Stock Market Liberalization with Information Asymmetry

Chenlai Shi *†

September 17, 2017

Abstract

This paper provides a quantitative analysis of joint effect of margin trading and short selling on stock volatility and extends Grossman-Stiglitz type of multiple asset pricing model with heterogeneous information and margin rules to reconcile the different empirical stylized facts concerning introduction of new margin requirements in developed and developing financial markets. Pilot program of stock market liberalization in China 2010 is associated with significant decline in both liquidity and volatility of selected firms. Main findings of this paper are relaxation of margin rules effectively reduces overall holdings of liquidity trader and price volatility when information asymmetry is severe.

*Ph.D. in Economics, UW-Madison, cshi29@wisc.edu

†I thank Noah Williams and Kenneth West for their effort and guidance. I thank Charles Engel, Enghin Atalay, Dean Corbae and all other workshop participants in UW-Madison for their helpful comments. All errors are mine.

I. Introduction

Liquidity and volatility have been considered as important components of stock market efficiency and stability. Stock market liquidity usually refers to the continuity of price and depth of market (Reilly, 1985) and two common liquidity measures are bid/ask spread and turnover rate, while historical volatility is captured by the realized standard deviation over a past period and the proxy of intraday volatility is the range-based high-low volatility (Helmes et al., 2010)(Chan et al., 2010).

Existing literatures have substantially studied the importance of short selling and margin trading in improving price discovery process, reducing liquidity risk (Woolridge and Dickison 1994) and enriching information of capital flows (Gregoriou 2011). Short selling refers to selling a borrowed stock without owning it while trading activities that investors build up a leveraged long position by borrowing money (or stocks) from registered security companies or from other resources is called margin trading. Seguin (1990) and Hardouvelis and Peristiani (1992) both find that lower margin requirements lead to an increase in liquidity. However, mixed evidences about volatility change are identified. Seguin (1990) claims that introduction of margin trading is associated with decline in volatility while Chang et al. (2007) shows higher volatility occurs after the introduction of short selling. On the other hand, emerging markets evidence may differ from developed markets due to factors such as weaker investor protection (Morck et al., 2000). For Korea and Taiwan market, Lee and Yoo (1993) find no relationship between margin requirements and stock return volatility.

China stock market has been developing rapidly since its establishment in 1990s and its market capitalization has surged to over 10 trillion dollars in 2015. On March 31, 2010, the China Securities Regulatory Commission (CSRC) introduces the pilot program of margin trading and short selling to incorporate more information into stocks prices, even though the relaxation of capital borrowing/lending is still implemented on a gradual basis. For example, before August 2012, only selected security brokers were approved of lending money or stock to qualified investors. Detailed regulations are released on http://www.sse.com.cn/services/tradingservice/margin/home/. According to the news report on Oct 5 2008, CSRC's chief motivation is 'to enlarge the supply and demand of funds and securities and increase the trading volume, thus leading to active liquidity'. Not as desired by the Chinese regulators, Sharif et al.(2014) find that the policy induced significant decline in liquidity and mild decrease in volatility. Their empirical results are based on the following regression structure.

$$Spread\_Diff_{i,t} = \alpha_0 + \alpha_1 Post\_period_t + \alpha_2 Post\_period_t * Dummy\_RETA_{i,t} + Controls + \epsilon_{i,t}$$

$$Volatility\_Diff_{i,t} = \alpha_0 + \alpha_1 Post\_period_t + \alpha_2 Post\_period_t * Dummy\_RETA_{i,t} + Controls + \epsilon_{i,t}$$

Spread_Diff is log[pilot stock (Ask - Bid)/((Ask + Bid)/2)]-log[matched stock (Ask - Bid)/((Ask + Bid)/2)], Volatility_Diff is log[pilot stock (High - Low)/((High + Low)/2)] - log[matched stock (High - Low)/((High + Low)/2)], interaction dummy is set to one when return of individual pilot A-share(RETA) is less than 0 during the post-period. The potential mechanism driving the empirical results is illustrated in Wang (2015), which shows that negative liquidity impact is more pronounced for the treated stocks with smaller funds ownership, without analyst coverage, or without cross-listed shares. He also finds that the liquidity significantly improves for the treated ETFs when margin-trading and short-selling are implemented, provided that information asymmetry is less concerned for the ETFs. This is consistent with Ausubel's (1990) prediction that uninformed traders with expectation of increased likelihood of trading against the informed will become more conservative.

