Can Hedge Funds Correct Mispricing and Provide Liquidity?

Evidence from Reg SHO [*]

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First draft: August 2017

This version: February 2018

Abstract

I study the effects of hedge fund arbitrage activities on mitigating mispricing and providing stock liquidity by employing Securities and Exchange Commission (SEC) Regulation SHO pilot program as a natural experiment. I find pilot stocks that are associated with hedge fund arbitrage activities experience decrease in abnormal returns and increase in liquidity after Reg SHO. The results are more pronounced for stocks that are more likely to have binding short-sale constraints and are robust when controlling for breadth of ownership and trading activities of other institutional investors. Overall, hedge funds help correct mispricing and improve stock liquidity.

Keywords: Hedge Funds, Limits of Arbitrage, Liquidity, Mispricing, Reg SHO

JEL Classifications: G12, G14, G23

[*] I am grateful to Vikas Agarwal, Hadiye Aslan, Mark Chen, Gerald Gay, Mehdi Haghbaali, Lixin Huang, Lei Jiang, Dalida Kadyrzhanova, Omesh Kini, Han Ma, Ron Masulis, Scott Murray, Honglin Ren, Chip Ryan, Mo Shen, Ashutosh Tyagi and Baozhong Yang for helpful comments and suggestions. I thank Vivian Fang for proving the SEC Regulation SHO data, and Vikas Agarwal and Baozhong Yang for sharing the 13F classification data. All errors are my own.

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1. Introduction

Understanding the role of hedge funds in financial market is important. On the one hand, hedge funds, unarguably one of the most sophisticated group of investors, may have incentives and capability to influence asset prices. Literature generally views hedge funds as a group of skilled investors, who are subject to less constraints and regulation restrictions compared with other institutional investors such as mutual funds or pension funds. These features of hedge funds drive concerns from investors and regulators. On the other hand, many consider hedge funds as informed traders[3]. Therefore, other investors may follow their trading strategies or trade against them, thus leading a spillover effect in the financial market. Indeed, hedge funds can be regarded as arbitrageurs who seek for arbitrage opportunities in financial products. Through their costly and active information gathering, hedge funds should be able to help correct mispricing and reduce asset pricing anomalies.

This paper studies whether hedge funds can attenuate mispricing in financial markets and provide liquidity. Hedge funds, as a traditional type of arbitrageurs, face several costs: non-fundamental risk (De Long, Shleifer, Summers, and Waldmann, 1990), short-selling costs (Tuckman and Vila, 1992; D'Avolio, 2002; Lamont and Thaler, 2003), leverage and margin constraints (Gromb and Vayanos, 2002, 2012), and constraints on equity capital (Shleifer and Vishny, 1997). These limits of arbitrage can prevent them from correcting mispricing or providing liquidity (Gromb and Vayanos, 2010). If the costs of arbitrage are reduced, mispricing in asset prices should be more easily eliminated or attenuated. However, identifying such a process is empirically difficult. For example, if reduced

[3] See, for example, Aragon and Martin (2012), Agarwal, Jiang, Tang, and Yang (2013), Aragon, Hertzel, and Shi (2013), Brown and Schwarz (2013), and Gao and Huang (2016).

arbitrage costs are associated with information flow, it is hard to distinguish whether arbitrageurs indeed help achieve the law of one price or information about fundamental values influences asset prices.

In this paper, I exploit a natural experiment, Regulation SHO (Reg SHO), to investigate the reduction of mispricing and improvement of liquidity during the process. On July 28, 2004, Securities and Exchange Commission (SEC) conducted Reg SHO pilot program by suspending the short-sale restrictions on a random set of stocks. This pilot program was effective from May 2, 2005 to August 6, 2007. The Pilot stocks, for which the short-sale restrictions were lifted, are randomly chosen from the Russell 3000 index as of June 2004. On May 2, 2005, every third stock ranked by average daily trading dollar volume over the prior one year on each respective exchange (AMEX, Nasdaq National Market and NYSE) is defined as a pilot stock. In this study, other stocks within the Russel 3000 index are labeled as control stocks. The suspension of the longstanding short-selling restrictions facilitates the short sales and thus reduces the arbitrage cost for pilot stocks. Because of the random assignment of pilot stocks and control stocks, Reg SHO provides an ideal setting to investigate the process of mispricing correction.

Miller (1977) models the combined effects of short-sale constraints and differences of opinions on stock prices. When short-sale constraints exist, stock prices reflect the opinions of optimists but do not incorporate the valuations of pessimists. On the one hand, because stocks are impossible or too expensive to sell short, pessimists choose to stay out of the market and stock prices are therefore higher than fundamental values. On the other hand, arbitrageurs are unable to exploit such arbitrage opportunities due to short-sale constraints (Lamont and Thaler, 2003). Hence, short sale constraints are one of the most crucial limits of arbitrage and prevent arbitrageurs from correcting mispricing (Chen, Hong, and Stein, 2002; Jones and Lamont, 2002; Lamont and Thaler, 2003; Nagel, 2005; Gromb and Vayanos, 2010). Diether, Lee, and Werner (2009) hypothesize that if short-sale restrictions prevent pessimists from trading in the market and result in overpricing, the suspension of them, i.e., Reg SHO, should lead to negative abnormal returns[4]. However, the presence of arbitrage activities will be important for such corrections. Who are the arbitrageurs? How do their arbitrage activities affect stock prices?

In this paper, I identify hedge funds as a typical group of arbitrageurs. Shleifer and Vishny (1997) suggest that hedge funds arbitrage activity accounts for a great deal of professional arbitrage activity and Gromb and Vayanos (2010) and Chen, Da, Huang (2015) both argue that arbitrage is often performed by specialized institutions such as hedge funds. Moreover, Agarwal, Jiang, Tang, and Yang (2013) and Aragon, Hertzel, and Shi (2013) both show that hedge funds are skilled, and Shive and Yun (2013) find that hedge funds can trade against mutual funds by front-running. These empirical evidences suggest that hedge funds are indeed arbitrageurs. Although hedge funds are not the only arbitrageurs in the financial market, the lack of data on other arbitrageurs makes it implausible to investigate arbitrage activity. The available data on hedge fund holding and trading provide possibility to explore arbitrage activity empirically. Meanwhile, as information acquired by hedge funds is costly, it is spontaneous to assume that hedge funds do not frequently change the stocks that they follow. First, hedge funds have limited capacity. Figure 1 shows that a median hedge fund reports around 60 to 70 stocks in its quarter-end portfolio while

[4] They do not find supportive evidence. Section 5 provides a replication, which confirms their finding, using a different methodology.

a median institutional investor other than hedge funds reports around 110 stocks[5]. Essentially, hedge funds concentrate on a smaller set of stocks and exploit multiple strategies such as taking short positions or using derivatives. Second, hedge funds have limited resources. A hedge fund is unable to exploit all arbitrage opportunities because of the constraints on equity capital, i.e. assets under management. Moreover, hedge funds typically impose lockup, notice and redemption periods, which allow them to utilize arbitrage opportunities and expose to illiquidity risk that both take a long time to deliver superior performance (Getmansky, Lo, and Makarov, 2004; Agarwal, Daniel, and Naik, 2009). Third, if they do change their following stocks frequently, it will incur sunk costs. Finally, frequently changing target stocks may lead to deviation of stated investment objectives. Hedge funds often compete with other funds within the same investment objectives or styles and deviation from them may affect returns and potential investor flows (Agarwal and Naik, 2000; Brown and Goetzmann, 2003; Jagannathan, Malakhov, and Novikov, 2010).

Hence, I use average quarterly change in aggregate hedge fund ownership over one-year prior to Reg SHO to proxy for hedge fund arbitrage activities and estimate the impact of such activities on stock prices. This measure can capture some arbitrage activities and reflects the efforts of information collection. Figure 2 illustrates how this measure is constructed and how it can reflect arbitrage activities. Suppose that a stock’s aggregate ownership increases by 15% in the first quarter and by 10% in the last quarter while it decreases by 20% and 5% in the second and the third quarter, respectively. Then the hedge

[5] The result is similar with Agarwal et al. (2013), who find that a median hedge fund holds 63 stocks, a median investment company hold 92 stocks, and a median bank or insurance company holds 220 stocks, as shown on their quarterly Form 13F.

fund arbitrage activities for this stock are the average of the absolute values of above four numbers, i.e., 12.5% over the one-year period. Although the aggregate ownership of this stock is 20% at both the beginning and the end, the hedge fund arbitrage activities measure shows that this stock is in fact frequently traded by hedge fund. The figure also shows that the one-year period contains four quarters from March 2004 to March 2005 since the hedge fund holdings are quarterly disclosed and March 2005 is the latest report date before Reg SHO. Using data before the execution of Reg SHO is to deal with the endogeneity concern because hedge funds may strategically trade pilot and control stocks differently. Securities Exchange Act Release No. 50104 confirms that the assignment of pilot stocks cannot be predicted before the execution of Reg SHO, thus endogeneity is not a concern for the measure of hedge fund arbitrage activities. Nevertheless, the limitations of this measure must be noticed. It captures some but not all hedge fund arbitrage activities because short positions of hedge funds are not available.

