

# Adverse Selection of Short Selling: Evidence from a Natural Experiment\*

## Abstract

We examine the effect of short selling on small retail investor's trading behavior and stock liquidity. Employing a unique setting that *permits* short selling on a selected group of securities (i.e., the pilot stocks) in an economy with heavy participation of retail investors and relatively weak information environment and investor protection, we document that the pilot stocks experience a significant decrease in trading by small retail investors; and the impact of short selling on investor participation is more pronounced for the pilot stocks with higher information asymmetry. We further document that this short selling induced shift in investor participation contributes to the reduction in the liquidity of these stocks. The evidence suggests that the change in investor participation is an important underlying mechanism that short selling affects market quality, which has largely been overlooked in prior empirical literature that focuses on developed markets. Our findings offer empirical support to the classical adverse selection theory of informed short selling (e.g., [Glosten and Milgrom, 1985](#), [Easley and O'hara, 2004](#)).

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# 1 Introduction

Protecting investors, especially retail investors, has been the long-standing mission of the securities regulators around the world in designing and evaluating their rules.<sup>1</sup> A critical step in this process is to understand the behavior of retail investors. In this paper, we study how uninformed small retail investors respond to a regulation that grants permission of short selling to selected stocks in the Chinese stock market, and its implications for the market quality.

The effects of short selling on investor participation and market quality are ongoing debates among both academic researchers and financial practitioners and regulators.<sup>2</sup> One strand of theoretical literature (e.g., [Diamond and Verrecchia, 1987](#); [Admati and Pfleiderer, 1988](#); [Bai et al., 2006](#)) shows that short selling allows informed investors to trade on their private information and makes the price more informative about the underlying stock. As the uncertainty about the economic fundamentals of the stock is mitigated, investor demand for the stock increases and the required risk compensation decreases, leading to increased investor participation and improved market quality. We refer to this effect as the *uncertainty resolution effect*. Another strand of literature demonstrates, on the other hand, that short selling can have an opposite effect on investor participation in and market quality of the shorted stock. The argument is that introduction of short selling for some stocks attracts better-informed investors and exacerbates the information asymmetry among market participants of these stocks. Uninformed investors, who are generally liquidity providers, become reluctant to trade against informed investors, leading to decreased market quality

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<sup>1</sup>For example, former Chairperson Mary Jo White describes investor protection as the highest priority of the U.S. Securities and Exchange Commission (SEC), and states that investor protection drives many of the SEC rulemaking and is always considered in all of SEC's rulemaking and policy initiatives. See <https://www.sec.gov/our-goals>; and <https://www.sec.gov/news/speech/mjw-speech-032114-protecting-retail-investor>.

<sup>2</sup>[Beber and Pagano \(2013\)](#) acknowledge that while most of the evidence up to date from developed countries suggests that short selling bans damage liquidity, ambiguous or even conflicting evidence is also present in some studies. In contrast to developed countries that temporarily impose (partial) ban on short selling, developing markets, such as China, introduce short selling to modernize their financial markets in the hope to improve security liquidity (e.g., China Securities Regulation Commissioners' Q&A Press Conference for the Margin Trading and Short Selling Pilot Program (in Chinese), which is available at <http://www.sse.com.cn/services/tradingservice/margin/home/news/c/3987575.shtml>).

(see [Milgrom and Stokey, 1982](#); [Glosten and Milgrom, 1985](#); [Easley and O’hara, 1987](#), and [Bhattacharya and Spiegel, 1991](#)). We refer to this effect as the *adverse selection effect*. While there has been considerable evidence on the uncertainty resolution effect of short selling (e.g., [Boehmer et al., 2013](#); [Beber and Pagano, 2013](#); [Marsh and Payne, 2012](#)), empirical support for the adverse selection effect has not been well established. This study seeks to bridge this gap.

Theory suggests that the overall effect of short selling on market quality is contingent on how the permission of or restriction on short selling affects investor participation in the shortable stocks. Despite such a strong implication from the extensive theoretical literature, direct evidence on changes in investor participation in response to short-selling related regulatory changes is sparse. Prior empirical studies that focus on imposing restrictions/bans on originally shortable stocks in developed markets during crisis periods are mostly silent on this topic because in the settings they examine, the predominance of sophisticated institutions in investor population makes these settings more conducive to uncertainty resolution, and offers only very limited scope for investor composition to change.<sup>3</sup> If however, the introduction of short selling to originally ineligible stocks brings informed investors into the market ([Boehmer et al., 2008](#)), fearing of being taken advantage of by these informed investors, uninformed investors may refrain from trading these stocks. This can generate a substantial shift in investor participation in the shorted stocks, especially in an economy where the information friction is high, investor protection is weak, and the investor base consists of a large proportion of less sophisticated retail investors. In such a case, the adverse selection effect can dominate the uncertainty resolution effect, and consequently, short selling can cause a decrease of investor participation in and deterioration of market quality of the shorted stocks. The Chinese financial market environment and the Chinese pilot Margin Trading and Short Selling (MTSS) program provide us an ideal setting to conduct

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<sup>3</sup>[Beber and Pagano \(2013\)](#) point out that the validity of the uncertainty resolution effect implied in [Diamond and Verrecchia \(1987\)](#) only applies if the short selling ban *equally* constrains *informed* and *uninformed* investors.

such an examination.

Although its large size makes the Chinese stock market comparable to that of a developed country, there still exist two distinct aspects between the two markets. First, the Chinese stock market consists of a large proportion of retail investors who trade frequently. According to a report from Shenzhen Stock Exchange, from 2007 to 2012, 42.8% of the total market capitalization was held by individual investors who accounted, on average, for 85.6% of the total transactions.<sup>4</sup> This stands in striking contrast to the U.S. capital market where individual investors account for only 3.68% of the total number of trades (Boehmer et al., 2017). Second, the Chinese market has severe information asymmetry among market participants due to relatively weaker investor protection and lower quality accounting disclosure (Brockman and Chung, 2003; Chen and Yuan, 2004; Wang et al., 2008). As a result, Chinese institutional investors have a strong information advantage over individual investors (Choi et al., 2013). Therefore, allowing short selling in a less-developed market such as China has the potential to cause substantial changes in the market structure. When informed investors enter the market, uninformed retail investors protect themselves by refraining from trading or requiring a higher expected return to compensate for the risk of trading against informed investors (Milgrom and Stokey, 1982, and Bhattacharya and Spiegel, 1991). This allows the adverse selection of short selling to play a dominant role in inducing changes in investor population and investor composition - i.e., the ratio of informed to uninformed investors (Glosten and Milgrom, 1985). However, developed markets, which are the focus of prior studies, consist mainly of institutional investors that are likely to be equally informed and sophisticated.<sup>5</sup> Thus policy changes in short selling are less likely to cause substantial changes in investor population and composition. Therefore, the uncertainty resolution effect dominates.

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<sup>4</sup>The report (in Chinese) is available at <http://www.szse.cn/main/aboutus/bsyw/39749823.shtml>.

<sup>5</sup>Kadan et al. (2018) use the New York Stock Exchange data to show that uninformed institutional investors, not individuals, provide liquidity to better-informed investors. Engelberg et al. (2012) document that the information advantage of US short sellers mainly comes from their superior ability to process public information.

Besides the institutional characteristics of the Chinese stock market, the Chinese MTSS program has features that are conducive to studying the adverse selection effect of short selling on reshaped investor participation. It is conducted during a normal economic time, unlike the policy changes studied in much of the prior work that mostly occur during crisis periods when market quality is intensively affected by other aggregate economic factors and market interventions. Moreover, the Chinese MTSS program is a *permission* of short selling on a *selected* group of stocks (referred to as the pilot stocks hereafter) in *different* industries among about 2500 listed stocks, while the policy changes in previous work are usually universal bans on short selling of either all stocks or only financial stocks.<sup>6</sup> These features of the Chinese MTSS program have several advantages. First, we are able to construct proper control groups and implement an improved difference-in-differences analysis. Second, a permission is more likely to change investor composition because it provides incentive for sophisticated investors (liquidity demanders) to gather information and enter the market, while offers uninformed retail investors (liquidity providers) flexibility to structure their trading activities (i.e., the timing and volume), and to an extreme, even exit the market completely. A temporary ban, on the other hand, is less likely to affect sophisticated institutional investors and retail investors in a substantially different manner. Therefore, we conjecture that the Chinese MTSS program provides a powerful setting to empirically test the implications of the adverse selection market microstructure theories (e.g., [Glosten and Milgrom, 1985](#), [Easley and O'hara, 2004](#)).

Consistent with the prediction that the adverse selection effect dominates in the Chinese MTSS pilot program, we find that allowing MTSS decreases small retail investors' incentive to trade the pilot stocks, which contributes directly to the deteriorating market quality of these stocks in both statistical and economic senses. First, using intra-day transaction-level data on each stock to empirically measure the trading of small retail investors, as proxied

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<sup>6</sup>Notable exceptions are studies on the US Regulation SHO (e.g., [Diether et al., 2009](#)). [Beber and Pagano \(2013\)](#) rely on the variations in starting and ending times of short selling bans across 20 countries, which improve the identification, but may be subject to the caveat of the differences in the institutional characteristics of different markets.

by small-sized trades that have no price impact (Fang et al., 2012), we document that small retail investors significantly reduce their trading activities of the pilot stocks: for an average pilot stock, small retail investors decrease their trading by 7.8%, 6.1%, and 6.4% in terms of trading volume, trading value, and number of trades, respectively. To mitigate the measurement concern of using small-sized trades to proxy small retail investors' trading activity, we obtain aggregated proprietary data from one of the two stock exchanges in China that categorizes investors into small retail investors, large retail investors and institutional investors. We provide consistent evidence that small retail investors are significantly less willing to participate in the pilot stocks.

The adverse selection hypothesis of market microstructure underlines the crucial role of information asymmetry between informed and uninformed investors in determining the effects of short selling on investor participation (e.g., Glosten and Milgrom, 1985). To provide further support to the adverse selection hypothesis, we explore the cross-sectional variations in the relation between MTSS and changes of small retail investors' participation in the pilot stocks. Using media coverage, sell-side analyst coverage, and analyst forecast errors as our information asymmetry measures (Clarke and Shastri, 2000 and Kelly and Ljungqvist, 2012), we show that the negative impact of MTSS on small retail investors' trading behavior is more pronounced for stocks with lower media coverage, lower analyst coverage, and higher forecast errors.

To show whether the adverse selection induced shift in small retail investors' trading behavior affects the market quality of the pilot stocks, we first establish that there is a significant reduction in the liquidity of the pilot stocks: After an average stock is added to the MTSS permission list, compared to control stocks that are not allowed for MTSS, its turnover ratio decreases by about 0.18, corresponding to 12.4% of the turnover ratio before the permission; the Amihud illiquidity ratio increases by 0.77, weighting 29.5% of the ratio before the permission; and the bid-ask spread increases by 0.42, which is 3.3% of the

spread before the permission.<sup>7</sup> More importantly, we further show that the reduced trading activities of the pilot stocks by small retail investors contribute directly to the deterioration of their market quality, explicitly establishing the link between investor participation and stock liquidity. This result provides direct support to the adverse selection hypothesis of market microstructure theory that the short selling-induced change in investor participation is an underlying channel through which short selling damages market quality of the shorted stocks.