This paper first investigates the volatility dynamics with data of longer time horizon and contributes to building a two-period asset pricing model to capture such stylized phenomenon from the aspect of information asymmetry. The rest of the paper is organized as follows. Section 2 introduces the benchmark model and the extended version in Section 3. Section 4 presents the dataset summary, estimation methods and difference-in-difference design of analysis. Section 5 illustrates the empirical evidences. Section 6 describes the simulation process and preliminary numerical results. Further improvements and concerns are discussed about in Section 7.

II. Benchmark Model

There are two types of risk-averse investors in the economy, liquidity traders and insiders. All investors are exogenously endowed with heterogeneous information about asset payoff. By assumption, liquidity traders are dominated by insiders in terms of information endowment, i.e. insiders are faced with less uncertainty and they have less volatile prior endowed belief of risky asset payoff. The asset space includes N risky asset and one riskless asset. Risky asset payoff is given by N by 1 vector f, which is exogenous but unknown to investors. The riskless asset has a return rate of r>1 every period. Market price imperfectly aggregates information and agents are endowed with heterogeneous signals about asset payoffs, i.e. own prior mean and variance. In period 0, investors optimize their portfolio based on their private signals and equilibrium prices. In period 1, all trading orders are executed and investors observe realized asset payoffs and obtain utility from their final wealth. Both types of investors' preferences are exponential and their budget constraint is

$$U_i = E_i(-exp(-\rho_i W_i))$$

$$W_i = (W_{i,0} - q_i' p)r + q_i' f$$

where ρ_i is risk aversion, W_i is final wealth, $W_{i,0}$ is initial wealth, q_i is N by 1 vector of asset quantities to hold, p is N by 1 vector of risky asset prices. Supply of asset is random and follows $\bar{x}+x$, $x \sim N(0, \sigma_x^2 I)$. Investors' prior belief is

$$f \overset{i.i.d}{\sim} N(\mu_i, \Sigma_i)$$

Agents' optimization problem is maximizing certainty equivalent of post-trading wealth, given negative exponential utility

$$\max_{q_i} -exp(-\rho_i q_i'(E_i(f) - pr) + \frac{1}{2}\rho_i^2 q_i' Var_i(f) q_i) \tag{1}$$

The conjecture of price function is

$$rp = A + Bf + Cx \tag{2}$$

This implies an unbiased signal, S(p), about f and let Σ_p denote the variance-covariance matrix of signal noise, $B^{-1}Cx$,then

$$\begin{aligned}S(p) &= B^{-1}(rp - A) = f + B^{-1}Cx \\ \Sigma_p &= \sigma_x^2 B^{-1}C(B^{-1}C)'\end{aligned}$$

By Bayes' law, investors' posterior belief after combining the signal from observing prices is

$$\begin{aligned}&f \sim N(\hat{\mu}_i, \hat{\Sigma}_i) \\ &\hat{\mu}_i = \hat{\Sigma}_i(\Sigma_i^{-1}\mu_i + \Sigma_p^{-1}S(p)) \\ &\hat{\Sigma}_i = (\Sigma_i^{-1} + \Sigma_p^{-1})^{-1}\end{aligned}$$

Optimal Portfolio and market clearing condition is

$$q_i = \frac{1}{\rho_i}\hat{\Sigma}_i^{-1}(\hat{\mu}_i - pr) \tag{3}$$

$$\int q_i di = \bar{x} + x \tag{4}$$

Let $\Psi = \int \frac{1}{\rho_i}\Sigma_i^{-1} di$, $\bar{\rho} = (\int \rho_i^{-1} di)^{-1}$, then the market clearing condition becomes

$$\begin{aligned}\Psi \int \mu_i di + \frac{1}{\bar{\rho}}\Sigma_p^{-1}S(p) - \int \frac{1}{\rho_i}\hat{\Sigma}_i^{-1} di\ pr = \bar{x} + x \\ \Psi f + \frac{1}{\bar{\rho}}(\Sigma_p^{-1}S(p) - \Sigma_p^{-1}rp) - \Psi rp = \bar{x} + x\end{aligned}$$