Therefore, in a Miller framework, among stocks with removed short-sale restrictions, those associated with intense hedge fund arbitrage activities should experience reduced abnormal returns (Figure 3). Miller also argues that the short run supply of a stock is fixed in real world and short sales increase the supply of a stock on the market. As shown in Figure 4, liquidity measures should imply that a stock becomes more liquid when short-sale restrictions are suspended. The theoretical work of Vayanos and Weill (2008) suggests that short-sellers concentrate on the more liquid asset, and their activity is what renders the asset more liquid. Gromb and Vayanos (2010) argue that the short-sale constraints prevent arbitrageurs from not only eliminating mispricing but also providing liquidity. Hence, I conjecture that pilot stocks that are associated with hedge fund arbitrage activities should (i) experience reduced abnormal returns and (ii) become more liquid after Reg SHO.

I find that, during Reg SHO, pilot stocks that are associated with hedge fund arbitrage activities experience reduced abnormal returns. The results are consistent when various factor and characteristic models are used to compute abnormal returns. A one standard deviation (8.66%) increase in hedge fund arbitrage activities for pilot stocks is associated with a 4.5 to 6.6 percentage points decrease per year in abnormal returns after Reg SHO, depending on the abnormal return measures chosen. The decrease in abnormal returns is not significant for non-pilot stocks or stocks that are not associated with hedge fund arbitrage activities. Moreover, the reduction in abnormal returns is more pronounced for stocks that are more likely to have binding short-sale constraints. Furthermore, the effects are strongest right after the implementation of Reg SHO and decrease monotonically with time. These results suggest that the combined effect of Reg SHO and hedge fund arbitrage activities mitigates mispricing. Finally, these stocks also become more liquid. A one standard deviation increase in hedge fund arbitrage activities for pilot stocks is associated with a 0.4 standard deviation increase per year in liquidity using Amihud (2002) illiquidity measure.

The results are robust when the breadth of ownership is taken into account to rule out the possibility that the results are driven by the change in supply side of stock loan market. To ascertain the likelihood that other institutional investors may also behave like arbitrageurs and therefore their trading activities can influence stock performance and liquidity, I control for trading activities by other institutional investors and the results still hold. These cross-sectional placebo tests also confirm that other institutional investors are unlikely to be arbitrageurs and hedge funds are distinct from them. Lastly, I create a pseudo-event as if it suspends price tests during a different time period, the time-series placebo test suggests that my results are unlikely to be driven by unobserved shocks that affect pilot and control stocks differently.

My paper contributes to three strands of literature. The first is the literature on hedge funds and their impacts on asset prices. In closely related studies, Cao, Chen, Goetzmann and Liang (2016) and Cao, Liang, Lo, Petrasek (2017) investigate how hedge funds exploit and help correct mispricing and find hedge fund holdings to be informative. I also argue that hedge funds help to eliminate mispricing. Different from their studies, I examine this problem under the unique natural experiment offered by Reg SHO.

This study also adds to the literature on limits of arbitrage. Also using Reg SHO as a natural experiment, Chu, Hirshleifer and Ma (2016) find that Reg SHO reduces several asset price anomalies among NYSE stocks. However, they do not identify which type of investors contribute to the reduced anomalies. Moreover, I find hedge funds not only help mitigate mispricing but also provide liquidity.

My paper also sheds lights on short-selling literature regarding how short-sale constraints affect stock prices and returns. I provide empirical evidence that echoes the models of Miller (1977), Hong and Stein (2003), Scheinkman and Xiong (2003) who argue that stocks are overvalued if frictions hinder short-selling.

My study provides some policy implications. First, my findings confirm the improvement of liquidity after Reg SHO, which is motivated to investigate the market quality by SEC. Second, as hedge funds are under increasing regulatory scrutiny recently, I provide supportive evidence that hedge funds help eliminate mispricing and provide liquidity, and therefore play a positive role in financial markets.

The rest of the paper is organized as follows. Section 2 develops the testable hypotheses. Section 3 describes the data and variables. Section 4 provides the empirical analysis. Section 5 checks robustness. Section 6 concludes.

2. Testable Hypotheses

In a Miller (1977) world, the stock prices only reflect the valuation of optimists but do not reflect that of pessimists because short-sale constrains prevent pessimists from incorporating their information into stock prices. The implication is that if short-sale constrains no longer exist, then the overpriced stocks should come back to the fundamentals and experience low abnormal returns (Figure 3). Literature provides some empirical evidence of the relationship between short-selling and subsequent returns[6]. Therefore, if the price tests push the stock prices to be higher than the fundamentals, the suspension of them, i.e., Reg SHO, should lead to reduced abnormal returns during the process of correcting mispricing.

In this paper, I argue that such effects should be more pronounced among stocks that are associated with hedge fund arbitrage activities. Gromb and Vayanos (2010) shows arbitrageurs as a key role in financial markets can help eliminate relative mispricing. Meanwhile, hedge funds are considered to be a classic type of arbitrageurs (Shleifer and Vishny, 1997; Chen, Da, and Huang, 2015). Therefore, a natural question is that whether hedge funds can help eliminate mispricing. When hedge funds actively seek for arbitrage

[6] See, for example, D'Avolio (2002), Asquith, Pathak and Ritter (2005), Cohen, Diether, and Malloy (2007), Boehmer, Jones, and Zhang (2008), and Diether, Lee, and Werner (2008).

opportunities, they should have larger impacts on stocks to which they pay greater attention. When combining these effects with the influences of Reg SHO, we should observe differences between stocks that are associated with hedge fund activities and those that are not, among stocks that are subject to the enforcement of Reg SHO.

One the one hand, because control stocks are not subject to the influence of Reg SHO, the impact of hedge fund arbitrage activities on them is expected to be indifferent before and after Reg SHO. Therefore, changes in the impact of hedge fund arbitrage activities should only be pronounced among pilot stocks. On the other hand, if Reg SHO affects how the hedge funds exploit arbitrage opportunities, the pilot and control stocks should experience differential influences, for stocks that are associated with hedge fund arbitrage activities.

Furthermore, the existence of the long-lasting short-sale restrictions does not necessarily indicate that the short-sale constraint is always binding. In occasions when investors cannot sell short stocks, they may exploit derivatives of these underlying stocks. For example, they can purchase put option if they believe the stocks are overvalued and subsequent prices will go down. Hence, one may expect the above predictions are more pronounced in stocks for which the short-sale constraints are binding. Literature suggests that small stocks are less likely to have put options available in the market. Thus, I conjecture that the short-sale constraints are more likely to be binding for small stocks.

Hypothesis 1: *Pilot stocks that are associated with hedge fund arbitrage activities should experience reduced abnormal returns after Reg SHO.*

Hypothesis 1a: For pilot stocks, stocks associated with higher hedge fund arbitrage activities should experience lower abnormal returns after Reg SHO. Such effect should not be pronounced for control stocks.

Hypothesis 1b: For stocks that are associated with hedge fund arbitrage activities, pilot stocks should experience lower abnormal returns than control stocks after Reg SHO. Such effect should not be pronounced for stocks that are not associated with hedge fund arbitrage activities.

Hypothesis 1c: The prediction of Hypothesis 1 is more pronounced for stocks that are more likely to have binding short-sale constraints.

Gromb and Vayanos (2010) investigate how arbitrage costs prevent arbitrageurs from eliminating mispricing and providing liquidity. Therefore, during the process of correcting relative mispricing, the mispriced stocks should also experience increasing liquidity, especially when liquidity measures are volume-based (Figure 4). Moreover, hedge funds often take contrarian positions in less liquid stocks, increasing their liquidity. Vayanos and Weill (2008) suggest that short-sellers concentrate on the more liquid asset, and their activity is what renders the asset more liquid.

Hypothesis 2: *Pilot stocks that are associated with hedge fund arbitrage activities become more liquid after Reg SHO.*

3. Data and Variables

A. Sample

A list of Pilot Stocks is determined by SEC's first pilot order of Regulation SHO (Securities Exchange Act Release No. 50104). Within the Russell 3000 index as of June

2004, stocks that are not listed on the NYSE, AMEX or Nasdaq national market (Nasdaq NM) and stocks whose IPO or spin-offs were after April 30, 2004 are excluded. For remaining stocks, they are sorted by average daily trading dollar volume over the prior one year on each respective exchange. Every third stock is defined as *Pilot* stocks. I use non-pilot stocks as *Control* stocks in this study. I then merge the initial sample with the Center for Research in Security Prices (CRSP) to form stock level variables and exclude stocks of financial firms to alleviate the concern of cross-holding by investment companies[7]. The final sample consists of 742 pilot stocks and 1,482 control stocks, with an approximate ratio of 1:2. *Pilot* is also an indicator variable equal to one if a stock is a *Pilot* stock and zero if it is a *Control* stock.

Reg SHO was effective from May 2, 2005 to August 7, 2007, which covers a 27-month window. To reduce the impacts of market condition change, I simply select a symmetric 27-month window before the effective date of Reg SHO. Therefore, the sample period in this study is from February 2003 to July 2007, a 54-month testing window.

B. Variable Construction

To investigate the effects of Reg SHO and hedge fund arbitrage activities on stock prices, I construct five return measures. The first is *Excess Return* which is the monthly stock return in excess of risk free rate. I also construct abnormal return measures based on factor models and characteristics. In particular, I use *CAPM Alpha*, *FF3 Alpha* based on

[7] Adding financial firms to the sample shows similar results. Tables are available from the author upon request.