To alleviate the concern that our findings are due to other specific characteristics of the Chinese stock market rather than adverse selection, we document that allowing MTSS actually *improves* the liquidity of exchange traded funds (ETFs), particularly the passive ETFs of which information asymmetry is not much of a concern, and thus there is no (or little) room for adverse selection to cause a change in investor participation.

This work contributes to our understanding of the behavior of retail investors and their role in capital markets. This understanding is critical in designing and evaluating regulations that are aimed to protect the interests of retail investors, which has been a top priority of securities regulators' rulemaking (SEC, 2014).<sup>8</sup> Retail investors are becoming an increasingly active group of stock market participants, even in developed markets such as the U.S. where retail trading used to account for a much smaller portion of the market trading (Eaton et al., 2022). However, the academic literature has presented mixed evidence on how retail investors affect financial markets. Some studies find that retail investors make naïve investment decisions by engaging in return-chasing or attention-based trading transactions (e.g., Barber and Odean, 2008, Hvidkjaer, 2008, and Michels, 2024), while others document that retail investors improve market quality by making informed trades and/or serving as

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<sup>7</sup>Two studies have examined the effect of MTSS on stock liquidity but generated conflicting results. While Li et al. (2017) document an increase in liquidity for the pilot stocks using bid-ask spreads to proxy for liquidity, Wan (2020) finds the opposite using Amihud illiquidity ratio. Applying an improved empirical research design, we document consistent results that the MTSS permission reduces stock liquidity, whether it is measured by bid-ask spreads, Amihud illiquidity ratio, or turnover ratio.

<sup>8</sup>According to former SEC Chairperson White, "The retail investor must be a constant focus of the SEC— if we fail to serve and safeguard the retail investor, we have not fulfilled our mission." <https://www.sec.gov/news/speech/mjw-speech-032114-protecting-retail-investor>.

liquidity providers (e.g., [Blankespoor et al., 2018](#), [Friedman and Zeng, 2023](#), and [Kaniel et al., 2012](#)). The evidence presented in our study underscores the importance of adverse selection in the trading behavior of small retail investors who are relatively information disadvantaged. Our findings suggest that the MTSS program, which aims to modernize the Chinese financial market and improve security liquidation may not achieve its set goal when a large proportion of the market participants (i.e., retail investors) can potentially be (unintentionally) disadvantaged by the regulation. Thus, this study adds to the literature on the role of securities regulation in market quality (see [Leuz and Wysocki, 2016](#)) and has potential implications for evidence-based policy making ([Leuz, 2018](#)).<sup>9</sup>

Our study also adds to the literature on the effect of short selling on investor behavior and market quality. Using the Chinese MTSS pilot program, we show that in a developing economy where information friction is severe and investor protection is relatively weak, the reduced liquidity for stocks with MTSS permission is associated with a systematic MTSS-induced change in uninformed small retail investors' trading of the pilot stocks, and information asymmetry is an important contributing factor to this association. These findings reveal the underlying mechanism that short selling influences market quality, providing direct empirical support to the adverse selection explanation of short selling and market microstructure. This is a classic prediction of an extensive theoretical work<sup>10</sup> that has largely been under-explored by the empirical literature. Thus our findings, together with the existing evidence from developed markets, underscore the importance of accounting for specific institutional characteristics in understanding the relation between short selling and

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<sup>9</sup>In this regard, our study has a similar spirit as [Blankespoor et al. \(2019\)](#), which documents that retail investors do not incorporate readily available earnings information in their trades and caution that regulations designed to reduce information costs are unlikely to help a sizable population of investors.

<sup>10</sup>for example, [Milgrom and Stokey, 1982](#), [Glosten and Milgrom, 1985](#), [Easley and O'hara, 1987](#), [Bhattacharya and Spiegel, 1991](#) and [Easley and O'hara, 2004](#).



market conditions.<sup>11</sup> In this regard, from a policy perspective, we echo [Morck et al. \(2000\)](#) that caution should be taken in generalizing the evidence from developed markets to emerging markets because of the remarkable differences in regulatory environments and market arrangements.

The rest of the paper is organized as follows. In Section 2, we describe the Chinese pilot MTSS program and develop testable hypotheses. Section 3 provides information on our data, measures and methodology. We present the main findings in Section 4 and robustness tests in Section 5. Section 6 concludes.

## 2 The Chinese MTSS Program and Hypothesis Development

### 2.1 The Program

As a step towards liberalizing its financial market, on February 12, 2010, the China Securities Regulation Commission (CSRC) launched a pilot program permitting MTSS on 90 stocks. The list of stocks with the MTSS permission was extended in three subsequent waves: on December 5, 2011, 185 stocks were added to the list; on January 31, 2013, 275 stocks were added; and on September 16, 2013, 186 stocks were added. By the end of 2013, a total

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<sup>11</sup>[Diamond and Verrecchia \(1987\)](#) and [Bai et al. \(2006\)](#) posit that a short selling ban widens bid-ask spreads when investor composition is held constant. Consistent with this prediction, [Boehmer et al. \(2013\)](#), [Beber and Pagano \(2013\)](#) and [Marsh and Payne \(2012\)](#) find that short selling bans during the crisis periods damaged stock liquidity in the United States, 20 developed countries and the United Kingdom, respectively. [Diether et al. \(2009\)](#) study how the suspension of short selling price tests in the United States affected short sellers' trading activities, and find that the tested stocks experience no significant increases in daily returns and volatility. Different from these studies, our work shows that in a developing market that has a significant presence of uninformed retail investors and severe information disparity among investors, allowing short selling can negatively affect stock liquidity through changing investors' trading behavior. [Jones \(2012\)](#) investigates how, in 1930s, the short-selling policy changes impacted liquidity in the United States, when the financial market was still a developing one. He finds that the restriction that required short sales to be executed only on upticks in 1931 and 1938 increased liquidity.

of 736 stocks had been added to the list in the four waves.<sup>12</sup> The detailed timeline of the program is presented in Panel A of Table 1.

[Table 1: Timeline of China's Margin-Trading and Short-Selling Program]

According to *Detailed Rules for Implementation of Margin Trading in Shanghai (Shenzhen) Stock Exchange* (SSE (2011), SZSE (2011), hereafter *Rules-2011*), to maintain eligibility for the program, the securities should satisfy the following six requirements: (1) they must have been traded in the stock market for longer than three months; (2) their market capitalization must be more than 800 million RMB (approximately 120 million USD); (3) the number of shareholders is greater than 4,000; (4) the average daily turnover is greater than 15% of the average daily turnover benchmark, and the daily trading value is not less than 50 million RMB (approximately 7.5 million USD); (5) the deviation of the average daily price fluctuation is less than 4% from the benchmark; and (6) the volatility is less than five times that of the benchmark. The securities that fail to satisfy these conditions will be delisted from the program.

These choice rules mean that the selected stocks are those that are of larger size and higher market liquidity. A potential concern about our analysis is, then, that the selection is not random. But such a choice rule would make it less likely that the market liquidity of the chosen stocks will be negatively affected by the pilot program. Another major characteristic of the Chinese MTSS program is that MTSS is open only to relatively sophisticated investors. According to the administrative rules promulgated by the CSRC, only qualified investors can conduct MTSS trades. Though the qualification requirements differ slightly across the security companies that undertake these business transactions, the qualified investors are more likely to be the informed ones. For example, qualified investors in the Haitong

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<sup>12</sup>Additional six stocks were added on other dates in this period, making the stocks with MTSS permission total 742. We focus on the four waves because our regression analysis includes wave fixed effects to control for the effect of time-varying trading preference, which is not applicable to small changes to the list. About a year later, a 5th wave of 218 stocks were added to the list on September 22, 2014. However, there is a significant portion of stocks in this wave were also included in the stocks under the Chinese Stock Connect program, which was launched in November 2014, within the 20-week window that we calculate our post-implementation measures. Thus we do not include this wave in our sample

Securities Company (one of the biggest brokerage houses in China) must (1) have a trading history of more than one and a half years using the company’s brokerage service (reduced to half a year after December 2011); (2) have invested at least half a million RMB in the stock market; and (3) pass an exam and a risk-attitude test to show that they understand the riskiness and complexity of MTSS trading. These restrictions are strict: in the first quarter of 2010, only 2.96% of the 52 million accounts held a portfolio has a market value higher than half a million RMB.<sup>13</sup> Moreover, conducting MTSS trades in China is very costly. Haitong Securities Company charged an annualized interest rate of 8.6% on MTSS in July 2012, which is three percentage points higher than the bank loan rate. The high cost further excludes small investors from MTSS. Therefore, it is expected that only professional traders who have strong information advantages in the market will engage in MTSS trading. This, together with fact that the Chinese stock market consists of a large proportion of uninformed investors, makes the MTSS pilot program a proper setting to study the adverse selection effect of MTSS on investor participation.

## 2.2 Testable Hypotheses

Theory suggests that short selling permission can have a significant influence on investor participation in trading the shorted stocks.<sup>14</sup> The empirical literature on short selling (e.g., [Desai et al., 2006](#); [Boehmer et al., 2008](#); [Christophe et al., 2010](#); [Drake et al., 2011](#); [Keckskés et al., 2013](#)) generally concludes that short sellers are informed traders that possess superior information about the traded stocks. The information advantage of informed short sellers affects investor participation in the shorted stocks in two opposing ways. On one hand, [Diamond and Verrecchia \(1987\)](#) focus on the informational role of short sales and demonstrate that informed short selling helps with resolution of uncertainty about fundamentals of

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<sup>13</sup>Statistics are from China Securities Depository and Clearing Corporation Limited and can be found in Wind. According to the statistics, the proportion of accounts that were valued at over half a million (item (2)) varied from 1.97% to 3.34% in the time period of our analysis.

<sup>14</sup>Margin trading works in a similar manner in affecting investor participation and market quality. For ease of exposition, our discussion focuses on short selling.

shorted stocks. As the perceived fundamental uncertainty decreases, less informed investors increase their demand for the assets (Bai et al., 2006).

On the other hand, as informed short sellers enter the market, information asymmetry among market participants exacerbates, creating adverse selection in the trading market for the shorted stocks. Uninformed investors, for fear of being exploited by informed traders, are reluctant to trade (see Bhattacharya and Spiegel, 1991, and Easley and O'hara, 2004), and to an extreme, may completely exit the market as predicted by the No-trade Theorem literature (Milgrom and Stokey, 1982). This is especially the case in the short selling setting where uninformed investors, on the demand side of the stocks, have discretion in strategically timing their buys (Admati and Pfleiderer, 1988).

Whether short selling permission increases or decreases uninformed investors' trading activities for the shorted stocks depends on which of the two effects, adverse selection or uncertainty resolution, dominates. We conjecture that the institutional features of the capital market in which short selling permission/restriction operates play a deciding role in the relationship between short selling and changes in investor participation. The Chinese stock market is featured with relatively severe information asymmetries among market participants and weak investor protection (Brockman and Chung, 2003; Wang et al., 2008). As a result, Chinese institutional investors have a strong information advantage over retail investors (Choi et al., 2013), and insider trading is common in China (Chakravarty et al., 1998). The Chinese regulators set high entry requirements for investors to participate in pilot short selling. This suggests that investors that are able to take advantage of shorting the pilot stocks under the Chinese MTSS program are likely better informed institutional investors.

