications. The economic impact is also negligible. In other words, stock prices react to information in a way similar to if short-selling was not banned. This finding is in line with the implication of Diamond and Verrechia (1987) who argue that investors rationally incorporate short-sales constraints into the stock prices by adjusting their stock demand. Prices are on average at the right level even when short-selling is not feasible. The constraints lead to no significant increases on the price delay and autocorrelation. However, it is important to note that no price delay does not mean that the actual negative information is revealed. It is the expected negative information that is reflected in the prices. Since an econometrician only observes the transaction prices, the actual effect of the short-sales constraints on the information efficiency would not be identified. The result also indicates that investors do not ask a higher risk premium as they might do in the world of Bai et al. (2006).

In addition, the price delay measure in Hou and Moskowitz (2005) is not related to the dynamic short-sales constraints either. The cross-sectional regression shows that the coefficient of short-sales constraints dummy does not explain the increase of price delay measure after controlling for the price limits, size and turnover rate. More constrained stocks, proxied by the number of ban days, do not contribute to a higher price delay measure in the constrained period. Both time-series and cross-sectional setups thus reach the same conclusion.

For the price limits, however, we find strong evidence that they have negative impact on the price reactions to information. Both lagged coefficient on market returns and the autoregressive term increase if the price hits the limits. Reaching price limits also generates volatility spillover to the subsequent day. Moreover, the price delay measure increases significantly with the number of days that the limits are hit. The price limits in Taiwan stock market restrain the prices from reacting to the shocks. Stock prices continue moving in the same direction on the next trading day. Unlike in the case of short-sales constraints, rational expectation does not help to bring stock price back to the right level since the stock price movements are limited. Any selling or buying pressures due to the rational expectation can only be satisfied on the next trading day.

Our paper is complementary to the large empirical literature on short-selling. Most studies so far have been devoted to testing whether high shorting demand or shorting costs can predict subsequent future returns.[6] Some recent articles test for the impact of the short-sales constraints on price efficiency.[7] These papers mainly use short interest or rebate

[6] See Diether, Lee and Werner (2008), Cohen, Diether and Malloy (2007), Boehmer, Jones and Zhang (2008), Asquith, Pathak and Ritter (2005), Jones and Lamont (2002), Nagel (2005), Chang, Cheng and Yu (2007), Geczy, Musto and Reed (2002), D'Avolio (2002), Ofek, Richardson and Whitelaw (2004), and Rubinstein (2004).

[7] See Wu (2008), Saffi and Sigurdsson (2008), Chang, Cheng, Pinegar and Yu (2008) and Bris, Goetzmann

rate as a proxy for the short-sales constraints. High short interest has been used as an indicator of high shorting demands and thus stringent short-sales constraints. However, short interest is the observed equilibrium quantity of lending supply and demand. If a stock is very costly to short due to limited supply, the equilibrium quantity could be very low resulting in opposite predictions (see Jones (2004) and Diether et al. (2008) for the detailed discussion of the shortcoming using short interest as a proxy).

Rebate rate (or lending fee) is argued to be a better measure for short-sales constraints as it reflects direct costs of shorting a stock. But the rebate rate may also suffer from endogeneity or reverse causality. Fabozzi (2004) points out that because security borrowers want to minimize the recall risks, they tend to work with lenders that are likely to extend the security loan contracts. The most reliable sources of stock loans are large institutional investors whose portfolios are rebalanced less frequently. Those investors tend to hold large and liquid stocks.[8] That leads the lending supply of small and illiquid stocks to be scarce and drives up the lending fees. One other reason is that institutional investors may be reluctant to lend out stocks that are overpriced or with lower information efficiency and this might tighten the short-sales constraints.

In both cases, we cannot rule out the possibility that some common factors affect both the lending market equilibrium and the price efficiency of stocks. Our dynamic short-sales constraints are not determined by the lending market equilibrium. This paper is thus related to Chang et al. (2007) in a way that it alleviates the concern for endogeneity. They use a natural experiment in the Hong Kong market to test the implication of Miller (1977). Moreover, the short interest is released at monthly frequency in the U.S. and the rebate rate is not easily observable to the uninformed investor. These two proxies for short-sales constraints are thus not as suitable as our dynamic constraints to test the implications of the theoretical papers with rational expectation framework like Diamond and Verrechia (1987) and Bai et al. (2006).

The rest of the paper proceeds as follows. In Section 2, we discuss the theory and evidence of the short-sales constraints. Section 3 contains a description of the institutional

and Zhu (2007).

[8] See Gompers and Metrick (2001).

facts in Taiwan stock market and the data. Section 4 describes the methodology. Section 5 presents the empirical results and Section 6 concludes.

2 Theory and Evidence of Short-Sales Constraints

2.1 Theory

Early theoretical work has established that short-sales constraints prohibit some informative trades. Miller (1977) argues that short-sales constraints reduce the number of investors that are able to express their opinions in the market, especially the pessimistic ones. This shifts the supply curve inward and thus leads to higher prices and lower subsequent returns. In our dynamic short-sales constraints, some negative information may not be reflected in price when short-selling is banned (price is always below its close price of the previous trading day). Price does not fall to the level as they should have without the ban. The under-adjustment to the shocks would get corrected on the following day when the ban is lifted. Hence, hypothesis of Miller (1977) implies a positive price delay or autocorrelation under the dynamic constraints.

Diamond and Verrechia (1987) use a rational expectation framework to model the effects of constraints on the distribution and the adjustment speed of stock prices. Rational investors take constraints into account when formulating their demand for stocks. In their setup, risk-neutral investors change their expectations on the price level accordingly. Short-sale constraints thus do not necessarily lead to biased prices. They show that only the price adjustment speed is negatively affected by the constraints. The reduced speed of adjustment to private bad news implies that relatively large value price changes are downward. The main empirical implication is thus that price distribution is more skewed to the left but remains unbiased in the mean. If the stock prices on average are at the right level, we should not identify any price delay or autocorrelation under our dynamic constraints.

In general, changing short-sales constraints affects the information content of observed transactions. Bai et al. (2006) take the rational expectation model one step further. They argue that uninformed investors ask a higher risk premium as compensation for bearing more risk due to less informative trades. Short-sales constraints limit trades driven by negative private information and thus increase the uncertainty about the asset values perceived by the investors. It reduces their demand of stocks, which drives prices downward. Contrary to Miller (1977), prices may fall beyond the level as they should have without the ban. The over-adjustment to the shocks would get corrected on the following day when the ban is lifted. Moreover, Bai et al. (2006) argue that the information asymmetry should be high enough to make such a prediction. In their setup, the ratio of informed traders over uninformed ones should be lower than certain threshold. In an emerging market like Taiwan with high retail investor participation, hypothesis of Bai et al. (2006) implies a possibility of a negative price delay or autocorrelation under our dynamic constraints.

To sum up, in the world of Miller (1977), stock prices do not reflect all the negative private information on the short-selling constrained day, which results in overpriced stocks. Under the framework in Diamond and Verrechia (1987), short-sales constraints do not bias the prices. The expected negative information is incorporated into the prices. With rational expectation in risk as well, however, the short-sales constraints may push prices further downward, which results in a bounce back when the ban is lifted on the subsequent day. Different theories on short-sales constraints have different implications for price behavior. It is thus an empirical question to ask which one prevails. Our dynamics of short-sales constraints serve ideally to answer it.

2.2 Evidence

Following Miller (1977), most empirical research focus on the correlation between short-sales constraints and return predictability. Jones and Lamont (2002) use historical loan data at NYSE from 1926 to 1933 to show that stocks which are difficult to short have lower returns for the next month. Entering loan crowd list is used as the proxy for high shorting demand. Without loan data, Nagel (2005) argues that low institutional ownership has direct effect on high cost of short-selling. It also has indirect effect that small percentage of investors is sophisticated enough to sell short when stocks are overpriced. He finds that, holding size fixed, the underperformance of stocks with high M/B ratio, analyst forecast dispersion, turnover, or volatility is most pronounced among stocks with low institutional ownership. Asquith et al. (2005) use both institutional ownership and short interest data and assume that stocks with high short interest and low institutional ownership have the severest short-sales constraints. They find highly shorted stocks underperform for next month. Following the same argument, Akbas et al. (2008) find that short interest can predict future earning surprises and the prediction power is stronger in the stocks with low level of institutional ownership.

Based on proprietary loan data from single custodian, the following papers have the advantage of accessing the observed equilibrium quantity and price of the lending market. Cohen et al. (2007) infer the relative shifts of lending demand and supply from loan data. They show that shorting demand can predict returns for the next month and short-selling is an important revelation mechanism of private information. Boehmer et al. (2008) also find that heavy shorted stocks underperform for the next 20 days. With the types of short-sellers data, they show that institutional non-program short sales are the most informative. Diether et al. (RFS forthcoming) find that positive past return is a trigger for short-selling activities. In turn, high short-selling activities predict negative cumulative returns of the next 2 to 5 days.

