Converting Short Sales Constraints*

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ABSTRACT

Historically, option market makers were exempt from borrowing shares when short selling. This allowed market makers to hedge their exposures in hard-to-borrow stocks and it allowed short sellers to use put options to short sell without paying high borrowing costs. Regulators removed this exemption in 2008 and in 2013 they also prohibited a workaround using so-called 'reverse conversions'. We find that these regulatory changes caused a significant increase in stock loan fees because they effectively reduced loan supply in hard-to-borrow stocks. Consequently, stock market quality has deteriorated: price efficiency is lower and hard-to-borrow stocks are more mispriced. Our results show that without the OMM exception, equity options are redundant securities among short sellers.

Keywords: Equity Options, Short Sales Constraints, Return Predictability, Price Efficiency, Equity Lending Market.

JEL Classification Numbers: G12, G14

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Historically, option market makers were exempt from borrowing shares when short selling. This allowed market makers to hedge their exposures in hard-to-borrow stocks and it allowed short sellers to use put options to short sell without paying high borrowing costs. Regulators removed this exemption in 2008 and in 2013 they also prohibited a workaround using so-called 'reverse conversions'. We find that these regulatory changes caused a significant increase in stock loan fees because they effectively reduced loan supply in hard-to-borrow stocks. Consequently, stock market quality has deteriorated: price efficiency is lower and hard-to-borrow stocks are more mispriced. Our results show that without the OMM exception, equity options are redundant securities among short sellers.

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I. Introduction

The financial crisis of 2008-2009 produced significant government action to stabilize the financial sector, and one key component of this program was restricting short selling. Some of the actions, such as a ban on short selling certain securities, were short-lived. Other actions, such as the removal of the option market-maker (OMM) exception, have persisted.

This paper is about the importance of the OMM exception in alleviating stock loan supply constraints and the persistent negative consequences of its removal. We document three regimes of options market regulation, in which the OMM exception is officially removed and then reinforced. The removal of the OMM exception has effectively reduced the supply of lendable shares in the stock loan market, which has increased stock loan fees. Higher loan fees, because they inhibit short selling, subsequently result in greater stock mispricing and market inefficiency.

The three regimes we identify are split on two regulatory actions by the Securities and Exchange Commission (SEC). The first was finalized in October 2008, when the SEC removed the OMM exception for all stocks. The OMM exception allowed OMMs to naked short sell in order to hedge option trades as a part of bona fide market making. The goal of removing the exception was to reduce the number of fails-to-deliver (FTD), which are a byproduct of naked short-selling. The SEC followed with a second regulatory action: a Risk Alert issued on August 9, 2013 that identified and banned resets on a trade called a "reverse conversion."[1] Reverse conversions allowed short sellers to circumvent the loss of the OMM exception (though at greater cost). Therefore, prohibiting this trade had a substantial impact, as we will show. We will simply refer the three periods as Early (pre-Sept 2008), Middle (Sept 2008 - August 2013) and Late (Sept 2013 - Dec 2015).

Figure 1 shows the basic patterns across these three regimes and the power of the second event in particular. We plot for each of the three regimes the distribution of two statistics summarized

[1] A reverse conversion is a put-call parity trade that shorts the stock and buys a synthetic share with matched put and call options. The specific behavior banned was the quick buying and re-selling of the stock to reset the clearing clock, avoiding the FTD. In an abuse of terminology for the sake of brevity, we will simply refer to these trades as 'reverse conversions' by which we imply the additional reset behavior that allows naked short selling.

by the Markit Daily Cost to Borrow Score (DCBS), a 10-group ordering based on stock loan fees.[2] Panel A shows that FTD declined from the early to middle regime, as has been documented before (e.g., Stratmann and Welborn, 2013). However, we show that from the middle to late regimes, it again drops and flattens across all DCBS bins. The drop in DCBS 10 is 66% from the early to middle regimes, and 52% from the middle to late regime, which shows the importance of the second action. This pattern is not due to a secular time trend. Overall mean FTD peaked in 2008, dropped to a low in 2013, and have modestly increased through 2015.[3]

The cause of this further reduction is evident in Figure 1 Panel B, where we plot put-call paired option volume. This is an option volume measure intended to capture reverse conversions, and is computed first by taking the minimum of put and call volume across strike-maturity pairs, then computing the daily average by firm across strike and maturity. Strikingly, paired put-call volume spikes in DCBS 10 during the middle period, when only reverse conversions are available to synthetically generate short sales. In the Late regime, when that trade has ceased, option volume across the board drops by 54% on average for bins 1-9 and 92% in bin 10.

The effect of these regulatory changes on loan fees is shown in Figure 2. Panel A plots the stock loan fees, which come from Markit, summarrized again by DCBS bin and regulatory regime. Within each DCBS bin, it is clear that stock loan fees are rising across the regimes. Panel B shows option implied fees, which follow a hump-shaped pattern within each DCBS bin across regimes. More helpful is Panel C, which shows the difference between the two, computed each day, then summarized. Here, we see the structural shift in the markets, primarily in DCBS bins 1-9. In the early regime, across all DCBS bins, loan fees on average exceed option implied fees. This stands to reason, since OMM could avoid paying high fees by naked short selling (Evans, Geczy, Musto, and Reed, 2009). In the middle regime, the two sets of fees are very close except in DCBS bin 10, where we expect the most activity in reverse conversions. This trade operated in a murky regulatory area, and so is likely only prevalent when most lucrative due to regulatory risk. In the final regime,

[2]The DCBS is not a decile rank, it is a 1-10 bin ordering of stocks by how costly they are to borrow. Bin 1 typically has approximately 80% of the sample because most stocks are inexpensive to borrow. The numbers behind Figure 1 (and other similar computations, showing robustness), are the Appendix

[3]A plot of this pattern is in the online appendix, but can be easily recreated with the raw SEC FTD data.

we see that now option implied fees exceed loan fees (the differences are now negative). This stands to reason if, as noted by Engelberg, Reed, and Ringgenberg (2017), OMM are now exposed to short selling risk by selling put options that must be continually re-hedged.[4]

It is clear from these basic patterns that some structural shift has occurred in these two markets. Our primary contribution is to document that the structural shift is due to regulatory actions in the equity options market, and these regulatory actions affected loan fees in the stock loan market, which in turn affect stock market efficiency.[5] We identify our specifications with a differences-in-differences framework around both regulatory actions. The primary sample is all stocks with either a lending market or tradable options (or both), monthly from July 2006 to December 2015, though for most analyses we subsample symmetric windows around the regulatory events for the difference-in-differences approach.

A difference-in-differences model's identifying assumption is that the time event is 'clean' – i.e. the only change was the regulatory action. This is clearly not the case in October 2008. To mitigate this, we compare data before the initial emergency action on July 2008 to data after the final rule was implemented in October 2008, which therefore removes (at least) the short selling ban as a confounding event (Battalio and Schultz, 2011). However, the financial crisis was cataclysmic enough its effects certainly outlived this narrow window and so we do not solely rely on that event for identification. The second regulatory action on August 9, 2013 is more plausibly isolated, however it is smaller in scope, only applying to the very hardest to borrow stocks due to its complexity and murky legal status.

In addition to the two-event difference-in-differences, we also test the early regime (pre-July 2008) versus the late regime (post-Aug 2013). This removes the crisis and its immediate aftermath as a possible source of variation and shows the persistent effect of both SEC actions, without con-

[4]Muravyev, Pearson, and Pollet (2016) examine short selling risk, but do not find this premium. However, their data set ends in 2013. We find a premium primarily in post-2013 data because only then do OMM have to borrow the stock.

[5]Others have noted that loan fees went up around the financial crisis of 2008 (Kolasinski, Reed, and Thornock, 2013, Stratmann and Welborn, 2013), but have not identified the effect of regulatory action due to the confounding effects of the financial crisis. We are the first to show that this pattern has continued and persisted as the SEC reinforced its regulatory stance in August 2013.

tamination from the financial crisis or subsequent recovery. This large gap perhaps also stretches the identifying assumptions of the difference-in-differences approach. However, any alternative explanation of our results would have to show what would fundamentally alter the relationship between equity options markets and stock loan markets over this period.

Our first result is to show across the three regulatory regimes that both stock lending fees and option implied lending fees have significantly increased, while the difference between the two has decreased. Since our outcome variable is fees, we use utilization (Shares Borrowed/Shares Supplied) as a treatment variable in the difference-in-difference specification instead of a fee-based variable to measure how hard a stock is to borrow. Across each regime change, as well as when we test the early vs. late regimes, we see statistically significant increases in the stock loan fee and option implied loan fee among high utilization stocks. We also see statistically significant decreases in the difference. This is a rigorous statistical test of what is easily seen in Figure 2. We also show that this increase in loan fees is due to the loss of 'shadow' loan supply in the form of the FTD shares. Our evidence of this is twofold: 1. in a difference-in-differences framework that over the same time, measured stock loan supply has *increased*, and 2. for a given change in demand among hard to borrow stocks, the change in loan fees is much greater after the removal of the OMM exception.

Second, with the price delay measures of Hou and Moskowitz (2005), we show in a differences-in-differences framework that delay has increased (i.e. price efficiency has decreased) among hard-to-borrow stocks with traded options.[6] This result extends the chain of causality: forcing OMMs to borrow stock generates an increase in short selling constraints, which in turn cause a reduction in price efficiency.

Third, we examine mispricing, which we measure as the magnitude of return predictability among short-constrained stocks. We show that mispricing has increased among hard-to-borrow stocks with traded options across the two regulatory actions. In contrast, among hard-to-borrow stocks that only have stock loans possible (no traded options), mispricing has remained the same

[6]Boehmer and Wu (2013) showed that short selling is associated with greater price efficiency as measured by the Hou and Moskowitz (2005) delay measure.

or even decreased during the same time period. This is striking given the difference in populations – stocks without options are typically smaller, less liquid stocks more prone to mispricing. This also helps eliminate the alternate explanation of a demand shift as causing the increase in fees: this alternative explanation has to explain why there has been a differential effect between stocks with options vs those without traded options.

Given the length of our data set (2006-2015), we can show these patterns as independent of the financial crisis, which is novel compared to previous studies (e.g., Stratmann and Welborn, 2013, Battalio and Schultz, 2011).[7] If our only result was around regulatory actions in Q3 2008, one could dismiss our results as confounded with the Financial Crisis and its aftermath. However, since we also find significant changes with the August 2013 SEC clarification on reverse conversions, we can identify regulatory action as a decisive factor. As further evidence, we persistently find significant differences comparing the pre-July 2008 time period with the post-August 2013 time period. Because this omits July 2008 - August 2013, this removes any possible confounding due the financial crisis and subsequent recovery.

We do not find any evidence of option market dislocation as in Battalio and Schultz (2011). Instead, our findings are consistent with a tight linkage between stock loan markets and option markets post-August 2013, now that OMM are required to borrow in the stock lending market. Interestingly, this implies that from the perspective of a short seller, options are now redundant securities. This redundancy is in contrast to markets prior to 2008, when OMM could naked short sell and therefore the options market provided elastic supply of shares for short selling when they were needed most, thus alleviating short constraints.

We find that recent regulatory actions taken by the SEC have diminished market quality by increasing short sales constraints, though we have focused narrowly on one aspect of these markets, the stock lending market. While the SEC actions have succeeded in reducing failures-to-deliver, the unintended consequence seems to be higher stock loan fees and thus much larger short sales

[7] Stratmann and Welborn (2013) compare Q2 2008 to Q4 2008 and find a reduction in FTD and option volume and increased loan fees. Battalio and Schultz (2011) investigate the effect of the short selling ban of 2008 on option market function.

constraints. These constraints, in turn, lead to less price efficiency and greater mispricing.

II. Background

In this section, we review the relevant literature to our research question and then more fully document the timeline of SEC regulatory actions taken with regard to short selling and options markets since 2007. We then fully develop our hypotheses.

A. Related Literature

Our work is closely related to the existing literature on the link between short selling and options markets, which has two viewpoints. The first focuses on the short demand side, where an investor expecting negative returns (or implementing a long/short arbitrage) can choose to either use stock markets or options markets to establish his short position. This literature posits that the existence of options markets mitigates short selling constraints. One of the earliest studies on this topic was Figlewski and Webb (1993), who show that optionable stocks have significantly higher short interest, indicating that options seem to increase supply for short sellers. In addition, Sorescu (2000), Danielsen and Sorescu (2001), and Battalio and Schultz (2006) all find that options ease short sale constraints by expanding supply for short positions. Danielsen and Van Ness (2007) provide counter evidence.

The second viewpoint of literature investigating equity lending markets and options markets focuses on the hedging motive of options market makers (e.g., Battalio and Schultz, 2011, Jameson and Wilhelm, 1992). If an investor chooses options to establish a short position, the option market maker then borrows and shorts the underlying stock to hedge the put option written (or call option bought). Of interest here is whether options markets act as additional supply or simply a pass-through for short demand to the stock loan market. If short sellers buy put options, for instance, but the market maker writing that option hedges by shorting the stocks and borrowing in the lending market, then the option market does not increase supply, but rather passes through the demand to the equity lending market. Battalio and Schultz (2011) study the 2008 short selling ban and find

strong support for this view.[8] Our findings show that options are a vital component in effective short selling and alleviating mispricing, but that it comes through the OMM exception and FTD as an expansion in stock loan supply, not via option listing alone. We confirm that the OMM hedging is a vital and universal activity, such that without the OMM exception, option markets do not expand supply in the stock loan market.