Fama and French (1992, 1993) three-factor model, *FFC4 Alpha* based on Carhart (1997) four-factor model and *DGTW Alpha*[8] (Daniel, Grinblatt, Titman, and Wemers, 1997).

For each month t, I estimate *CAPM Alpha*, *FF3 Alpha*, and *FFC4 Alpha* using betas estimated over a 36-month window ending in month *t-1*. I require at least 12 valid monthly returns when estimating betas. The computation is as follows:

$$R_{i,s} = \hat{\alpha}_{i,t-1} + \sum_{k=1}^{K} \hat{\beta}_{i,k,t-1} F_{k,s} + \varepsilon_{i,s}, \quad s = t-36, \dots, t-1 \qquad (1)$$

$$\alpha_{i,t} = R_{i,t} - \sum_{k=1}^{K} \hat{\beta}_{i,k,t-1} F_{k,t} \qquad (2)$$

where i indicates stocks, s and t indicate months, R is the monthly return of stock i, K is the number of factor(s) in each factor model, and F is the monthly returns of the factors. For CAPM, K is 1 and F is the monthly return of excess market. For Fama-French three-factor model, K is 3 and F is the monthly returns of excess market, size, and book-to-market. For Fama-French-Carhart four-factor model, K is 4 and F is the monthly returns of excess market, size, book-to-market, and momentum. *DGTW Alpha* is calculated as the monthly return of stock i in excess of monthly characteristic-based benchmark returns.

Next, I construct a number of variables to study the changes on stock liquidity, including *Amihud*, *Turnover,* and *Dollar Volume. Amihud* is the monthly average of daily Amihud (2002) illiquidity measures. Following Agarwal et. al (2015), I construct this measure as follow,

[8] The DGTW benchmarks are available via
http://www.smith.umd.edu/faculty/rwermers/ftpsite/Dgtw/coverpage.htm

$$Amihud_{i,d} = \frac{1}{D_t}\sum\sqrt{\frac{|r_{i,d}|}{P_{i,d} * Vol_{i,d}}} \qquad (3)$$

where *i* and *d* index stocks and dates, respectively. D_t is the number of trading days in month *t*, $r_{i,d}$ is the daily stock return, $P_{i,d}$ is the daily stock price, and $Vol_{i,d}$ is the daily trading volume. *Turnover* is the monthly average of daily trading volume divided by shares outstanding. *Dollar Volume* is the monthly average of daily trading dollar volume (*price*volume).* For *Amihud* and *Dollar Volume*, I take the natural logarithm of these monthly average measures.

Chen, Hong and Stein (2002) (henceforth CHS) argues that low breadth of a stock signals that the short-sales constraint is binding and that the price is above the fundamental. Therefore, it is necessary to control the effects of change in ownership breadth. I follow CHS approach which uses mutual fund holding as a proxy for breadth and calculate the breadth of ownership of a stock every month. The data on mutual fund holdings come from the Thomson Reuters S12 Mutual Fund Holdings Database. All mutual funds are included regardless of their investment objectives and incorporation countries. In each month *t*, $Breadth_t$ is computed as the ratio of the number of mutual funds that hold a long position in the stock to the total number of mutual funds in month *t-1*. Moreover, $\Delta Breadth_t$ is the change in breadth in a given month *t*.

Furthermore, I construct several stock characteristic control variables, including *Size*, the natural logarithm of market equity; *Book-to-Market*, the ratio of book equity to market equity; *Momentum*, the cumulative stock return from month *t -12* to month *t -1* for a given month *t*.

In the empirical analysis, all variables, except for indicator variables, are winsorized at the 1% and 99% levels for all stock-month observations.

C. Hedge Fund Arbitrage Activities Proxy

Since hedge fund trades are not directly observed, I use SEC Form 13F to obtain hedge funds' equity and derivative holdings. SEC requires all institutional investment companies with over \$100 million assets under management to disclose their holdings and investment activities on Form 13F at each quarter-end. Security positions with over 10,000 shares or over \$200,000 in market value are subject to this rule. I obtain Form 13F filings from Thomson Reuters database.

The first task to use SEC Form 13F is to identify hedge funds since institutional investment companies do not indicate their types on Form 13F directly. Agarwal et al. (2013) provides classification of institutional categories, including (i) hedge funds, (ii) investment companies and investment advisors, (iii) banks and insurance companies, and (iv) other institutions. I use their classification and rename institutional investment companies into three categories: Hedge Funds (Type (i)), Asset Management Companies (Type (ii)), and Other Institutions (Type (iii) and (iv)).

As hedge funds correct mispricing through seeking for arbitrage opportunities, I construct a measure to proxy for the arbitrage activities for a given stock. *HF Arbitrage Activity* indicates a stock's average quarterly percentage change in hedge funds ownership over one-year prior to the execution of Reg SHO. I keep this variable time-invariant throughout the sample period and create before Reg SHO to deal with the endogeneity concern, which arises if hedge funds tend to favor *pilot* or *control* stock. An illustration of this measure is shown in Figure 2.

It is plausible to argue that the correction of mispricing and the improvement of market quality are driven by other institutional investors such as mutual funds, pension funds, banks or insurance companies. Meanwhile, it is also possible that hedge fund ownership and other institutional ownership can be correlated, leading to an amplified result. To confirm that the findings in this paper is solely driven by hedge funds, I construct two comparable variables to control the influences of other institutions: *AM Activity* and *OI Activity* where *AM* denotes Asset Management Companies and *OI* denotes Other Institutions. The construction of them follows the above approach for hedge funds.

4. Empirical Analysis

A. The Random Assignment of Pilot and Control Stocks

I first verify the randomness of pilot stocks. To do so, I compare the means and medians of firm characteristics for pilot group and control group. All variables are winsorized at the 1st and 99th percentiles of all stock-month observations to eliminate the effects of outliers. Panel B of Table I shows that two groups have statistically indifferent characteristics and confirms that the assignment of pilot stocks is indeed random.

B. The Impacts of Hedge Fund Arbitrage Activities and Reg SHO on Stock Returns

B1. Baseline Regression: A triple-difference approach

To evaluate the effects of Reg SHO and hedge fund arbitrage activity on stock performance, I first compute the monthly stock excess returns and abnormal returns over the entire sample period, i.e., February 2003 to July 2007. Then, I construct the proxy for hedge fund arbitrage activity.

Next, I test the effects of the hedge fund arbitrage activity and Reg SHO on stock returns. I estimate the following difference-in-difference-in-differences regression for each return variable *y*:

$$y_{i,t} = \mu_t + \alpha_i + \gamma HFArbitrageActivity_{\,i} \times During_t \times Pilot_i + \gamma_1 HFArbitrageActivity_i \times During_t + \gamma_2 During_t \times Pilot_i + \varepsilon_{it} \qquad (4)$$

where *i* and *t* index stock and month; $y_{i,t}$ is *Excess Return, CAPM Alpha, FF3 Alpha, FFC4 Alpha* or *DGTW Alpha;* μ_t is month fixed effects; α_i is stock fixed effects; $HFArbitrageActivity_i$ is the average quarterly change in aggregate hedge fund ownership over one-year period before Reg SHO; $Pilot_i$ is a dummy variable equal to one if stock *i* is a pilot stock and zero if it is a control stock; $During_t$ is a dummy variable equal to one if month *t* is between May 2005 and July 2007, i.e. when Reg SHO pilot program was effective, and zero otherwise. $HFArbitrageActivity_i$, $Pilot_i$ and their interaction term are omitted because stock fixed effects are implemented. $During_t$ is dropped because of the month fixed effects.

Table II presents the estimation results. The primary independent variable of interest is $HFArbitrageActivity_{\,i} \times During_t \times Pilot_i$. *Hypothesis 1* predicts that the coefficients $\gamma's$ are negative. The results show that for all four abnormal return measures, the coefficients of triple-interaction terms are negative and statistically significant at the 1% percent level. The magnitudes are also economically large. During Reg SHO, a one standard deviation (8.66%) increase in hedge fund arbitrage activities for pilot stocks is associated with a 37 to 55 basis points decrease per month, or 4.5 to 6.6 percentage points decrease per year, in abnormal returns, depending on the abnormal return measures chosen. This provides consistent evidence that pilot stocks that are associated with higher hedge fund arbitrage activities should experience lower abnormal returns during Reg SHO.

B2. Decomposition of the Combined Impacts

In this subsection, I decompose the impact of hedge fund arbitrage activities and the impact of Reg SHO to further confirm the validity of *Hypothesis 1*. Hence, I explicitly test *Hypothesis 1a* and *Hypothesis 1b.*

Based on the main measure *HF Arbitrage Activity*, I sort stocks into quintiles. The highest quintile is defined as *High* group while the lowest quintile is defined as *Low* group. I also construct an indicator variable equal to one if a stock belongs to *High* group and zero if it falls in *Low* group.

To verify *Hypothesis 1a*, I exploit below diff-in-diff approach for *Pilot* group and *Control* group, respectively,

$$y_{it} = \mu_t + \alpha_i + \beta High_i \times During_t + \varepsilon_{it} \qquad (5)$$

where variables are defined same as in Table II. The *Hypothesis 1a* predicts that β is negative for pilot group and indifferent from zero for control group.