More importantly, the Chinese stock market consists of a large proportion of relatively small retail investors who trade frequently and account for a vast majority of the total transactions. These unsophisticated small retail investors usually lack the ability to infer information from observed prices or extract information from public sources. Thus there is

no or little room for uncertainty resolution to work. This stands in striking contrast to the U.S. capital market, where institutional investors are the predominantly major players in the stock market and only a very minor proportion of transactions are conducted by individual investors. The information advantage of the short sellers in the US market is mostly from their ability to process publically available information including observed prices rather than from some internal channels, and institutional investors, not retail investors, are the ones who provide the needed demand (see [Engelberg et al., 2012](#); [Kadan et al., 2018](#)). Given that the US institutional investors are relatively equally sophisticated, it is likely that short selling facilitates uncertainty resolution. Therefore, the institutional structure of the Chinese stock market and the characteristics of the Chinese MTSS program are more conducive to generating adverse selection in the trading of the pilot stocks when the permission of short selling brings disparity of information access by different market participants.

Based on the above discussion, we expect that once a stock is allowed for short selling under the Chinese MTSS program, uninformed small retail investors will reduce their demand for that stock, and therefore, their trading activities of that stock will decrease.

### **Hypothesis 1**

*Uninformed small retail investors' trading activities of a stock decrease after the stock is added to the MTSS permission list, compared to a control stock that is not on the list.*

As the asymmetric-information market microstructure model suggests, if adverse selection is the driving force of the shift in retail investor demand for the pilot stocks, we should observe differential impacts of short selling on retail investor participation in the cross-section with regard to the severity of information asymmetry of the pilot stocks. [Easley and O'hara \(2004\)](#) and [Kelly and Ljungqvist \(2012\)](#) show that uninformed investor demand falls as information asymmetry increases, and a decrease in the number of retail traders increases the relative size of informed trading ([Easley et al., 2002](#)). Therefore, we expect that the decrease in the retail investors' trading activities to be larger for the pilot stocks

with severer information asymmetry. This leads to the following hypothesis:

## **Hypothesis 2**

*The decreases in small retail investors' trading activities of the stocks included in the MTSS permission list are more pronounced for those with greater information asymmetry.*

Next, we examine how the permission of short selling affects the liquidity of the pilot stocks.<sup>15</sup> The uncertainty resolution hypothesis argues that as informative tradings by informed short sellers facilitate the resolution of the fundamental uncertainty about the stock, the information risk faced by uninformed investors is lower. Consequently, uninformed investors are willing to pay a higher price and the bid-ask spread tightens. This also results in a higher likelihood of transactions being executed, and thus trading volume increases.

It is well established in the adverse selection market microstructure theory that (changes in) investor participation is an important channel through which short selling permission negatively affects stock liquidity (e.g., [Glosten and Milgrom, 1985](#); [Easley and O'hara, 2004](#); [Kelly and Ljungqvist, 2012](#)). To provide a direct test of this theoretical prediction, we investigate whether the change in liquidity of the pilot stocks are associated with the change in the trading activities of these stocks by uninformed small retail investors. In particular, we predict that pilot stocks experiencing larger decreases in uninformed investors' trading activities suffer more from reduced liquidity.

## **Hypothesis 3**

*The reduction in liquidity of a stock after it is added to the MTSS permission list is positively related to the decrease in uninformed investors' trading activities of the stock.*

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<sup>15</sup>Both theory and empirical evidence support the idea that short selling improves price discovery (e.g., [Diamond and Verrecchia, 1987](#); [Easley et al., 2002](#); [Boehmer et al., 2013](#); [Beber and Pagano, 2013](#), and [Chen et al., 2016](#)). The effect of short selling on stock liquidity, however, is less clear (see [Beber and Pagano \(2013\)](#)).

## 3 Data, Measurement and Empirical Strategy

### 3.1 Data and Variable Measurement

We conduct the analysis with weekly data in a 40-week time window around each of the four stock addition waves. To be more specific, we take the 20 weeks before the announcement week (i.e., the week that a stock is announced to be added to the MTSS list) as the benchmark time window and the 20 weeks after the effective week (i.e., the week that MTSS takes effect for that chosen stock) as the treatment time window to estimate changes in investor trading and stock liquidity. The weeks between the announcement and the effective weeks are dropped to have a clear evaluation of the effects of the permission.

We merge several databases to conduct the analyses. The list of stocks with MTSS permission is obtained from the websites of the Shanghai Stock Exchange and the Shenzhen Stock Exchange. We screen the announcements of the two exchanges regarding the changes in the list from January, 2010 to December, 2013. As summarized in Panel A of Table 1, by the end of 2013, MTSS had been approved for 736 stocks. As shown in Panel B of Table 1, within a month after their addition to the MTSS list, 52 of these 736 stocks were selected into two re-financing programs that allow institutions to borrow assets from a government-backed institution (i.e., China Securities Finance Corporation Limited, or CSF) when they can not meet the borrowing demand from investors (ten were added on January 31, 2013, and 42 were added on September 16, 2013). The re-financing programs may also affect investor trading and stock liquidity. Thus, these 52 stocks are excluded from our analysis to avoid any contamination of the effects of MTSS permission on investor trading and liquidity of these stocks by the re-financing programs.<sup>16</sup> 684 treated stocks are retained in our sample after this step.

Stocks' daily closing prices, trading volumes, trading values, and bid and ask prices are

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<sup>16</sup>The *re-financing* programs (Fund Re-lending and Security Re-lending or “Zhuǎn Róng Zī” and “Zhuǎn Róng Quàn” in Chinese respectively) cover 293 stocks in total from the MTSS pilot stocks, of which 241 had already been eligible for MTSS more than six months before they were included in the re-financing programs.

retrieved from Datastream. Month-level information of firm characteristics, including market capitalization and number of common shares outstanding are acquired from Worldscop. We then merge these two databases by the International Securities Identification Number (ISIN). Two treated stocks have missing ISINs and five are suspended from trading for longer than two months around the MTSS addition events. These seven stocks are dropped. We have 677 treated stocks in the program with 26,293 stock-week observations.

Small retail investors' trading activities are measured in two ways: small trades based on the size of trades, and trades conducted by small retail investors. First, we follow [Fang et al. \(2012\)](#) and use small trades that are unlikely to generate any impact on prices. To construct this measure, we manually collect the intraday transaction data for each stock from the high-frequency trading database of RESSET. the high-frequency trading database of RESSET provides the execution time, transaction price, trading volume, and trading value for each trade. In particular, we pick trades with values lower than RMB 7,776 (approximately USD 1,200), which represent the bottom 25% of all trades in the sample sorted by trading value. Given that more than 80% of the trading accounts (valued at less than RMB 100,000) are held by individual investors who do not possess private information on stocks, it is reasonable to assume that these small trades with no price impact are executed by uninformed retail investors. We derive weekly averages of the total daily trading volumes, trading values, and numbers of trades for those identified small trades of the sample stocks during the 20 weeks before and the 20 weeks after each MTSS permission. These weekly averages serve as our first set of measures of uninformed retail investors trading behavior.

One potential issue with this measure is that relatively larger trades (i.e., those over the amount of RMB 7,776) conducted by uninformed retail investors are not captured. We complement it by constructing a second measure using a proprietary data from the Shanghai Stock Exchange. In particular, we categorize all investors registered with the Shanghai Stock Exchange into three groups: small individual investors whose portfolios are valued less than half a million RMB, large individual investors whose portfolios are valued more than or equal



to half a million RMB, and institutional investors. Note that small individual investors are illegible to short due to the restrictions imposed by the the administrative rules promulgated by the CSRC (i.e., only investors with a portfolio of at least half a million are allowed to short the pilot stocks). Then, on each trading day, the number of trades, trading volume and trading value of each stock in the sample by small individual investors are identified and calculated. Similar to the first approach, our second set of measures of uninformed investors trading are the weekly averages of the daily trading volumes, trading values, and numbers of trades from all those small individual investors during the 20 weeks before and the 20 weeks after each MTSS permission. This approach allows us to capture all the trading activities of small retail investors, but we are only able to access the aggregated trading data of small retail investors on the Shanghai Stock Exchange.<sup>17</sup>

Our measures of severity of information asymmetry of a stock are based on media coverage and analyst forecasts. We obtain this information from *CSMAR*. Our first measure is media coverage. We count the number of new stories covering a particular firm in the main financial media in the 20 weeks before that firm’s stock is added to the permission list (*Press Coverage*). Our second measure is *Analyst Coverage*, which is the number of brokerage houses that have issued forecasts or reports on a stock within 20 weeks before the stock is added to the MTSS program. Then we use  $-\ln(1+ \textit{Press Coverage})$  and  $-\ln(1+ \textit{Analyst Coverage})$  to measure information asymmetry. The third measure is the analysts’ forecast error on firms’ earnings-per-share (EPS) for the current year. We use the last forecast issued by each brokerage house within 20 weeks before a stock is added to the MTSS list to calculate the consensus forecast for the stock. Then we calculate the absolute difference between the consensus forecast and the realized EPS and scale it by the stock price at the beginning of our analysis window to get forecast errors. Some stocks have no forecasts, and

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<sup>17</sup>One may observe from the subsequent analysis that the data with Shanghai Stock Exchange delivers more significant results potentially due to more accurate measurements. However, it is limited to the stocks listed on Shanghai Stock Exchange, which accounts for 55.8% of the stocks listed in the mainland China). We thus decide to present the results with both data sources balancing the needs of the scope of analysis and the accuracy of measurement.

we assign the largest forecast error of all stocks in the same period as their forecast errors.<sup>18</sup>

Finally, following the literature, we construct three measures of stock liquidity. The first one is the turnover ratio, which is defined as the weekly average of the ratio of daily trading volume divided by number of common shares outstanding. A higher value of the turnover ratio indicates higher trading frequencies and thus better liquidity. The second measure is the Amihud illiquidity ratio (Amihud and Mendelson, 1986; Amihud, 2002), which is calculated as the absolute value of daily stock returns divided by the trading value and then averaged over each week. A higher value of the Amihud illiquidity ratio means that for per-unit share trades, the price impact is larger and thus, liquidity is lower. The third measure is the weekly average of daily bid-ask spreads. A larger value of bid-ask spread means lower stock liquidity. All the measures of small retail investors' trading activities and stock liquidity are constructed at the weekly level.

### 3.2 Construction of the Control Group

Our empirical model is a difference-in-differences regression that estimates the changes in uninformed investors' trading behavior and the liquidity of the stocks with MTSS permission relative to those of the control stocks. According to *Rules-2011*, the major characteristics that determine the selection of the treated stocks are the stock's market capitalization and turnover ratio.<sup>19</sup> Thus, it is important that the control sample is constructed to narrow the pre-MTSS differences between the treated and control stocks along these two dimensions. Given the importance of market capitalization in affecting both MTSS and stock liquidity, we restrict the analysis

In our analysis, we rely on two control groups. The first one include the ineligible stocks

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<sup>18</sup>Our results hold if we drop observations that have missing values in forecast errors.