Establishing the correlation between short-sales constraints and subsequent returns implies price efficiency is affected. Recently, several papers aim to directly test the effect. Bris et al. (2007) use the price delay measures in Morck et al.(2000) and Hou and Moskowitz (2005) to see whether short-sales constraints have any effect on those measures. They find that short-sales constraints impede negative price information but reduce the negative skewness. Saffi and Sigurdsson (2008) use similar price delay measures and find them negatively related to lending supply and positively related to borrowing fees. Wu (2008) use both pricing errors based on Hasbrouck (1993) and absolute value of 30-minute quote midpoint return autocorrelation as short-term delay measures and find them correlated with lagged short interests. She also find similar results using the measures in Hou and Moskowitz (2005)

The main concern of the research mentioned above is the endogeneity or reverse causality. The general hypothesis is that information efficiency is affected by the short-sales constraints. But it is also possible that institutional investors are less willing to buy and lend stocks with low price efficiency. Low supply of such stocks increases borrowing fees. We cannot rule out the possibility that some common factors affect both the lending market equilibrium and the price efficiency of stocks.

Chang et al. (2007) and Chang et al. (2008) tackle the endogeneity problem by exploring the short-selling policy change in the Hong Kong market. The first paper uses the events when stocks enter a list of designated securities on which short-sales are permitted. They find negative cumulative abnormal returns up to 60 days after stocks enter the list. Chang et al. (2008) also use the Hong Kong data but focus on exiting rather than entering the short-list. They regress stock returns on negative market returns, moderate market returns and positive market returns and find that short-sales constraints do not induce price convexity.

The Taiwan data used in this paper shares similar advantages of the policy change in the HK market. These natural experiments make paired-test feasible, which mitigates problems from inter-firm differences. Moreover, days when short-sales constraints are effective differ across firms such that concurrent events are less likely to contaminate the interpretation of empirical results. Compared with the HK data, the Taiwan data has two extra advantages. First, there are much more event days when short-sales constraints are binding for each stock. Importantly, the daily dynamics of the constraints enable us to run a time-series regression with more observations to gauge the effect. Second, there is no endogeneity issue of entering and exiting the short-list. The dynamic constraints in Taiwan are applied to all stocks at the same time.

3 Institutional Environment and Data

3.1 Institutional environment

Like the United States, there is no centralized lending market for individual stocks in Taiwan. However, the rebate rate in general are the same for all stocks held in each brokerage firm. Investors do not have to negotiate the rate for each stock in the same brokerage firm. Across brokerage firms, the rate may vary. Taiwan Stock Exchange (TWSE) imposes a quota limit for each stock to prevent short-sellers from concentrating on shorting one stressed stock. The stock is not allowed to sold short if the short interest reaches the 25% of its outstanding shares. But the number of shares sold short is usually far below the quota. The number of shares available to borrow thus depends mainly on the number of shares managed by the brokerage firms rather than on the quota limit. If the number of shares available for short-sales in a brokerage firm cannot meet the demand, TWSE provides solutions such as special auction service for the firm to borrow the shares.

To engage in short-selling, investors have to apply for a margin trade account in brokerage firms on their personal credit. Investors are allowed to sell stocks short up to their credit lines. They have to deposit cash equal to 90% of the stock value they sell short. They have to pay 14.25 basis point of trading commission, 8 basis point of short-sales commission, and the lending fees to the brokerage firms. Besides, they also have to pay a transaction tax on stock sales of 0.3 percent.

Like most emerging markets, the TWSE has daily price limits of 7% for both sides based on the close price of the previous trading day. Stocks that hit their price limits are tradable as long as the transaction price is within the limits. Hence, the price limits in Taiwan are floor and ceiling prices, not circuit breakers.

3.2 Unique short-sales constraints and individual investors

On 4th of September 1998, the Taiwanese Securities and Futures Bureau prohibited investors from short-selling a stock at a price below its close price of the previous trading day. It was initially a stability measure for the aftermath of the Asian financial crisis. The rule was applied to all stocks until 16th of May 2005, when the stocks on the ETF-50 list were exempted from the constraints.

The Securities and Futures Bureau in Taiwan intended to adopt the up-tick rule as applied in the US market. In the end, according to Huang et al. (2007), they decided to adopt different standards based on the following concerns of the up-tick rule. First, investors have to track the transaction prices closely to see whether the uptick rule is in effect. Second, the uptick rule is more complicated than benchmarking to one reference price (close price of the previous trading day). Third, the proposal met with fierce opposition from brokerage firms due to higher operational costs if uptick rule was adopted. The brokerage firms were also afraid of more potential disputes between them and investors for complicated short-sales rules.

One thing to note is that institutional investors, domestic or foreign, were not allowed to short sell before July 2003 (our sample ends in January 2003). Although only individual investors can sell stocks short, the ratio of short-sales and short covering over total trading volume is not trivial. Figure 1 shows that the short-selling in Taiwan stock market accounts for 3% to 5% of total trading values from 1994 to 2002. This is partly due to high participation of individual investors in the stock market. Figure 2 shows that trades from individual investors account 92% of the total trading volume in 1994 and slowly decrease to 82% in 2002. With such high individual investors participation, the Securities and Futures Bureau thus decided to impose clear and simple short-sales rules to avoid possible disputes between brokerage firms and investors.

Besides this main policy change in 1998, stocks with close price below its par value (10 NT$) were not allowed to sell short from October 19th 2000 to July 12th 2001. It is a temporary measure to stabilize the market after the dotcom bubble. The effect of the policy is also incorporated into our short-sales constraints dummy.

3.3 Data

The stocks and market data are from Taiwan Economic Journal (TEJ). The margin trade statistics and investor composition statistics are from Taiwan Securities and Futures Bureau website. We have daily stock returns and other characteristics from 13th of September in 1994 to 19th of January in 2003. We only include stocks that were continually listed on TWSE during this period. In total we have 186 stocks spanning 1,128 trading days both in the unconstrained and constrained periods. We stop at 20th of January in 2003 because it was the day of the first stock option being introduced in Taiwan stock market. In our sample period, therefore, short-selling is the only way for investors to express negative private opinion without holding the stocks.

Descriptive statistics are reported in Table 1. Stocks are sorted into quartiles by the ratio of short-sales constrained days over total trading days. We report the mean of the variables in each quartile. The first thing to note is that both price limit hit ratio and volatility increases in the constrained period. But the turnover rate in general decreases. Short-sales constraints ratio increases partly due to the poor market performance after Asian financial crisis and the burst of dotcom bubble. It is also because the temporary policy that a stock with price below its par value is banned from short-selling. This explains the 3rd and 4th quartiles mainly contain small stocks.

4 Methodology

In this section, we first provide the market model setup with short-sales constraints and price limits dummies in the lagged coefficient on market returns. In Section 4.2, we propose an autoregressive setup with short-sales constraints and price limits dummies in the autoregressive term. We discuss the price delay measure in Hou and Moskowitz (2005) in Section 4.3.

4.1 Short-sales constraints and price limits dummies in the lagged coefficient on market return

Unlike the US stock market, the short-sales constraints in Taiwan are not based on the uptick rule. Although they are both designed to ease downward price pressure, the constraints in Taiwan are stricter and also clearer to the short-sellers. Short sale is allowed if the short-selling price is not below the close price of the previous trading day. For each day, there is only one reference price whether short-selling order at a given price can be executed. The rule thus results in three scenarios and creates daily dynamic short-sales constraints. First, there are days when the constraints are always binding. Second, there are days when the constraints are never binding. And there are days when the constraints are binding for some trading hours. We focus on evaluating the impact on the price reactions in the first scenario as no private information can be revealed by the short sales. Specifically, if highest price of a stock at day t never exceeds its close price at day $t-1$, investors cannot sell the stock short at any point in time at day t. The short-sales constraints dummy variable is thus defined as follows:

$$D_{i,t}^{SC} = 1 \quad if \quad price_{i,t}^{high} < price_{i,t-1}^{close} \tag{1}$$

Hou and Moskowitz (2005) argue that market frictions have adverse effect on stock price responses to new information. The average price delay can be captured by the market model with lagged returns. However, to exploit the daily dynamics of the short-sales constraints in Taiwan, we extend their empirical methodology and run the following regression:

$$r_{i,t} = \alpha_i + \beta_i * r_{m,t} + (\delta_i + \gamma_i * D_{i,t-1}^{SC}) * r_{m,t-1} + \varepsilon_{i,t} \tag{2}$$

where $r_{i,t}$ is excess return for stock i on day t, $r_{m,t}$ is the market excess return, the dummy $D_{i,t-1}^{SC}$ is the short-sales constraints dummy on day $t-1$ and $r_{m,t-1}$ is the one-day lagged market excess return. In this way, we model the effect of short-sales constraints directly.

If the market is frictionless, we would expect both δ_i and γ_i to be zero. Past market information should be fully reflected in stock prices. However, for days when short-sales constraints are binding for all trading hours, i.e. $D_{i,t}^{SC} = 1$, some negative information might not be revealed and would be captured by γ_i. The coefficient δ_i captures other firm-specific price delays such as nonsynchronous trading, although high turnover rate in Taiwan stock market should alleviate the problem. The turnover rate of Taiwan stock market reported in Barber, Lee, Liu and Odean (2008) is 300% annually during 1995 to 1999. In contrast, annual turnover on the New York Stock Exchange (NYSE) averaged 97% annually from 2000 through 2003.