Next, I use a similar approach for *High* group and *Low* group, respectively, as follows.

$$y_{it} = \mu_t + \alpha_i + \lambda Pilot_i \times During_t + \varepsilon_{it} \qquad (6)$$

The *Hypothesis 1b* predicts that λ is negative for *High* group and indifferent from zero for *Low* group.

Table III present results that are consistent with both hypotheses. Specifically, for *Pilot* group, the coefficient of the primary variable of interest $High_i \times During_t$ are all negative and statistically significant at 1% level in Panel A. It suggests that for pilot stocks, stocks associated with highest hedge fund arbitrage activities experience over 1% lower abnormal return per month than stocks not associated with such activities. Such effect is not pronounced for *Control* group as all coefficients are statistically insignificant in Panel B. Panel C and D provide analogous results for *High* and *Low* groups. The coefficients of the interaction term are all negative and significant at conventional levels for *High* group but all statistically insignificant for *Low* group. Hence, absent of arbitrage activities, Reg SHO exerts no differential impacts between pilot stocks and control stocks.

B3. Size subsamples

Hypothesis 1c predicts that the effects are more pronounced for stocks that are more likely to have binding constraints. I repeat the baseline analysis for two subsample groups that are divided by median size.

Table IV suggests that the results are consistent with the hypothesis. For below median size firms, the coefficients of the triple interaction terms are all negative and statistically significant while the results are less pronounced for above median size firms.

B4. Dynamics

Moreover, if the hedge funds exploit arbitrage opportunities rapidly, then the reduction in abnormal returns should be stronger right after the implementation of Reg SHO. Table

V indicates the suggested case. Before Reg SHO, there is no significant effect. This evidence also suggests that the assignment of pilot stocks is random because hedge funds are unable to predict the assignment ex ante. After Reg SHO, the combined effects on stock abnormal returns are strongest in the first quarter, further confirming that Reg SHO has substantial effect on reducing the limit of arbitrage. The coefficients stay negative during entire Reg SHO and the magnitudes of all specifications monotonically decrease with time. Therefore, the price correction appears to be permanent and there is no subsequent price reversal. Nevertheless, the combined effects become negligible after one year and a half.

B5. Controlling for Breadth in Ownership and Other Institutional Ownership

The breadth of a stock represents differences of opinion in the stock and thus should be controlled when investigating the relaxation of short selling restrictions induced by Reg SHO. Meanwhile, the breadth of ownership in CHS is measured as the mutual funds' long positions in the stock. Since mutual funds are a major component on the supply side of stock loan market, controlling the breadth of a stock also reduces the likelihood that the results are driven by the unexpected shocks to the supply side of short sales.

Moreover, although the results in the previous section shows that high hedge fund arbitrage activity is associated with correcting mispricing, it remains possible that this measure proxies for other institutional trading activities and that high institutional trading activities can also eliminate mispricing. To rule out this alternative scenario, I use two types of institutions as control groups: Asset Management Companies and any Other Institutions.

I complement the trading activities of the two control groups along with the change in breadth to the baseline regression and estimate the following regression:

$$
\begin{aligned}
y_{i,t} = \mu_t + \alpha_i + \gamma HFArbitrageActivity_{\ i} \times During_t \times Pilot_i \\
+ \gamma_1 HFArbitrageActivity_i \times During_t + \gamma_2 During_t \times Pilot_i \\
+ \theta \Delta Breadth_{i,t} \times During_t \times Pilot_i + \theta_1 \Delta Breadth_{i,t} \times During_t \\
+ \theta_2 \Delta Breadth_{i,t} \times Pilot_i + \theta_3 \Delta Breadth_{i,t} \\
+ \delta ControlActivity_i \times During_t \times Pilot_i \\
+ \delta_1 ControlActivity_i \times During_t + \varepsilon_{it} \qquad (7)
\end{aligned}
$$

where *i* and *t* index stock and month; $y_{i,t}$ is *Excess Return, CAPM Alpha*, *FF3 Alpha*, *FFC4 Alpha* or *DGTW Alpha;* μ_t is month fixed effects; α_i is stock fixed effects; $HFArbitrageActivity_i$ is the average quarterly change in aggregate hedge fund ownership over one-year period before Reg SHO; $ControlActivity_i$ is *AM Activity* or *OI Activity* or both, where *AM Activity* (*OI Activity*) is the average quarterly change in aggregate Asset Management Companies (Other Institutions) ownership over one-year period before Reg SHO; $\Delta Breadth_{i,t}$ is the monthly change of breadth in ownership; $Pilot_i$ is a dummy variable equal to one if stock *i* is a pilot stock and zero if it is a control stock; $During_t$ is a dummy variable equal to one if month *t* is between May 2005 and July 2007, i.e. when Reg SHO pilot program was effective, and zero otherwise. $HFArbitrageActivity_i$, $ControlActivity_i$, $Pilot_i$ and their interaction term are omitted because stock fixed effects are implemented. $During_t$ is dropped because of the month fixed effects.

The results of the estimation are presented in Table VI. During Reg SHO, a one standard deviation (8.66%) increase in hedge fund arbitrage activities for pilot stocks is associated with a 4.9 to 7.6 percentage points decrease per year in abnormal returns, depending on the factor models or characteristic model chosen. Overall, the change in breadth, and asset management companies and other institutions trading activities do not alter the inference that pilot stocks that are associated with high hedge fund arbitrage activities experience negative abnormal returns during Reg SHO.

C. The Impacts of Hedge Fund Arbitrage Activities and Reg SHO on Stock Liquidity

To estimate the impacts of hedge fund arbitrage activities and Reg SHO on stock liquidity and test *Hypothesis 2*, I exploit following triple-difference approach:

$$\begin{aligned} y_{i,t} = \mu_t + \alpha_i + \gamma HFArbitrageActivity_{\,i} \times During_t \times Pilot_i \\ + \gamma_1 HFArbitrageActivity_i \times During_t + \gamma_2 During_t \times Pilot_i \\ + \rho y_{i,t-1} + \vartheta' Controls_{i,t} + \varepsilon_{it} \qquad (8) \end{aligned}$$

where i and t index stock and month; $y_{i,t}$ is *Amihud, Turnover*, or *Dollar Volume;* μ_t is month fixed effects; α_i is stock fixed effects; $HFArbitrageActivity_i$ is the average quarterly change in aggregate hedge fund ownership over one-year period before Reg SHO; $Pilot_i$ is a dummy variable equal to one if stock i is a pilot stock and zero if it is a control stock; $During_t$ is a dummy variable equal to one if month t is between May 2005 and July 2007, i.e. when Reg SHO pilot program was effective, and zero otherwise; *Controls* include *Size, Book-to-Market* and *Momentum*; $HFArbitrageActivity_i$, $Pilot_i$ and their interaction term are omitted because stock fixed effects are implemented. $During_t$ is dropped because of the month fixed effects.

Table VII presents the estimation results. *Hypothesis 2* predicts that the coefficients $\gamma' s$ are negative for *Amihud*, and positive for *Turnover* and *Dollar Volume*. The results show that for all three liquidity measures, the coefficients of triple-interaction terms are statistically significant at conventional levels. During Reg SHO, a one standard deviation (8.66%) increase in hedge fund arbitrage activities for pilot stocks is associated with a 0.4 to 0.9 standard deviation increase in liquidity per year, depending on the liquidity measures used. This evidence is consistent with the prediction that pilot stocks that are associated with higher hedge fund arbitrage activities should become more liquid during Reg SHO.

5. Robustness Check

A. Time-Series Placebo Test

As a precaution that some unobserved shocks have different effects on pilot stocks and control stocks, it is necessary to rule out the possibility that such unobserved shocks, if any, drive the inference of the triple-difference results. Although the summary statistics of pilot stocks and control stocks imply that the assignment of pilot stocks is indeed random and unlikely to be correlated with any unobserved shocks, I still conduct a time-series placebo test to check the robustness.

I first create a pseudo-Reg SHO event as if it was effective from February 2003 to April 2005. The placebo test period is from November 2000 to April 2005. I then run the triple-difference regression.

$$
\begin{aligned}
y_{i,t} = \mu_t + \alpha_i + \gamma' HFArbitrageActivity_{\,i} \times\ PseudoDuring_t \times Pilot_i \\
+ \gamma_1' HFArbitrageActivity_i \times\ PseudoDuring_t \\
+ \gamma_2' PseudoDuring_t \times\ Pilot_i + (\vartheta' Controls_{i,t}) + \varepsilon_{it} \qquad (9)
\end{aligned}
$$

The results of the time-series placebo test are shown in Table VIII. The coefficients on $HFArbitrageActivity_{i} \times PseudoDuring_{t} \times Pilot_{i}$ are all statistically insignificant. The time-series placebo test therefore confirms that the baseline results are unlikely to be driven by unobservables that may have different impacts on pilot and control stocks.