<sup>19</sup>Endogeneity related to this non-randomness of MTSS selection of pilot stocks is not a major concern here because the selection criteria work against documenting the predicted relationship between MTSS permission and stock liquidity. However it is still important to construct an appropriate control sample to alleviate the concern that investors may have time-varying investing preferences: For example, investors could prefer large capitalized stocks to small ones under one market condition, and reverse this order of preference under another market condition. Using an appropriate control sample also mitigates the selection issue.

with a market capitalization and turnover ratio greater than the 5th percentile of the treated stocks for each addition-wave. With this control sample, we conduct penal regressions to estimate the impacts of MTSS on retail investors' trading and stock liquidity.

To further gauge the characteristics of the pilot program and conduct a difference-in-differences identification method, we follow [Beber and Pagano \(2013\)](#) and [Boehmer et al. \(2013\)](#) to construct a percentage distance matched control sample.<sup>20</sup> More specifically, for each treated stock  $i$ , the matched stock is chosen by solving the following problem:

$$\arg \min_j \sqrt{\left(\frac{MV_j - MV_i}{MV_i}\right)^2 + \left(\frac{P_j - P_i}{P_i}\right)^2 + \left(\frac{Value_j - Value_i}{Value_i}\right)^2} \quad (1)$$

*s.t.* : Ineligible Stock  $j$  is from the same exchange as the Treated Stock  $i$ .

where  $i$  indicates a treated stock.  $MV$  is the market capitalization at the end of the previous fiscal year.  $P$  is the average price during the 30 days before the addition to the program is announced.  $Value$  is the 30-day averaged daily total amount of trading by uninformed investors (i.e. the total amount of trades that are amounted less than RMB 7,776 and without price impacts). The 30-day average trading amounts of uninformed investors is included to ensure the treated stocks and the control stocks have similar amounts of uninformed traders before MTSS. The 30-day average price before the announcement day is chosen to avoid a potential liquidity shock on a stock, which could distort the matching procedure. We then apply the regression estimates of this model to compute the probability (i.e., the score) that a stock would be eligible for the MTSS program given its market capitalization and average market price. Finally, each treated stock is matched with the ineligible stock that has the closest score. We impose a further restriction that the matching should happen within an exchange because the listed stocks in the two exchanges in China are substantially different in both size and ownership structure.

In constructing the control group, we take into account both the MTSS membership

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<sup>20</sup>In robustness tests, we construct the control sample using the propensity score match following [Foucault et al. \(2011\)](#).

dynamics because we have four addition waves, and the over-time variations in stock characteristics because the four waves span a long period of time (i.e., more than three years). We do so by including the stocks that are added to the MTSS permission list in later waves as control candidates for the pilot stocks in earlier waves, and making all non-pilot stocks available as control candidates for each of the addition waves regardless whether they have been selected as control stocks for the pilot stocks in prior waves.<sup>21</sup>

[Table 2: Summary Statistics]

Table 2 reports the summary statistics of the stock-week level variables for the treatment and control groups. Compared to stocks in the control group, the treated stocks are similar in stock volatility, market capitalization, and analyst forecast error, but are more liquid and more heavily covered by analysts.

## 4 Main Results

### 4.1 Descriptive Statistics

[Table 3: Univariate Analysis]

Table 3 reports the univariate analysis of the MTSS-induced changes in uninformed investors' trading activities (Panels A and B). Panel A and B present, respectively, the analysis of small retail investors' trading with the data from RESSET, where we use small trades to proxy small retail investors' trading, and the Shanghai Stock Exchange, where an investor is classified as a small retail investor if the investor is a retail investor with a portfolio size lower than the requirements of MTSS. In columns (1)-(2), (3)-(4), and (6-7), the mean values and the standard deviations (in parenthesis) of the variables of interest

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<sup>21</sup>For example, if stocks A, B, C are included in the permission list in waves 1, 2, and 3, respectively, then stock C can be a control candidate for A or B. Moreover, C can be selected as a control stock for A in wave 1, and B in wave 2 later. This operation takes into account the potential that stocks included in the permission list in later waves can be appropriate control stocks for the pilot stocks in earlier waves, while causing no issue since each addition wave is more than half a year apart from the adjacent wave(s).

are reported for the treated, control samples, and the matched control sample before and after the MTSS takes effect, respectively. The difference between changes in these variables pre- and post-MTSS for the two groups are reported in columns (5) and (8). Panels A and B show that compared to stocks in the control sample, the treated stocks experience a significant reduction in small retail investors' trading activities after they become eligible for margin trading and short selling, in terms of both trading values and number of trades, whether measured by small trades or trades by small retail investors.

## 4.2 Impact on Small Retail Investors' Trading Behavior

Hypothesis 1 predicts that small retail investors will decrease their trading of the pilot stocks to avoid being exploited by better-informed traders. To test this hypothesis, we estimate the following empirical model:

$$y_{i,t} = \beta Post_t * Treat_i + \gamma X_{i,t} + \alpha_i + \phi_t + \varepsilon_{i,t}, \quad (2)$$

where  $y_{i,t}$  is the small retail investor trading activities of stock  $i$  for week  $t$ , which is measured by the logarithms of 1 plus the trading volume, trading value, or number of trades, using either small trades (i.e., trades below RMB 7,776) from both Shanghai and Shenzhen Stock Exchanges, or trades by small retail investors (i.e. retail investors with a portfolio of less than half a million RMB) from the Shanghai Stock Exchange only.  $Post_t$  is a dummy variable that equals 1 after a stock is added to the MTSS program in a wave, and 0 before the addition.  $Treat_i$  is a dummy variable that equals 1 if stock  $i$  is eligible for the MTSS program in a wave, and 0 if it has not been selected to the program.  $X_{i,t}$  is the vector of other stock-level control variables including the logarithms of market capitalization and stock return volatility.  $\alpha_i$  is the *stock*  $\times$  *wave* fixed effect and  $\phi_t$  is the week fixed effect. All standard errors are two-way clustered at the *stock*  $\times$  *wave* and week levels.

The results of the estimation of model (2) are reported in Table 4. The parameter of

interest is  $\beta$ , which captures the change in uninformed investor trading of the pilot stocks before and after being eligible for MTSS, relative to that of the control stocks. If Hypothesis 1 is true,  $\beta$  should be significantly negative. Estimation results using trading volume, trading value, and number of trades are tabulated in columns (1) - (3), respectively.

[Table 4: The Impact of MTSS on Small Retail Investors' Trading Activities]

In panel A Table 4, where small trades are used to proxy trades conducted by uninformed investors, the estimated coefficient of the interaction term  $Post \times Treat$  across columns (1) - (3) are all significantly negative, suggesting that compared to stocks that are not permitted for MTSS, pilot stocks experience a significant reduction in trading by uninformed investors: uninformed investors' trading decreases by 0.081, 0.063, and 0.066 for trading volume, trading value, and number of trades, respectively. The decreases are not only statistically significant, but also economically important: for an average stock, the decrease weights to 7.8% in trading volume, 6.1% in trading value and 6.4% in number of trades.<sup>22</sup> The regression results using trades by small retail investors are consistent (and even stronger): uninformed investors' trading decreases by 0.153, 0.137, and 0.146 for trading volume, trading value, and number of trades, respectively, all at 1% level, which accounts for 14.2%, 12.8%, and 13.6% of the trading volume, amounts, and number of trades before the pilot program.

In summary, Table 4 provides evidence that small retail investors are less reluctant to trade the pilot stocks under MTSS, consistent with our adverse selection conjecture.<sup>23</sup>

### 4.3 The Role of Information Asymmetry

Information asymmetry plays a determining role in the adverse selection theory of short selling and market structure. Next, we explicitly test this implication (i.e., Hypothesis 2),

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<sup>22</sup>The economic significance is calculated using the following formula:  $\frac{Trading_{after} - Trading_{before}}{Trading_{before}} = \frac{(1 + Trading_{before})(e^{\hat{\beta}} - 1)}{Trading_{before}}$ , where  $\hat{\beta}$  is the estimated coefficient of  $Post \times Treat$ .

<sup>23</sup>To intuitively illustrate the changes in retail investors' trading behaviors, we plot the estimates of the average trading measures for time points around the week for the treated and matched control groups in Figure 1. The figure suggests a clear reduction for pilot stocks after the inclusion into the MTSS list.

i.e., the negative impact of MTSS on uninformed investor trading and stock liquidity is stronger for stocks with severer information asymmetry.

In particular, we first estimate the following empirical model:

$$y_{i,t} = \beta_1 Post_t * Treat_i + \beta_2 Post_t * Asym_i + \beta_3 Treat_i * Asym_i + \beta_4 Post_t * Treat_i * Asym_i + \gamma X_{i,t} + \alpha_i + \phi_{pt} + \varepsilon_{i,t}, \quad (3)$$

where  $y_{i,t}$  is uninformed investors' trading activities, and  $Asym_i$  is the measure of the pre-program information asymmetry associated with stock  $i$ , which is measured by 1) the number of media mentions; 2) the number of analyst following or 3) error of the consensus forecast. For 1) and 2) we multiple the original measure by minus one so that for all three measures, a higher number means higher information asymmetry. The measures are constructed based on information within 20 weeks before the addition events and each stock have one value of each measure in each wave. The control variables are the same as in the empirical model (2).  $\alpha_i$  is the *stock*  $\times$  *wave* fixed effect and  $\phi_{pt}$  is the *pair*  $\times$  *week* fixed effect. The standard errors are also two-way clustered at the *stock*  $\times$  *wave* and time levels. The parameter of interest is the coefficient on the triple interaction term *Post* $\times$ *Treat* $\times$ *Asym*, or  $\beta_4$ , which captures the incremental effect of information asymmetry on uninformed investor trading over the MTSS permission. We expect that  $\beta_4$  to be significantly negative.

[Table 5: Effects of Information Asymmetry on the Impacts of MTSS on Small Retail Investor Trading]

The results are reported in Table 5, with small trades in Panel A and trades by small retail investors in Panel B. The dependent variables are trading volume in columns (1) and (2), trading value in columns (3) and (4), and number of trades in columns (5) and (6). Results with media coverage, analyst coverage and analyst forecast error as information asymmetry measure are presented in columns (1), (4) and (7), columns (2), (5), and (8), and columns (3), (6), and (9), respectively. As Table 5 shows, the estimated coefficients on

$Post \times Treat \times Asym$  are significant and negative across all specifications at the 1% level when small retail investors are used to proxy uninformed investors. When we use small trades to measure uninformed investor trading, the results are consistent, although a bit weaker. These results suggest that information asymmetry is indeed crucial in driving uninformed investors' reluctance to trade the pilot stocks under the Chinese MTSS program.