Matching coefficients yields,

$$\begin{aligned}&A = -\bar{\rho}(\bar{\rho}\Psi + \Sigma_p^{-1})^(-1)\bar{x} \\ &B = I \\ &C = -\Psi^{-1}\end{aligned}$$

A is the unconditional expected return, whose volatility is captured by the posterior belief of a synthetic "average" investor. It becomes more obvious if the risk aversion is the same for all investors. Under this assumption about risk aversion, $A = -\rho \int \hat{\Sigma}_i^{-1} d i \bar{x}$. C is the sensitivity of price to asset supply shocks and its volatility is related to prior information precisions of a synthetic "average" investor. The most important conclusion from the benchmark model is investors want to hold assets that they are optimistic about, high $\hat{\mu}_i$, or they have less uncertainty about, low $\hat{\Sigma}_i$.

III. Model Extension

Under the same environmental settings as benchmark model, the extended version intends to incorporate the margin rules. Let $\phi_{i,t,n}$ denote investor i's holding of asset n in period t (t=0,1), where $n = 0, 1, 2...N$, asset 0 is riskless asset. Margin trading is considered as cheaper leverage than borrowing against riskless asset. If investor decides to take a leveraged position on risky asset, he will always first borrow via margin in this model. p denotes the price vector of N risky assets while the price for riskless asset is normalized to 1. κ is the margin requirement for risky asset holdings. In period 0, each investor is endowed with a portfolio $q_{i,0}$, which is a N by 1 vector of risky asset quantities holdings. Investors can choose to rebalance their portfolio in period 0 and thus hold a new risky asset portfolio $q_{i,1}$, either with margin or not, similar to propositions in Tong et al.(2016).Their budget constraint becomes

$$W_{i,0} = q'_{i,0} p + \phi_{i,0,0} = \sum_{0}^{N} \phi_{i,n} p_n = \kappa q'_{i,1} p + \phi_{i,0,1}$$

$$W_{i,1} = (W_{i,0} - \kappa q'_{i,1} p) r + q'_{i,1} f$$

The optimal portfolio selection problem of investor i can be stated as

$$\max_{q_{i,1}} -exp(-\rho_i q'_{i,1}(E_i(f) - \kappa p r) + \frac{1}{2}\rho_i^2 q'_{i,1} Var_i(f) q_{i,1}) \tag{5}$$

subject to market clearing condition $\int q_{i,1} di = \bar{x} + x$.

If the investor does not trade on margin, then his optimality condition is the same as in benchmark model. The motivation of margin trading is high precision of payoff or optimistic view about expected return as illustrated in benchmark model. Therefore, in a developing financial market, where information heterogeneity is severe, introduction of margin trading will induce liquidity trader to retreat from stocks that insiders probably take on margin. China's stock market is dominated by liquidity traders, where individual investor trading value accounts for over 80% of the market and more than 60% of market cap is held by small investors. After the implementation of the liberalization policy, both liquidity and volatility decline as consequences of liquidity trader escaping from pilot firms stocks.

IV. Data and Methodology

Daily stock return, trading volume, value of shares traded, daily short-selling and margin trading data are obtained from Chinese Securities Market and Accounting Research (CSMAR). **Pilot firms' sample** has 321882 observations, covering trading data from 29 Jan 1991 to 31 Dec 2015. To trim noise from missing data, I focused my analysis on sample from 4 Jan 2005 to 31 Dec 2015, 2671 trading days in total. Intraday volatility is calculated as $log(\frac{high_i - low_i}{(high_i + low_i)/2})$, which is available every trading day except for no variations in daily high/low price.

i. Heterogeneity of Firm

Trading data from 29 Jan 1991 to 31 Dec 2015 are embedded with huge heterogeneity across firms. 2137 was listed and among them, 77 exited before policy implementation(Mar 2010);889 new firms entered after policy implementation. Among the 96 pilot firms, Agricultural Bank of Chian Limited started trading on 15 Jul 2010, which is the only firm that does not appear in both pre and post-policy periods. So in general, a stable surge of listed firms is observed but in the history of China stock market, it occurred that turmoil led to widely spread trade suspension and liquidity shrink. In 1997, firms involved in the biggest Securities Fraud(Hainan Minyuan Modern Agricultural Development Co., Ltd) since the launch of stock exchange, were penalized and suspended all trading activities. In July 2005, over 25% of the listed firms conducted trade suspension in one week to protect themselves when facing the stock market turbulence. To remove the effect of environment and industry heterogeneity, I select comparable firms to those in the pilot program.