B. The Unconditional Tests

It remains possible that the underperformance of high arbitrage activities pilot stocks comes solely from the impact of Reg SHO. In other word, the effects of hedge fund arbitrage activities are neutral to pilot group and control group. Therefore, I exploit a basis difference-in-difference approach to test the influence on pilot stocks from Reg SHO,

$$y_{it} = \mu_t + \alpha_i + \beta Pilot_i \times During_t + \beta_1 Pilot_i + \varepsilon_{it} \qquad (10)$$

where y_{it} is *CAPM Alpha*, *FF3 Alpha*, *FFC4 Alpha* or *DGTW Alpha* of stock *i* in month *t*; $During_t$ is a dummy variable which is equal to one if month *t* is between May 2005 and July 2007, i.e. when Reg SHO pilot program was effective; $Pilot_i$ is a dummy variable which is equal to one if stock *i* is a pilot stock and zero if it is a control stock; μ_t is month fixed effects; α_i is stock fixed effects.

Table IX shows that the performance of pilot stocks is indifference from that of control stocks. Diether, Lee and Werner (2009) hypothesizes that pilot stocks experience negative abnormal returns during Reg SHO but does not find supportive evidence. The unconditional test provides consistent results. Therefore, this evidence rules out the possibility that my results are driven by Reg SHO only and verifies that the effects of hedge fund arbitrage activities on stocks are identifiable and are important in the process of price correction.

6. Concluding Remarks

In this paper, I study the role of hedge funds in eliminating mispricing and providing liquidity. Literate views hedge funds as informational traders and arbitrageurs. As they actively search for arbitrage opportunities in the financial market, their trading activities should be more prominent on stocks that are more likely to be mispriced and that deviate from fundamentals more severely.

SEC lifted the short-sale restriction for a random set of stocks between May 2005 and August 2007 with Reg SHO pilot program. This regulation change provides an ideal setting to test the process of correcting mispricing and the improvement of liquidity. If short-sale restrictions push stock prices to be above the fundamentals, i.e. overvalued, suspending them will result in low abnormal returns. Therefore, stocks that are correlated with hedge fund arbitrage activities should experience reduced abnormal returns if their short-sale restrictions are suspended.

I find that pilot stocks that are associated with hedge fund arbitrage activities on average have reduced abnormal returns after Reg SHO. Such effect is not significant for non-pilot stocks or stocks that are unrelated with hedge fund arbitrage activities. The decrease in abnormal returns is more pronounced for stocks which are more likely to have binding short-sale constraints. In addition, the combined effects of hedge fund arbitrage activities and Reg SHO are more substantial right after the implementation of Reg SHO and decrease monotonically with time. These results suggest that hedge funds help eliminate mispricing. I also find that pilot stocks that are associated with hedge fund arbitrage activities become more liquid after Reg SHO, indicating that hedge funds also provide liquidity to security. Overall, this study supports that hedge funds play a positive and crucial role in financial markets.

One possible extension is to investigate the performance of hedge funds whose portfolios are centralized in the pilot stocks and to examine whether they gain or lose during the process of eliminating mispricing. Therefore, one can infer the trade-offs and incentives of hedge funds as they act as both arbitrageurs and liquidity providers in the market.

Appendix

A. Adjusting Delisting Return

The final sample of this study consists of 2,280 stocks, but the number of stocks that have all valid independent variables is 1,719 in July 2007. Therefore, some stocks are delisted during the sample period and it is necessary to adjust the delisting returns. I obtain all data from CRSP.

I follow Hou, Xue and Zhang (2017) and Beaver, McNichols, and Price (2007). I adjust the monthly stock returns, if a stock is delisted during the month, by compounding the daily stock returns in the month before delisting with delisting event return from the daily CRSP delisting file (DSEDELIST).

If delisting occurs before the last trading day of month t, then the monthly delisting-adjusted return of month t is to compound the cumulative daily stock returns and the delisting event return. If delisting occurs on the last trading day of month t, then the cumulative daily stock returns account for the monthly return of month t and delisting event return is the monthly delisting-adjusted return of month $t+1$.

In cases where delisting event returns are missing, I replace missing delisting event returns using the average available delisting event returns with the same exchange code and same delisting type over the past 60 months. Hou, Xue and Zhang (2017) argues that delisting event returns vary substantially across exchanges and delisting types and allowing time-variant replacement values can capture the time trend.

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Figure 1

The Number of Stocks on Each Report

This figure shows the number of stocks on each Form 13F report across different types of institutional investors. A median hedge fund reports around 60 to 70 stocks while a median other institution reports around 110 stocks.

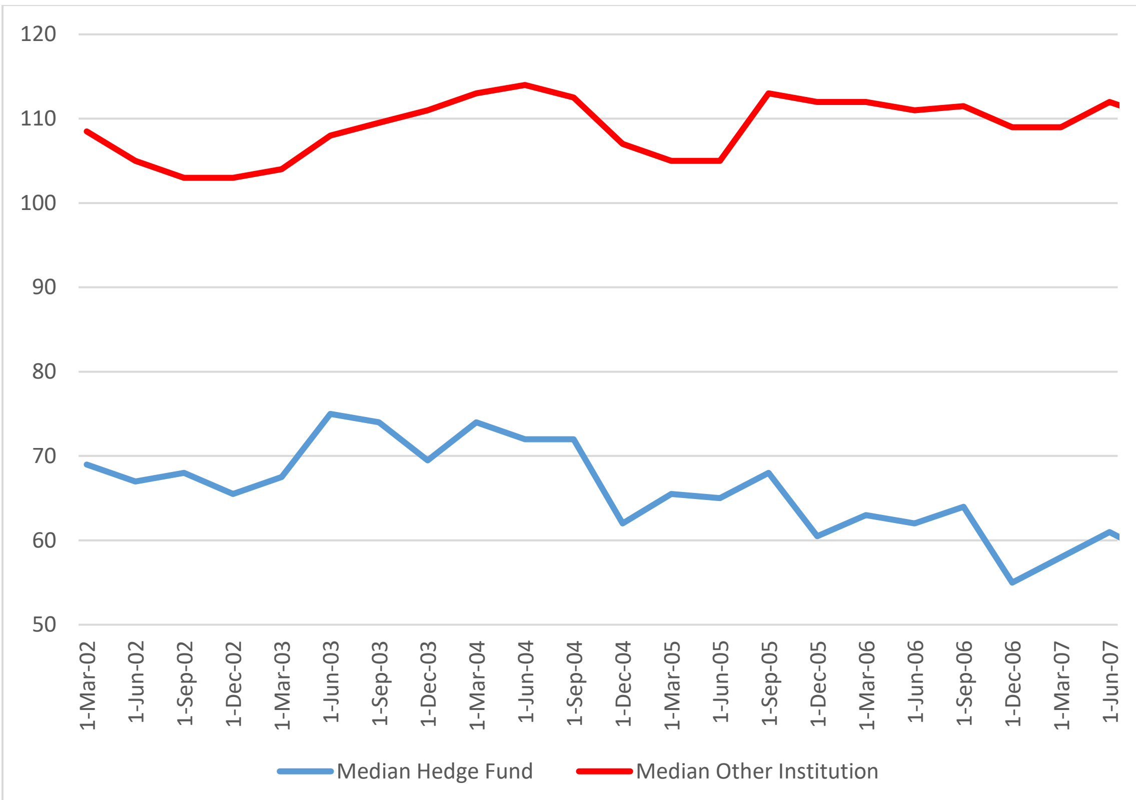
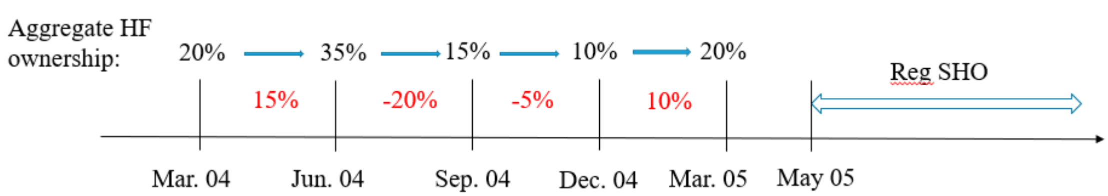


Figure 2

The Construction of Hedge Fund Arbitrage Activities Measure

This figure shows how the hedge fund arbitrage activities measure is constructed. SEC Form 13F from March 2004 to March 2005 are used to calculate the aggregate hedge fund ownership. Hedge fund arbitrage activities are defined as the average quarterly change in aggregate hedge ownership over one-year prior to Reg SHO.

.



HF arbitrage activities:=(|15%|+|-20%|+|-5%|+|10%|)/4=12.5%

Figure 3

Valuation of a stock with or without short-sale constraints

This figure assumes that the distribution of valuation of investors for a stock is normally distributed and shows the valuation of investors for such as stock before and after short-sale restrictions are removed. When short-sale restrictions exist, some pessimists stay out of the market and the price P does not reflect their valuations. After short-sale restrictions are removed, a smaller price P' contains the valuation of short-sellers. Therefore, stock is overpriced when there are short-sale constraints.