#### 4.4 The mechanism: Small Retail Investor Trading and Stock liquidity

Hypothesis 3 posits that the shift in small retail investors' trading activities contributes directly to the change in the liquidity of the pilot stocks. Li et al. (2017) document an increase in liquidity for the pilot stocks using bid-ask spreads to proxy for liquidity, while Wan (2020) documents a decrease in liquidity using Amihud illiquidity ratio. Given such apparent conflicting findings in the literature, before we formally test Hypothesis 3, we first show that, using our improved empirical design, the permission of short selling adversely affects the liquidity of the pilot stocks as predicted by the adverse selection market microstructure theory (Glosten and Milgrom, 1985, Easley and O'hara, 2004). We estimate an empirical model similar to (2) in subsection 4.2, with the dependent variable being changed to measures of stock liquidity, i.e., turnover ratio, Amihud illiquidity ratio and bid-ask spread. The parameter of interest is  $\beta$ , which captures the change in liquidity of the pilot stocks before and after being eligible for MTSS, compared to that of the control stocks. We expect  $\beta$  to be significantly positive. The estimation results are reported in Table 6

[Table 6: Impact of Small Retail Investor Trading on Stock liquidity]

Table 6 Panel A presents the univariate analysis of the MTSS-induced changes in stock liquidity. The results suggest that, compared to the stocks in both control groups, the turnover ratio decreases and the Amihud illiquidity ratio and the bid-ask spread increase after a stock is added to the MTSS permission list. Panel B provides further evidence by



presenting the results of regressions that include control variables. Columns (1-3) presents the results of panel regressions, where the *stock*  $\times$  *wave* and *week* fixed effects are included. Columns (4-6) present the results of the estimation with the matched difference-in-difference regressions, where *stock*  $\times$  *wave* and *pair*  $\times$  *week* fixed effects are included. The results are consistent with the expectation that MTSS permission worsens stock liquidity in China.

We test Hypothesis 3 formally by estimating the following empirical model:

$$y_{i,t} = \beta_1 Post_t * Treat_i + \beta_2 Post_t * TradeDecreases_i + \beta_3 Treat_i * TradeDecreases_i + \beta_4 Post_t * Treat_i * TradeDecreases_i + \gamma X_{i,t} + \alpha_i + \phi_{pt} + \varepsilon_{i,t}, \quad (4)$$

where  $y_{i,t}$  is the liquidity of stocks;  $TradeDecreases_i$  is the percentage change in small retail investor trading of stock  $i$  before and after it is permitted for MTSS. The control variables are the same as in the empirical model (2).  $\alpha_i$  is the *stock*  $\times$  *wave* fixed effect and  $\phi_{pt}$  is the *pair*  $\times$  *week* fixed effect. The standard errors are also two-way clustered at the *stock*  $\times$  *wave* and time levels.  $\beta_4$  is the parameter of interest and we expect it to be significantly positive. The estimation results are reported in Table 6, where small trades and trades by small retail investors are used as explanatory variables in Panels C and D, respectively.

In Panels C and D of Table 6, the estimation results with stock liquidity being measured by *turnover ratio*, *Amihud illiquidity ratio* and *bid-ask spread* are reported in columns (1)-(3), (4)-(6), and (7)-(9), respectively. In Panel C, where small trades are used for small retail investors' trades, the estimated coefficients on the decreases in retail investors' trading activities are significantly negative for all three measures of trading activities (i.e., volume, value, and number of trades) when *turnover* ratio is used for liquidity, and are significantly positive for all measures of trading activities when either *Amihud Ratio* or *Bid-Ask Spread* is used for liquidity. The results are robust to using small retail investors' trades as the explanatory variables (see Panel D). These findings are consistent with the prediction that after a stock becomes legible for MTSS, the reduction in uninformed investors' trading of

this pilot stock contributes directly to the deterioration of its market liquidity.

## 5 Robustness

### 5.1 The Pre-Program Trend

One concern is that our results may be due to different pre-program trends in the treated and control stocks. To see if this is the case, we estimate the normal trading activities of small retail investors, and plot the time series of their abnormal trading activities for both the treated and control groups. Figure 1 shows that for all three measures of small retail investors' trading activities, i.e., the number of trades conducted, the number of shares traded, and the trading values, there is no significant difference before the stocks are added to the MTSS program.

[Figure 1: Time Series of Small Retail Investors' Trading Activities]

To address the concern of the pre-program trends more formally, we construct a time trend variable,  $Trend$ , which is equal to 0 for the 20th week before MTSS, increases by 1 after each week, and equals 19 for the week right before the program. Then we regress the (il)liquidity measures on  $Trend$ , as well as the interaction term of  $Trend$  with the treated stock dummy. If our findings are driven by the trend, we should observe that the coefficient for the interaction term is significantly negative when the dependent variable is a measurement of uninformed investors' trading, and turnover ratio, and significantly positive when it is Amihud illiquidity ratio or bid-ask spread.

[Table 7: Pre-Program Trend in Small Retail Investors' Trading]

The estimation results are reported in Table 7. We find that there is no difference between the treated and control stocks in terms of uninformed trading measured with trading amounts. Although there is significant differences between the two groups in trading volumes when measured with Shanghai Stock Exchange data, it is positive. Similarly, we find

that there is no difference between the treated and control stocks in terms of the Amihud illiquidity ratio and the turnover ratio. There are significant differences between the two groups in bid-ask spread, but they are in the opposite sign, implying that the differences in pre-program trends cannot drive our findings.

## 5.2 Results with Propensity Score Matched Sample

Following Foucault, Sraer and Thesmar (2011), we first estimate the propensity score by estimating the following logistic model:

$$Treat_i = a + \beta_1 MV_i + \beta_2 P_i + \varepsilon_i, \quad (5)$$

where  $Treat_i=1$  if stock  $i$  is in the treatment sample, and 0 otherwise.  $MV$  is the market capitalization at the end of the previous fiscal year and  $P$  is the average price during the 30 days before the addition to the program is announced. The 30-day average price before the announcement day is chosen to avoid a potential liquidity shock on a stock, which could distort the matching procedure. We then apply the regression estimates of this model to compute the probability (i.e., the score) that a stock would be eligible for the MTSS program given its market capitalization and average market price. Finally, each treated stock is matched with the ineligible stock that has the closest score. We impose a further restriction that the matching should happen within an exchange because the listed stocks in the two exchanges in China are substantially different in both size and ownership structure.

We report the estimation results using the propensity score-matched control sample in Table 8. To save space, we only report results on the effect of MTSS on small retail investor trading (Panels A and B) .<sup>24</sup>

[Table 8: Results with Propensity Score Matched Sample]

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<sup>24</sup>We also perform analyses on the effect of the MTSS-induced change in investor participation on stock liquidity, and the roles of information asymmetry in driving changes in the behavior of small retail investors and the stock liquidity. Our inference based on the results (untabulated) remains unchanged.

Results in Table 8 are similar to the main results presented in the previous section with the propensity score matched control sample, in terms of both the magnitudes of coefficients and the significance levels. To summarize, MTSS permission reduces small retail investors incentive in trading the pilot stocks, and this reduction in small retail investor trading decreases the market liquidity of the pilot stocks.

To further rule out the concern on that the pre-event trend may drive our results, we conduct a stricter matching method than Beber and Pagano (2013) and Boehmer et al. (2013) by incorporating the pre-program turnover ratio of the stocks as an additional matching variable. The results (untabulated) with this more strictly matched sample remain qualitatively unchanged, implying that our main inferences are not driven by the difference in the pre-program liquidity of treated and control stocks.

### 5.3 The Impacts of MTSS on ETF Liquidity

One may be concerned that our findings are due to other specific factors in the Chinese stock market besides the information asymmetry issues. To provide further evidence on the importance of information asymmetry, in this section, we show that the MTSS permission actually improves the liquidity of Exchange Trading Funds (ETFs) that are less subject to information asymmetry. By the end of 2013, ten ETFs had been included for the program. Three out of these ten funds were selected shortly after their foundation and, thus, are excluded from our analysis due to the lack of pre-MTSS program data. And because the number of ETFs in China is small, we include all remaining 24 ineligible ETFs as control funds.

[Table 9: The Impacts of MTSS on ETF Liquidity]

We estimate a model similar to (2) for ETFs and report the results in Panel A of Table 9. The dependent variable is the fund liquidity measure that is equal to the Amihud illiquidity ratios or bid-ask spreads of the fund. These measures are constructed in a similar way as

for stocks. We find that the estimated coefficient on the interaction term  $Post \times Treat$  is significantly negative for both Amihud illiquidity ratio and bid-ask spread. These results show that the fund liquidity is improved after MTSS is allowed on the fund. This is consistent with theory that when information asymmetry is not a concern, the uncertainty resolution effect can dominate the adverse selection effect.

We further expect that the positive effect of MTSS on fund liquidity is stronger for passive funds compared to active funds, as passive funds simply replicate indices and thus are mainly involved systemic risks. To test this, we split the ETFs sample into passive funds and active funds. Five (two) out of the seven funds in the program are passive (active) funds. One of the active funds tracks the stocks with a high and stable dividend payout ratio (SSE 180 Corporation Administration), while the other tracks the stocks with better corporate governance (Huatai-Pine Bridge SSE Dividend Index). The estimated results are reported in Panel B of Table 9, from which we find that the positive impact on fund liquidity is driven mainly by the passive funds.

## 6 Conclusion

This paper employs the Chinese pilot MTSS program to study the adverse selection effect of short selling (and margin trading) on investor participation in and market quality of the stocks included in the program. We provide evidence that after MTSS is permitted on a selected group of stock, small retail investors trade less of these stocks, and liquidity of these stocks deteriorates. We also show the degree of information asymmetry of the pilot stocks is positively associated with the negative impacts of MTSS on the liquidity of the pilot stocks and the small retail investors' incentive to trade these stocks. More importantly, we identify the critical role of the MTSS-induced changes in market micro-structure in determining the relationship between short selling and stock liquidity, and we show that the stocks with larger decreases in small retail investors' trading activities experience a greater reduction

in their liquidity. We mitigate the concern that our documented results are due to special characteristics of the Chinese market by showing that allowing MTSS improves the liquidity of ETFs that are selected to the program, because the ETFs are less subject to information asymmetry. Our results provide direct evidence on the adverse selection hypotheses of the effects of MTSS on investor participation in and the resultant market quality of the pilot stocks, which is a classic prediction of the theoretical literature, but has been largely overlooked by the empirical short-selling literature. These findings have implications for securities regulations that aim to protect the interest of retail investors.

Our findings extend the empirical literature on the effects of short selling by looking into a market environment that differs from developed markets. We highlight the importance of the specific market environment in determining the direction of the impact of MTSS on the trading behavior of small retail investors. In a developing financial market like China's, with serious information asymmetry and a large proportion of small retail investors who trade frequently and account for a large proportion of the market activities, MTSS permission generates a negative impact on market quality through reduced investor participation - an opposite finding from that of the developed markets by [Beber and Pagano \(2013\)](#) and others. Thus, this paper delivers nuanced insights for policy makers in making short-selling policies.

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# Figures and Tables

Figure 1: Impacts on Small Retail Investors' Trading

The figure displays the mean of residuals from the regression  $y_{i,t} = \gamma X_{i,t} + \alpha_i + \phi_t + \varepsilon_{i,t}$ , for the treated and the matched control group. Time is measured weekly.  $y_{i,t}$  is the small retail investors' volumes/values/numbers of trades on stock  $i$  for week  $t$ .  $\alpha_i$  is the *stock*  $\times$  *wave* fixed effect.  $X_{i,t}$  is the vector of other stock-level control variables, including the logarithm's value of market capitalization and stock return volatility.  $\phi_t$  is the week dummy, and its coefficient captures the group mean for week  $t$ . The sample period covers 20 weeks before and 20 weeks after MTSS was implemented. Similar to the regression analysis, we drop the weeks between the event and announcement days. Therefore, week zero in this figure is the first week after the treatment is implemented and week minus one is the previous week before the event is announced.