ii. Matching Process

I adopt similar approach to Boulton and Braga-Alves (2010) to identify firms with similar characteristics. Comparable firms are selected from non-pilot ones, required to be within the same industry, listed throughout the policy implementation period(i.e. issued and did not exit before 1 Apr 2010) and for at least 250 trading days(approximately 1 year). The matching is based on 5-year trading data between 4 Jan 2005 and 31 Dec 2009 and minimizing distance equation[1]. Factors in the distance equation refers to the average market value of equity, closing stock price, volatility of

[1] $Distance = \sum_i |\frac{factor_{pilot} - factor_{match}}{(factor_{pilot} - factor_{match})/2}|$

daily returns and daily turnover. There are multiple pilot firms matched to the same comparable firm and in total 92 pilot firms find matches that satisfy the above requirements.

iii. Summary Statistics

Table 2 presents the statistics of main variable of interest from 4 Jan 2005 to 31 Dec 2015, 2671 trading days in total.

Insert Table 2 Here

Figure 1 plots short-sales and margin trading activity as percentage of total trading volume. I calculated the daily mean among all pilot firms. Starting from the policy implementation(1 Apr 2010), margin trade is growing with more and more importance among all trading activities while short-sale remains at low level. Limited number of brokers and institutions qualified for lending stocks constrained the scale of short-sale. So this piece of evidence is suggesting price discovery after constraint relaxation is not facilitated by short sellers and informed investors are not engaged in extracting returns via short-sales.

Insert Figure 1 Here

V. Results

i. Univariate Analysis

Table 3 presents the mean and distribution tests for 92 pilot firms and their matched equivalent companies from 4 Jan 2005 to 31 Dec 2015. The mean of intraday volatility difference declines dramatically by more than 240%. Mean test with Newey-West standard errors, taking into account the heteroscedasticity and possible autocorrelation, delivers significant result at 1% level, suggesting that on average, stock price for pilot firms are less volatile than their comparable.

Insert Table 3 Here

ii. Multivariate Analysis

I estimated pool regressions with firm fixed effect and clustered standard errors across firms to control the autocorrelations of the residuals. The regression models for volatility difference(Panel 1) is,

$$Volatility\_Diff_{i,t} = \alpha_i + \beta_1 Dummy\_policy + \beta_2 Volatility\_Diff_{i,t-1} + \epsilon_{i,t} \tag{2}$$

Panel 1 suggests noticeable volatility decline in pilot program stocks (relative to comparable). The difference in mean of intraday volatility difference before and after policy implementation is -0.111 and the coefficient of estimate on policy dummy is -0.0594, significant at 1% level, which accounts for almost 53.5% of decrease. This result is consistent with the short-term analysis of Sharif et al.(2014) and introduction of short sell and margin trade stabilizes the stock pricing via information increment.

VI. Simulation

i. Benchmark Model

Parameter values are set as follows, $\rho = 1$; $r = 1.01$; $\kappa = 0.3$; $N = 100$. Supply of asset is random and follows $\bar{x} + x$, $x \sim N(0, \sigma_x^2 I)$, where $\bar{x} = 0$, $\sigma_x^2 = 0.1$. Prior belief of liquidity traders about mean payoff vector(N by 1) is assumed to be i.i.d around true payoff. Without loss of generality, let it be uniformly distributed between 0.7 and 1.7, N by N variance-covariance matrix is i.i.d $N(0, \sigma_{lq}^2) + I$; Insiders' prior belief about mean payoff vector(N by 1) is also assumed to be uniformly distributed between 0.7 and 1.7, N by N variance-covariance matrix is i.i.d $N(0, 1) + I$. I plot the mean asset holding share of liquidity trader and price volatility as percentage of liquidity trader increases in Figure 2 and 3, $\sigma_{lq} = 2$ and 5 respectively. The increase of liquidity trader percentage is associated with increase of average market uncertainty. Compared to the case of higher degree of information asymmetry (larger σ_{lq}^2), liquidity traders are less reluctant to hold risky assets and thus price tend to be less volatile.