Our work is also related to the literature investigating failures-to-deliver. With pre-September 2008 data, Evans, Geczy, Musto, and Reed (2009) show that options market makers (OMM) fail to deliver when expensive-to-borrow stocks are recalled and this failure passes through to options prices as violations of put-call parity. Boni (2006) provides evidence that these FTD were strategic. Stratmann and Welborn (2013) show that the Evans, Geczy, Musto, and Reed (2009) effect was mitigated (i.e. FTD decreased) when the SEC revoked the options market maker exception in October 2008. However, they also show that this regulation was not fully effective, concluding "... the options market is an alternative to the securities lending market when borrowing constraints exist." (Stratmann and Welborn, 2013, p. 203), but do not explain how this happens. We provide evidence that the option market continued to provide additional supply through a reverse conversion trade (with the accompanying naked short selling), which was subsequently forbidden by the SEC in August 2013.

Our work is most closely related to recent papers investigating short selling and stock options around the 2008 crisis. Fotak, Raman, and Yadav (2014) show that higher FTD lead to higher liquidity and greater pricing efficiency, and that both liquidity and price efficiency decline among banned stocks during the short sale ban of 2008. They find no negative consequences of FTD. Stratmann and Welborn (2013) compared data from the second quarter of 2008 to the fourth quarter of 2008 and find that FTD declined, option volume declined, and stock loan fees increased. All of these findings are consistent with the authors' hypotheses, but they cannot be differentiated from the effects of the financial crisis. Our longer time period and second regulatory action in August 2013 better identify regulatory action as the driving factor behind the observed changes in markets.

[8] Also see, in particular, the discussion in Battalio and Schultz (2011) on option market maker hedging motives and behavior.

We also investigate option market-lending market dislocation, price efficiency and mispricing due to short constraints, in addition to basic market shifts like volume, liquidity, and price.[9]

B. Timeline of SEC rule changes

We divide our sample into three regimes based on two SEC actions. The split in our monthly data happens around the July-October 2008 and August 2013 events, respectively. To better provide context for these choices, we briefly summarize the timeline of events regarding relevant SEC action, short selling, and stock options during this period.[10]

Before 2008, the equity options market provided a virtually unlimited supply of shares for short sellers. The options market maker (OMM) had an exception to the close-out requirement, which means she could naked short sell stocks when done for bona fide hedging (the "OMM exception"). Therefore, a short seller could simply purchase a put option rather than short the stock, and the market maker could in turn short the stock (at no cost to her) to hedge that sale. This behavior was documented by Evans, Geczy, Musto, and Reed (2009) who showed that failure was an option for the option market maker and that this behavior was mutually beneficial to both the OMM (who kept the lending fee) and trader (who could profit from his short sale).

A downside of this behavior was a high rate of so-called "failure-to-deliver" (FTD). A FTD happens when the stock buyers of the shares sold short cannot obtain the shares from the options market makers at clearing. Since she had sold short without buying the shares, the OMM cannot deliver them to the buyer. While on the surface, this seems problematic, there are no documented negative effects of FTD in the academic literature. Rather, Stratmann and Welborn (2013) and Fotak, Raman, and Yadav (2014) indicate that FTD *enhance* market function, likely through the channel we identify: a shadow supply of stock loans for short sellers.

The first recent action regarding the OMM exception was proposed on August 7, 2007 (Amendment to Regulation SHO, Proposed Rule Release No. 34-5613). This rule proposed the removal of the option market maker exception, which would have the effect of requiring OMM to locate

[9]Thanks in particular to Rich Evans for useful conversations about failures-to-deliver.

[10]Battalio and Schultz (2011) also provide an excellent timeline of the events of Fall 2008.

and borrow shares in order to hedge put option sales. Comments were closed on September 13, 2007 and no final action was taken by the SEC. To put this in context, this proposed rule came shortly after the announcement that two Bear Stearns hedge funds had "very little value" even after a bailout by the firm a month earlier.[11] It also corresponded with the quantitative hedge fund meltdown (Khandani and Lo, 2011).

Subsequently, the financial crisis began to unfold and Bear Stearns was taken over/bailed out in March 2008. On July 7, 2008, the SEC again proposed removing the OMM exception, with a comment period ending August 13, 2008. However, the SEC issued an emergency order eight days later on July 15 banning short sales and eliminating the OMM exemption only on a list of financial stocks.[12] The proximate reasoning was downward price pressure on financial firms' equity, particularly Fannie Mae and Freddie Mac, as well as Lehman Brothers.[13] The SEC expanded the list of securities on September 18, 2008, but in this same Emergency Order, the SEC reversed itself and reinstated the OMM exception on banned stocks, reiterating that it was only to be used for bona fide market making.[14] A month later, the SEC reversed course again, and finalized the rule removing the OMM exception on October 17, 2008.[15] This action clearly succeeded in its primary goal: to reduce the numbers of failures-to-deliver (Stratmann and Welborn, 2013, Fotak, Raman, and Yadav, 2014), though the regulatory uncertainty (and short sales ban) had large deleterious effects on options markets (Battalio and Schultz, 2011).

The timeline of SEC action on options markets and short selling does not end here because traders adapted to the new rule. After markets began recovering and the short sales ban was lifted, traders began using so-called "reverse conversions" to synthetically expand the supply of lendable shares for short selling. Reverse conversions are typically used as a put-call parity arbitrage trade,

[11] 2 Bear Stearns Funds Are Almost Worthless, July 17, 2007, New York Times, http://www.nytimes.com/2007/07/17/business/17cnd-bond.html

[12] Emergency Order Pursuant to Section 12(k)(2) of the Securities Exchange Act of 1934 Taking Temporary Action to Respond to Market Developments, SEC Rel. No. 34-58166.

[13] For a nice contemporaneous summary of market sentiment, see SEC Moves to Curb Short-Selling, July 16, 2008, The Wall Street Journal https://www.wsj.com/articles/SB121614248005255151.

[14] Emergency Order Pursuant to Section 12(k)(2) of the Securities Exchange Act of 1934 Taking Temporary Action to Respond to Market Developments, SEC Rel. No. 34-58592.

[15] Amendments to Regulation SHO, SEC Rel. No. 34-58775.

where the arbitrageur sells the stock and buys a synthetic share with put and call options, arbitraging the spread between them. However, post-2008, this trade was put to use by traders to short sell stocks. The trader would buy the entire market-neutral trade from his broker, then sell the stock, holding the synthetic short position. This trade is more expensive and more complicated than buying a put option, and also operated in a regulatory grey area since the position had to be re-established every few days to avoid a failure-to-deliver.[16] This "reverse-conversion-as-short-sale" behavior ended on August 9, 2013, when the SEC issued guidance specifically identifying this trade and notifying market participants that the SEC considered it an illegal bypass of the fail-to-deliver requirements.[17]

In summary, we argue that per SEC regulation since August 9, 2013, the equity options market no longer acts as an additional market for informed shorts as shown empirically by Sorescu (2000) and Danielsen and Sorescu (2001), and now simply passes demand through to the stock loan market. We will show that this regulatory change has profound implications for market function, in the form of price efficiency and mispricing.

C. Hypotheses

We have just documented a rule change by the SEC that disallowed naked short selling by options market makers, implemented in two stages. Our overarching hypothesis is that the removal of the OMM exception by the SEC had the following sequence of effects:

1. Reduced the (effective) supply of shares for short sellers.

2. Increased short selling constraints among the stocks affected (as proxied by loan fees).

3. Decreased market efficiency demonstrated by lower price efficiency and greater mispricing.

[16] If a market maker sells and re-buys the position every three days, it resets the 'clock' on clearing and thus avoids a formal failure-to-deliver. This obeys the letter of the rule but violates the intent of the rule. We provide more detail and an example of a reverse conversion in the appendix

[17] "Strengthening Practices for Preventing and Detecting Illegal Options Trading Used to Reset Reg SHO Close-out Obligations," SEC Risk Alert Volume III, Issue 2, August 9, 2013.

As stated in Evans, Geczy, Musto, and Reed (2009), a failure-to-deliver is a form of zero-rebate equity loan from the buyer to the seller who fails to deliver. Since FTD primarily happen among hard-to-borrow stocks, this behavior has the effect of alleviating supply constraints right as they are most likely to bind. Therefore, the removal of this exception (all else equal) should increase lending fees by restricting supply to that which is available in the equity loan market alone.[18] Therefore, we hypothesize that the removal of the OMM exception generated a supply shock to the equity lending market.

Hypothesis 1: *The removal of the OMM exception caused a supply shock (reduction).*

We provide some indirect (equilibrium) evidence in Figure 3. This figure plots the relationship between supply, demand, and lending fees in the different regimes, but not in a Price-Quantity framework. Instead, on the x-axis, we plot utilization, which is the ratio of Quantity Demanded divided by Total Supply Quantity. This is a variable in the Markit data on stock lending. We plot ten points per regime, one pair averaged within a DCBS bin, which is a Markit proprietary ten-bin grouping of stocks by cost to borrow. Paired with each utilization observations is the average lending fee. This plot then captures the intersection of supply and demand on the x axis and the lending fee on the y axis. The figure shows a clear shift in the curve across the three regimes, such that for a fixed utilization (imagine a vertical line), the fee is increasing by regime. Thus, for a given demand and supply (i.e. utilization), the fee is higher in more recent regimes.

This pattern is consistent with the options market, via FTD, providing more supply for short sellers in the early regime, then disappearing after the SEC action to revoke the OMM exception. Consider the early regime curve, in blue. Now, assume that some amount of supply is not recorded, but part of the FTD instead. This means that supply, in the denominator of utilization on the x axis, is understated.[19] Thus, if the hidden supply provided by OMM FTD were included, true utilization for a given fee would be lower, and the curve should be shifted leftward, thus bringing it more

[18] Blocher, Reed, and Van Wesep (2013) model such a supply shock, specifically showing that reductions in supply via loan recalls around dividend effects cause higher loan fees.

[19] FTD will not show up in the supply numbers provided by Markit, which are derived from beneficial owners of the stock providing their portfolios as potential loan inventory.

in line with the later regime curves where the effect of FTD is minimal. The same pattern exists between the middle and late regimes – the middle curve, assuming inclusion of FTD into supply, would shift leftward, bringing it in line with the late curve where there is minimal FTD hidden supply due to SEC enforcement. While this is suggestive, it is not rigorous. We show later in our Results section that this pattern also holds up in a multivariate regression setting.

C.1. Market function: price efficiency and mispricing

If the lowering of FTD reduced stock loan supply and increased short selling constraints, we expect diminished price efficiency because it will take longer for information (particularly negative information) to be impounded into prices (Boehmer and Wu, 2013). We also expect more mispricing, in particular overpricing, since short investors are more constrained from participating in markets due to higher cost to borrow shares (e.g., Miller, 1977).

Hypothesis 2: *The removal of the OMM exception caused decreased price efficiency.*

Hypothesis 3: *The removal of the OMM exception caused increased mispricing.*

To be clear, we articulate our null hypothesis. Most proponents of the rule change believed that reducing FTD would smooth market function without having a negative effect. Some believed that short selling (as proxied by FTD data) was *causing* mispricing, so eliminating FTD should improve price efficiency and reduce mispricing. However, to be conservative, our null hypothesis is simply that the rule change had no effect on market function: price efficiency and mispricing should be the same, on average, before and after.

In some cases, we include results for stocks *without* traded options for comparison. These stocks are not a good baseline test or control group because stocks without traded options are not comparable to those with traded options, because options listing is endogenous (Mayhew and Mihov, 2004). However, these results provide context or a frame of reference in some cases.

III. Data

Our sample is all CRSP common stocks (share codes 10 or 11) from July 1, 2006 through December 31, 2015 that have stock loan data, traded options, or both, though our primary sample includes only stocks with both stock loan data and traded options. The starting date is due to data availability within the Markit/Data Explorers dataset. Prior to July 2006, the Markit data had much lower coverage of the securities lending market.

Our univariate summary statistics are primarily using daily frequency data, but aggregating to the monthly level and then summarizing would not affect our results. For our regression analysis, we use the monthly frequency for comparability with the extant literature on short selling constraints and because the price efficiency measures we use are lower frequency measures.