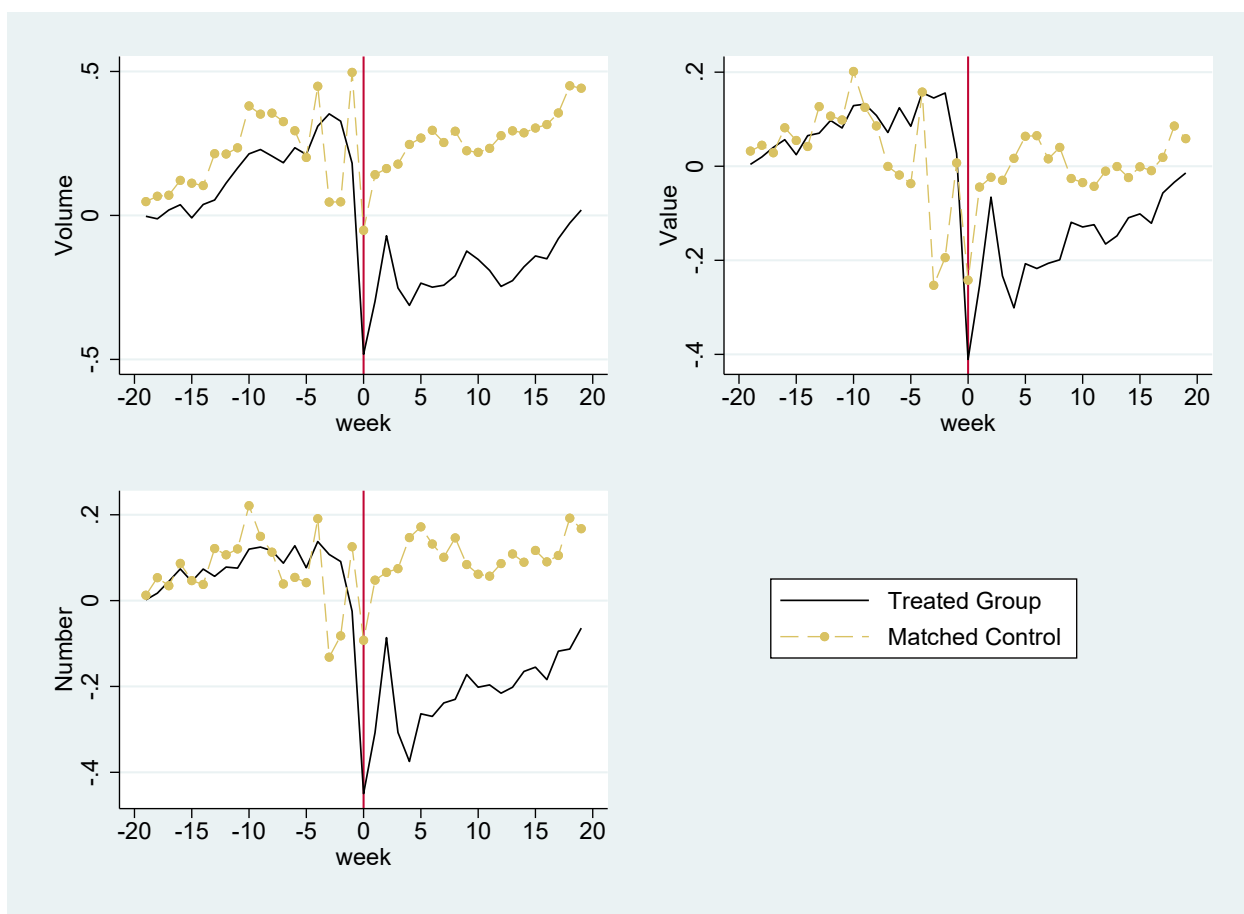


Table 1: Timeline of the China's Margin-Trading and Short-Selling Program

Panel A illustrates China's *margin-trading and short-selling* (MTSS) program. The paper covers four waves of addition events that extended the sets of stocks eligible for MTSS. Column (1) assigns a wave number for each stock-addition event. Column (2) lists the announcement date of the addition events, and column (3) gives effective dates when MTSS was permitted on the stocks in the program. Column (4) shows the number of treated stocks that were added to the set in each addition event. Panel B reports the timeline of China's *re-financing program* to the end of 2013. Column (4) gives the number of stocks selected to this program that overlap with those in the MTSS program. 52 stocks (ten from the addition event of January 31, 2013 and 42 from the addition event of September 16, 2013) were added to the *re-financing program* soon after they were added to the MTSS program and, thus, are excluded in our analysis. The information in the table is from the websites of the Shanghai Stock Exchanges (SSE) and the Shenzhen Stock Exchanges (SZSE).

(1)	(2)	(3)	(4)
Wave Number	Announcement Date	Effective Date	Number of Treated Stocks
Panel A: MTSS Program			
Wave 1	February 12, 2010	March 31, 2010	90
Wave 2	November 25, 2011	December 5, 2011	185
Wave 3	January 25, 2013	January 31, 2013	275
Wave 4	September 6, 2013	September 16, 2013	186
			Total: 736
Panel B: Re-financing Program			
	February 26, 2013	February 28, 2013	53 from Wave 1 23 from Wave 2 10 from Wave 3 Total: 86
	September 16, 2013	September 18, 2013	21 from Wave 1 64 from Wave 2 80 from Wave 3 42 from Wave 4 Total: 207

Table 2: Summary Statistics

The table reports the means of the key variables with their standard deviations in parentheses below the means, for the treated and control groups. Column (1) is for the treatment group; column (2) is for the control group; and column (3) is for the matched control group. *Stock-Week Obs.* is the number of stock-week observations in each group. *Number of Stocks* is the number of stocks in each group. *Turnover ratio* is the weekly average ratio of daily trading volume divided by common shares outstanding. *Amihud illiquidity ratio* is the absolute value of daily stock returns divided by trading value and then averaged over each week, which is denoted in basis points per million RMB. *Bid-ask spread* is computed as the difference between bid and ask prices divided by the mean of the bid and ask prices, and then averaged over each week, which is denoted in basis points. *Volume, Value* and *Number of trades* (by Trading Amount) are the weekly averages of the total daily trading volume, trading value and the number of trades that are less than 7,776 RMB (which represent the bottom 25% of all trades in the sample sorted by trading volume) and have no impact on stock prices. *Volume, Value* and *Number of trades* (by Portfolio Size) are the weekly averages of the total daily trading volume, trading value and the number of trades from retail investors whose portfolio sizes are less than half a million RMB. *Press Coverage* is the number of new stories on a stock in the main financial medias in the 20 weeks before the announcement date. *Analyst Coverage* the number of forecasters (research departments) covering a stock in the main financial media in the 20 weeks before the announcement date. *Forecast Error* is the forecast error of the consensus of forecasters' most recent forecasts in the 20 weeks before the announcement date, and assigned to be the largest forecast error if the stock is not covered. *Volatility* is the weekly standard deviation of daily raw returns. *MV* is the stock's market capitalization in the previous fiscal year in thousands.

Variable	Treated Group	Control Group	Matched Control Group
Stock-Week Obs.	26293	75655	26078
Number of Stocks	677	1968	677
ln(1+Volume) (by Trading Amount)	6.327 (1.202)	6.206 (1.045)	6.091 (1.115)
ln(1+Value) (by Trading Amount)	13.453 (0.598)	13.305 (0.520)	13.319 (0.533)
ln(1+ Number of trades) (by Trading Amount)	5.294 (0.601)	5.167 (0.523)	5.166 (0.532)
ln(1+Volume) (by Portfolio Size)	14.854 (3.808)	13.912 (4.115)	15.053 (1.239)
ln(1+Value) (by Portfolio Size)	8.331 (2.250)	7.478 (2.332)	8.182 (0.964)
ln(1+ Number of trades) (by Portfolio Size)	17.053 (4.317)	15.998 (4.684)	17.402 (1.294)
Turnover ratio (%)	1.349 (1.394)	1.092 (1.078)	1.153 (1.230)
Amihud iliquidity ratio	2.552 (2.824)	5.897 (5.800)	4.641 (4.760)
Bid-ask spread (%)	12.973 (8.274)	14.654 (8.888)	13.780 (8.772)
Number of News Stories	41.445 (27.788)	31.642 (9.731)	33.723 (12.463)
Analyst Coverage	7.228 (6.942)	5.274 (5.520)	5.836 (5.821)
Forecast Error	0.428 (0.730)	0.564 (0.834)	0.424 (0.606)
Stock Volatility	2.405 (1.263)	2.348 (1.312)	2.426 (1.348)
ln(MV)	16.258 (0.993)	15.559 (0.587)	15.918 (0.768)

Table 3: Univariate Analysis: Small Retail Investors' Trades

The table reports the results of the univariate analysis changes of the transactions by small retail investors after the MTSS program. Panel A exploits the RESSET high-frequency trading data and Panel B the Shanghai Exchange Trading data, respectively. Means of the variables with standard deviations in parentheses are reported separately for the treated and control groups. Columns (1) and (2) are the means of the variables in the 20 weeks before and the 20 weeks after the MTSS program for the treated group. Columns (3) and (4) are the means of the variables in the 20 weeks before and the 20 weeks after the MTSS program for the quasi-full control group. Column (5) reports the changes of the variables in the control group after the MTSS program, compared to the treated group. Columns (6) and (7) are the means of the variables in the 20 weeks before and the 20 weeks after the MTSS program for the matched control group. Column (8) reports the changes of the variables in the matched control group after the MTSS program compared to the treated group. \*, \*\*, and \*\*\* denote significance at the 10%, 5% and 1% levels, respectively.

	Treated Group		Quasi-full Control Group			Matched Control Group		
	(1) Before	(2) After	(3) Before	(4) After	(5) diff-in-diff	(6) Before	(7) After	(8) diff-in-diff
<b>Panel A: Uninformed Investors' Trades by Trading Amount</b>								
ln(1+Volume)	6.284 (1.196)	6.369 (1.206)	6.164 (1.060)	6.249 (1.027)	-0.001 (-0.038)	6.237 (1.113)	6.317 (1.072)	-0.008 (-0.774)
ln(1+Value)	13.421 (0.647)	13.486 (0.542)	13.256 (0.549)	13.353 (0.485)	-0.032*** (-4.184)	13.338 (0.574)	13.416 (0.496)	-0.021*** (-3.024)
ln(1+Number of trades)	5.256 (0.645)	5.333 (0.551)	5.115 (0.542)	5.219 (0.497)	-0.027*** (-3.452)	5.194 (0.554)	5.277 (0.512)	-0.016*** (-2.484)
<b>Panel B: Uninformed Investors' Trades by Portfolio Size</b>								
ln(1+Volume)	15.081 (3.424)	14.570 (4.223)	14.010 (3.842)	13.807 (4.384)	-0.308*** (-3.709)	14.955 (1.553)	15.203 (1.010)	-0.323*** (-15.348)
ln(1+Value)	17.328 (3.863)	16.709 (4.802)	16.128 (4.371)	15.860 (4.992)	-0.351*** (-3.724)	17.264 (1.618)	17.499 (0.934)	-0.362*** (-16.273)
ln(1+Number of trades)	8.481 (2.063)	8.143 (2.452)	7.509 (2.203)	7.445 (2.461)	-0.273*** (-5.741)	8.095 (1.140)	8.269 (0.872)	-0.312*** (-18.013)



Table 4: The Impacts of MTSS on Small Retail Investors' Trades

This table reports the estimation of the impacts of MTSS on the transactions conducted by small retail investors. Panel A exploits the RESSET high-frequency trading data and Panel B the Shanghai Exchange Trading data, respectively. The results of the estimation with uninformed investors' trades measured by  $\ln(1+Volume)$  are reported in column (1),  $\ln(1+Value)$  in column (2) and  $\ln(1+Number\ of\ trades)$  in column (3). (*Volume*, *Value* and *Number of trades* are the weekly averages of the total daily trading volume, trading value and the number of trades that are less than 7,776 RMB, which represent the bottom 25% of all trades in the sample sorted by trading volume, and have no impact on stock prices.) In columns (1-3), the panel regression is conducted with the quasi-full control group. In columns (4-6), the difference-in-difference regression is estimated with the matched sample. We include market capitalization ( $Ln(MV)$ ) and stock return volatility (*Volatility*) as controls. All standard errors are two-way clustered at the *stock* $\times$ *wave* and week levels. t-statistics are in parentheses. \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels, respectively.