Insert Figure 2,3 Here

ii. Extended model

Under the same parameter value settings and assumptions about prior belief stucture, introduction of margin rules effectively reduces overall holdings of liquidity trader and price volatility based on the plot of the mean asset holding share of liquidity trader and price volatility as percentage of liquidity trader increases in Figure 4 and 5, $\sigma_{lq} = 2$ and 5 respectively. This phenomenon is more significant when information asymmetry is severe.

Insert Figure 4,5 Here

VII. Conclusion and Discussion

Further investigation into the volatility dynamics with data of longer time horizon shows noticeable volatility decline in pilot program stocks (relative to comparable). Building on a two-period asset pricing model, simulated numerical results manage to capture such stylized phenomenon as well as decline of liquidity trader holdings from the aspect of information asymmetry. Limitations of this paper include that the model proposed lacks a channel to explain abnormal price volatility peaks with respect to different aggregate market uncertainty and does not consider the financial frictions in margin trading or short selling. Analysis would be also potentially improved and more comprehensive if more flexibility of margin rules and risk aversion could be allowed.

VIII. Appendix

Figure 1

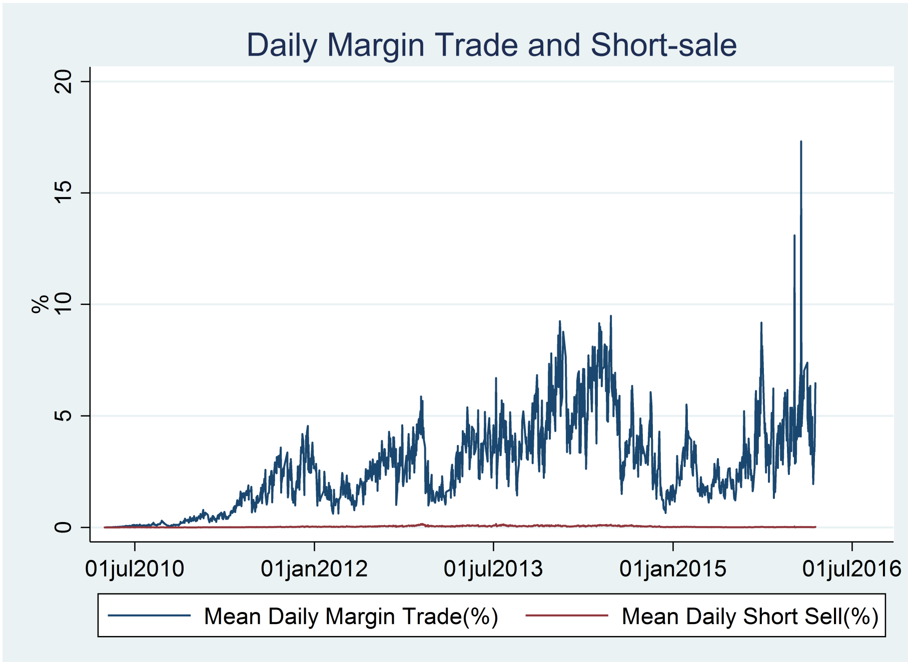

Figure 2: *Benchmark model:*$\sigma_{lq} = 2$

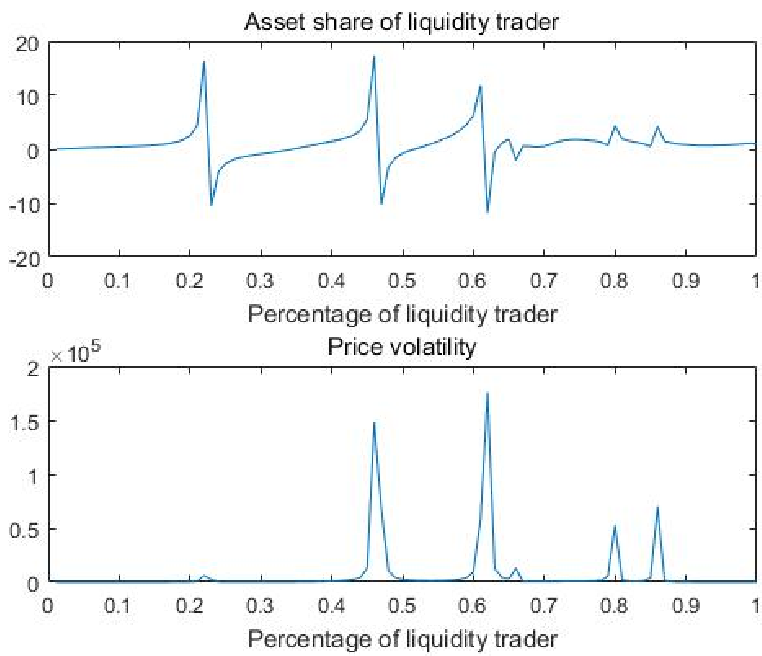

Figure 3: *Benchmark model:*$\sigma_{lq} = 5$

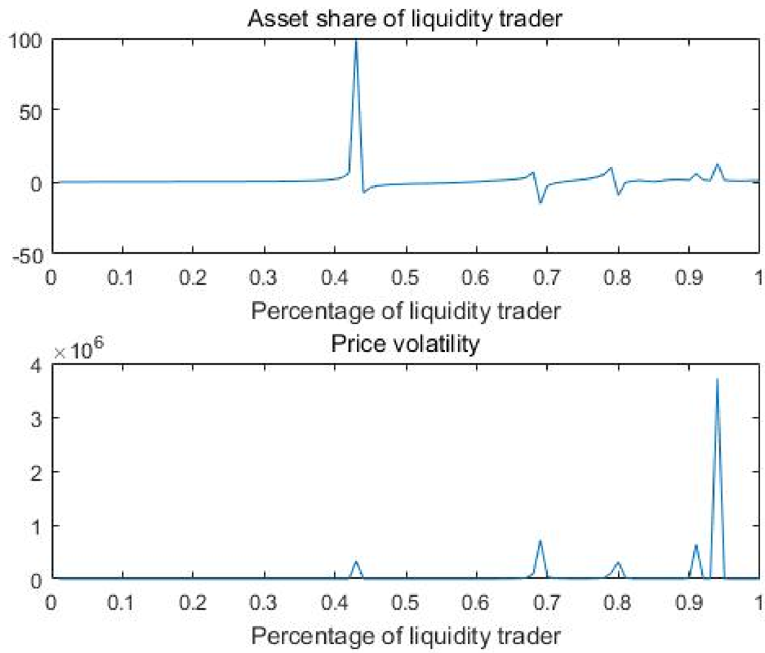

Figure 4: *Extended model:*$\sigma_{lq} = 2$

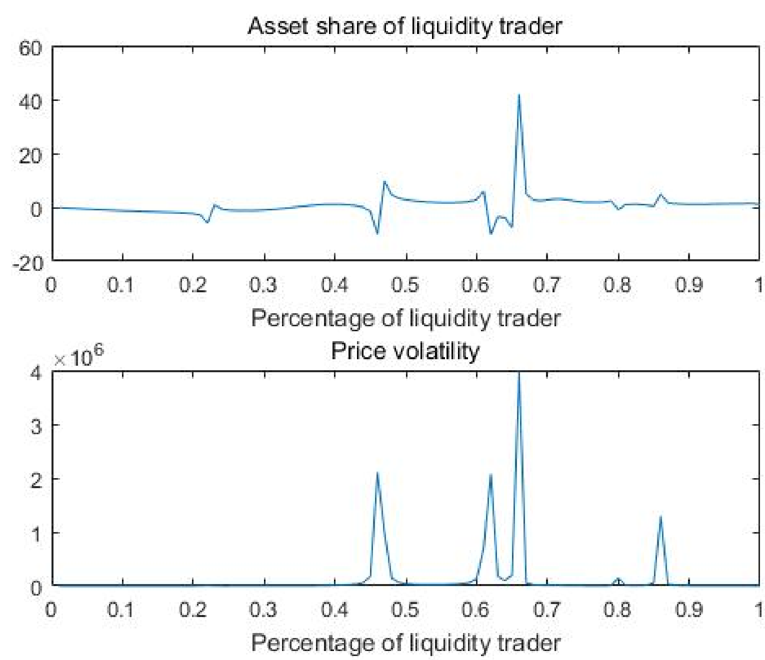

Figure 5: *Extended model:*$\sigma_{lq} = 5$

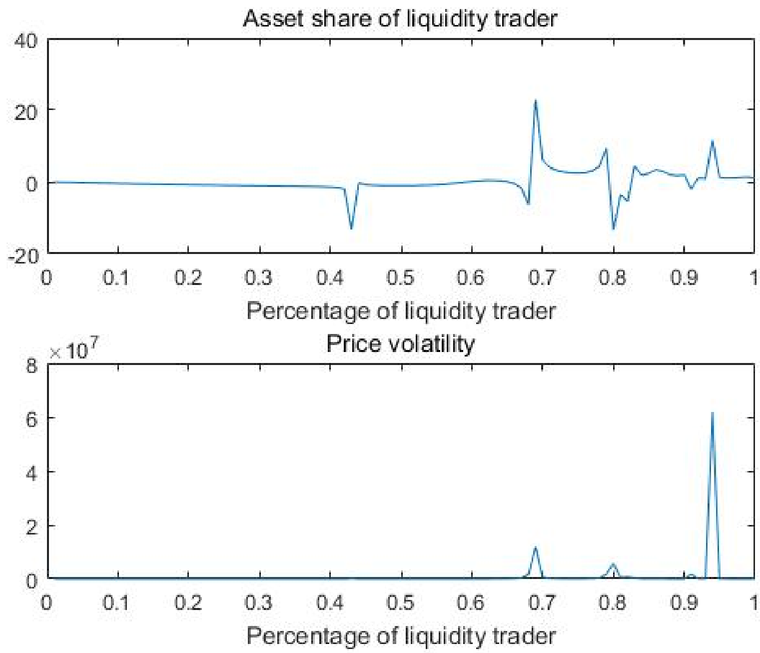

Table 1: *Variable Definition*

Variable	Definition
daysd	Intraday volatility, calculated as $log(\frac{high_i - low_i}{(high_i + low_i)/2}$
d2	A dummy variable, equals one if trading date is after 1 Apr 2010 (policy implementation) and zero otherwise
delta_daysd	Intraday volatility difference between pilot firm and comparable
Ldelta_daysd	Lagged term of intraday volatility difference between pilot firm and comparable
dretwd	Daily return with cash dividend reinvested
dsmvtll	Total market value

Table 2: *Descriptive Statistics-Pilot firms' Sample*

	frequency	first obs	last obs	trading days/quarters	count	mean	sd	min	max	missing	min obs per firm	max obs per firm
delta_daysd	daily	4 Jan 2005	31 Dec 2015	2671	186746	-0.117	0.545	-3.529	3.576	29,707	1214	2587
Before 1 Apr 2010												
delta_daysd	daily	4 Jan 2005	31 Mar 2010	1273	67547	-0.046	0.514	-3.519	2.545	24,827	59	1204