A. Equity Options

We obtain option data from OptionMetrics for the period 1996 through 2015, though in most cases we only use 2006-2015. We drop options with greater than 180 days or less than 7 days to maturity and an offer price greater than ask price, both of which must be greater than zero.[20]

We also obtain the risk free rate from OptionMetrics, and linearly interpolate it for days to maturity where no rate is listed. Our sample of options is unique by firm/date/strike/expiration/put-call-flag, and where duplicates arise, we keep the option with the highest traded volume. Duplicates can arise because OptionMetrics aggregates data from multiple sources, so this choice has the effect of choosing the most liquid option.[21]

We include dividend-paying stocks in our sample. Thus, we need to account for both the present value of the dividend and the early exercise premium. We obtain dividends from Op-

[20] We correct the lag in the open interest variable starting November 28, 2000 in Option Metrics as noted in Barraclough and Whaley (2012).

[21] For options data starting in 2006, we use the closing stock price data from OptionMetrics. As of February 13, 2006, U.S. equity option markets close at 4pm, instead of 4:02pm ET (SEC release 34-53246). Prior to this change, Battalio and Schultz (2006) note that option markets close at 4:02pm ET while equity markets close at 4:00pm ET. The equity prices provided by OptionMetrics prior to 2006 are the closing (i.e., 4:00 pm ET) prices, which could lead to a bias in the calculation of implied loan fees. Accordingly, for options data before 2006, we take the last trade price on or prior to 4:02pm ET from TAQ. We make this adjustment, though it matters little since our primary sample starts in July 2006.

tion Metrics, and only keep regular dividends (distribution type = 1) that are paid annually, semi-annually, quarterly, and monthly. Because we limit the time to expiration to 180 days, we only need to keep the next six dividends for any given stock. We exclude contracts for stocks that had liquidating dividends, canceled dividends, and duplicate dividends (more than one payment in a day).

We compute the early exercise premium (EEP) using the Cox-Ross-Rubenstein (Cox, Ross, and Rubinstein, 1979) binomial option pricing model.[22] For each option, we compute both the European and American price of the option using binomial trees and take the difference, using the one year trailing daily volatility as the volatility input. The OptionMetrics implied volatility will be systematically biased for hard-to-borrow stocks due to put-call parity violations (Cremers and Weinbaum, 2010), so we cannot use it to get a precise and unbiased EEP estimate.[23]

Summary statistics for our options sample are displayed in Table I. The implied volatility is provided by OptionMetrics, and Early Exercise Premiums (EEP) are computed as just described. The Ofek-Richardson-Whitelaw measure is the ratio between the closing stock price and option implied stock price for put-call parity to hold, as computed in Ofek, Richardson, and Whitelaw (2004). This ratio is calculated as $R = 100 \times ln(S/S^i)$, where S is the observed closing stock price and S^i is the implied stock price calculated assuming put-call parity holds. If put-call parity violations are symmetric, then the distribution of R should be centered around 0.

B. Equity Lending Data

Information on the cost of short selling comes from Markit (formerly known as Data Explorers), a leading provider of data in the equity loan market. Markit aggregates and distributes information regarding equity loan positions at the daily frequency. The data is sourced directly from a wide variety of contributing customers including beneficial owners, hedge funds, investment

[22]Call options on stocks without dividends will never be exercised early and so have an EEP = 0. All other EEPs are computed.

[23]Barone-Adesi and Whaley (1987) showed how to estimate the EEP, but we are able to precisely compute the EEP by computing both the American and European option price and taking the difference. Thanks to the Vanderbilt ACCRE computing grid for multiple weeks running dozens of 8-core parallel MATLAB jobs. The EEPs are available from the authors and will be posted online post-publication.

banks, lending agents, and prime brokers. Our sample includes all U.S. equities and exchange-traded funds in their database, from 2002 to September 2016, but we eliminate data prior to July 2006 due to its unreliability and 2016 due to the lack of options data.

The database contains a number of statistics summarizing transactions in the equity loan market at the stock-day level. The SAF is the simple average fee, which represents the buy-side (e.g. hedge funds) cost to borrow, the Daily Cost to Borrow Score (DCBS) is a 1-10 grouping of stocks, daily, by how expensive they are to borrow. We also use utilization, which is the ratio of shares supplied to shares demanded, each of which is also available alone in the data. We also use the BO Inventory Concentration Ratio for our measure of Inventory Concentration.

To measure stock loan fees, we begin with the simple average fee (SAF) provided in this dataset, but this field is not populated for every observation. Thus, we follow the procedure in Blocher and Whaley (2016), which interpolates the missing lending fees with the SAF provided and replaces missing values with the estimates back into the data using the DCBS monthly average SAF, because the DCBS is populated for every observation. They show that this estimation procedure yields a correlation coefficient very close to 1 when comparing estimated fees to known market-based fees. Unless we specifically identify the fee as the Markit SAF, when we refer to lending fees, we mean the Blocher and Whaley (2016) interpolated fee.

C. Option Implied Lending Fees

To facilitate the comparison of lending costs between equity loans and options, we compute an *Option Implied Loan Fee*. Conceptually, this is the required lending fee to eliminate the put-call parity deviations identified in Ofek, Richardson, and Whitelaw (2004).

In the U.S., a short seller must borrow a share in the equity lending market and she must use the proceeds as collateral for the position. The short seller then sells the share in the stock market and hopes the stock price falls. At the end of the transaction, the short seller buys a share in the stock market and returns it to the lender. The collateral is typically invested in money market instruments and thus earns a risk-free rate of return, r_f. However, at the end of the transaction, the short seller

only receives an amount, rr, often termed the *rebate rate*. In effect, the short seller is paying a loan fee, expressed as a percentage of the share's price, to keep this position open and this fee is given by the difference between the actual rate of return and the rebate rate (e.g., $Loan\ Fee_{i,t}$ = r_f - rr). Occasionally, the rebate rate can be negative, indicating a high loan fee. Accordingly, the cash-flow for a short seller who sells a share of stock i on date t for price S and pays a loan fee f is as follows:

$$S_{i,t} - S_{i,t} \times e^{-f(T-t)}, \tag{1}$$

where T is the end date of the position. By the law of one price, the cost of initiating a traditional short position must equal the cost of a synthetic short constructed with equity option contracts. It is well known that the payoffs of a short transaction can be replicated by selling an at-the-money call option and simultaneously buying an at-the-money put contract. Thus, by the law of one price, it must be that:

$$Call_{i,t} - Put_{i,t} = S_{i,t} - S_{i,t} \times e^{f(T-t)}, \tag{2}$$

where $Call$ is the observed price for a call option on stock i on date t maturing on date T with strike S and Put is the observed price for a put option on stock i on date t maturing on date T with strike S. Of course, with a few minor modifications, equation 2 is the familiar put-call parity equation for non-dividend paying stocks originally defined by Stoll (1969):

$$Call_{i,t} - Put_{i,t} = S_{i,t} - K \times e^{-r_f(T-t)} - EEP, \tag{3}$$

where $Call$ is the observed price for a call option on stock i on date t maturing on date T with strike K, Put is the observed price for a put option on stock i on date t maturing on date T with strike K, S is the price of stock i, and EEP is the early exercise premium for American options (both put and call EEP are combined here into a single EEP). Note that in a frictionless market, r_f is equal to the risk-free rate on a zero coupon bond that matures at time T.

However, in practice the implied interest rate r_f that makes equation 3 hold will be influenced by the cost of shorting in accordance with the law of one price. Thus, we reformulate the put-

call parity equation with a generalized discount rate and include K expected future dividends for generality:

$$Call_{i,t} - Put_{i,t} = S_{i,t} - K \times e^{-f(T-t)} - EEP - \sum_{k=1}^{K} D_k e^{f(T_k - t)}, \tag{4}$$

and solve for the loan fee f. Since this loan fee is defined for each put-call pair (by expiration and strike price), we estimate a firm's daily option implied loan fee as the mean implied loan fee across all possible put-call pairs for each stock and date. We weight this mean by volume and open interest, as noted. [24]

Unfortunately, computing option implied loan fees using market quoted option data generates a very noisy dataset. This problem has been noted in the literature estimating risk neutral distributions (RND) (Breeden and Litzenberger, 1978) for individual stock options, which is why most of the literature on RNDs has focused on index options. Yet, even estimating the RND for an index option has proven difficult, such that various smoothing methods have been developed (Figlewski, 2008). To get a more precise measure of a stock's option implied fees, we follow the approach of Carr and Wu (2010) to develop a volatility surface across a grid of pre-determined strike prices and maturities. Then, focusing on the at-the-money series, we compute option implied fees for varying maturities, which we then average into a single estimate per stock-day.[25]

D. Other data

We obtain fail-to-deliver data in total shares from the SEC website.[26] Before September 16, 2008, reports of less than 10,000 were omitted from the data, after that date, all fails were reported. To ensure comparability since September 2008 corresponds to our first regulatory action, we adjust the later data to omit observations with less than 10,000 shares. This has no difference in our reported results.

[24] It could be argued that the discount rate for the dividends should simply be r_f, not f. However, because the dividend theoretically reduces the stock price and thus the amount of reinvested collateral for a stock loan, we believe that f is the correct discount rate. We compute it both ways and find the difference to be minimal.

[25] This procedure will be discussed in more detail soon in a new working paper.

[26] https://www.sec.gov/help/foiadocsfailsdatahtm.html

Summary statistics for our combined, monthly sample are in Table II. In Panel A, we sort the data by market capitalization decile to provide a familiar ordering of the data, as observed in the summary of market capitalization, volume, volatility, and spread. The next four items are from the stock loan market, which are estimates of demand and supply (both in $M in market value), the utilization, which is Demand/Supply, and the interpolated lending fee in basis points. The remaining columns summarize data from the options market: Volume, Open Interest, and Spreads. Each of these are computed as the mean across option contracts each day, then the monthly value is the mean of that daily value. "Pair" measures are paired puts and calls by strike and expiration, with the minimum Volume and Open Interest across pairs kept and the maximum spread across pairs is kept.

Panel B presents the same data, but sorted differently. Here it is sorted by the DCBS, which is a proxy for difficulty in borrowing, with higher DCBS indicating harder to borrow stocks (by loan fees). Higher DCBS firms are typically smaller (though the average market capitalization in DCBS 10 is $218, which places it between market cap deciles 4 and 5) and more volatile. They also have greater option market activity by all measures, though options spreads are somewhat consistent across DCBS bins.

IV. Identification

Our identification stems from two regulatory events: the removal of the OMM exception in July-October 2008 and the SEC Risk Alert officially banning reverse conversions as a method of naked short selling on August 9, 2013. Our primary test is a difference-in-differences method, which assumes that the first difference, in our case the regulatory action, is the only event that affects the 'treated' group.

The 2008 event is fraught with challenges. First, the crisis itself had multiple regulatory actions, market reactions (and over-reactions) that would confound any result relying on that action alone. Second, there isn't a clear 'event' upon which to condition. Since multiple, contradictory SEC actions spanned July to October 2008, generating significant uncertainty, we drop these four

months from our analysis.[27]

The second event is clean – i.e. nothing else of note happened in August 2013 – but it may not be large enough to generate a result. This is ultimately an empirical question; if we find a result, then it was big enough. Another critique is that the event itself is not relevant, rather we are just picking up a time trend and any breakpoint in 2012-2014 would generate a similar result. The burden is to show that this second regulatory action actually changed trader behavior. This critique may be valid given the time trends in option volume shown in Figure 4. Whether measured as Open Interest or Volume, among Calls or Puts, summing or averaging, there is a clear hump-shaped pattern in option market activity. The peak is right around the financial crisis of 2008. Since then, equity option markets have shown a pretty clear downward trend in volume and open interest. We need to show that the second regulatory event had a clear effect specifically on hard-to-borrow stocks, which is the second difference in the difference-in-differences approach.

To see the impact of this second event in particular, turn again to Figure 1. Each statistic is summarized across the Markit Daily Cost to Borrow Score (DCBS), which is a proxy for lending fees. The DCBS is not a decile grouping: approximately 80% of the observations are in DCBS 1, scores of 2 and higher typically represent stocks that are "on special" or hard-to-borrow. Each statistic is summarized separately in the three regimes just described to see the change in behavior.

Panel A plots fails-to-deliver (in millions of shares), which as already noted elsewhere (Stratmann and Welborn, 2013, Kolasinski, Reed, and Thornock, 2013), decreased significantly after the OMM Exception was removed in October 2008. However, note that in the middle regime, there is still a weak upward trend as stocks get more expensive to borrow, with pretty substantial fails in DCBS 10. The pattern flattens out substantially from the early to middle regimes, but again drops from the middle to final regimes, mostly among the highest DCBS stocks. To emphasize the importance of the second SEC action in 2013, FTD in the DCBS 10 bin dropped by 66% after the first regulatory action in 2008, and by 51% after the 2013 action.

[27] An early version of this paper instead split this four months between the early and middle regimes, and found similar results, so this omission is not vital to support our findings. We omit these months because we believe that it is the most correct approach in terms of identification.