One other difference from the US stock market is that Taiwan stock market imposes 7% price limits on both sides as another stability measure in our sample period. On the one hand, in theory, the price limits could calm down overreaction and reduce volatility. On the other hand, if 7% price movement cannot fully reflect the new information, we shall see positive (negative) subsequent returns for stocks that hit their upper (lower) limits. The price limits thus merely delay price adjustments and spill volatility across the subsequent day. We can incorporate the price limits into the equation directly by running the following equation:

$$r_{i,t} = \alpha_i + \beta_i * r_{m,t} + (\delta_i + \gamma_i * D^{SC}_{i,t-1} + \lambda_i * D^{\pm 7\%}_{i,t-1}) * r_{m,t-1} + \varepsilon_{i,t} \tag{3}$$

where $D^{7\%}_{i,t-1} = 1$ indicates stock i hits its price limits on day $t-1$.

If price limits can effectively calm down overreaction at daily frequency, we should see no effect on subsequent returns. However, if price limits just hinder price discovery, we would expect the price continuation documented in Kim and Rhee (1997) by a positive λ_i.

A natural extension of the model is to distinguish the effects from positive and negative market returns like the regressions in Bris et al. (2007). We extend equation (2) and (3) into piece-wise format as follows:

$$\begin{aligned} r_{i,t} &= \alpha_i + \beta^{up}_i * \max(r_{m,t}, 0) + \beta^{down}_i * \min(r_{m,t}, 0) \\ &\quad + \delta^{up}_i * \max(r_{m,t-1}, 0) + (\delta^{down}_i + \gamma_i * D^{SC}_{i,t-1}) * \min(r_{m,t-1}, 0) + \varepsilon_{i,t} \end{aligned} \tag{4}$$

and

$$\begin{aligned} r_{i,t} &= \alpha_i + \beta^{up}_i * \max(r_{m,t}, 0) + \beta^{down}_i * \min(r_{m,t}, 0) \\ &\quad + (\delta^{up}_i + \lambda^{up}_i * D^{7\%}_{i,t-1}) * \max(r_{m,t-1}, 0) \\ &\quad + (\delta^{down}_i + \gamma_i * D^{SC}_{i,t-1} + \lambda^{down}_i * D^{-7\%}_{i,t-1}) * \min(r_{m,t-1}, 0) + \varepsilon_{i,t} \end{aligned} \tag{5}$$

where $\max(r_{m,t}, 0)$ and $\min(r_{m,t}, 0)$ capture the positive and negative market returns respectively.

After the imposition of the new rule, the loading γ_i should tell whether it has any effect on the price behaviors. In theory, however, γ_i may also capture firm-specific characteristics such as higher illiquidity in a down market. Hence, we run the regressions above separately in the unconstrained and constrained periods and compare the difference of parameters in interest to disentangle the effect. Any confounding firm-specific feature should be largely cancelled out by this kind of paired-test. Unlike potential omitted variables problem in cross-sectional regression, which is often used in the short-selling literature, our setup yields more robust results.

Our hypothesis focuses on testing whether on average the short-sales constraints have impact on the price reactions. We thus run regressions for each stock first, and evaluate the average effect of the parameters in interest. Specifically, we test the following hypothesis:

$$H_0 : \Delta\gamma = \gamma^C - \gamma^U = 0 \tag{6}$$

and

$$H_0 : \Delta\lambda = \lambda^C - \lambda^U = 0 \tag{7}$$

where γ^C (γ^U) captures the effect of short-sales constraints in the constrained (unconstrained) period and λ^C (λ^U) captures the effect of price limits in the constrained (unconstrained) period. We use the number of short-sales constrained days or the number of days that stocks hit the limits as the weight to calculate the sample average. It is because the precision of the estimates on the short-sales constraints and price limits dummies depends on the numbers of observations. Using weighted average improves the estimation efficiency. We only include stocks with at least five observations in both dummies to avoid outliers. The sample counterparts of γ^C, γ^U, λ^C, λ^U are as follows:

$$\overline{\gamma}^U = \sum_i \gamma_i^U * \omega_{i,\gamma}^U, \qquad \overline{\gamma}^C = \sum_i \gamma_i^C * \omega_{i,\gamma}^C \tag{8}$$

and

$$\overline{\lambda}^U = \sum_i \lambda_i^U * \omega_{i,\lambda}^U, \qquad \overline{\lambda}^C = \sum_i \lambda_i^C * \omega_{i,\lambda}^C \tag{9}$$

where ω_i are the weights. The standard errors for $\Delta\overline{\gamma}$ and $\Delta\overline{\lambda}$ are based on the White-adjusted variance-covariance matrix. Importantly, we do not assume zero correlations between each stock's gamma (or lambda). Instead, we estimate the variance-covariance matrix of the gamma (or lambda) through the correlations of the stock returns. Specifically, we assume that correlations between stock returns are only contemporaneous but can vary over time.

We can also incorporate short-sales constraints and price limit dummies into the alpha. Because both constraints may not only affect the price reactions but also risk-adjusted returns. Following the setup of lagged coefficient on the market return, we make the alpha a function of a constant, short-sales constraints dummy and price limit dummy. The regressions are as follows:

$$\begin{aligned} r_{i,t} &= \alpha_{i,0} + \alpha_{i,sc} * D_{i,t-1}^{SC} + \alpha_{i,pl} * D_{i,t-1}^{\pm 7\%} \\ &\quad + \beta_i * r_{m,t} + (\delta_i + \gamma_i * D_{i,t-1}^{SC} + \lambda_i * D_{i,t-1}^{\pm 7\%}) * r_{m,t-1} + \varepsilon_{i,t} \end{aligned} \tag{10}$$

and

$$\begin{aligned} r_{i,t} &= \alpha_{i,0} + \alpha_{i,sc} * D_{i,t-1}^{SC} + \alpha_{i,up} * D_{i,t-1}^{7\%} + \alpha_{i,down} * D_{i,t-1}^{-7\%} \\ &\quad + \beta_i^{up} * \max(r_{m,t}, 0) + \beta_i^{down} * \min(r_{m,t}, 0) \\ &\quad + (\delta_i^{up} + \lambda_i^{up} * D_{i,t-1}^{7\%}) * \max(r_{m,t-1}, 0) \\ &\quad + (\delta_i^{down} + \gamma_i * D_{i,t-1}^{SC} + \lambda_i^{down} * D_{i,t-1}^{-7\%}) * \min(r_{m,t-1}, 0) + \varepsilon_{i,t} \end{aligned} \tag{11}$$

4.2 Short-sales constraints and price limits dummies in the autoregressive term

The impact of short-sales constraints on stock prices could also be captured by an autoregressive model. Higher autoregressive term indicates more price delay. To test whether the short-sales constraints dummy contributes to higher AR term, we propose the following regression:

$$r_{i,t} = \mu_i + (\rho_i + \gamma_i * D_{i,t-1}^{SC}) * r_{i,t-1} + \varepsilon_{i,t} \tag{12}$$

where γ_i captures the short-sales constraints effect and ρ_i captures other firm-specific autoregressive effect.

Similarly, the autoregressive effect would also be affected by the price limits. We can incorporate them into the regression directly as in the equation (3). The regression is as follows

$$r_{i,t} = \mu_i + (\rho_i + \gamma_i * D^{SC}_{i,t-1} + \lambda_i * D^{\pm 7\%}_{i,t-1}) * r_{i,t-1} + \varepsilon_{i,t} \tag{13}$$

where λ_i captures the price continuation effect documented in Kim and Rhee (1997) for the price limits.

We also expand the AR model into piece-wise form to see whether gains and losses contribute to different autoregressive natures:

$$r_{i,t} = \mu_i + (\rho^{up}_i + \lambda^{up}_i * D^{7\%}_{i,t-1}) * \max(r_{i,t-1}, 0) + (\rho^{down}_i + \gamma_i * D^{SC}_{i,t-1} + \lambda^{down}_i * D^{-7\%}_{i,t-1}) * \min(r_{i,t-1}, 0) + \varepsilon_{i,t} \tag{14}$$

We then test the $\Delta\overline{\gamma}$ and $\Delta\overline{\lambda}$ like previous section.

4.3 Price delay measures in Hou and Moskowitz (2005)

While the first two methods test the effects of dynamic short-sales constraints in a time-series fashion, the effect of the new short-selling rule can also be evaluated by a cross-sectional regression. Following Hou and Moskowitz (2005), we regress stock returns on contemporaneous and lagged market returns. However, the regression is done at daily frequency to reflect the short-term nature of lending activities documented in Diether et al. (2008).[9] We first run the following regression:

$$r_{i,t} = \alpha_i + \beta_i r_{m,t} + \sum_{n=1}^{n=4} \delta_i(-n) * r_{m,t-n} + \varepsilon_{i,t} \tag{15}$$

where $r_{i,t}$ represents returns of stock i on day t, $r_{m,t-n}$ are market returns on the corresponding day $t-n$.

The price delay measures are defined as[10]

[9] We only include 4 lagged returns since the turnover rate is extremely high in the Taiwan market.