After 1 Apr 2010												
delta_daysd	daily	1 Apr 2010	31 Dec 2015	1398	119199	-0.157	0.558	-3.529	3.576	4,880	651	1391

Table 3: *Univariate test of means and distributions*

Variable	Mean		P-value	
	Before	After	Test 1[1]	Test 2[2]
Intraday volatility diff	-.046	-.157	0.000	0.000

[1] Two-sample t test with Newey-West standard errors(maximum of 20 lags allowed for daily observed variables)

[2] Two-sample Kolmogorov-Smirnov test for equality of distribution functions

Table 4: *Benchmark Regression with Firm Fixed-effect*

	(1)
	delta_daysd
d2	-0.0594***
	(0.012)
Ldelta_daysd	0.355***
	(0.009)
N	184844
R^2	0.248
$RMSE$	.471
Frequency	daily
Start date	4 Jan 2005
End date	31 Dec 2015
Number of firm	92
Max obs per firm	2587
Min obs per firm	1214

Standard errors in parentheses,* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Panel 1 is pool regression of intraday volatility difference on its lagged term and policy implementation dummy with firm fixed effect. Delta_daysd is intraday volatility difference between pilot firm and comparable, while Ldelta_daysd is the lagged term. D2 is a dummy variable, equals one if trading date is after 1 Apr 2010 (policy implementation) and zero otherwise.

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