The most important piece of evidence in favor of the importance of the second regulatory action is in Panel B, which plots put-call option volume.[28] We take put-call pairs daily across strike and maturity and compute the minimum volume of each pair (omitting zero open interest observations). This is intended to identify the volume of reverse conversions, which require both contracts. We then take the daily average across strike and maturity, then average across days again to get monthly averages. In the early regime, volume shows higher levels across the DCBS and a general upward trend with DCBS. In the middle regime, we see that for DCBS 1-9, volume flattens out, but in DCBS 10 it spikes up to 70, more the double the next largest observation in any DCBS, in any regime. This shows how all the options volume has moved to the most lucrative to short since the reverse conversion bypasses the stock loan market. It also shows how traders know this is a grey area, legally, since they primarily seem willing to do the trade when it is very profitable, implying an extra premium required. In the Late Regime, after August 2013, when the SEC outlawed the trade explicitly, we see all option volume drop substantially, by about half or more across all DCBS groups. This lack of volume in the options market is an indicator that (among other possible causes), the inability to short was once an important generator of option trades and no longer is possible.

It may be that this final regulatory event is not convincing. Therefore, in subsequent tests, we not only test differences between the early and middle, then middle and late regimes, but we also test the early versus late regimes. This has the effect of omitting the middle regime, when markets are experiencing the aftermath of the financial crisis. By any estimation, markets had recovered by August 2013 and so this test should be free of confounding effects from the financial crisis. In addition, this can be seen as a test of the combined effect of both regulations, since both events happened between the early and late regimes.

In unreported results, we also test that our difference-in-differences framework is fully identified by re-running our specifications with plausible control variables that explain the dependent variable in an OLS specification. If the difference-in-difference is well specified, these additional

[28]The same pattern exists in open interest, as well as if we sum volume across contracts, or take the max of min vol across daily contracts, available in the appendix

variables should not affect the magnitude or statistical significance of the difference-in-differences estimated coefficient. In all specifications that we report, this is the case.

V. Results

We have three main sets of results. First, we document that regulatory action is instrumental in loan fee increases among hard-to-borrow stocks. We provide evidence that the mechanism is the reduced loan supply due to the limitation of FTD.

Second, we implement the two Delay measures of Hou and Moskowitz (2005) to measure price efficiency across the three regimes. We find that delay has increased (price efficiency has decreased) comparing early to late regimes, and some evidence that it increased around the August 2013 action. We find no decrease in price efficiency around the financial crisis.

Third, we measure mispricing as proxied by return predictability. Among stocks with traded options, we find return predictability to be larger in the recent regime compared to pre-July 2008. In contrast, return predictability has *decreased* among stocks with only stock loans available (and no traded options).

A. Increases in Loan Fees: Fails-to-Deliver as Lost "Shadow" Loan Supply

We start by documenting the increase in loan fees and showing that it is the result of the contraction of supply available in the OMM exception, and the resulting loss of FTD "inventory". Of course, the loan fee increases are already clear looking at Figure 2, Panel A. We can clearly see, at least comparing the Early to Late regimes (or Early to Middle regimes) that fees have increased, and increased the most for stocks that are most costly-to-borrow (higher DCBS groups).

There is further evidence of fee increases in Figure 5. This plots the distribution of the Simple Average Fee (SAF) from Markit, using a box-and-whisker plot for each year. Each box plots the interquartile range, and the upper and lower 'whisker' show the 5^{th} and 95^{th} percentile. The upper and lower panel plot the same data, but with different resolution. The upper panel ranges from 0 to 1,200 bps to show the whole distribution. The lower panel ranges from -50 to 200 bps to focus

on the pattern in the mean and median. The mean of the SAF rises from about 50 bps in 2007 up to between 150-200 in the past few years. The distribution is also more skewed than before, with the mean well above the 75th percentile.

Figure 5 shows the challenges of using the October 2008 regulatory action as instrumental. Loan fees clearly fall from 2008 to 2009 by any measure: mean, median, any percentile - even the standard deviation is lower. This stands to reason after the huge drop in financial markets that there would be little demand for short selling in 2009 across all stocks. Indeed, the S&P 500 did not recover its pre-crisis level of 1,550 (Oct 2007) until February 2013. However, if we compare the period of 2013-2015 to the pre-2008 period, we see a clear difference in loan fees in Figure 5.

We show this with rigorous statistics in Table III, which is a difference-in-differences estimation of stock loan fees and option implied loan fees. The first difference is the regime shift, which is Early-Middle (Model 1), Middle-Late (Model 2) and Early-Late (Model 3). These transitions test the two regulatory actions (Models 1 and 2) and the cumulative effect of the two by testing the pre-July 2008 data to post-Aug 2013 data (Model 3). The treatment variable (or second difference) is 'High Utilization' defined as a utilization (demand/supply) of 60% or greater. This represents stocks that are hard to borrow without using loan fees (since fees is the outcome variable). [29] The dependent variable is the logarithm of the loan fee. The Regime indicator is omitted from the specification because it is collinear with our Time-based fixed effects, which provide more granular control for time-based effects. We use Firm and Time-Industry fixed effects and clustered standard errors because it is possible that high utilization stocks have an industry-based bias (i.e. during the crisis, they were Auto stocks, more recently they are perhaps biotechnology stocks). There are no other controls in the specification, which is standard in a difference-in-difference specification. Indeed, we have tested our identification by including various controls and showing that they do not affect the magnitude or statistical significance of our coefficient estimates (available on request).

[29] We exclude firms with between 40% and 60% utilization, which is only 7.9% of the sample. We get weaker results when we use these Moderate Utilization observations as the treatment variable. Ideally, we would use FTD as the treatment, but this is not possible. Post-regulation, we would need to be able to identify stocks that would have high FTD if they were allowed, but this not measurable. Thus, we need to use proxies for hard-to-borrow, a situation where stocks are expensive to borrow and thus borrowers would prefer to FTD if they could.

The results in Table III confirm Figure 2, Panel A and Figure 5. There is a clear step change in fees around the financial crisis (Model 1), no effect around the August 2013 event, but a substantial effect comparing the early regime to the late regime, which measures the cumulative effect of the two regulatory actions (Model 3). It is not surprising that we do not find an effect from middle to late, because the effect of reverse conversions was likely isolated to a relatively small group of stocks, so the effect on average loan fees may not be detectable. Panels A and B show results for three and six month symmetric windows respectively, with twelve month symmetric windows showing similar results, and available upon request.

In Models 4-6, we see a similar pattern among option implied fees. Fees rise substantially around the financial crisis, drop around the second regulatory action, but when comparing the early regime to the late regime (Model 6), the upward shift is present and the same magnitude as Model 4. To compare the two, Models 7-9 repeat the analysis with the difference between the two now as the dependent variable. Here, we see a negative relationship across the regulatory events, meaning that the difference is getting smaller (or even becoming negative). The positive coefficient in Model 8 does not appear to affect the overal shift seen in Model 9 from the early to late regime.

Next, in Table IV, we show how the relationship between Demand and Loan Fees has changed due the removal of FTD, which shows that it constituted a supply shock to the equity loan market. The three models are just as before, measuring the three different regime changes. This is not, however, a difference-in-difference because we interact the regime changes with Demand, a continuous variable. Instead, what we show is that the interaction term is positive in both Model 1 (Early-Middle) and Model 3 (Early-Late), which shows that a move in Demand results in an even larger move in loan fees post-regulation. While this is not irrefutable evidence, it is indicative of the shift in equilibrium due to the lost of 'shadow' supply in FTD, and backs up what we see in Figure 3 with statistical evidence.

As further support for the loss of FTD, we show in Table V that there is a *positive* trend in measured supply among hard-to-borrow stocks. This is unsurprising given current results showing that more and more stock owners see lending as an important income stream (Blocher and Whaley,

2016, Evans, Ferreira, and Prado, 2017). Thus, we should expect that supply constraints have eased over time: for a given shift in demand, prices should move less if there is more supply now than in the past. Instead, we find the opposite, which backs up our hypothesis that the loss of the FTD 'shadow supply' has played an important role in the increase in loan fees.

B. Price Efficiency measured as Delay

Both this section and the next perform tests of market function due to increased short constraints. We have already shown that lending fees rose due to the regulatory action, which we linked to the loss of stock loan supply due to lower FTD. Blocher, Reed, and Van Wesep (2013) showed that fees can be seen as a short constraint, where a ban on short sales is simply modeled as a lending fee of infinity. Our goal in this section and the next is to quantify how much these increased fees translate into constraints that affect market function.

Therefore, we next analyze price efficiency with the Delay measures in Hou and Moskowitz (2005). These delay measures derive fundamentally from a regression of weekly firm returns on weekly market returns with lags. We use four lags as as in Hou and Moskowitz (2005). The Delay1 measure is

$$Delay1 = 1 - \frac{R^2_{constrained}}{R^2_{unconstrained}} \tag{5}$$

where the constrained regression is one that forces the lags on market returns to be zero. Delay2 is

$$Delay2 = \frac{\sum_{n=1}^{4} n\delta^{-n}}{\beta + \sum_{n=1}^{4} n\delta^{-n}} \tag{6}$$

where the δ^{-n} represent the coefficients on the market return lags and β is the return on the contemporaneous lag.

On the whole, both of these measures capture the differential rate at which information is incorporated into a stock price. If information is incorporated quickly, the market lags should be uniformative and statistically zero, which with both measures will produce a result very close to zero. In contrast, if information takes longer to incorporate into prices, the lags become more

statistically significant, and the delay measures increase, indicating lower efficiency.

Our primary results are in Table VI. This table is in the differences-in-differences framework just as the results in Tables III. The dependent variable is now the Delay1 and Delay2 measures in Hou and Moskowitz (2005) (Panel A and B, respectively). Our goal is to show how this delay measure changes from regime to regime. The treatment is 'Special', which is an industry term for hard-to-borrow. We define Special as a month that has at least 19 days with a lending fee above 100 bps. We get similar results with other definitions of special. To test our identification, we include multiple controls for stock liquidity, since Hou and Moskowitz (2005) showed liquidity to be a key determinant of the delay measure, and find that these do not affect the coefficient estimates, which indicates that our difference-in-differences specification is fully identified. Models 1-3 in each panel are for three month symmetric windows, and models 4-6 are for six month symmetric windows.

As with any difference-in-difference specification, we focus on the interaction term, Regime # Special. We see no increase in Delay around the financial crisis, which is Models 1 and 4 (three and six month windows, respectively). Indeed, if anything, the estimates are negative, but not statistically significant. However, we do find some evidence of an increase in delay from the middle to late transition (Models 2 and 5 for three and six month windows, respectively). Only in the six month window (Model 4, Panel A and B) is it statistically significant. Our strongest result is the increase in delay from pre-2008 (early) to post-2013 (late), which is positive and significant in all specifications (Models 3, and 6, Panels A and B).

Table VII is a more robust specification, which uses month-industry fixed effects and clusters (and drops the Regime indicator due to collinearity) instead of just industry fixed effects and clusters. We get very similar results for the early-late regime transition (Models 3, and 6, Panels A and B), but now lose significance on the middle-late transition (Model 5, both panels). Thus, we have some indicative, but weak evidence of an increase in Delay (a decrease in price efficiency) across the second regulatory action in August 2013, but robust evidence that there has been reduced price efficiency among short constrained stocks comparing pre-July 2008 data to post-August 2013 data

(early-late).

C. Mispricing Measured as Return Predictability

We now address stock mispricing, which is linked to short selling constraints, as in Section B. If constraints are higher, as we suspect they are given the increase in lending fees already discussed, then we should see greater mispricing.

Our proxy for mispricing is the subsequent measured stock return conditional on a stock being constrained. We measure constrained as being hard-to-borrow, based on lending fees (what we have also called 'Special' or 'Specialness'). The mispricing result is in Table VIII. There, we show returns measured as (Fama and French, 1993) three factor abnormal returns, with monthly data from July 2006 to December 2015, with the event dates omitted (July 2008-October 2008 and August 2013), though our results are not sensitive to this choice. We include stocks with traded options as well as those that do not have traded options for reference. We also split the sample into the same three regimes, Early, Middle, and Late, and perform a T-test of differences between the hard-to-borrow and easy-to-borrow stocks, which we define differently in each panel to show robustness.

In Panel A, we define hard-to-borrow as a stock having at least 19 trading days with daily lending fees above 100 bps, the same as in previous analyses. In Panel B, we define hard-to-borrow as 19 days per month with lending fees above 200 bps. In Panel C, we define hard to borrow as monthly average lending fee above the 95^{th} percentile, measured monthly. This accounts for the fact that the entire distribution of lending fees has been increasing with time, as shown in Figure 5 and Table III.

The result is similar regardless of how we define hard-to-borrow: in the most recent regime, we see more mispricing. In Panel A, we see this in relative terms compared to the sample of stocks without traded options. In that sample, we see less mispricing in an absolute sense: returns on hard-to-borrow stocks are -1.10%, -0.50%, and -0.38%, respectively, in the early, middle, and late regimes. We also see it in the relative sense: in the late regimes, the difference between hard-to-

borrow and easy-to-borrow is 0.84% vs 1.00%. However, among stocks with options, we see a big drop in mispricing from the early to middle regime (-2.12% to -0.34%) but then a rebound in the late regime to -1.94%. There is a similar pattern in the difference between hard-to-borrow and easy-to-borrow.