[10] Hou and Moskowitz (2005) also estimate a price delat measure based on R^2. We do not use it as it does not distinguish between shorter and longer lags or the precision of the estimates.

$$D_i = \frac{\sum_{n=1}^{n=4} \delta_i(-n)}{\beta_i + \sum_{n=1}^{n=4} \delta_i(-n)} \tag{16}$$

or

$$D_i = \frac{\sum_{n=1}^{n=4} \frac{\delta_i(-n)}{\sigma(\delta_i(-n))}}{\frac{\beta_i}{\sigma(\beta_i)} + \sum_{n=1}^{n=4} \frac{\delta_i(-n)}{\sigma(\delta_i(-n))}} \tag{17}$$

We then run the following cross-sectional regression to investigate the effect of short-sales constraints

$$\Delta D_i = \alpha + \beta_1 * SumD_i^{SC} + \beta_2 * \Delta SumD_i^{\pm 7\%} + controls + \varepsilon_i \tag{18}$$

where ΔD_i is the difference between the delay measures of the unconstrained and constrained periods, $SumD_i^{SC}$ is the number of short-sales constrained days in the constrained period, $\Delta SumD_i^{7\%}$ is the difference between number of days that price hits the limits of the unconstrained and constrained periods. Since the new short-selling rule is effective only in the constrained period, the number of unconstrained days is not included in the regression. Control variables include the average size of firms in the constrained period, the size difference between the unconstrained and constrained periods, and the turnover rate difference between the unconstrained and constrained periods. We also include mean stock price level in the constrained period to control the effect from the temporary policy that short sales are banned if stock price is below the its value.

If price reaction is affected by the number of short-sales constrained days, we would see the loading on $SumD_i^{SC}$ differs from zero. However, as mentioned above, equation (18) is an indirect test. Higher number of days that short-selling is banned may not necessarily lead to higher lag market coefficients in a small sample. For instance, if most of the constrained days are clustered in a very short period, the influence may be diluted by the rest days. The mechanism linking short-sales constraints and price delays is thus complicated by the aggregation. Lots of information at the daily frequency is averaged out. Hence, in the empirical section, we mainly focus on the results of first two methods and report the result from the price delay measure for comparison.

5 Empirical Results

In this section, we start by discussing whether our short-sales constraints and price limits dummies have effects on the lagged coefficient on market return and autoregressive term. We also investigate their impact on the total and idiosyncratic variances. We show the results from the price delay measures in Hou and Moskowitz (2005) in section 5.2. We discuss the robustness check in section 5.3.

5.1 Main results

Results for market model setup

Table 2 Panel A shows the results of lagged market beta as a function of a constant, short-sales constraints dummy and price limits dummy. We show the coefficients estimated in the unconstrained and constrained periods and their differences with three regression specifications. Specification 1 and 2 contains only short-sales constraints dummy or price limit dummy while Specification 3 has both.

Specification 1 shows that gamma, the loading on short-sales constraints dummy, increases from -0.01 to -0.004. The increment in gamma captures the effect of short-sales constraints on the lagged coefficient since short-selling is not restricted in the unconstrained period. However, the difference is not significant. Specification 3, which includes price limits dummy in lagged coefficient as well, shows that the gamma increases from -0.09 to -0.06. But the difference is still insignificant. The economic impact is also negligible. We find no evidence that imposing constraint on short-selling price contributes to higher lagged coefficient on market return.

Panel B shows the piece-wise regression results as we distinguish positive and negative market returns. In general, short-sales constraints only affect the price responses to negative information. Hence we only include constraints dummy in the lagged negative market return. Specification 4 and 6 show that the difference in gamma is insignificant as well.

This finding is in line with the implication of Diamond and Verrechia (1987) who argue that investors rationally incorporate short-sales constraints into stock prices. The simple short-selling rule in Taiwan i.e., one reference price per day, makes uninformed investors clearly aware of whether short-selling order can be executed or not at any point in time. It is relatively easy, compared with the uptick rule, for uninformed investors to take the constraints into account when formulating their stock demand. For days when short-selling is possible during the trading hours, negative information can be incorporated into stock prices through short sales. For days when short-selling is banned during the entire day, stock prices fall not so much due to the actual revelation of negative information but through the rational expectation of the uninformed investors. Uninformed investors reduce their stock demand either by buying less or selling more to bring down the prices. If stock prices on average fall in the similar magnitude in both cases, the effect of the constraints would not be identified. In other words, the short-sales constraints have no effect on delaying the price responses to negative information. This may explain we do not find significant results that the lagged market coefficient is affected by the short-sales constraints. The result also indicates that investors do not ask a higher risk premium as they might do in the world of Bai et al. (2006).

However, no price delay does not mean that the actual negative information is revealed. It is the expected negative information is incorporated into the prices. Although the prices are on average at the right level, the content of the "true" information are still lower due to less informative trades. Hence, whether price efficiency is affected depends on the definition. If price efficiency is defined as the variance of the expected mean from the uninformed investors as in Bai et al. (2006), it might be reduced due to the short-sales constraints. However, the current data does not enable us to quantify the magnitude unless we know the uninformed investors' expectations and their detailed trading records.

For price limits, we find strong evidence that they have large negative effect on the price reactions. Specification 2 in Table 2 Panel A shows that the lagged coefficient increases by

0.38 and 0.364 in the unconstrained and constrained periods respectively if stock prices hit the limits on the previous day. Specification 3 shows similar results. Panel B shows that the price reaction is reduced more when stocks hit the upper limits. For example, Specification 5 reports that lagged coefficient increases by 0.532 for hitting the upper limit and by 0.379 for hitting the lower limit in the unconstrained period. The results suggest that the price limits in the Taiwan stock market restrain the prices from reacting to the new information. Stock prices continue moving in the same direction on the next trading day.

One thing to note is that rational expectation does not help to bring stock price back to the right level when price limits are hit as it does for the short-sales constraints. Investors understand some information has not been revealed when price limits are hit. But even the investors want to incorporate that into the prices by adjusting their stock demand accordingly, the stock price movements are still confined. The selling or buying pressures due to the rational expectation can only be satisfied on the next trading day. The price reactions are thus delayed. This can explain the strong price continuation phenomenon we found in the regressions.

Table 3 shows the results with short-sales constraints and price limits dummies are also in the alphas. In Panel A, both Specification 1 and 3 show that the short-sales constraints have no effect in alpha either. The differences between the loadings of the unconstrained and constrained periods are small and insignificant. The short-sales constraints and price limits effects in the lagged coefficient are similar to those in Table 2. Distinguishing for positive and negative market returns in Panel B also leads to the same conclusion. We find no evidence that short-sales constraints cause price delays, nor do they carry past information into the alpha. The negative information is on average incorporated into stock prices even when short-selling, the only channel to reveal information for those who do not hold stocks, is prohibited.

In Table 3 Panel A, Specification 2 shows that hitting price limits affects both the price delays and the risk-adjusted returns. Alpha increases by 0.32% and 0.45% in the unconstrained and constrained periods respectively. The effect is dominated by hitting upper limits since the frequency of hitting upper limits is roughly twice often than hitting lower limits as reported in Table 1. We can have a clear view on the effect of upper and lower limits by looking at the results from distinguishing the directions of market return. In Panel B, Specification 5 shows that alpha increases (decreases) by 0.74% (0.95%) when upper (lower) price limit is hit in unconstrained period. The result is similar when taking short-sales constraints into account. However, in the constrained period, the effects on the alpha of both directions become much larger and lead the loadings in the beta insignificant. But we interpret this result with caution since multicollinearity problem might occur as we put many dummies into the regression.

Results for autoregressive setup

Table 4 Panel A reports the results where the autoregressive term is a function of a constant, the short-sales constraints dummy and price limits dummy. Specification 1 shows that gamma, loading on the short-sales constraints dummy, increases by 0.04 when constraints are binding. But it is not significant. The result remains the same after controlling the price limits in Specification 3. Results in Panel B, where we distinguish positive and negative lagged returns, show that the difference between gammas of the unconstrained and constrained periods is not significant either. In sum, we cannot reject that the short-sales constraints have no influence on price reactions in both the market model and autoregressive setups.

On the contrary, hitting price limits contributes significantly to the increase of the autoregressive term. Panel A shows that, in unconstrained period, autoregressive coefficient increases by 0.19 if price limits are hit on the previous day. In more volatile constrained period, the price limit effect pushes the autoregressive coefficient up by 0.26. Price continuation is substantial. Panel B shows that this continuation effect is larger when the upper limits are hit in both periods. Specification 3 in the unconstrained period, for instance, shows that the autoregressive coefficient increases by 0.21 (0.157) when price hitting upper (lower) limits.

We reach the same conclusion whether we use the market model or autoregressive setup. Imposing short-sales constraints cannot stop stock prices from reflecting negative information. The price reaction, measured either by the lagged coefficient on market returns or autoregressive term, is not affected by the short-selling bans. Imposing price limits, however, causes higher price delays and contributes to the price continuation.