<b>Panel A: Small Retail Investors' Trades by Trading Amount</b>						
Dependent Variable:	Panel Regression			Matched DID		
	Volume	Value	Number	Volume	Value	Number
	(1)	(2)	(3)	(4)	(5)	(6)
Post*Treat	-0.081*** (-2.84)	-0.063*** (-2.78)	-0.066*** (-2.99)	-0.028 (-1.17)	-0.042** (-2.13)	-0.041** (-2.15)
Volatility	0.034*** (8.71)	0.050*** (12.35)	0.043*** (12.15)	0.003 (0.84)	0.016*** (3.66)	0.010** (2.55)
Ln(MV)	-0.225*** (-6.48)	-0.016 (-0.57)	-0.043* (-1.67)	-0.386*** (-7.99)	-0.158*** (-4.70)	-0.184*** (-5.57)
Stock*Wave FEs	Yes	Yes	Yes	Yes	Yes	Yes
Pair*Week FEs	No	No	No	Yes	Yes	Yes
Week FEs	Yes	Yes	Yes	No	No	No
Observation	99,729	99,729	99,729	49,948	49,948	49,948
$R^2$	0.016	0.027	0.024	0.947	0.837	0.867
<b>Panel B: Small Retail Investors' Trades by Portfolio Size</b>						
Dependent Variable:	Panel Regression			Matched DID		
	Volume	Value	Number	Volume	Value	Number
	(1)	(2)	(3)	(4)	(5)	(6)
Post*Treat	-0.153*** (-3.61)	-0.137*** (-2.89)	-0.146*** (-3.62)	-0.248*** (-8.43)	-0.282*** (-6.07)	-0.260*** (-5.81)
Volatility	0.209*** (21.34)	0.220*** (20.80)	0.209*** (22.03)	0.226*** (24.79)	0.238*** (23.98)	0.223*** (24.12)
Ln(MV)	0.258*** (4.61)	0.334*** (5.66)	0.201*** (3.47)	0.249*** (4.35)	0.395*** (5.37)	0.181** (2.54)
Stock*Wave FEs	Yes	Yes	Yes	Yes	Yes	Yes
Pair*Week FEs	No	No	No	Yes	Yes	Yes
Week FEs	Yes	Yes	Yes	No	No	No
Observation	42,931	42,931	42,931	29,542	29,542	29,542
$R^2$	0.201	0.173	0.166	0.889	0.827	0.858

Table 5: Effects of Information Asymmetry on the Impacts of MTSS on Small Retail Investors' Trades

This table presents the results of the estimation of the effects of Information Asymmetry on the Impact of MTSS on Small Retail Investors' Trades. The results of the estimation with uninformed investors' trades measured by  $\ln(1+Volume)$  are reported in columns (1-3),  $\ln(1+Value)$  in columns (4-6) and  $\ln(1+Number\ of\ trades)$  in columns (7-9). In the row after the column numbers, the measure of information asymmetry is indicated. Results with information asymmetry measured by  $-\ln(1+Press\ Coverage)$  ( $\#News$ ) are reported in columns (1), (4) and (7), by  $-\ln(1+Analyst\ Coverage)$  ( $\#Analyst$ ) in columns (2), (5) and (8), and by analysts' forecast errors in columns (3), (6) and (9). *Asym* is the corresponding information asymmetry measure as indicated. We include market capitalization ( $\ln(MV)$ ) and stock return volatility (*Volatility*) as controls. All standard errors are two-way clustered at the *stock* $\times$ *wave* and week levels. t-statistics are in parentheses. \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels, respectively.

<b>Panel A: Small Retail Trading by Trading Amount</b>									
Dependent Variable:	Volume			Value			Number		
Asym-Infor Measure:	(1) #News	(2) Coverage	(3) Forecast-Error	(4) #News	(5) Coverage	(6) Forecast-Error	(7) #News	(8) Coverage	(9) Forecast-Error
Post*Treat*Asym	-0.270*** (-2.75)	-0.014 (-0.59)	-0.138 (-1.03)	-0.232*** (-2.81)	-0.026 (-1.44)	-0.197* (-1.93)	-0.210*** (-2.71)	-0.017 (-1.02)	-0.135 (-1.36)
Post*Treat	-1.019*** (-2.95)	-0.069* (-1.83)	-0.034 (-1.08)	-0.876*** (-3.03)	-0.079*** (-2.75)	-0.022 (-0.90)	-0.799*** (-2.94)	-0.064** (-2.32)	-0.025 (-1.07)
Post*Asym	0.042 (0.51)	-0.013 (-0.67)	0.027 (0.25)	-0.005 (-0.08)	-0.011 (-0.72)	-0.016 (-0.18)	-0.012 (-0.22)	-0.008 (-0.56)	0.006 (0.08)
Volatility	0.002 (0.43)	0.002 (0.43)	0.002 (0.46)	0.014*** (3.11)	0.014*** (3.04)	0.014*** (3.06)	0.009** (2.28)	0.008** (2.22)	0.009** (2.23)
Ln(MV)	-0.396*** (-8.15)	-0.402*** (-7.99)	-0.403*** (-7.94)	-0.166*** (-4.58)	-0.172*** (-4.47)	-0.172*** (-4.42)	-0.191*** (-5.44)	-0.197*** (-5.28)	-0.197*** (-5.24)
Stock*Wave FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pair*Week FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observation	49,948	49,948	49,948	49,948	49,948	49,948	49,948	49,948	49,948
R <sup>2</sup>	0.945	0.945	0.945	0.837	0.835	0.835	0.869	0.868	0.867

<b>Panel B: Small Retail Trading by Portfolio Size</b>									
Dependent Variable:	Volume			Value			Number		
Asym-Infor Measure:	(1) #News	(2) Coverage	(3) Forecast-Error	(4) #News	(5) Coverage	(6) Forecast-Error	(7) #News	(8) Coverage	(9) Forecast-Error
Post*Treat*Asym	-0.318*** (-3.09)	-0.168*** (-3.60)	-1.567*** (-3.64)	-0.455*** (-2.93)	-0.257*** (-2.90)	-2.437*** (-2.80)	-0.429*** (-2.82)	-0.245*** (-3.04)	-2.343*** (-2.98)
Post*Treat	-1.369*** (-3.68)	-0.495*** (-5.93)	-0.129*** (-3.97)	-1.892*** (-3.26)	-0.657*** (-3.99)	-0.094** (-2.16)	-1.781*** (-3.15)	-0.620*** (-4.13)	-0.079* (-1.90)
Post*Asym	0.269*** (2.95)	0.060* (1.89)	0.313 (1.12)	0.338*** (2.80)	0.103** (1.99)	0.660 (1.38)	0.310** (2.53)	0.089* (1.85)	0.670 (1.54)
Volatility	0.225*** (24.88)	0.224*** (25.08)	0.224*** (25.04)	0.237*** (23.98)	0.236*** (24.10)	0.236*** (24.06)	0.222*** (24.17)	0.221*** (24.36)	0.220*** (24.38)
Ln(MV)	0.246*** (4.34)	0.246*** (4.43)	0.248*** (4.35)	0.393*** (5.44)	0.388*** (5.60)	0.388*** (5.56)	0.179** (2.56)	0.177*** (2.63)	0.173** (2.55)
Stock*Wave FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Pair*Week FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observation	29,542	29,542	29,542	29,542	29,542	29,542	29,542	29,542	29,542
R <sup>2</sup>	0.889	0.890	0.891	0.828	0.829	0.830	0.858	0.860	0.860

Table 6: Effects of Decreases in Small Retail Investors' Trades on Stock Liquidity

This table presents the results of the estimation on how MTSS affects stock liquidity through decreasing small retail investors' trades. Panel A reports the summary statistics of the impacts of MTSS on stock liquidity. Panel B reports the estimation results. The results of the estimation with stock liquidity measured by *turnover ratio* are reported in columns (1) and (4), with stock illiquidity measured by the *Amihud illiquidity ratio* in columns (2) and (5), with stock illiquidity measured by *bid-ask spreads* in columns (3) and (6). In columns (1-3), the panel regression is conducted with the quasi-full control group. In columns (4-6), the difference-in-difference regression is estimated with the matched sample. Panels C and D report the main mechanism tests that the decreases in small retail investor participation contribute to reduced stock liquidity. Panel B exploits the RESSET high-frequency trading data and Panel C exploits the Shanghai Stock Exchange Trading data. The decrease in small retail investors' trades is measured by the percentage decrease in the 20-week average trades conducted by small retail investors before and after the MTSS program where trades are measured by *volume*, *value*, and *number of trades*. All standard errors are two-way clustered at the *Pair* level. t-statistics are in parentheses. \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels, respectively.