The pattern is more striking in Panel B, when we raise the bar for specialness to 200 bps instead of 100 bps. This is reasonable since stocks have become more expensive in recent time. Here, we see a similar decrease in mispricing among the stocks with Loans Only (-1.45%, -0.75%, and -0.64%, respectively for early, middle, and late) but a drop and large rebound among those with Options and Loans: -1.78% in the early period, down to -0.63%, then back up to -2.52%. Again, the differences between hard-to-borrow and easy-to-borrow follow the same pattern.

Finally, in Panel C, we use the 95th percentile of loan fees as a daily fee threshold. Specifically, we compute the 95th percentile loan fee in each regime, which is 145 bps in the early regime, 193 in the middle regime, and 540 bps in the late regime. Again, to be defined as special, a stock must exceed this threshold for 19 days or more each month. We again get the same pattern among stocks with both Options and Loans, though now the Loans Only sample is more stable, with a hard-to-borrow return of -0.60% in both the early and late regime. This final specification gives the largest effects in the late regime across all Panels, though the differences are not statistically significant.

It stands to reason that the differences would be greatest among the hardest-to-borrow stocks (i.e. the highest threshold in Panel C). If we assume that OMM borrow stocks when they can, and only fail-to-deliver (in the early or middle regimes) when they cannot find the stock, then we expect to see the biggest differences among these stocks. The less constrained stocks did not see as much of a change in supply, since they were not were most of the FTD activity was occurring.

We present multivariate results in Table IX. We use the same threshold for specialness as in Panel C of Table VIII, which is the 95th percentile loan fee in each regime. We see that the magnitude of the coefficient on the indicator variable is approximately double in Models 5 and 6 (late regime) compared to Models 1 and 2 (early regime), and all are statistically significant.

These results are suggestive, but not rigorous statistically. We test the differences between regimes in Table X. In this table, the regime indicator turns on for the middle (Models 1 and 2) and late (Models 3 and 4) regimes, and is zero only for the early regime. This tests the coefficient difference between the early regime and the regime labeled. We use the same special measurement and controls as in Table IX. As the interaction term (first row) shows, the differences are negative and statistically significant at the 10% level, which indicates that return predictability has increased in both the middle and late regimes versus the early regime.

For reference, Models 5-8 show the same specification, but for stocks without options. Of note here is that while there is an incremental effect in the Middle vs Early specifications (Models 5-6), it disappears when comparing Late vs Early (Models 7-8). This indicates that among these stocks, there may have been some increased mispricing around the financial crisis, but that it did not persist. However, among stocks with traded options (where the option market regulation has remained), we see a persistent effect.

Together with the previous section, we have shown that the removal of the OMM exception has reduced supply for short selling, therefore increased short selling constraints, and had the expected outcome that stocks are more overpriced and stock prices are less efficient.

VI. Conclusion

Eliminating the OMM exception has had a real effect on short sellers, and therefore on overall market function. This indicates that the SEC should consider reinstating the OMM exception to again allow a better functioning short selling market. There is no evidence that FTD have a deleterious effect or that they are a signal of short sellers manipulating prices. It is quite the opposite. Consistent with past research showing that FTD may be beneficial, we show why: FTD provide a 'shadow' supply of lendable shares to otherwise constrained loan markets, which in turn allows short sellers to impound information into prices more quickly, and thus generate better stock pricing.

The primary goal of the removal of the OMM exception was to reduce fails-to-deliver (FTD).

Since FTD can be though of as a zero-interest stock loan, this rule had the effect of significantly reducing supply of the most in-demand stocks in the stock loan market. We show with rigorous identification, removing the confounding effects of the financial crisis, that these regulatory changes had the (perhaps) unintended consequence of increasing constraints to short selling. As a result, we show the expected outcome of that action: less price efficiency and greater mispricing.

The timing of the SEC action removing the OMM exception (September/October 2008) was at the peak of the financial crisis. IndyMac was put into conservatorship by the FDIC on July 11, 2008, Bank of America acquired Merrill Lynch under duress on September 14, 2008, Lehman Brothers filed for bankruptcy on September 15, 2008, AIG effectively collapsed on September 16, 2008, and Washington Mutual was seized by the Office of Thrift Supervision on September 25, 2008. The Troubled Asset Relief Program (TARP) was passed on October 3, 2008. The TED spread had gapped out to unprecedented levels and there was a very real fear that multiple banks would follow Lehman. The U.S. Federal Reserve announced $600B of quantitative easing (which would end up as round one of three) in November 2008. Citibank was rescued in November 2008 as a part of the government response to the crisis, and Wachovia was bought by Wells Fargo in a forced sale on December 31, 2008.

All of these events created an environment hostile to short selling. The short selling ban was explicitly for the purpose of limiting short selling, but it expired, ultimately lasting only from September 22, 2008 to October 8, 2008. We have shown that removing the option market maker exception has substantially increased constraints on short selling, but since it did not expire, those constraints have persisted with predictable results. We believe it is time to reconsider this action and reinstate the option market maker exception to facilitate more efficient market operation. Given the dearth of evidence on the detriments of failures-to-deliver, and the evidence that FTD may even be beneficial, this seems like a low risk change.

References

Barone-Adesi, Giovanni, and Robert E Whaley, 1987, Efficient Analytic Approximation of American Option Values, *J. Finance* 42, 301–320.

Barraclough, Kathryn, and Robert E Whaley, 2012, Early Exercise of Put Options on Stocks, *J. Finance* 67, 1423–1456.

Battalio, Robert H, and Paul Schultz, 2006, Options and the Bubble, *J. Finance* 61, 2071–2102.

——— , 2011, Regulatory Uncertainty and Market Liquidity: The 2008 Short Sale Ban's Impact on Equity Option Markets, *J. Finance* 66, 2013–2053.

Blocher, Jesse, Adam V Reed, and Edward D Van Wesep, 2013, Connecting two markets: An equilibrium framework for shorts, longs, and stock loans, *J. Financ. Econ.* 108, 302–322.

Blocher, Jesse, and Robert E Whaley, 2016, Two-Sided Markets in Asset Management: Exchange-Traded Funds and Securities Lending, *SSRN Working Paper*.

Boehmer, Ekkehart, and Julie Wu, 2013, Short Selling and the Price Discovery Process, *Review of Financial Studies* 26, 287–322.

Boni, Leslie, 2006, Strategic delivery failures in U.S. equity markets, *Journal of Financial Markets* 9, 1–26.

Breeden, Douglas T, and Robert H Litzenberger, 1978, Prices of State-Contingent Claims Implicit in Option Prices, *J. Bus.* 51, 621–651.

Carr, Peter P, and Liuren Wu, 2010, A New Simple Approach for Constructing Implied Volatility Surfaces, *SSRN Working Paper*.

Cox, John C, Stephen A Ross, and Mark Rubinstein, 1979, Option pricing: A simplified approach, *J. Financ. Econ.* 7, 229–263.

Cremers, K. J. Martijn, and David Weinbaum, 2010, Deviations from Put-Call Parity and Stock Return Predictability, *Journal of Financial and Quantitative Analysis* 45, 335–367.

Danielsen, Bartley, and Sorin M Sorescu, 2001, Why Do Option Introductions Depress Stock Prices? A Study of Diminishing Short Sale Constraints, *Journal of Financial and Quantitative Analysis* 36, 451–484.

Danielsen, B R, and B F Van Ness, 2007, Reassessing the impact of option introductions on market quality: A less restrictive test for event-date effects, *Journal of Financial and*.

Engelberg, Joseph E, Adam V Reed, and Matthew C Ringgenberg, 2017, Short Selling Risk, *The Journal of Finance*.

Evans, Richard, Miguel A Ferreira, and Melissa Porras Prado, 2017, Fund Performance and Equity Lending: Why Lend What You Can Sell?, *Rev. Finance*.

Evans, Richard, Christopher C Geczy, David K Musto, and Adam V Reed, 2009, Failure Is an Option: Impediments to Short Selling and Options Prices, *Review of Financial Studies* 22, 1955–1980.

Fama, Eugene F, and Kenneth R French, 1993, Common risk factors in the returns on stocks and bonds, *J. Financ. Econ.* 33, 3–56.

Fama, Eugene F, and James MacBeth, 1973, Risk, Return, and Equilibrium: Empirical Tests, *Journal of Political Economy* 81, 607–636.

Figlewski, Stephen, 2008, Estimating the Implied Risk Neutral Density for the U.S. Market Portfolio , in Tim Bollerslev, Jeffrey R Russell, and Mark Watson, ed.: *Volatility and Time Series Econometrics Essays in Honor of Robert F. Engle*.

——— , and Gwendolyn P Webb, 1993, Options, Short Sales, and Market Completeness, *J. Finance* 48, 761–777.

Fotak, Veljko, Vikas Raman, and Pradeep K Yadav, 2014, Fails-to-deliver, short selling, and market quality, *J. Financ. Econ.* 114, 493–516.

Hou, Kewei, and Tobias J Moskowitz, 2005, Market Frictions, Price Delay, and the Cross-Section of Expected Returns, *Review of Financial Studies* 18, 981–1020.

Jameson, Mel, and William Wilhelm, 1992, Market Making in the Options Markets and the Costs of Discrete Hedge Rebalancing, *J. Finance* 47, 765–779.

Khandani, Amir E, and Andrew W Lo, 2011, What happened to the quants in August 2007? Evidence from factors and transactions data, *Journal of Financial Markets* 14, 1–46.

Kolasinski, Adam C, Adam V Reed, and Jacob R Thornock, 2013, Can Short Restrictions Actually Increase Informed Short Selling?, *Financial Management* 42, 155–181.

Mayhew, Stewart, and Vassil Mihov, 2004, How Do Exchanges Select Stocks for Option Listing?, *J. Finance* 59, 447–471.

Miller, Edward, 1977, Risk, Uncertainty, and Divergence of Opinion, *J. Finance* 32, 1151–1168.

Muravyev, Dmitriy, Neil D Pearson, and Joshua Matthew Pollet, 2016, Is There a Risk Premium in the Stock Lending Market? Evidence from Equity Options, *SSRN Working Paper*.

Ofek, Eli, Matthew Richardson, and Robert F Whitelaw, 2004, Limited arbitrage and short sales restrictions: evidence from the options markets, *J. Financ. Econ.* 74, 305–342.

Sorescu, Sorin M, 2000, The Effect of Options on Stock Prices: 1973 to 1995, *J. Finance* 55, 487–514.

Stoll, Hans R, 1969, The relationship between put and call option prices, *J. Finance* 24, 801–824.

Stratmann, Thomas, and John W Welborn, 2013, The options market maker exception to SEC Regulation SHO, *Journal of Financial Markets* 16, 195–226.

Figure 1. Univariate statistics by Regulatory Regime.

The "Early Regime" is pre-Sept 2008 when the OMM Exception was in place. The "Middle Regime" is between September 2008 and August 2013 when reverse conversions were the only method to use option markets to short stocks. The "Late Regime" is Sept 2013 to Dec 2015 and represents the current state. Data are daily, summarized by Markit's Daily Cost to Borrow Score (DCBS) which a 1-10 grouping based on how hard a stock is to borrow.