Variance

Besides the price delays and risk-adjusted returns, it is also interesting to see whether variance is affected by the short-sales constraints and price limits. In theory, if short-sellers are prohibited to express their private information on a particular day, the variance of the next trading day could increase due to more information inflow. In Table 5, we estimate the total variance and idiosyncratic variance as a function of a constant, the short-sales constraints dummy and price limits dummy. The idiosyncratic variance is from the residuals of the full-fledged regression model with short-sales constraints and price limits dummies in the alpha and the lagged coefficient on market return. The estimation is as follows:

$$\overline{r}_{i,t}^{2} = \delta_i + \gamma_i * D_{i,t-1}^{SC} + \lambda_i * D_{i,t-1}^{\pm 7\%}$$

or

$$\overline{\widetilde{\varepsilon}}_{i,t}^{2} = \delta_i + \gamma_i * D_{i,t-1}^{SC} + \lambda_i * D_{i,t-1}^{\pm 7\%}$$

where $r_{i,t}$ is the return of stock i on day t, $\widetilde{\varepsilon}_{i,t}$ is the residual of equation (11). Specification 1 shows that both total and idiosyncratic variances increase in the constrained periods in general. But the short-sales constraints do not contribute to higher level of the variances. The difference in gamma is actually negative and but insignificant. The negative information is rationally incorporated into the prices, resulting in no higher variance on the following day. On the contrary, two variances increase dramatically if stock price hits its limits on the previous trading day. For instance, total variance increases around 10% in both periods when limits are hit on the previous day. Imposing price limits not only delays price discovery as found in previous section but also spills the volatility across the subsequent day.

5.2 Results for price delay measures

We have discussed the results with short-sales constraints and price limits incorporated into the time-series regression directly. Now we turn to the price delay measures in Hou and Moskowitz (2005) with a cross-sectional setup. In Table 6, we report the results of regressing the difference in price delay measure on the proxy of short-sales constraints, difference between number of days that prices hit the limits and the control variables. The price delay measure reported is from equation (16), the ratio of the sum of four lagged market coefficients over the sum of four lagged coefficients and the market beta.[11] We use number of days that short-selling is prohibited for all trading hours as the proxy for the constraints.

Column one shows that the market frictions in general increase in the constrained period. The price delay measure increases by 0.19. Column three reports that the increase in the price delay measure is positively related to the number of short-sales constrained days and the increment in number of days that prices hit the limits. However, after controlling for size and the size difference, the number of short-sales constrained days loses its explanatory power in the last column. In contrast, the effect of price limits on the price delay remains highly significant in all specifications. Hence, both time-series and cross-sectional setups reach the same conclusion.[12]

One concern for the cross-sectional regression is that too much information is lost in aggregating time-series variable. In Saffi and Sigurdsson (2008), they also have to aggregate weekly lending supply and fees data into annual frequency since they compute the price delay measures per year. By doing so, lots of time-series information of lending market equilibria gets averaged out. The loss of information makes the test of mechanism, linking short-sales constraints and price delays indirect.

5.3 Robustness Check

In the previous analyses, we use the stocks that are continuously listed on the market from 13th of September in 1994 to 19th of January in 2003, spanning 1,128 trading days both in the unconstrained and constrained periods. For the robustness check, we redo the analysis

[11] Results using equation (17) are very similar. We do not report them for brievity.

[12] One may think that our time-series model only includes one-day lagged return and might not be enough for the investors to react to the constranits or new infomation. However, the price delay measure contains four lagged retuns and reach the same conclusion. The concern should be alleviated.

in the Table 2 and Table 4 with samples consisting of stocks that are continuously listed for 500, 750 and 1000 trading days both in the unconstrained and constrained periods. Stocks with less than 5 observations in the short-sales constraints, upper price limit and lower price limit dummies are still excluded for proper identification.

For brevity, Table 7 only shows the coefficients of the short-sales constraints, upper price limit and lower price limit dummies re-estimated based on the specification 6 in Table 2 and Table 4 respectively. The results in general are close to what we found in the previous section. The difference in gamma, the coefficient of short-sales constraints dummy, is insignificant in all samples. For price limits, the impact on the price delay is pronounced and significant. The price continuation phenomenon is also evident as shown in the autoregressive model for all three samples.

We also redo the analysis with samples that exclude stocks containing less than 10 observations in the short-sales constraints, upper price limit and lower price limit dummies. The results (nontabulated) are similar. The last robustness check is to winsorize the coefficients of short-sales constraints, upper price limit and lower price limit dummies in each tail at 2.5% and 97.5% to mitigate the effect from the extreme estimates. We still get similar results (nontabulated).

6 Conclusion

While short-selling is not viewed as a threat to the market stabilization in the normal times, it is often depicted as unethical practice of making money at innocent investors' pockets in the turmoil. It is thus tempting for regulators to impose short-sales constraints during financial crisis, like the current credit crunch, without fully understanding the mechanism behind them. Many theoretical research tries to understand the effect of short-sales constraints, but not until recently better data have been used in an attempt to shed light on this issue. Using a unique short-selling rule in Taiwan stock market, this paper provides an empirical strategy to study the consequences of short-sales constraints on the price behaviors.

We take advantage of a natural experiment by which the investors are prohibited from short-selling a stock at a price below its close price of the previous trading day since September 1998. The policy creates dynamics of short-sales constraints. Using such dynamics has several advantages over existed proxies. The main one is the constraints are imposed by regulators rather than determined by lending supply and demand. This alleviates the concern of endogeneity or reverse causality. It simplicity also helps investors to form their rational expectations. Other advantages like less concurrent confounding macroeconomics events, no option market and more observations also help to provide a cleaner environment for the empirical tests. In addition, we also examine whether the price limits in Taiwan delay the price reactions and spill volatility across the subsequent day.

We find no evidence that imposing the constraints on short-selling price contributes to more price delays. In other words, stock prices react to information in a way as if short-selling is not restricted in the constrained period. Under the rational expectation framework, investors take short-sales constraints into account when formulating their stock demand. Stock prices are on average driven down to the level where the price reactions are not delayed. However, no price delay does not mean that the actual negative information is revealed. It is the expected negative information is incorporated into the prices.

We do not find significant results that more short-sales constrained days contribute to higher price delay measure in Hou and Moskowitz (2005) either. The short-sales constraints may be widely imposed in the crisis but they are not effective to alleviate downward pice pressures. Finally, our result cannot reject an important hypothesis stated in Diamond and Verrechia (1987): "short-sales constraints are unimportant, perhaps because there is little private information."

For price limits, we find strong evidence that they have large negative effect on price reactions. the price limits in the Taiwan stock market restrain the prices from reacting to the new information. Stock prices continue moving in the same direction on the next trading day.

Appendix 1: short-selling ban or restrictions due to the credit crunch[13]

Australia: Short-selling is banned for all stocks since 22nd of September for one month.

Belgium: Short-selling is banned for banks and insurers for three months from 22nd of September.

Canada: Short-selling is banned for part of financial stocks from 19th of September to 03rd of October.

France: Short-selling is banned for credit institutions, investment companies, and insurance companies listed on the French regulated markets (Euronext, Matif, Monep) from 22nd of September to 19th of December.

Germany: Short-selling is banned for financial stocks from 19th of September to the end of the year.

Greece: The Greek stock exchange will flag short sales from 24th of September 31st of December. Anyone who has short positions in excess of 0.1% must disclose them.

Hong Kong: "Naked" short-selling activities are monitored and financial penalty on short sellers failing to settle trades would be doubled.

Indonesia: Short-selling is banned for all stocks for October.

Ireland: Short-selling of four Irish banks is banned until further notice.

Italy: Short-selling is banned for financial and insurance stocks from October 1st until October 31st

Japan: Naked short-selling is banned from 4 November 2008 to 31 March 2009.

Luxembourg: "Naked" short-selling is banned from 19th of September to 22nd of December.

Netherlands: Naked short selling banned on equities of financial institutions traded on Euronext from 22nd of September to 22nd of December.

Portugal: Short-selling is banned for financial stocks since 22nd of September.

Singapore: "Naked" short-selling rules are tightened to discourage short-sellers on 22nd of September.

South Korea: Short-selling is banned for all stocks until the end of the 2008.

[13] Data source: Dataexplorers.com and various new papers in early October.

Spain: Short-selling is banned for financial stocks from 19th of September to the end of the year since 24th of September until further notice.

Switzerland: Short-selling is banned for financial stocks traded on SWX Europe in London from 22nd September to 19th of December. "Naked: short-selling is banned for all stocks.

Taiwan: On 21st of September, the authority was re-imposing a ban on short-selling shares in 150 companies below their closing prices in the previous session. Investors cannot short stock in 150 companies in the Taiwan 50 Index, the Taiwan Mid-Cap 100 Index and the Taiwan Information Index from Sept. 22 to Oct. 3. Short-selling is banned for all stocks from 1st of October to 14th of October and then extended till the end of the year.

United Kingdom: Short-selling is banned for financial stocks from 19th of September 2008 to 16th of January 2009.

United States: Short-selling is banned for 799 financial stocks from 19th of September to 2nd of October. The ban are extended on 2nd of October. SEC extends ban on short sales whilst Congress works on $700 billion bailout plan. The ban ends on 9th of October, three days after congress passes the bailout.

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Table 1: Descriptive Statistics

This table shows descriptive statistics for our sample. Stocks are sorted into quartiles by the ratio of short-selling constrained days over total trading days. Statistics of unconstrained (from Sep 13th 1994 to Sep 03rd 1998) and constrained (from Sep 04th 1998 to Jan 19th 2003) periods are reported separately. We report the mean of the following variables in each quartile: ratio of upper price limit hit days over total trading days, ratio of lower price limit hit days over total trading days, daily return, size, annual turnover rate and annul volatility.