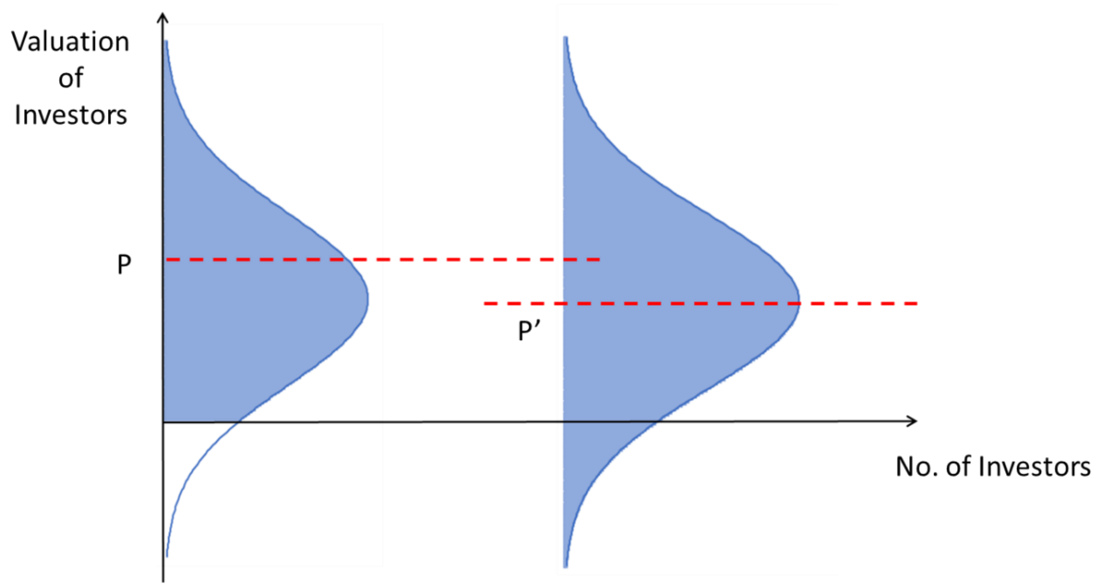


Figure 4

Volume of a stock with or without short-sale constraints

This figure shows that the short run supply of a stock is fixed and that short sales increase the supply of a stock after short-sale restrictions are removed. Therefore, volume-based liquidity measures should increase after the removal of short-sale restrictions.

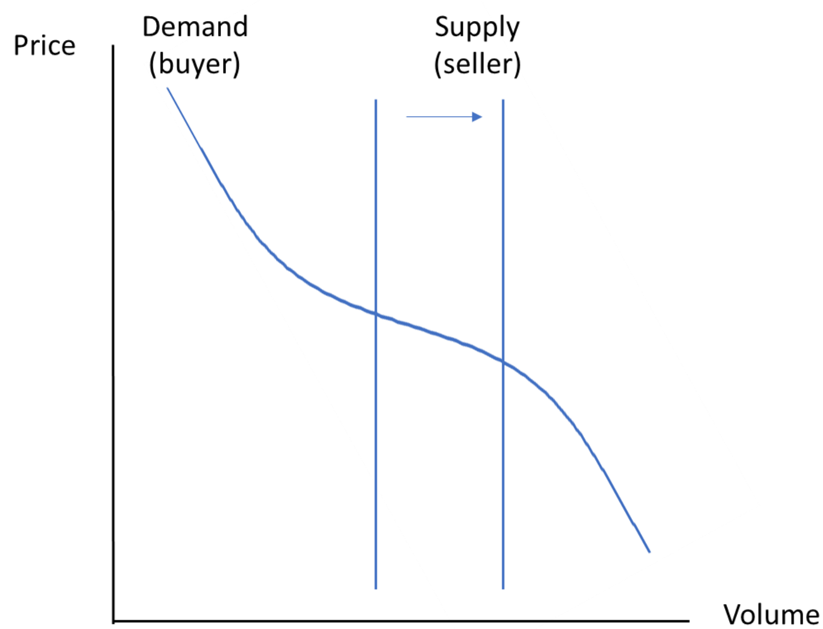


Table I

Summary Statistics

This table reports stock level variables between February 2003 to July 2007. Panel A describes overall sample and Panel B compares variables of pilot stocks and control stocks prior to Reg SHO. *HF Arbitrage Activity (AM Activity/OI Activity)* is the average quarterly change in aggregate hedge funds (asset management companies/other institutions) ownership over one-year prior to Reg SHO. *Excess Return* is the monthly stock return in excess of risk-free rate. *CAPM Alpha, FF3 Alpha, FFC4 Alpha* and *DGTW Alpha* are abnormal returns based on CAPM, Fama-French 3-factor model, Fama-French-Carhart 4-factor model and DGTW characteristics benchmark, respectively. *Size* is the natural logarithm of market capitalization. *Book-to-Market* is the ratio of book equity to market equity. *Momentum* is the cumulative stock return from month *t -12* to month *t -1* for a given month *t*. *Amihud* is the Amihud (2002) illiquidity measure. *Turnover* is the monthly average of daily trading volume scaled by shares outstanding. *Dollar Volume* is the monthly average of daily trading dollar volume. *Breadth* is the fraction of all mutual fund long the stock and *ΔBreadth* is the change in *Breadth* in a month. All variables are winsorized at the 1% and 99% levels.

Panel A: Overall Sample

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Mean	Median	Std. Dev.	P25	P75	N
HF Arbitrage Activity	8.66%	6.79%	6.94%	3.63%	11.70%	2,224
AM Activity	17.19%	13.39%	13.39%	7.38%	22.69%	2,224
OI Activity	10.33%	8.83%	6.64%	5.59%	13.48%	2,224
Excess Return	1.68%	1.05%	11.00%	-4.48%	7.08%	113,762
CAPM Alpha	0.24%	0.00%	10.40%	-5.45%	5.49%	113,762
FF3 Alpha	0.04%	-0.20%	10.60%	-5.72%	5.43%	113,762
FFC4 Alpha	0.07%	-0.16%	10.80%	-5.78%	5.58%	113,762
DGTW Alpha	0.25%	-0.17%	9.70%	-5.19%	5.10%	108,296
Size	7.020	6.829	1.478	5.926	7.914	113,762
Book-to-Market	0.542	0.438	0.472	0.255	0.693	113,762
Momentum	0.222	0.127	0.555	-0.091	0.389	113,762
Amihud	-10.060	-10.100	1.039	-10.790	-9.356	113,757
Turnover	0.953	0.706	0.822	0.414	1.204	113,762
Dollar Volume	15.840	15.900	1.829	14.620	17.110	113,760
Breadth	0.017	0.009	0.024	0.001	0.019	113,762
ΔBreadth	0.000	0.000	0.001	0.000	0.000	113,762

Table I - *continued*

Panel B: Pilot vs Control: Comparison Prior to Reg SHO

	Mean			Median		
VARIABLES	Pilot	Control	*p*-value	Pilot	Control	*p*-value
HF Arbitrage Activity	8.63%	8.68%	0.884	6.43%	6.94%	0.105
AM Activity	16.70%	17.50%	0.217	13.30%	13.40%	0.857
OI Activity	10.30%	10.40%	0.742	8.66%	8.93%	0.472
Excess Return	2.21%	2.14%	0.512	1.96%	2.01%	0.653
CAPM Alpha	0.65%	0.46%	0.102	0.79%	0.72%	0.368
FF3 Alpha	0.15%	0.02%	0.265	0.21%	0.11%	0.418
FFC4 Alpha	0.18%	0.06%	0.315	0.15%	0.16%	0.787
DGTW Alpha	0.43%	0.39%	0.723	0.17%	0.25%	0.434
Size	6.937	6.824	0.075	6.66	6.555	0.208
Book-to-Market	0.61	0.588	0.291	0.509	0.496	0.589
Momentum	0.303	0.305	0.892	0.219	0.22	0.928
Amihud	-9.915	-9.862	0.216	-9.871	-9.856	0.857
Turnover	0.87	0.915	0.153	0.712	0.703	0.787
Dollar Volume	15.64	15.57	0.334	15.6	15.53	0.589
ΔBreadth	0.000047	0.000041	0.630	0.000009	0.000001	0.418

Table II

The Impact of Hedge Fund Arbitrage Activity and Reg SHO on Stock Returns

This table reports following regression from February 2003 to July 2007:

$$y_{i,t} = \mu_t + \alpha_i + \gamma HFArbitrageActivity_i \times During_t \times Pilot_i + \gamma_1 HFArbitrageActivity_i \times During_t + \gamma_2 During_t \times Pilot_i + \varepsilon_{it},$$

where i and t index stock and month; $y_{i,t}$ is *Excess Return*, *CAPM Alpha, FF3 Alpha*, *FFC4 Alpha* or *DGTW Alpha*. *HF Arbitrage Activity* is the average quarterly change in aggregate hedge fund ownership over one-year prior to Reg SHO. *Pilot* is an indicator variable equal to one if a stock is a pilot stock and zero if it is a control stock. *During* is an indicator variable equal to one if an observation is between May 2005 and July 2007, i.e. when Reg SHO pilot program was effective, and zero otherwise. All variables, except indicator variables, are winsorized at the 1% and 99% levels. All standard errors are clustered at the stock level. The robust t-statistics are presented in the parentheses below the coefficient estimates. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

VARIABLES	(1) Excess Return	(2) CAPM Alpha	(3) FF3 Alpha	(4) FFC4 Alpha	(5) DGTW Alpha
HF Arbitrage Activity x *During* x *Pilot*	-0.0473**	-0.0586***	-0.0546**	-0.0634***	-0.0432**
	(-2.415)	(-2.752)	(-2.421)	(-2.743)	(-2.243)
HF Arbitrage Activity x *During*	-0.0201*	-0.00459	0.00323	0.00511	-0.0181
	(-1.733)	(-0.358)	(0.248)	(0.380)	(-1.488)
During x *Pilot*	0.00289	0.00330*	0.00356*	0.00413**	0.00276
	(1.614)	(1.730)	(1.813)	(2.052)	(1.586)
Constant	-0.0271***	-0.00425*	0.00265	0.00312	-0.00130
	(-11.23)	(-1.683)	(1.074)	(1.262)	(-0.540)
Month fixed effects	Yes	Yes	Yes	Yes	Yes
Stock fixed effects	Yes	Yes	Yes	Yes	Yes
Number of observations	113,762	113,762	113,762	113,762	108,296
R-squared	0.151	0.028	0.004	0.003	0.004
Number of stock	2,224	2,224	2,224	2,224	2,191

Table III
The Impact of Hedge Fund Arbitrage Activity and Reg SHO on Stock Returns: Decompositions

This Table reports following regressions from February 2003 to July 2007:

$y_{it} = \mu_t + \alpha_i + \beta High_i \times During_t + \varepsilon_{it}$, and $y_{it} = \mu_t + \alpha_i + \lambda Pilot_i \times During_t + \varepsilon_{it}$.