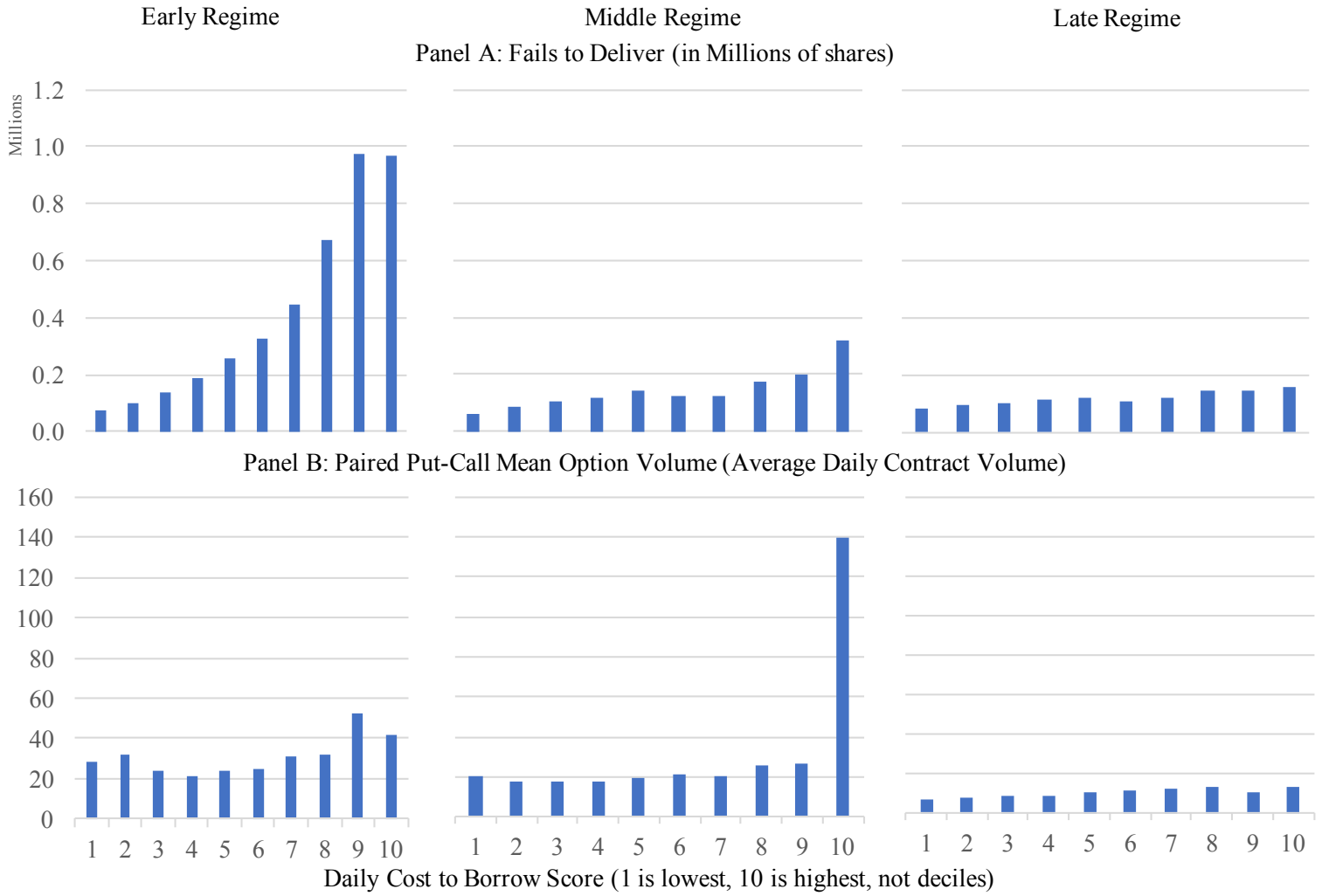

Figure 2. Loan Fees and Option Implied Loan Fees across Regimes

This set of plots shows changes in stock loan fees and option implied loan fees across the three regimes. "Early" is pre-Sept 2008 when the OMM Exception was in place. "Middle" is between September 2008 and August 2013 when reverse conversions were the only method to use option markets to short stocks. "Late" is Sept 2013 to Dec 2015 and represents the current state. Panel A shows the daily loan fees from Markit. Panel B shows the daily average option implied loan fees. Panel C shows differences between the two, computed by stock-day and then summarized.

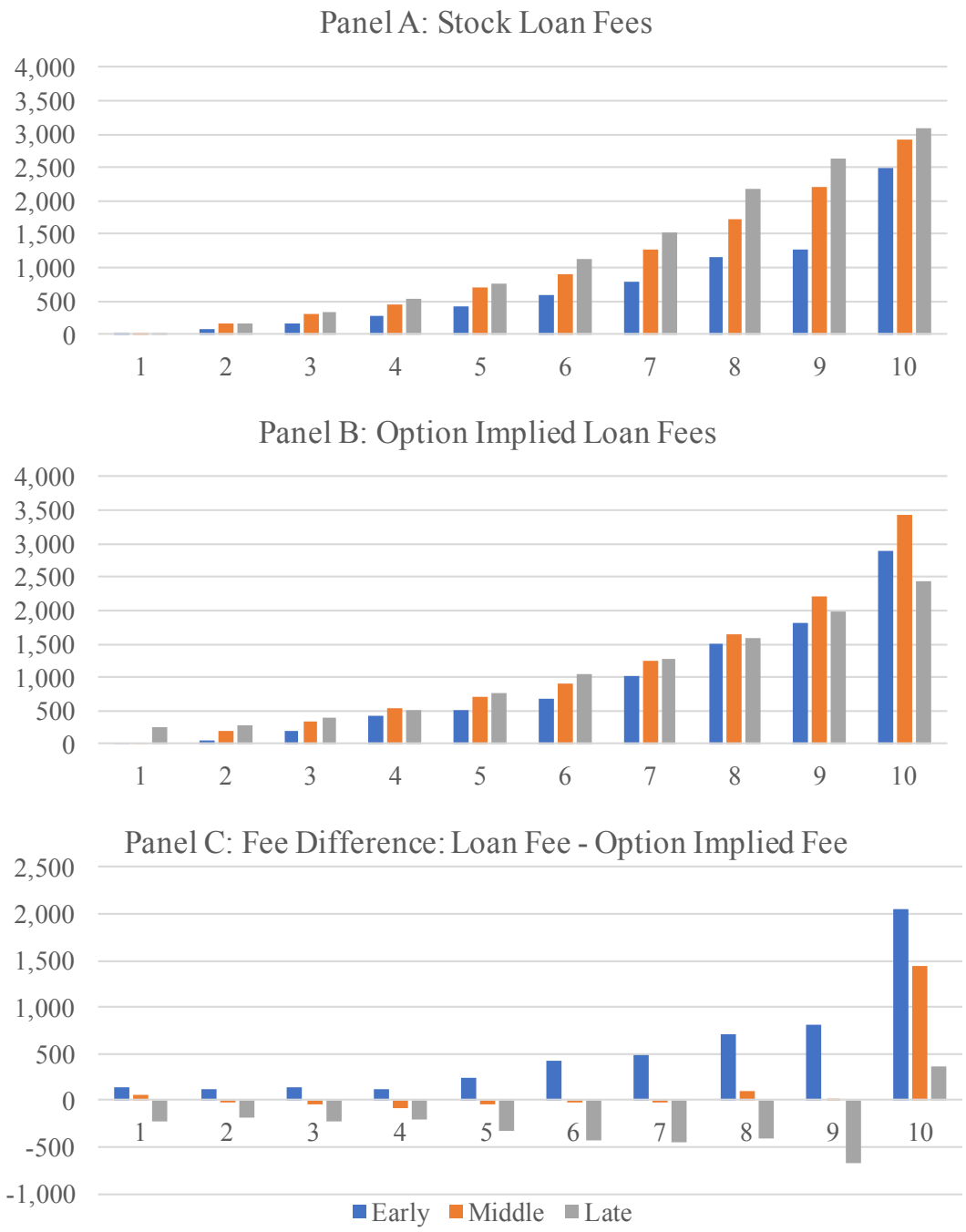

Figure 3. Relationship Between Lending Fees and Utilization by Regime

"Early" is pre-Sept 2008 when the OMM Exception was in place. "Middle" is between September 2008 and August 2013 when reverse conversions were the only method to use option markets to short stocks. "Late" is Sept 2013 to Dec 2015 and represents the current state. Data are daily, summarized by Markit's Daily Cost to Borrow Score (DCBS) which a 1-10 grouping based on how hard a stock is to borrow. Plotted is the average Utilization versus average Lending Fee, by DCBS in each regime, such that each regime has 10 points plotted. The trendline included is a simple power law best fit line to help ease comparison. Of note is how this relationship has changed across regimes: for the same utilization, stocks are more expensive in each regime.

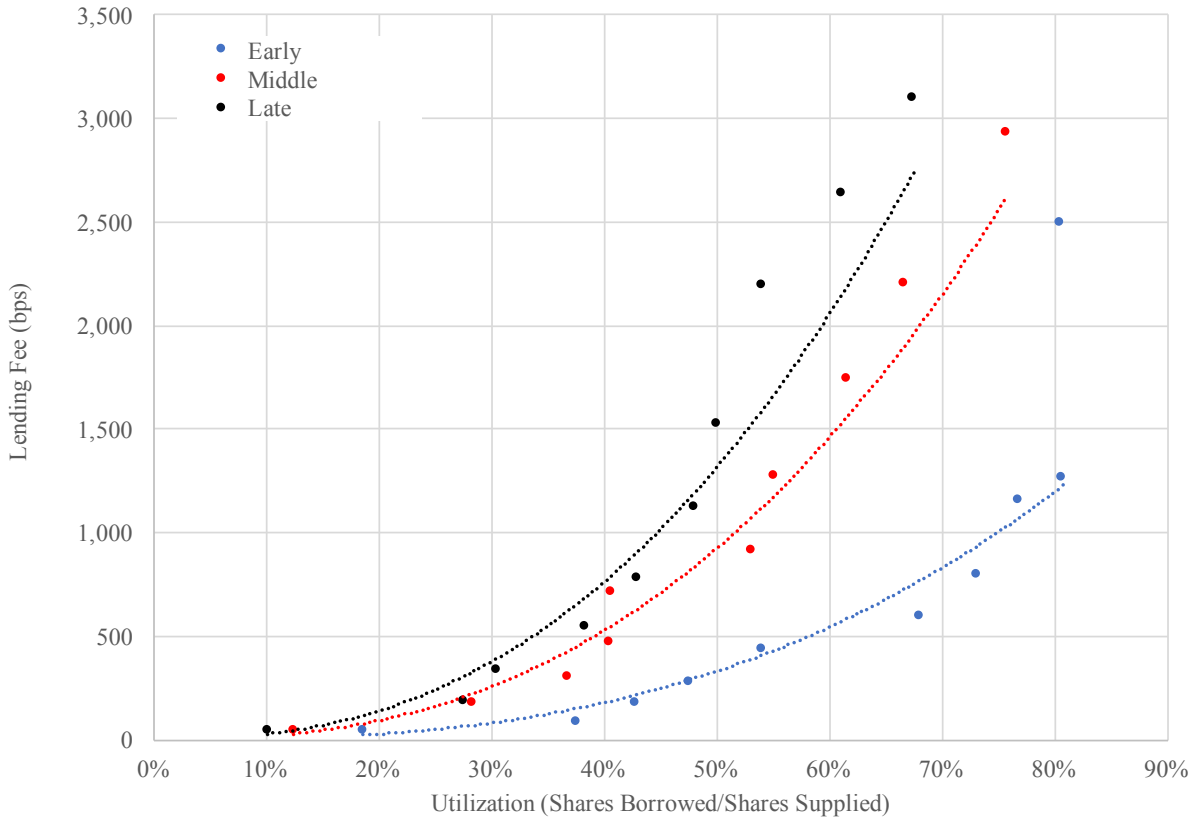

Figure 4. Option Volume and Open Interest

Plotted are equity option volume and open interest by year. In Panel A, volume or open interest are averaged across all strike-expiration pairs per day, then averaged again for the annual summary statistic. In Panel B, volume or open interest are summed daily across all strike-expiration pairs, then averaged for the annual summary statistic. We drop options with greater than 180 days or less than 7 days to maturity, zero open interest, and an offer price greater than an ask price.

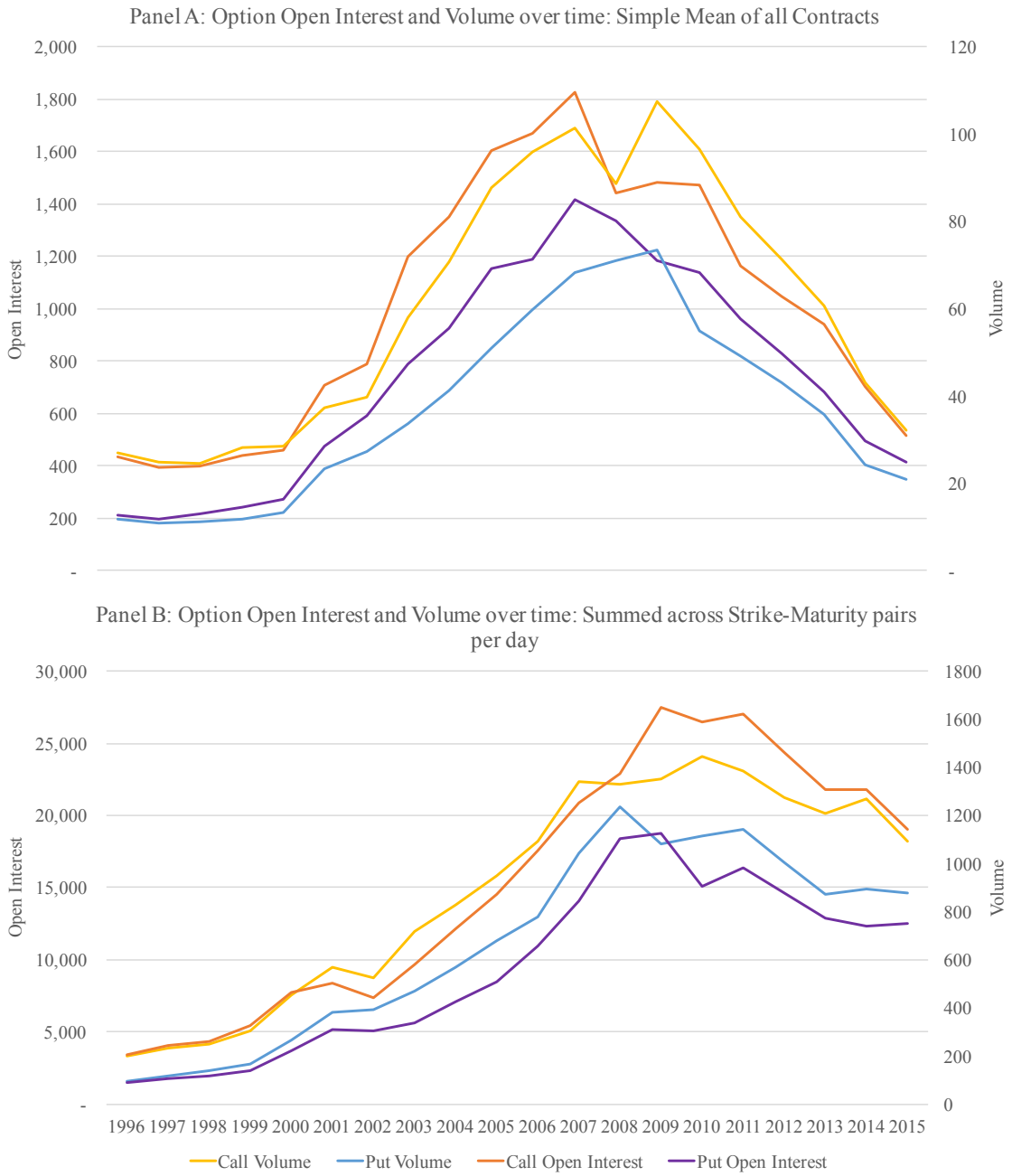

Figure 5. Distribution of Lending Fees through time

Plotted is the distribution of Markit's Simple Average Fee (SAF), annually, from 2007-2015 using daily data. Both panels plot the same data, but the lower panel zooms in the Y axis to focus on the range between -50 bps and 200 bps. The box-and-whisker plot shows the range from the 5th to 95th percentile, and the box represents the interquartile range.The line between light and dark grey is the median. The black line is the mean of the distribution. On the bottom panel, the dotted line is the average option implied fee.