Unconstrained Period	Short Constraint (%)	Uplimit (%)	Downlimit (%)	Daily Return (%)	Size (mn. NT$)	Turnover (%)	Volatility (%)
1st quartile	5.0	1.4	0.7	-0.015	22,838	244	33
2nd quartile	6.3	1.6	0.8	0.009	21,876	279	34
3rd quartile	7.3	2.2	1.3	0.020	12,892	331	37
4th quartile	9.3	2.9	1.8	0.034	22,283	326	40
Constrained Period							
1st quartile	9.5	4.8	3.7	0.022	47,131	274	47
2nd quartile	18.5	6.8	4.9	0.025	44,442	254	51
3rd quartile	23.1	5.2	3.7	0.011	9,678	145	47
4th quartile	27.2	6.4	4.7	-0.031	2,558	117	49

Table 2: Short-Sales Constraints and Price Limits Dummies in Lagged Coefficient

Panel A shows results of the market model regression with one lagged market return. Spec 1 reports the results of lagged coefficient as a function of a constant and short-sales constraint dummy. Spec 2 reports the results of lagged coefficient as a function of a constant and price limits dummy. Spec 3 reports the results of lagged coefficient as a function of a constant, short-sales constraints and price limits dummies. Panel B shows results of the regressions that distinguish positive market returns, negative market returns and their lags. Spec 4 to 6 are like Spec 1 to 3 with coefficients of up and down market respectively. The regressions are done for the unconstrained period (from Sep 13th 1994 to Sep 03rd 1998) and the constrained period (from Sep 04th 1998 to Jan 19th 2003) separately. The differences of coefficients are reported in the last three columns. Standard errors are in parenthesis. Significance levels are 1% for a, 5% for b and 10% for c respectively.

Panel A: Market model with one lagged return, where the regression is as follows:

$$r_{i,t} = \alpha_i + \beta_i * r_{m,t} + (\delta_i + \gamma_i * D^{SC}_{i,t-1} + \lambda_i * D^{\pm 7\%}_{i,t-1}) * r_{m,t-1} + \varepsilon_{i,t}$$

	Unconstrained Period			Constrained Period			Difference		
	Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3
Alpha	0.008	0.010	0.002	0.016	0.017	0.010	0.008	0.007	0.009
	(0.017)	(0.017)	(0.017)	(0.033)	(0.033)	(0.033)	(0.050)	(0.050)	(0.050)
Beta	0.896[a]	0.899[a]	0.897[a]	0.786[a]	0.787[a]	0.786[a]	-0.110[a]	-0.112[a]	-0.111[a]
	(0.016)	(0.016)	(0.016)	(0.018)	(0.018)	(0.018)	(0.034)	(0.034)	(0.034)
Delta	0.050[a]	0.004	0.016	0.133[a]	0.059[a]	0.074[a]	0.084[a]	0.055[c]	0.057[c]
	(0.015)	(0.015)	(0.016)	(0.021)	(0.019)	(0.021)	(0.037)	(0.034)	(0.037)
Gamma	-0.010		-0.090[a]	-0.004		-0.062[c]	0.005		0.028
	(0.034)		(0.036)	(0.041)		(0.040)	(0.074)		(0.076)
Lambda		0.380[a]	0.405[a]		0.364[a]	0.373[a]		-0.016	-0.032
		(0.047)	(0.034)		(0.041)	(0.041)		(0.082)	(0.075)
# firms	186	185	185	186	185	185	186	185	185

Panel B: Market model with one lagged return and distinguishing positive and negative market returns, where the regression is as follows:

$$\begin{aligned} r_{i,t} &= \alpha_i + \beta_i^{up} * \max(r_{m,t}, 0) + \beta_i^{down} * \min(r_{m,t}, 0) \\ &+(\delta_i^{up} + \lambda_i^{up} * D_{i,t-1}^{7\%}) * \max(r_{m,t-1}, 0) \\ &+(\delta_i^{down} + \gamma_i * D_{i,t-1}^{SC} + \lambda_i^{down} * D_{i,t-1}^{-7\%}) * \min(r_{m,t-1}, 0) + \varepsilon_{i,t} \end{aligned}$$

	Unconstrained Period			Constrained Period			Difference		
	Spec 4	Spec 5	Spec 6	Spec 4	Spec 5	Spec 6	Spec 4	Spec 5	Spec 6
Alpha	0.046	0.055[c]	0.060	0.161[b]	0.148[b]	0.156[b]	0.115	0.094	0.096
	(0.031)	(0.032)	(0.032)	(0.064)	(0.068)	(0.067)	(0.095)	(0.100)	(0.099)
Beta_up	0.814[a]	0.820[a]	0.819[a]	0.728[a]	0.748[a]	0.745[a]	-0.086	-0.072	-0.074
	(0.032)	(0.033)	(0.033)	(0.033)	(0.035)	(0.035)	(0.064)	(0.069)	(0.068)
Delta_up	0.083[a]	0.042	0.039	0.090[a]	0.008	0.007	0.007	-0.034	-0.032
	(0.030)	(0.031)	(0.031)	(0.035)	(0.035)	(0.035)	(0.064)	(0.066)	(0.066)
Beta_dn	0.966[a]	1.000[a]	0.999[a]	0.853[a]	0.864[a]	0.866[a]	-0.113[b]	-0.136[a]	-0.134[b]
	(0.021)	(0.022)	(0.022)	(0.032)	(0.033)	(0.032)	(0.053)	(0.055)	(0.054)
Delta_dn	0.000	-0.041	-0.023	0.160[a]	0.095[a]	0.118[a]	0.161[b]	0.136[c]	0.141[b]
	(0.027)	(0.027)	(0.035)	(0.040)	(0.036)	(0.038)	(0.071)	(0.063)	(0.067)
Gamma	0.023		-0.055[a]	0.035		-0.065	0.012		-0.011
	(0.039)		(0.035)	(0.047)		(0.044)	(0.085)		(0.079)
Lambda_up		0.539[a]	0.540[a]		0.532[a]	0.532[a]		-0.007	-0.008
		(0.068)	(0.068)		(0.077)	(0.077)		(0.146)	(0.144)
Lambda_dn		0.379[a]	0.397[a]		0.450[a]	0.466[a]		0.071	0.069
		(0.045)	(0.039)		(0.062)	(0.058)		(0.107)	(0.097)
# firms	186	160	160	186	160	160	186	160	160

Table 3: Short-Sales Constraints and Price Limits Dummies in Lagged Coefficient and Alpha

This table follows the setup of Table 2 with the alpha of the market model as a function of short-sales constraints and price limit dummies as well. Panel A reports results of the alpha and lagged coefficient as a functions of short-sales constraints dummy, price limit dummies, and both in Spec 1, Spec 2 and Spec 3 respectively. Panel B shows results with distinguishing positive, negative market returns and their lags. Spec 4 to 6 are like Spec 1 to 3 with coefficients of up and down market respectively. The regressions are done for the unconstrained period (from Sep 13th 1994 to Sep 03rd 1998) and the constrained period (from Sep 04th 1998 to Jan 19th 2003) separately. The differences of coefficients are reported in the last three columns. Standard errors are in parenthesis. Significance levels are 1% for a, 5% for b and 10% for c respectively.

Panel A: Market model with one lagged return

$$\begin{aligned} r_{i,t} &= \alpha_{i,0} + \alpha_{i,sc} * D^{SC}_{i,t-1} + \alpha_{i,pl} * D^{\pm 7\%}_{i,t-1} \\ &\quad + \beta_i * r_{m,t} + (\delta_i + \gamma_i * D^{SC}_{i,t-1} + \lambda_i * D^{\pm 7\%}_{i,t-1}) * r_{m,t-1} + \varepsilon_{i,t} \end{aligned}$$

	Unconstrained Period			Constrained Period			Difference		
	Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3
Alpha_0	0.016	0.000	0.004	0.048	-0.028	0.000	0.033	-0.028	-0.004
	(0.017)	(0.015)	(0.017)	(0.036)	(0.031)	(0.035)	(0.053)	(0.048)	(0.051)
Alpha_sc	-0.176[a]		-0.236[a]	-0.181[b]		-0.196[a]	-0.005		0.041
	(0.046)		(0.044)	(0.072)		(0.073)	(0.120)		(0.117)
Alpha_pl		0.320[a]	0.296[a]		0.450[a]	0.468[a]		0.130	0.172
		(0.071)	(0.064)		(0.085)	(0.083)		(0.155)	(0.147)
Beta	0.895[a]	0.898[a]	0.896[a]	0.786[a]	0.787[a]	0.786[a]	-0.109[a]	-0.111[a]	-0.109[a]
	(0.016)	(0.016)	(0.016)	(0.018)	(0.018)	(0.018)	(0.034)	(0.034)	(0.034)
Delta	0.049[a]	0.003	0.013	0.132[a]	0.059[a]	0.069[a]	0.083[b]	0.055[c]	0.056
	(0.016)	(0.015)	(0.016)	(0.021)	(0.018)	(0.021)	(0.038)	(0.033)	(0.037)
Gamma	-0.056		-0.138[a]	-0.021		-0.064	0.035		0.074
	(0.041)		(0.037)	(0.042)		(0.043)	(0.083)		(0.080)
Lambda		0.386[a]	0.415[a]		0.376[a]	0.376[a]		-0.010	-0.038
		(0.037)	(0.035)		(0.044)	(0.043)		(0.081)	(0.078)
# firms	186	185	185	186	185	185	186	185	185