High is an indicator variable equal to one if a stock is in the highest quintile sorted on *HF Arbitrage Activity* and zero if it is in the lowest quintile. *HF Arbitrage Activity* is the average quarterly change in aggregate hedge fund ownership over one-year prior to Reg SHO. *Pilot* is an indicator variable equal to one if a stock is a pilot stock and zero if it is a control stock. *During* is an indicator variable equal to one if an observation is between May 2005 and July 2007, i.e. when Reg SHO pilot program was effective, and zero otherwise. Stock fixed effects and month fixed effects are used for all specifications but are unreported. All standard errors are clustered at the stock level. The robust t-statistics are presented in the parentheses below the coefficient estimates. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively

VARIABLES	(1) Excess Return	(2) CAPM Alpha	(3) FF3 Alpha	(4) FFC4 Alpha	(5) DGTW Alpha
Panel A: Pilot Group					
High x *During*	-0.0125***	-0.00993***	-0.00840**	-0.00957**	-0.0114***
	(-3.731)	(-2.713)	(-2.219)	(-2.479)	(-3.552)
# of obs.	15,279	15,279	15,279	15,279	14,518
R-squared	0.142	0.031	0.009	0.009	0.008
# of stock	300	300	300	300	294
Panel B: Control Group					
High x *During*	-0.00423**	-0.000732	0.000931	0.00143	-0.00285
	(-1.965)	(-0.316)	(0.390)	(0.583)	(-1.295)
# of obs.	30,219	30,219	30,219	30,219	28,431
R-squared	0.145	0.028	0.006	0.005	0.005
# of stock	595	595	595	595	581
Panel C: High Group					
Pilot x *During*	-0.00656*	-0.00728*	-0.00665*	-0.00844**	-0.00603*
	(-1.912)	(-1.939)	(-1.691)	(-2.103)	(-1.790)
# of obs.	22,711	22,711	22,711	22,711	20,929
R-squared	0.161	0.039	0.010	0.009	0.012
# of stock	465	465	465	465	452
Panel D: Low Group					
Pilot x *During*	0.00178	0.00191	0.00265	0.00251	0.00270
	(0.884)	(0.899)	(1.252)	(1.163)	(1.396)
# of obs.	22,787	22,787	22,787	22,787	22,020
R-squared	0.135	0.023	0.006	0.005	0.005
# of stock	430	430	430	430	423

Table IV

The Impact of Hedge Fund Arbitrage Activity and Reg SHO on Stock Returns: Size Subsamples

This table reports following regression from February 2003 to July 2007:

$$y_{i,t} = \mu_t + \alpha_i + \gamma HFArbitrageActivity_i \times During_t \times Pilot_i + \gamma_1 HFArbitrageActivity_i \times During_t + \gamma_2 During_t \times Pilot_i + \varepsilon_{it}$$

Firms are divided into two subsamples based on median firm size. *HF Arbitrage Activity* is the average quarterly change in aggregate hedge fund ownership over one-year prior to Reg SHO. *Pilot* is an indicator variable equal to one if a stock is a pilot stock and zero if it is a control stock. *During* is an indicator variable equal to one if an observation is between May 2005 and July 2007, i.e. when Reg SHO pilot program was effective, and zero otherwise. For brevity, only coefficients γ's are reported. All standard errors are clustered at the stock level. The robust t-statistics are presented in the parentheses below the coefficient estimates. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Excess Return	CAPM Alpha	FF3 Alpha	FFC4 Alpha	DGTW Alpha
	Panel A: Below Median Size Firm				
HF Arbitrage Activity x *During* x *Pilot*	-0.0788***	-0.0868***	-0.0795**	-0.0887***	-0.0755***
	(-2.718)	(-2.837)	(-2.394)	(-2.641)	(-2.604)
Month fixed effects	Yes	Yes	Yes	Yes	Yes
Stock fixed effects	Yes	Yes	Yes	Yes	Yes
Number of observations	56,884	56,884	56,884	56,884	53,568
R-squared	0.158	0.040	0.008	0.006	0.006
	Panel B: Above Median Size Firm				
HF Arbitrage Activity x *During* x *Pilot*	-0.0342	-0.0432	-0.0394	-0.0513	-0.0331
	(-1.027)	(-1.136)	(-1.064)	(-1.300)	(-1.027)
Month fixed effects	Yes	Yes	Yes	Yes	Yes
Stock fixed effects	Yes	Yes	Yes	Yes	Yes
Number of observations	56,878	56,878	56,878	56,878	54,728
R-squared	0.161	0.024	0.008	0.008	0.004

Table V

The Impact of Hedge Fund Arbitrage Activity and Reg SHO on Stock Returns: Dynamics

This table repeats the analysis in Table II but breaks down the indicator variable *During* to track the effects before and after the implementation of Reg SHO. The sample period is from February 2003 to July 2007. Month *t* denotes May 2005, when Reg SHO becomes effective. $During^{t-3,\, t-1}$ is the last quarter before Reg SHO and $During^{t,\, t+2}$ is the first quarter after Reg SHO. Other indicator variables are defined analogously. *HF Arbitrage Activity* is the average quarterly change in aggregate hedge fund ownership over one-year prior to Reg SHO. *Pilot* is an indicator variable equal to one if a stock is a pilot stock and zero if it is a control stock. For brevity, only coefficients of triple interaction terms are reported. All standard errors are clustered at the stock level. The robust t-statistics are presented in the parentheses below the coefficient estimates. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

VARIABLES	(1) Excess Return	(2) CAPM Alpha	(3) FF3 Alpha	(4) FFC4 Alpha	(5) DGTW Alpha
HF Arbitrage Activity x $During^{t-3,\, t-1}$ x *Pilot*	-0.0207	-0.0290	-0.0434	-0.0443	-0.0241
	(-0.450)	(-0.631)	(-0.889)	(-0.898)	(-0.538)
HF Arbitrage Activity x $During^{t,\, t+2}$ x *Pilot*	-0.101**	-0.0958**	-0.0905**	-0.105**	-0.0989**
	(-2.532)	(-2.260)	(-2.104)	(-2.429)	(-2.444)
HF Arbitrage Activity x $During^{t+3,\, t+5}$ x *Pilot*	-0.0554	-0.0706	-0.0841*	-0.0862*	-0.0523
	(-1.258)	(-1.527)	(-1.785)	(-1.792)	(-1.141)
HF Arbitrage Activity x $During^{t+6,\, t+18}$ x *Pilot*	-0.0458*	-0.0612**	-0.0592**	-0.0660**	-0.0363
	(-1.810)	(-2.242)	(-2.042)	(-2.259)	(-1.462)
HF Arbitrage Activity x $During^{t+19,\, t+26}$ x *Pilot*	-0.0281	-0.0433	-0.0352	-0.0478	-0.0313
	(-0.971)	(-1.445)	(-1.112)	(-1.460)	(-1.119)
Month fixed effects	Yes	Yes	Yes	Yes	Yes
Stock fixed effects	Yes	Yes	Yes	Yes	Yes
Number of observations	113,762	113,762	113,762	113,762	108,296
R-squared	0.151	0.028	0.004	0.003	0.004
Number of stock	2,224	2,224	2,224	2,224	2,191

Table VI

The Impact of Hedge Fund Arbitrage Activity and Reg SHO on Stock Returns: Cross Sectional Placebo Test