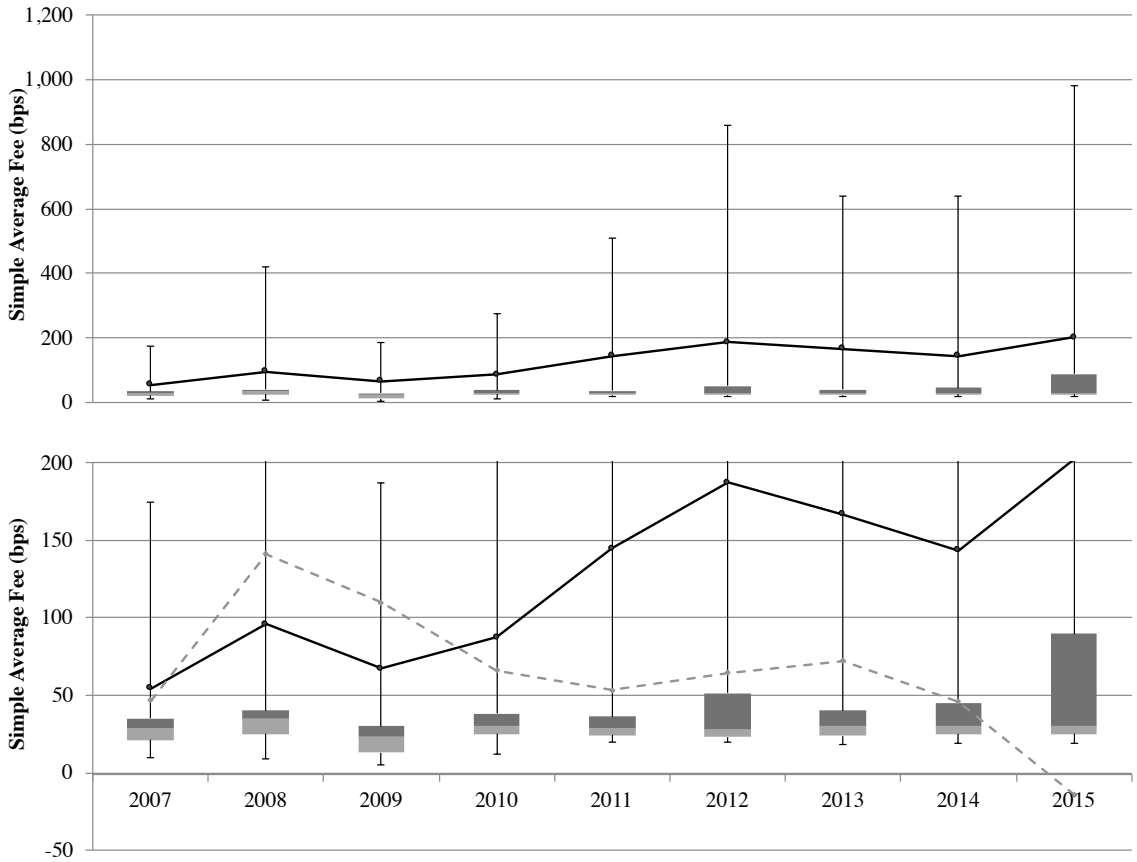

Table I
Summary Statistics - Options and Option Implied Lending Fees

Summary statistics for Options data from 2006-2015. Data are daily from OptionMetrics. Implied volatilities are from OptionMetrics. Early Exercise Premiums (EEP) are computed using the binomial model as the difference between a European and American option. Missing values are non-dividend paying stocks that have an EEP of 0. The Ofek-Richardson-Whitelaw Measure is as computed in Ofek, Richardson, and Whitelaw (2004). Option Implied Lending Fees are computed by solving for the necessary lending fee to bring each Put-Call option pair into parity.

	Num Obs	Mean	Std Dev	Min	Max
Days to Expiration	110,789,775	81.75	51.05	7.25	179.81
Implied Volatility (Call)	103,829,046	0.45	0.22	0.01	3.00
Implied Volatility (Put)	106,314,105	0.46	0.23	0.01	3.00
Open Interest (Call)	109,276,798	1,057.13	6,600.05	-	1,974,755.03
Open Interest (Put)	109,185,384	829.10	4,814.22	-	1,549,734.77
Volume (Call)	110,789,775	67.49	1,170.82	-	1,054,830.91
Volume (Put)	110,789,775	42.87	531.33	-	455,567.07
Early Exercise Premium (Call)	110,789,775	0.04	0.22	-	16.45
Early Exercise Premium (Put)	110,789,775	0.02	0.10	-	6.84
Ofek-Rich-Whitelaw Measure	110,785,521	0.10	1.91	(249.85)	340.77
Option Implied Lending Fee (bps)	110,785,738	52.13	1,494.33	(674,789.08)	212,635.08

Table II
Summary Statistics - Monthly Master Sample

Summary statistics for CRSP stock data from 2006-2015. Data are Monthly, share code 10 and 11. Market capitalization deciles use NYSE-NASDAQ-AMEX breakpoints. Mkt Cap is daily market capitalization computed as price times shares outstanding, in $M. Volume is daily shares traded times closing price, in $M. Annualized volatility is computed using daily data over the past 21 days and annualized. Spread is the bid minus ask divided by the midpoint. Demand and Supply are in $M from Markit, Utilzation is the ratio of the two. Lending fee is the interpolated lending fee in basis points. Volume and Open Interest are the daily mean across option contracts, averaged across days to get a monthly estimate. Paired option estimate are for matched put-call pair contracts, where volume and open interest is the minimum of the put and call across contracts. The option implied fee is the required fee to enforce put-call parity, in basis points.

Panel A: Sorted by Market Capitalization Decile

Decile	N	Mkt Cap ($M)	Volume ($M)	Ann Vol (%)	Spread	Demand ($M)	Supply ($M)	Util (%)	Lending Fee (bps)	Pair Vol	Call Vol	Put Vol	Pair Open Int	Call Open Int	Put Open Int	Pair Spread	Call Spread	Put Spread	Option Implied Fee (bps)
N/A	528	$1,281	$405.01	66.0%	0.015	26.88	371.18	24.9%	221	3.0	26.0	10.7	277	867	371	0.62	0.46	0.34	261
1	31,895	$22	$4.56	82.8%	0.042	0.23	0.87	15.6%	460	1.7	19.8	5.3	132	570	253	1.05	0.90	0.62	605
2	40,290	$56	$6.78	61.1%	0.026	0.64	3.22	14.0%	316	1.3	14.5	4.7	93	431	156	1.06	0.88	0.67	483
3	38,609	$104	$13.58	56.4%	0.016	2.01	9.58	17.3%	257	2.0	16.5	6.3	129	489	210	0.99	0.79	0.65	406
4	38,220	$182	$25.90	53.4%	0.008	5.46	25.60	19.4%	175	1.7	14.6	6.7	115	400	213	0.94	0.72	0.62	335
5	38,761	$296	$53.03	53.2%	0.004	12.83	54.72	21.9%	152	1.9	15.5	7.2	116	415	210	0.87	0.65	0.59	312
6	40,719	$490	$97.29	49.2%	0.003	26.07	107.22	22.9%	121	1.9	14.2	7.3	108	338	209	0.83	0.59	0.57	276
7	44,009	$834	$193.32	45.4%	0.002	54.96	211.90	24.0%	102	2.3	16.7	8.9	124	384	245	0.74	0.51	0.51	237
8	46,486	$1,547	$379.79	40.7%	0.001	104.32	405.72	24.2%	86	3.4	21.2	13.0	160	457	336	0.68	0.45	0.48	210
9	48,518	$3,478	$897.57	36.1%	0.001	160.41	871.92	17.9%	60	5.0	30.4	18.8	220	619	446	0.59	0.36	0.41	159
10	50,314	$28,362	$4,976.33	31.2%	0.001	412.20	6,547.62	9.6%	44	30.3	124.8	77.5	909	2,134	1,633	0.41	0.22	0.28	110
All:	418,349	$4,184	$784.64	49.3%	0.009	89.78	971.70	18.7%	164	8.3	40.4	24.1	297	783	554	0.69	0.47	0.47	223

Panel B: Sorted by Daily Cost to Borrow Score (DCBS)

DCBS	N	Mkt Cap ($M)	Volume ($M)	Ann Vol (%)	Spread	Demand ($M)	Supply ($M)	Util (%)	Lending Fee (bps)	Pair Vol	Call Vol	Put Vol	Pair Open Int	Call Open Int	Put Open Int	Pair Spread	Call Spread	Put Spread	Option Implied Fee (bps)
N/A	1,706	$4,536	$1,015.39	42.0%	0.002	N/A	N/A	N/A	N/A	14.7	83.0	39.1	894	2,295	1,277	0.61	0.40	0.39	196
1	320,418	$5,261	$965.15	43.1%	0.006	103.21	1,232.65	12.8%	38	7.9	38.8	23.3	276	732	524	0.68	0.46	0.48	174
2	34,740	$1,055	$273.11	62.7%	0.019	53.81	205.47	26.3%	147	8.5	46.2	26.3	365	964	682	0.71	0.52	0.44	271
3	19,796	$375	$127.88	67.6%	0.019	40.91	52.76	33.4%	270	6.4	38.2	21.7	328	854	616	0.72	0.54	0.43	337
4	12,794	$310	$111.64	72.1%	0.020	39.02	44.31	39.2%	433	8.0	43.6	24.3	348	927	629	0.72	0.56	0.43	417
5	8,332	$291	$109.06	74.7%	0.021	37.78	39.78	43.1%	652	8.2	40.2	24.5	338	940	604	0.75	0.57	0.45	532
6	5,894	$320	$131.99	79.0%	0.017	44.48	45.35	53.4%	923	8.0	41.6	24.5	388	1,038	711	0.74	0.58	0.44	645
7	5,235	$330	$117.80	80.4%	0.017	41.23	39.98	55.5%	1,284	8.6	43.1	24.1	393	1,007	682	0.76	0.61	0.44	769
8	2,874	$418	$221.31	84.1%	0.015	56.44	52.47	62.4%	1,767	20.0	68.5	39.6	523	1,252	857	0.71	0.57	0.39	1,002
9	2,839	$335	$153.00	85.8%	0.014	42.48	38.92	67.0%	2,279	19.2	62.6	40.2	589	1,312	1,026	0.74	0.59	0.41	1,220
10	3,721	$218	$120.82	91.3%	0.013	21.89	19.04	72.7%	2,950	36.4	100.8	63.9	766	1,898	1,139	0.77	0.64	0.42	1,672
All:	418,349	$4,184	$784.64	49.3%	0.009	89.78	971.70	18.7%	164	8.3	40.4	24.1	297	783	554	0.69	0.47	0.47	223