Panel B: Market model with one lagged return and distinguishing positive and negative market returns

$$
\begin{aligned}
r_{i,t} \;=\; & \alpha_{i,0} + \alpha_{i,sc} * D^{SC}_{i,t-1} + \alpha_{i,up} * D^{7\%}_{i,t-1} + \alpha_{i,down} * D^{-7\%}_{i,t-1} \\
& + \beta^{up}_i * \max(r_{m,t}, 0) + \beta^{down}_i * \min(r_{m,t}, 0) \\
& + (\delta^{up}_i + \lambda^{up}_i * D^{7\%}_{i,t-1}) * \max(r_{m,t-1}, 0) \\
& + (\delta^{down}_i + \gamma_i * D^{SC}_{i,t-1} + \lambda^{down}_i * D^{-7\%}_{i,t-1}) * \min(r_{m,t-1}, 0) + \varepsilon_{i,t}
\end{aligned}
$$

	Unconstrained Period			Constrained Period			Difference		
	Spec 4	Spec 5	Spec 6	Spec 4	Spec 5	Spec 6	Spec 4	Spec 5	Spec 6
Alpha_0	0.058[c]	0.044	0.061[c]	0.192[a]	0.085	0.101	0.134	0.041	0.040
	(0.031)	(0.031)	(0.032)	(0.036)	(0.063)	(0.065)	(0.098)	(0.094)	(0.097)
Alpha_sc	-0.178[a]		-0.190[a]	-0.175[c]		-0.043	0.003		0.148
	(0.056)		(0.052)	(0.072)		(0.091)	(0.146)		(0.143)
Alpha_up		0.744[a]	0.734[a]		1.774[a]	1.772[a]		1.030[a]	1.038[a]
		(0.121)	(0.121)		(0.132)	(0.132)		(0.254)	(0.253)
Alpha_dn		-0.950[a]	-0.811[a]		-1.356[a]	-1.343[a]		-0.406	-0.532
		(0.178)	(0.186)		(0.187)	(0.182)		(0.365)	(0.367)
Beta_up	0.813[a]	0.823[a]	0.821[a]	0.729[a]	0.755[a]	0.751[a]	-0.084	-0.068	-0.069
	(0.032)	(0.034)	(0.034)	(0.033)	(0.034)	(0.033)	(0.064)	(0.067)	(0.067)
Delta_up	0.078[a]	0.049	0.042	0.088[b]	0.042	0.040	0.010	-0.007	-0.002
	(0.030)	(0.031)	(0.031)	(0.035)	(0.035)	(0.035)	(0.065)	(0.066)	(0.065)
Beta_dn	0.966[a]	0.997[a]	0.997[a]	0.852[a]	0.865[a]	0.866[a]	-0.114[b]	-0.133[b]	-0.130[b]
	(0.021)	(0.022)	(0.022)	(0.032)	(0.031)	(0.031)	(0.052)	(0.053)	(0.053)
Delta_dn	0.007	-0.041	-0.020	0.176[a]	0.096[a]	0.125[a]	0.169[b]	0.137[b]	0.145[b]
	(0.031)	(0.027)	(0.029)	(0.040)	(0.035)	(0.039)	(0.072)	(0.062)	(0.069)
Gamma	-0.039		-0.118[a]	-0.034		-0.092	0.005		0.026
	(0.051)		(0.045)	(0.047)		(0.059)	(0.115)		(0.104)
Lambda_up		0.264[a]	0.269[a]		-0.021	-0.023		-0.286[c]	-0.292[c]
		(0.077)	(0.077)		(0.077)	(0.077)		(0.154)	(0.153)
Lambda_dn		0.142[a]	0.208[a]		0.026	0.047		-0.117	-0.161
		(0.048)	(0.051)		(0.091)	(0.086)		(0.139)	(0.137)
# firms	186	160	160	186	160	160	186	160	160

Table 4: Short-Sales Constraints and Price Limits Dummies in Autoregressive Coefficient

Panel A shows results of the autoregressive regression with one lagged return. Spec 1 reports the results of AR coefficient as a function of a constant and short-sales constraint dummy. Spec 2 reports the results of AR coefficient as a function of a constant and price limits dummy. Spec 3 reports the results of AR coefficient as a function of a constant, short-sales constraints and price limits dummies. Panel B shows results of regressions that distinguish positive lagged returns and negative lagged returns. Spec 4 to 6 are like Spec 1 to 3 with coefficients of up and down lagged returns respectively. The regressions are done for the unconstrained period (from Sep 13th 1994 to Sep 03rd 1998) and the constrained period (from Sep 04th 1998 to Jan 19th 2003) separately. The differences of coefficients are reported in the last three columns. Standard errors are in parenthesis. Significance levels are 1% for a, 5% for b and 10% for c respectively.

Panel A: Autoregressive model with one lagged return, where the regression is as follows:

$$r_{i,t} = \mu_i + (\rho_i + \gamma_i * D^{SC}_{i,t-1} + \lambda_i * D^{\pm 7\%}_{i,t-1}) * r_{i,t-1} + \varepsilon_{i,t}$$

	Unconstrained Period			Constrained Period			Difference		
	Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3
Mu	0.008	0.002	-0.006	0.013	-0.032	-0.030	0.005	-0.034	-0.024
	(0.040)	(0.041)	(0.040)	(0.054)	(0.055)	(0.054)	(0.094)	(0.096)	(0.094)
Rho	0.021	-0.027[c]	-0.021	0.104[a]	0.009[a]	0.009	0.083[a]	0.036	0.030[a]
	(0.015)	(0.015)	(0.015)	(0.014)	(0.014)	(0.015)	(0.029)	(0.029)	(0.030)
Gamma	-0.023		-0.039	0.018		0.002	0.041		0.041
	(0.042)		(0.042)	(0.029)		(0.027)	(0.070)		(0.70)
Lambda		0.187[a]	0.189[a]		0.260[a]	0.259[a]		0.073[b]	0.071[b]
		(0.017)	(0.017)		(0.016)	(0.016)		(0.033)	(0.032)
# firms	186	185	185	186	185	185	186	185	185

Panel B: Autoregressive model with one lagged return and distinguishing positive and negative lagged returns, where the regression is as follows:

$$r_{i,t} = \mu_i + (\rho_i^{up} + \lambda^{up} * D_{i,t-1}^{7\%}) * \max(r_{i,t-1}, 0) + (\rho_i^{down} + \gamma * D_{i,t-1}^{SC} + \lambda^{down} * D_{i,t-1}^{-7\%}) * \min(r_{i,t-1}, 0) + \varepsilon_{i,t}$$

	Unconstrained Period			Constrained Period			Difference		
	Spec 4	Spec 5	Spec 6	Spec 4	Spec 5	Spec 6	Spec 4	Spec 5	Spec 6
Mu	-0.040	-0.011	-0.007	-0.060	-0.012	-0.012	-0.020	-0.001	-0.005
	(0.043)	(0.044)	(0.043)	(0.056)	(0.055)	(0.056)	(0.099)	(0.106)	(0.098)
Rho_up	0.045[b]	-0.021	-0.023	0.131[a]	-0.005	-0.005	0.086[b]	0.017	0.018
	(0.020)	(0.020)	(0.020)	(0.017)	(0.017)	(0.017)	(0.036)	(0.037)	(0.037)
Rho_dn	-0.015	-0.028	-0.019	0.061[b]	0.022	0.021	0.077	0.050	0.041
	(0.030)	(0.028)	(0.029)	(0.030)	(0.023)	(0.026)	(0.060)	(0.051)	(0.055)
Gamma	0.004		-0.022	0.049		0.001	0.045		0.023
	(0.044)		(0.044)	(0.039)		(0.037)	(0.082)		(0.081)
Lambda_up		0.210[a]	0.210[a]		0.279[a]	0.279[a]		0.069[b]	0.069[b]
		(0.018)	(0.018)		(0.014)	(0.014)		(0.032)	(0.032)
Lambda_dn		0.153[a]	0.157[a]		0.251[a]	0.248[a]		0.098	0.092
		(0.033)	(0.034)		(0.034)	(0.033)		(0.067)	(0.066)
# firms	186	160	160	186	160	160	186	160	160

Table 5: Variance as a function of Short-sales Constraints and Price Limits

This table shows results of daily total variance and idiosyncratic variance in upper and lower panel respectively. Spec 1 reports the results of variance as a function of a constant and short-sales constraints dummy. Spec 2 reports the results of variance as a function of a constant and price limits dummy. Spec 3 reports the results of variance as a function of a constant, short-sales constraints and price limits dummies. The idiosyncratic variance is estimated from the residuals of full-fledged regression model with short-sales constraints and price limits dummies in both alpha and lagged coefficient on market return. The regressions are done for the unconstrained period (from Sep 13th 1994 to Sep 03rd 1998) and the constrained period (from Sep 04th 1998 to Jan 19th 2003) separately. The differences of coefficients are reported in the last three columns. Standard errors are in parenthesis. Significance levels are 1% for a, 5% for b and 10% for c respectively.