This table reports the following regression from February 2003 to July 2007: $y_{i,t} = \mu_t + \alpha_i + \gamma HFArbitrageActivity_i \times During_t \times Pilot_i + \gamma_1 HFArbitrageActivity_i \times During_t + \gamma_2 During_t \times Pilot_i + \theta \Delta Breadth_{i,t} \times During_t \times Pilot_i + \theta_1 \Delta Breadth_{i,t} \times During_t + \theta_2 \Delta Breadth_{i,t} \times Pilot_i + \theta_3 \Delta Breadth_{i,t} + \delta ControlActivity_i \times During_t \times Pilot_i + \delta_1 ControlActivity_i \times During_t + \varepsilon_{it}$. *HF Arbitrage Activity (AM Activity/OI Activity)* is the average quarterly change in aggregate hedge fund (asset management company/other institution) ownership over one-year prior to Reg SHO. *ControlActivity* is *AM Activity* and *OI Activity*. *ΔBreadth* is the monthly change in breadth of stock ownership. *Pilot* is an indicator variable equal to one if a stock is a pilot stock and zero if it is a control stock. *During* is an indicator variable equal to one if an observation is between May 2005 and July 2007, i.e. when Reg SHO pilot program was effective, and zero otherwise. For brevity, only coefficients of triple interaction terms are reported. All standard errors are clustered at the stock level. The robust t-statistics are presented in the parentheses below the coefficient estimates. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)
VARIABLES	Excess Return	CAPM Alpha	FF3 Alpha	FFC4 Alpha	DGTW Alpha
HF Arbitrage Activity x *During* x *Pilot*	-0.0540**	-0.0675***	-0.0664***	-0.0727***	-0.0471**
	(-2.483)	(-2.851)	(-2.671)	(-2.855)	(-2.232)
ΔBreadth x *During* x *Pilot*	-1.385	-0.851	-0.445	-0.278	-0.783
	(-0.813)	(-0.539)	(-0.283)	(-0.173)	(-0.497)
AM Activity x *During* x *Pilot*	0.0190**	0.0252***	0.0240**	0.0227**	0.0129
	(2.093)	(2.689)	(2.420)	(2.207)	(1.459)
OI Activity x *During* x *Pilot*	-0.00998	-0.0162	-0.00508	-0.0102	-0.00637
	(-0.492)	(-0.750)	(-0.225)	(-0.436)	(-0.326)
Other independent variables	Yes	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes	Yes
Stock fixed effects	Yes	Yes	Yes	Yes	Yes
Number of observations	113,762	113,762	113,762	113,762	108,296
R-squared	0.160	0.036	0.011	0.010	0.013
Number of stock	2,224	2,224	2,224	2,224	2,191

Table VII

The Impact of Hedge Fund Arbitrage Activity and Reg SHO on Stock Liquidity

This table reports the following regression from February 2003 to July 2007: $y_{i,t} = \mu_t + \alpha_i + \gamma HFArbitrageActivity_i \times During_t \times Pilot_i + \gamma_1 HFArbitrageActivity_i \times During_t + \gamma_2 During_t \times Pilot_i + \left(\theta \Delta Breadth_{i,t} \times During_t \times Pilot_i + \theta_1 \Delta Breadth_{i,t} \times During_t + \theta_2 \Delta Breadth_{i,t} \times Pilot_i + \theta_3 \Delta Breadth_{i,t} + \delta ControlActivity_i \times During_t \times Pilot_i + \delta_1 ControlActivity_i \times During_t\right) + \vartheta' Controls_{i,t} + \varepsilon_{it}$. *Controls* include *Size, Book-to-Market* and *Momentum*. All other variables are defined same as in Table I and Table VI. For brevity, only coefficients of triple interaction terms are reported. All standard errors are clustered at the stock level. The robust t-statistics are presented in the parentheses below the coefficient estimates. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Baseline Regression

VARIABLES	(1) *Amihud*	(2) Turnover	(3) Dollar Volume
HF Arbitrage Activity x *During* x *Pilot*	-0.356**	0.708**	0.661**
	(-2.410)	(2.427)	(2.360)
Control variables	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes
Stock fixed effects	Yes	Yes	Yes
Number of observations	113,757	113,762	113,760
R-squared	0.670	0.098	0.618
Number of stock	2,224	2,224	2,224

Panel B: ΔBreadth and Institutional Activity

VARIABLES	(1) *Amihud*	(2) Turnover	(3) Dollar Volume
HF Arbitrage Activity x *During* x *Pilot*	-0.383**	0.717**	0.683**
	(-2.360)	(2.230)	(2.200)
ΔBreadth x *During* x *Pilot*	-8.788***	14.51*	15.58***
	(-2.579)	(1.952)	(2.686)
AM Activity x *During* x *Pilot*	0.0765	-0.0429	-0.142
	(1.099)	(-0.294)	(-1.029)
OI Activity x *During* x *Pilot*	-0.0616	0.0305	0.196
	(-0.343)	(0.0911)	(0.566)
Control variables	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes
Stock fixed effects	Yes	Yes	Yes
Number of observations	113,757	113,762	113,760
R-squared	0.672	0.102	0.620
Number of stock	2,224	2,224	2,224

Table VIII

Robustness: Time-Series Placebo Test

This table reports the following regression:

$$y_{i,t} = \mu_t + \alpha_i + \gamma HFArbitrageActivity_{\,i} \times PseudoDuring_t \times Pilot_i + \gamma_1 HFArbitrageActivity_i \times PseudoDuring_t + \gamma_2 PseudoDuring_t \times Pilot_i (+\vartheta' Controls_{i,t}) + \varepsilon_{it}$$

HF Arbitrage Activity is the average quarterly change in aggregate hedge fund ownership over one-year prior to Reg SHO. *Pilot* is an indicator variable equal to one if a stock is a pilot stock and zero if it is a control stock. *Pseudo During* is an indicator variable equal to one if an observation is between February 2003 to April 2005, i.e. as if Reg SHO pilot program was effective during such period, and zero otherwise. The placebo test period is from November 2000 to April 2005. For brevity, only coefficients γ's are reported. All standard errors are clustered at the stock level. The robust t-statistics are presented in the parentheses below the coefficient estimates. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Abnormal Returns

VARIABLES	(1) Excess Return	(2) CAPM Alpha	(3) FF3 Alpha	(4) FFC4 Alpha	(5) DGTW Alpha
HF Arbitrage Activity x *Pseudo-During* x *Pilot*	-0.00595	0.0115	0.0199	0.0150	-0.00729
	(-0.359)	(0.615)	(1.118)	(0.790)	(-0.435)
Month fixed effects	Yes	Yes	Yes	Yes	Yes
Stock fixed effects	Yes	Yes	Yes	Yes	Yes
Number of observations	113,428	113,427	113,427	113,427	106,390
R-squared	0.187	0.040	0.012	0.006	0.006
Number of stock	2,167	2,167	2,167	2,167	2,136

Table VIII - *continued*

Panel B: Market Quality

VARIABLES	(1) Amihud	(2) Turnover	(3) Dollar Volume
HF Arbitrage Activity x *Pseudo-During* x *Pilot*	-0.103	0.280	0.313
	(-1.074)	(1.245)	(1.406)
Control variables	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes
Stock fixed effects	Yes	Yes	Yes
Number of observations	113,425	113,428	113,425
R-squared	0.750	0.125	0.654
Number of stock	2,167	2,167	2,167

Table IX

Robustness: Unconditional Test

This table reports the results of following regression: $y_{it} = \mu_t + \alpha_i (or\ \beta_2 During_t) + \beta Pilot_i \times During_t + \beta_1 Pilot_i + \varepsilon_{it}$, where i and t index stock and month; $y_{i,t}$ is *Excess Return, CAPM Alpha, FF3 Alpha, FFC4 Alpha* or *DGTW Alpha*. *Pilot* is a dummy variable equal to one if a stock is a pilot stock and zero if it is a control stock; *During* is a dummy variable equal to one if an observation is between May 2005 and July 2007, i.e. when Reg SHO pilot program was effective, and zero otherwise. All standard errors are clustered at the stock level. The robust t-statistics are presented in the parentheses below the coefficient estimates. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively

Panel A: Unconditional Test with Month Fixed Effects

VARIABLES	(1) Excess Return	(2) CAPM Alpha	(3) FF3 Alpha	(4) FFC4 Alpha	(5) DGTW Alpha
During Dummy x *Pilot*	-0.000756	-0.00128	-0.00136	-0.00127	-0.000659
	(-0.642)	(-1.016)	(-1.057)	(-0.969)	(-0.566)
Month FE	Yes	Yes	Yes	Yes	Yes
Stock FE	Yes	Yes	Yes	Yes	Yes
# of obs.	113,762	113,762	113,762	113,762	108,296
R-squared	0.149	0.027	0.003	0.003	0.002
Number of stock	2,224	2,224	2,224	2,224	2,191

Panel B: Unconditional Test with *During Dummy*

VARIABLES	(1) Excess Return	(2) CAPM Alpha	(3) FF3 Alpha	(4) FFC4 Alpha	(5) DGTW Alpha
During Dummy x *Pilot*	-0.000866	-0.00130	-0.00134	-0.00126	-0.000654
	(-0.740)	(-1.036)	(-1.043)	(-0.963)	(-0.564)
During Dummy	-0.01000***	-0.00653***	-0.000680	-0.000724	-0.00293***
	(-14.79)	(-8.996)	(-0.928)	(-0.962)	(-4.384)
Month FE	No	No	No	No	No
Stock FE	Yes	Yes	Yes	Yes	Yes
# of obs.	113,762	113,762	113,762	113,762	108,296
R-squared	0.149	0.027	0.003	0.003	0.002
Number of stock	2,224	2,224	2,224	2,224	2,191