Panel A Univariate Analysis: MTSS and Stock Liquidity								
	Treated Group		Quasi-full Control Group			Matched Control Group		
	(1) Before	(2) After	(3) Before	(4) After	(5) diff-in-diff	(6) Before	(7) After	(8) diff-in-diff
Turnover (%)	1.414 (1.490)	1.284 (1.284)	1.037 (1.048)	1.148 (1.105)	-0.241*** (-14.415)	1.039 (1.173)	1.079 (1.102)	-0.169*** (-9.319)
Amihud illiquidity ratio	2.610 (3.027)	2.492 (2.598)	6.468 (6.408)	5.317 (5.042)	1.033*** (13.940)	5.098 (5.787)	4.191 (4.468)	0.738*** (10.853)
Bid-ask spread (%)	12.849 (8.205)	13.102 (8.342)	14.950 (9.012)	14.353 (8.750)	0.850*** (6.798)	14.274 (8.572)	13.941 (8.805)	0.516*** (5.368)

Panel B Regression: MTSS and Stock Liquidity

Dependent Variable:	Panel Regression			Matched DID		
	Turnover (1)	Amihud Ratio (2)	Bid-Ask Spread (3)	Turnover (4)	Amihud Ratio (5)	Bid-Ask Spread (6)
Post*Treat	-0.176*** (-4.40)	0.769** (2.33)	0.422** (2.45)	-0.147*** (-4.28)	0.588** (2.59)	0.412*** (2.97)
Volatility	0.306*** (14.59)	0.207*** (5.76)	-0.329*** (-8.78)	0.295*** (9.05)	0.135*** (4.06)	-0.241*** (-6.07)
Ln(MV)	0.148** (2.14)	-1.983*** (-5.54)	-1.522*** (-4.68)	-0.035 (-0.43)	-1.071*** (-3.50)	-1.076*** (-3.62)
Stock*Wave FEs	Yes	Yes	Yes	Yes	Yes	Yes
Pair*Week FEs	No	No	No	Yes	Yes	Yes
Week FEs	Yes	Yes	Yes	No	No	No
Observation	101,948	101,948	101,948	50,592	50,592	50,592
R <sup>2</sup>	0.181	0.012	0.007	0.831	0.793	0.859

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**Panel C Mechanism Test: Small Retail Trading by Trading Amount**

Dependent Variable:	Turnover Ratio Change			Amihud Ratio Change			Bid-Ask Spread Change		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Decreases in Volume	-0.433*** (-8.25)			0.449*** (16.36)			0.124*** (10.19)		
Decreases in Amount		-0.439*** (-8.50)			0.454*** (16.43)			0.128*** (10.56)	
Decreases in Number			-0.948*** (-8.03)			0.859*** (14.23)			0.283*** (10.82)
Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observation	1,312	1,312	1,312	1,312	1,312	1,312	1,312	1,312	1,312
$R^2$	0.639	0.641	0.654	0.773	0.775	0.760	0.686	0.688	0.698

**Panel D Mechanism Test: Small Retail Trading by Portfolio Size**

Dependent Variable:	Turnover Ratio Change			Amihud Ratio Change			Bid-Ask Spread Change		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Decreases in Volume	-8.154*** (-7.57)			4.145*** (9.07)			0.637** (2.52)		
Decreases in Amount		-8.504*** (-7.98)			5.057*** (9.83)			1.150*** (4.52)	
Decreases in Number			-4.589*** (-7.74)			2.559*** (10.46)			0.577*** (4.35)
Pair FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observation	772	772	772	772	772	772	772	772	772
$R^2$	0.661	0.652	0.661	0.681	0.693	0.690	0.667	0.681	0.679

Table 7: Pre-Program Trends in Small Retail Investors' Trading and Stock Liquidity

This table reports the results of the tests for the pre-program trends of Small Retail Investors' Trades (Panel A) and stock liquidity (Panel B). The results of the estimation with stock liquidity innovation trend before the MTSS program measured by *turnover ratio* are reported in column (1) (with different fixed effects), with stock liquidity measured by *Amihud illiquidity ratio* in column (2) and with stock liquidity measured by *bid-ask spreads* in columns (3). In all the regressions, *Trend* is the time trend that is equal to 0 for the 20th week before MTSS, and increases by 1 after each week, and is equal to 40 for the 20th week after the program. We include market capitalization ( $Ln(MV)$ ) and stock return volatility (*Volatility*) as controls. All standard errors are two-way clustered at the  $stock \times wave$  and week levels. t-statistics are in parentheses. \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels, respectively.

<b>Panel A: Uninformed Investors' Trades by Trading Amount</b>			
Dependent Variable:	Volume	Value	Number
	(1)	(2)	(3)
Trend	-0.003 (-0.24)	-0.018 (-1.08)	-0.014 (-1.34)
Trend*Treat	0.003 (0.99)	-0.000 (-0.05)	0.002 (0.69)
Control	Yes	Yes	Yes
Stock*Wave FEs	Yes	Yes	Yes
Time FEs	Yes	Yes	Yes
Observation	50,255	50,255	50,255
$R^2$	0.028	0.015	0.026
<b>Panel B: Uninformed Investors' Trades by Portfolio Size</b>			
Dependent Variable:	Volume	Value	Number
	(1)	(2)	(3)
Trend	0.067 (1.60)	0.088* (1.91)	0.064 (1.33)
Trend*Treat	0.007* (1.78)	0.006 (1.56)	0.004 (1.24)
Control	Yes	Yes	Yes
Stock*Wave FEs	Yes	Yes	Yes
Time FEs	Yes	Yes	Yes
Observation	22,887	22,887	22,887
$R^2$	0.187	0.159	0.162
<b>Panel C: Stock Liquidity</b>			
Dependent Variable:	Turnover	Amihud-Ratio	B-S Spread
	(1)	(2)	(3)
Trend	0.009 (0.18)	-0.393*** (-3.36)	-1.005*** (-13.98)
Trend*Treat	0.007 (1.54)	-0.009 (-0.23)	-0.058*** (-3.43)
Control	Yes	Yes	Yes
Stock*Wave FEs	Yes	Yes	Yes
Week FEs	Yes	Yes	Yes
Observation	51,477	51,477	51,477
$R^2$	0.155	0.008	0.004

Table 8: Impact on MTSS with Propensity Score Matched Control Group

This table reports the results of reports of the estimation of the impacts of MTSS on small retail investors' trading with the propensity score matched control group. We include market capitalization ( $Ln(MV)$ ) and stock return volatility ( $Volatility$ ) as controls. All standard errors are two-way clustered at the  $stock \times wave$  and week levels. t-statistics are in parentheses. \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels, respectively.

<b>Panel A: Small Retail Investors' Trades by Trading Amount</b>			
Dependent Variable:	Volume	Value	Number
	(1)	(2)	(3)
Post*Treat	-0.038 (-1.50)	-0.040* (-1.93)	-0.044** (-2.16)
Control	Yes	Yes	Yes
Stock*Wave FEs	Yes	Yes	Yes
Pair*Week FEs	Yes	Yes	Yes
Observation	49,622	49,622	49,622
$R^2$	0.941	0.824	0.855

<b>Panel B: Small Retail Investors' Trades by Portfolio Size</b>			
Dependent Variable:	Volume	Value	Number
	(1)	(2)	(3)
Post*Treat	-0.262*** (-9.00)	-0.288*** (-6.39)	-0.278*** (-6.45)
Control	Yes	Yes	Yes
Stock*Wave FEs	Yes	Yes	Yes
Pair*Week FEs	Yes	Yes	Yes
Observation	29,474	29,474	29,474
$R^2$	0.890	0.828	0.854

Table 9: The Impacts of MTSS on ETF Liquidity

This table reports the impact of MTSS on the liquidity of exchange-traded funds (ETFs). Panel A compares the treated and control ETFs. In Panel B, the treated ETFs are divided into active and passive funds, and they are compared to the control ETFs separately. In each panel, results with the liquidity of ETFs measured by  $\ln(\text{Volume})$  (*Volume* means *trading volume*) are reported in columns (1-2), by *Amihud illiquidity ratio* in columns (3-4) and by *bid-ask spreads* in columns (5-6) (with different fixed effects). *Treat* is the dummy variable that is equal to 1 if the fund is in the MTSS program and 0 otherwise. *Post* is the dummy variable that is equal to 1 if the MTSS is implemented and 0 before the program. *Volatility* is the standard deviation of daily fund returns. All standard errors are two-way clustered at the fund and week levels. t-statistics are in parentheses. \*, \*\*, and \*\*\* denote significance at the 10%, 5%, and 1% levels, respectively.

<b>Panel A: Average Effects</b>						
Dependent Variable:	Volume		Amihud-Ratio		Bid-Ask Spread	
	(1)	(2)	(3)	(4)	(5)	(6)
Treat	3.285*** (4.42)		-3.092** (-2.50)		-0.394*** (-4.15)	
Post*Treat	0.598*** (3.37)	0.784*** (4.54)	-1.446* (-1.75)	-1.903*** (-2.97)	-0.193** (-2.09)	-0.212*** (-3.06)
Volatility	0.478** (2.13)	0.019 (0.42)	1.133 (1.12)	0.908* (1.70)	0.105* (1.96)	0.097*** (3.03)
Fund FEs	No	Yes	No	Yes	No	Yes
Week FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observation	1,069	1,069	1,069	1,069	1,069	1,069
$R^2$	0.458	0.057	0.123	0.017	0.210	0.029

<b>Panel B: Passive Funds Versus Active Funds</b>						
Dependent Variable:	Volume		Amihud Ratio		Bid-Ask Spread	
	(1)	(2)	(3)	(4)	(5)	(6)
Treat	3.277*** (4.39)		-3.089** (-2.50)		-0.393*** (-4.14)	
Post*Passive	1.635*** (2.64)	0.919*** (7.03)	-1.771** (-2.25)	-2.079*** (-3.35)	-0.296*** (-2.88)	-0.254*** (-4.30)
Post*Active	-2.034** (-2.53)	0.446 (1.34)	-0.622 (-0.64)	-1.460** (-2.24)	0.070 (0.34)	-0.105 (-0.89)
Volatility	0.394* (1.79)	0.015 (0.35)	1.160 (1.13)	0.912* (1.70)	0.113** (2.14)	0.098*** (3.09)
Fund FEs	No	Yes	No	Yes	No	Yes
Week FEs	Yes	Yes	Yes	Yes	Yes	Yes
Observation	1,069	1,069	1,069	1,069	1,069	1,069
$R^2$	0.521	0.063	0.123	0.017	0.219	0.031

## Appendix A: Definitions of the Variables

In this appendix, we define the variables used in the empirical tests. The three liquidity measurements are defined as follows:

- *Turnover ratio* is the weekly average ratio of daily trading volume divided by common shares outstanding.
- *Amihud illiquidity ratio* is the absolute value of daily stock returns divided by trading value and then averaged over each week and denoted in basis points per million RMB.
- *Bid-ask spread* is computed as the ratio of the difference between bid and ask prices divided by the mean of the bid and ask prices, and then averaged over each week and denoted in basis points.

Three variables are used to measure information asymmetry:

- *Press Coverage* is the number of news stories shown in the main financial media in the 20 weeks before the stock-addition event for each stock.
- *Analyst Coverage* is the number of brokerage houses that have issued forecasts or reports on a stock within 20 weeks before the stock-addition events.
- *Forecast Error* is the forecast error of the consensus of the last forecasts by analysts following a stock in the 20 weeks before the stock-addition events.

Three variables are used to measure the behavior of uninformed investors with two data sources:

- *Volume by trading amount* is the weekly average value of the total daily trading volumes with trading values that are less than 7,776 RMB (which represent the bottom 25% of all trades in the sample sorted by trading volume) and have no impact on stock prices.
- *Value by trading amount* is the weekly average value of the total daily trading values that are less than 7,776 RMB (which represent the bottom 25% of all trades in the sample sorted by trading volume) and have no impact on stock prices.
- *Number of trades by trading amount* is the weekly average value of the number of trades with trading values that are less than 7,776 RMB (which represent the bottom 25% of all trades in the sample sorted by trading volume) and have no impact on stock prices.
- *Volume by portfolio size* is the weekly average value of the total daily trading volumes by investors whose portfolio sizes are less than half a million RMB.
- *Value by trading amount* is the weekly average value of the total daily trading value by investors whose portfolio sizes are less than half a million RMB.
- *Number of trades by trading amount* is the weekly average value of the number of trades by investors whose portfolio sizes are less than half a million RMB.

Dummy variables and Controls:



- *Treat* is the dummy variable that is equal to 1 if the stock is in the MTSS program and 0 otherwise.
- *Post* is the dummy variable that is equal to 1 after the stock-addition events and 0 before the events.
- *MV* is the stock's market capitalization denoted in thousands of RMB.
- *Volatility* is the weekly standard deviation of daily raw returns.