	Unconstrained Period			Constrained Period			Difference		
Total Variance (%)									
	Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3
Delta	5.205[a]	5.266[a]	5.213[a]	9.436[a]	8.998[a]	8.921[a]	4.231[a]	3.732[a]	2.950[a]
	(0.138)	(0.140)	(0.140)	(0.191)	(0.179)	(0.187)	(0.328)	(0.319)	(0.327)
Gamma	1.513[a]		0.824[b]	1.081[a]		0.461	-0.432		-0.363
	(0.377)		(0.354)	(0.363)		(0.345)	(0.739)		(0.699)
Lambda_up		9.536[a]	9.598[a]		10.175[a]	10.164[a]		0.640	0.566
		(0.467)	(0.467)		(0.389)	(0.387)		(0.856)	(0.854)
Lambda_dn		11.158[a]	10.615[a]		9.590[a]	9.286[a]		-1.568	-1.328
		(1.097)	(1.098)		(0.804)	(0.791)		(1.900)	(1.889)
Idiosyncratic Variance (%)									
	Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3	Spec 1	Spec 2	Spec 3
Delta	3.788[a]	3.602[a]	3.609[a]	7.115[a]	6.557[a]	6.559[a]	3.327[a]	2.954[a]	2.950[a]
	(0.065)	(0.059)	(0.061)	(0.115)	(0.096)	(0.105)	(0.180)	(0.155)	(0.166)
Gamma	0.231[b]		-0.096	0.199		0.002	-0.032		0.097
	(0.132)		(0.121)	(0.203)		(0.186)	(0.335)		(0.310)
Lambda_up		6.350[a]	6.343[a]		7.124[a]	7.090[a]		0.774	0.747
		(0.301)	(0.300)		(0.307)	(0.307)		(0.607)	(0.607)
Lambda_dn		4.900[a]	4.900[a]		3.601[a]	3.585[a]		-1.300	-1.316
		(0.458)	(0.462)		(0.382)	(0.376)		(0.840)	(0.838)
# firms	186	160	160	186	160	160	186	160	160

Table 6: Price Delay Measure and Short-sales Constraints and Price Limits

This table shows results of regressing the difference between the price delay measures of constrained and unconstrained periods on the number of short-sales constrained days in the constrained period (SSC), the difference between number of price limit hit days of unconstrained and constrained periods (dPriceLimit) and controls. Control variables include: First, mean stock price in the constrained period. Second, the average size of firms in the constrained period. Third, the size difference between unconstrained and constrained periods. Fourth, the turnover rate difference between unconstrained and constrained periods. Standard errors are in parenthesis. Significance levels are 1% for a, 5% for b and 10% for c respectively.

Dependent: Price Delay Measure Constrained Period - Price Delay Measure Unconstrained Period								
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 5	Spec 6	Spec 7	Spec 8
Intercept	0.1935[a]	0.0867[c]	-0.0508	-0.248	0.4934[a]	-0.0070	-0.0494	0.3233[b]
	(0.0156)	(0.0500)	(0.0466)	(0.0471)	(0.1297)	(0.0455)	(0.0472)	(0.1556)
SSC		0.0009[b]	0.0007[b]	0.0008[b]	0.0000	0.0003	0.0007[c]	0.0001
		(0.0004)	(0.0003)	(0.003)	(0.0004)	(0.0003)	(0.0004)	(0.0004)
dPriceLimit			0.0021[a]	0.0021[a]	0.0017[a]	0.0015[a]	0.0021[a]	0.0015[a]
			(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
MeanPriceA				-0.0025[b]				-0.0002
				(0.0010)				(0.0011)
SizeA					-0.0492[a]			-0.0316[b]
					(0.0110)			(0.0143)
dSize						-0.0979[a]		-0.0565[c]
						(0.0222)		(0.0299)
dTurnover							-0.0050	0.0122
							(0.0250)	(0.0242)
R^2		0.0266	0.2760	0.2999	0.3475	0.3460	0.2762	0.3643
# firms	186	186	186	186	186	186	186	186

Table 7: Robustness Check

This table shows results of the robustness check. We redo the analysis in Table 2 Panel B Spec 6 and Table 4 Panel B Spec 6 with samples consisting of stocks that are continuously listed in the market for 500, 750 and 1000 days both before and after the imposition of the new short-sales rules. Only the coefficients of short-sales constraints dummy, upper price limits dummy and lower price limits dummy are reported. Stocks with less than 5 observations in the three dummies are excluded from the analysis. Standard errors are in parenthesis. Significance levels are 1% for a, 5% for b and 10% for c respectively.

	Unconstrained Period			Constrained Period			Difference		
Table 2 Panel B Spec 6									
	500 days	750 days	1000 days	500 days	750 days	1000 days	500 days	750 days	1000 days
Gamma	-0.050	-0.052	-0.073	-0.067	-0.074	-0.070	-0.018	-0.022	0.003
	(0.049)	(0.053)	(0.038)	(0.060)	(0.048)	(0.047)	(0.109)	(0.102)	(0.084)
Lambda_up	0.781[a]	0.755[a]	0.580[a]	0.633[a]	0.562[a]	0.580[a]	-0.148	-0.193	0.000
	(0.080)	(0.084)	(0.075)	(0.069)	(0.083)	(0.080)	(0.149)	(0.167)	(0.143)
Lambda_dn	0.572[a]	0.510[a]	0.411[a]	0.575[a]	0.486[a]	0.466[a]	0.002	-0.024	0.055
	(0.062)	(0.058)	(0.046)	(0.071)	(0.064)	(0.060)	(0.134)	(0.121)	(0.106)
# firms	149	147	161	149	147	161	149	147	161

Table 4 Panel B Spec 6									
	500 days	750 days	1000 days	500 days	750 days	1000 days	500 days	750 days	1000 days
Gamma	-0.053	-0.030	-0.018	-0.015	-0.028	-0.025	0.047	0.002	-0.007
	(0.054)	(0.047)	(0.045)	(0.050)	(0.041)	(0.039)	(0.041)	(0.089)	(0.084)
Lambda_up	0.247[a]	0.228[a]	0.202[a]	0.293[a]	0.316[a]	0.291[a]	0.089	0.088[a]	0.089[a]
	(0.021)	(0.018)	(0.017)	(0.020)	(0.016)	(0.015)	(0.085)	(0.034)	(0.033)
Lambda_dn	0.179[a]	0.172[a]	0.155[a]	0.269[a]	0.237[a]	0.255[a]	0.038	0.065	0.100
	(0.047)	(0.040)	(0.030)	(0.039)	(0.041)	(0.033)	(0.104)	(0.081)	(0.063)
# firms	149	147	161	149	147	161	149	147	161

Figure 1: Margin Trade Value over Total Trading Value on TWSE

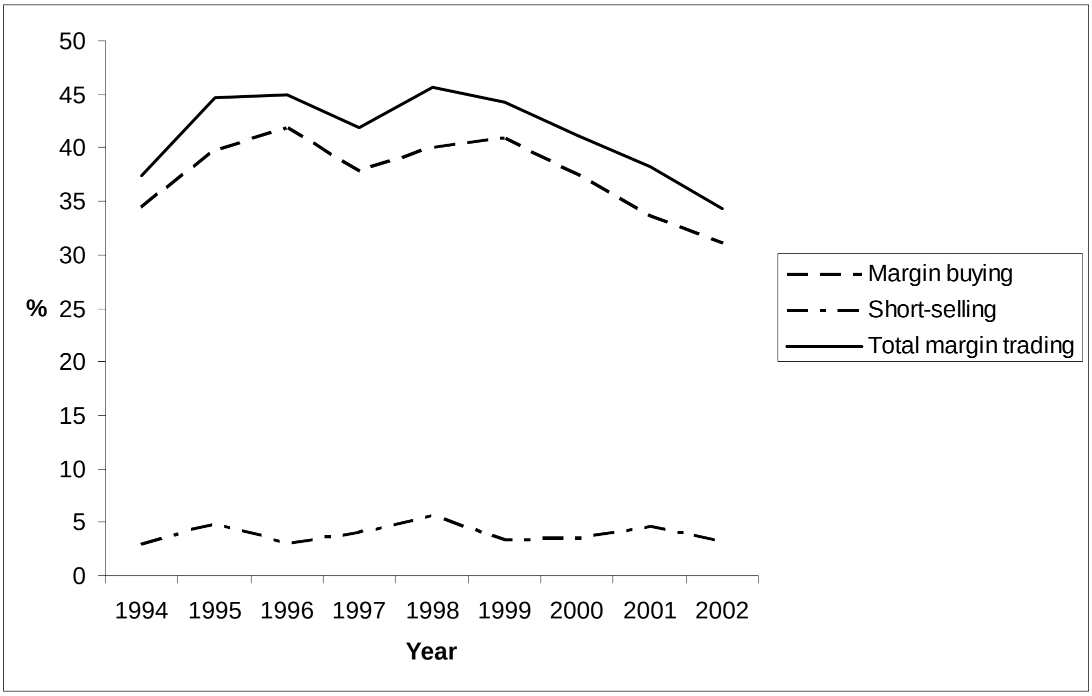

Figure 2: Investors Composition by Trading Value on TWSE