Table III
Stock Loan Fees, Option-Implied Loan Fees, and Regulatory Regimes

Data is monthly from July 2006 to December 2015. The "Early Regime" is pre-July 2008 when the OMM Exception was in place. The "Middle Regime" is between November 2008 and August 2013 when reverse conversions were the only method to use option markets to short stocks. The "Late Regime" is Sept 2013 to Dec 2015 and represents the current state. Sample includes only stocks with both traded options and stock loan fee data. Results include only three and six month symmetric windows around each event, omitting the event month(s). Omitted months are July-Nov 2008 for Early-Middle, August 2013 for Middle-Late, and July 2008 - Aug 2013 for Early-Late. The treatment variable is utilization above 60%, which represents 8.1% of the sample, and the most hard-to-borrow stocks. Untreated is 84% of the sample that is cheap to borrow. The dependent variable in models 1-3 is the logged loan fee. In models 4-6, it is the logged option implied fee. In models 7-9, it is Loan Fee - OI Fee. Util is the indicator for the treatment variable. The Regime indicator is omitted due to collinearity with the month-industry FE, which more rigorously control for time-based effects. Specifications include firm and month-industry fixed effects, and standard errors are clustered by firm and month-industry. T-statistics are in parentheses. ***, **, * indicates significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Three Month Symmetric Window

	Loan Fee			Option Implied Fee			Loan Fee - Opt Impl Fee		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Ear-Mid	Mid-Late	Ear-Late	Ear-Mid	Mid-Late	Ear-Late	Ear-Mid	Mid-Late	Ear-Late
Regime # Util	0.5218***	0.0531	0.3069*	0.9595***	-0.2084**	0.6662***	-0.4088***	0.2097**	-0.4397***
	(7.96)	(0.76)	(1.97)	(10.72)	(-2.12)	(3.93)	(-3.69)	(2.31)	(-3.16)
Util	0.7313***	1.1258***	1.4221***	-0.1763*	0.6958***	0.4878***	1.0716***	0.5246***	1.0368***
	(9.88)	(8.70)	(18.97)	(-1.93)	(3.97)	(4.88)	(10.25)	(3.39)	(10.35)
Observations	9,415	12,241	10,957	6,092	4,961	6,092	6,043	4,951	6,047
R Squared	0.93	0.96	0.91	0.66	0.58	0.65	0.6	0.47	0.6
Firm-Spec Clusters	1,940	2,275	2,595	1,461	1,244	1,758	1,451	1,241	1,749
Time-Ind Clusters	60	60	60	60	60	60	60	60	60

Panel B: Six Month Symmetric Window

Regime # Util	0.5789***	0.0009	0.3236**	1.0313***	-0.1362	0.6936***	-0.4279***	0.1057	-0.3617***
	(8.23)	(0.01)	(2.51)	(12.07)	(-1.43)	(4.26)	(-4.79)	(1.34)	(-2.71)
Util	0.7523***	1.3800***	1.3290***	-0.1884**	0.7620***	0.4345***	1.0345***	0.7116***	0.9588***
	(14.46)	(14.60)	(20.29)	(-2.50)	(6.71)	(4.85)	(11.64)	(6.21)	(10.94)
Observations	19,091	24,144	21,958	11,938	9,929	12,047	11,844	9,915	11,960
R Squared	0.91	0.94	0.9	0.58	0.5	0.57	0.51	0.38	0.52
Firm-Spec Clusters	2,131	2,395	2,774	1,677	1,563	2,112	1,669	1,560	2,102
Time-Ind Clusters	120	120	120	120	120	120	120	120	120

Table IV
Showing the Effects of a Supply Shock

Data is monthly from July 2006 to December 2015. The "Early Regime" is pre-Sept 2008 when the OMM Exception was in place. The "Middle Regime" is between September 2008 and August 2013 when reverse conversions were the only method to use option markets to short stocks. The "Late Regime" is Sept 2013 to Dec 2015 and represents the current state. The dependent variable is the loan fee, logged. Models 1-3 are only among stocks with traded options; models 4-6 are only among stocks that do not have traded options; models 7-9 are the pooled sample.
Demand/Supply are the monthly average of daily demand/supply divided by shares outstanding. Market Cap is logged market capitalization. Specifications include firm and month-industry fixed effects, and standard errors are clustered by firm and month-industry. T-statistics are in parentheses. ***, **, * indicates significance at the 1%, 5%, and 10% levels, respectively.

	(1) Early-Middle	(2) Middle-Late	(3) Early-Late
Regime # Demand	1.6796***	-0.1732	1.2542***
	(7.11)	(-0.63)	(3.20)
Demand	3.9033***	5.7574***	3.9351***
	(18.45)	(25.11)	(16.00)
Supply	-2.3963***	-2.2216***	-2.3873***
	(-17.32)	(-15.27)	(-14.89)
Market Cap	-0.1386***	-0.1242***	-0.0958***
	(-8.56)	(-7.25)	(-4.98)
Observations	146,428	153,760	75,448
R Squared	0.77	0.80	0.82
Firm Clusters	3,275	3,246	3,417
Time-Ind Clusters	750	860	470

Table V
Increase in Stock Loan Supply

Data is monthly from July 2006 to December 2015. The "Early Regime" is pre-Sept 2008 when the OMM Exception was in place. The "Middle Regime" is between September 2008 and August 2013 when reverse conversions were the only method to use option markets to short stocks. The "Late Regime" is Sept 2013 to Dec 2015 and represents the current state. The dependent variable is the Supply Ratio (Shares Supplied/Shares Outstanding), logged. Sample includes only stocks with both traded options and stock loan fee data. Samples include a three/six/twelve month symmetric window around each event for Panels A/B/C, respectively, omitting the event month(s). Omitted months are July-Nov 2008 for Early-Middle, August 2013 for Middle-Late, and July 2008 - Aug 2013 for Early-Late. The treatment variable is utilization above 60%, which represents 8.1% of the sample, and the most hard-to-borrow stocks. Untreated is 84% of the sample that is cheap to borrow. Util is the indicator for the treatment variable, but its coefficient estimates are omitted for visual clarity. The Regime indicator is omitted from the specification due to collinearity with the month-industry FE, which more rigorously control for time-based effects. Specifications include firm and month-industry fixed effects, and standard errors are clustered by firm and month-industry. T-statistics are in parentheses. ***, **, * indicates significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Three Month Symmetric Window

	(1) Early-Middle	(2) Middle-Late	(3) Early-Late
Regime # Util	0.0335	0.0378*	0.1564**
	(1.11)	(1.83)	(2.30)
Observations	9,415	12,241	10,957
R Squared	0.95	0.98	0.92
Firm-Spec Clusters	1,940	2,275	2,595
Time-Ind Clusters	60	60	60

Panel B: Six Month Symmetric Window

Regime # Util	0.0441	0.0583**	0.1136*
	(1.42)	(2.45)	(1.82)
Observations	19,091	24,144	21,958
R Squared	0.93	0.96	0.92
Firm-Spec Clusters	2,131	2,395	2,774
Time-Ind Clusters	120	120	120

Panel C: Twelve Month Symmetric Window

Regime # Util	0.0527*	0.0988***	0.1237**
	(1.68)	(3.45)	(2.09)
Observations	39,376	47,965	44,428
R Squared	0.90	0.93	0.90
Firm-Spec Clusters	2,410	2,657	3,117
Time-Ind Clusters	240	240	240

Table VI
Difference-in-Difference Analyzing Price Efficiency

Data is monthly from July 2006 to December 2015. The "Early Regime" is pre-Sept 2008 when the OMM Exception was in place. The "Middle Regime" is between September 2008 and August 2013 when reverse conversions were the only method to use option markets to short stocks. The "Late Regime" is Sept 2013 to Dec 2015 and represents the current state. The first difference is around regulatory events that define these regimes. The treatment variable is stock specialness, defined as a month having at least 19 days of daily loan fee above 100 bps. The dependent variable is the Delay1 (Panel A) and Delay2 (Panel B) variable in Hou and Moskowitz (2005). Models 1-3 are estimated in three month symmetric windows, models 4-6 are estimated in six month symmetric windows, omitting the event month(s). Omitted months are July-Nov 2008 for Early-Middle, August 2013 for Middle-Late, and July 2008 - Aug 2013 for Early-Late. Specifications include firm and industry fixed effects, and standard errors are clustered by firm and industry. T-statistics are in parentheses. ***, **, * indicates significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Delay1 Measure

	Three Month Window			Six Month Window		
	(1)	(2)	(3)	(4)	(5)	(6)
	Early-Middle	Middle-Late	Early-Late	Early-Middle	Middle-Late	Early-Late
Regime # Special	-0.0276	0.0190	0.1605***	-0.0182	0.0335*	0.1563***
	(-1.11)	(1.12)	(4.53)	(-0.83)	(2.20)	(5.23)
Regime	-0.1159***	0.0023	-0.0754***	-0.1184***	-0.0005	-0.0582**
	(-9.02)	(0.38)	(-3.94)	(-9.47)	(-0.05)	(-3.10)
Special	0.0358	-0.0086	0.0303	0.0257	-0.0234	0.0090
	(1.52)	(-0.20)	(1.48)	(1.77)	(-0.92)	(0.54)
Observations	9,828	12,426	11,213	19,642	24,407	22,177
R Squared	0.68	0.80	0.70	0.63	0.69	0.67
Firm Clusters	1,963	2,264	2,601	2,102	2,332	2,736
Industry Clusters	10	10	10	10	10	10

Panel B: Delay2 Measure

	Three Month Window			Six Month Window		
	(1)	(2)	(3)	(4)	(5)	(6)
	Early-Middle	Middle-Late	Early-Late	Early-Middle	Middle-Late	Early-Late
Regime # Special	0.0021	0.0164	0.0941***	0.0036	0.0243**	0.0952***
	(0.16)	(1.57)	(5.29)	(0.25)	(2.62)	(6.81)
Regime	-0.0788***	0.0040	-0.0749***	-0.0869***	0.0084	-0.0612***
	(-7.73)	(0.81)	(-5.96)	(-8.33)	(1.20)	(-4.80)
Special	0.0095	-0.0047	0.0212	0.0095	-0.0123	0.0095
	(0.53)	(-0.17)	(1.65)	(1.16)	(-0.61)	(0.98)
Observations	9,854	12,442	11,235	19,690	24,446	22,225
R Squared	0.66	0.77	0.69	0.61	0.66	0.64
Firm Clusters	1,967	2,266	2,604	2,105	2,337	2,741
Industry Clusters	10	10	10	10	10	10

Table VII
Difference-in-Difference Analyzing Price Efficiency - Robustness

Data is monthly from July 2006 to December 2015. The "Early Regime" is pre-Sept 2008 when the OMM Exception was in place. The "Middle Regime" is between September 2008 and August 2013 when reverse conversions were the only method to use option markets to short stocks. The "Late Regime" is Sept 2013 to Dec 2015 and represents the current state. The first difference is around regulatory events that define these regimes. The treatment variable is stock specialness, defined as a month having at least 19 days of daily loan fee above 100 bps. The dependent variable is the Delay1 (Panel A) and Delay2 (Panel B) variable in Hou and Moskowitz (2005). Models 1-3 are estimated in three month symmetric windows, models 4-6 are estimated in six month symmetric windows, omitting the event month(s). Omitted months are July-Nov 2008 for Early-Middle, August 2013 for Middle-Late, and July 2008 - Aug 2013 for Early-Late. Specifications include firm and month-industry fixed effects, and standard errors are clustered by firm and month-industry. The Regime indicator is omitted because month-industry FE are collinear with it. T-statistics are in parentheses. ***, **, * indicates significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Delay1 Measure

	Three Month Window			Six Month Window		
	(1)	(2)	(3)	(4)	(5)	(6)
	Early-Middle	Middle-Late	Early-Late	Early-Middle	Middle-Late	Early-Late
Regime # Special	-0.0236	0.0090	0.1550***	-0.0170	0.0168	0.1491***
	(-1.19)	(0.53)	(4.12)	(-0.94)	(0.88)	(4.58)
Special	0.0331	-0.0073	0.0257	0.0318*	-0.0198	0.0085
	(1.16)	(-0.21)	(1.09)	(1.75)	(-0.71)	(0.43)
Observations	9,828	12,426	11,213	19,642	24,407	22,177
R Squared	0.70	0.80	0.72	0.66	0.70	0.68
Firm-Spec Clusters	1,963	2,264	2,601	2,102	2,332	2,736
Time-Ind Clusters	60	60	60	120	120	120

Panel B: Delay2 Measure

	Three Month Window			Six Month Window		
	(1)	(2)	(3)	(4)	(5)	(6)
	Early-Middle	Middle-Late	Early-Late	Early-Middle	Middle-Late	Early-Late
Regime # Special	0.0032	0.0086	0.0903***	0.0035	0.0140	0.0930***
	(0.24)	(0.84)	(3.97)	(0.29)	(1.21)	(4.62)
Special	0.0050	-0.0027	0.0179	0.0107	-0.0100	0.0070
	(0.27)	(-0.12)	(1.16)	(0.85)	(-0.54)	(0.56)
Observations	9,854	12,442	11,235	19,690	24,446	22,225
R Squared	0.68	0.78	0.70	0.64	0.67	0.66
Firm-Spec Clusters	1,967	2,266	2,604	2,105	2,337	2,741
Time-Ind Clusters	60	60	60	120	120	120

Table VIII
Mispricing: Return Predictability

Data is monthly from July 2006 to December 2015. The "Early Regime" is pre-Sept 2008 when the OMM Exception was in place. The "Middle Regime" is between September 2008 and August 2013 when reverse conversions were the only method to use option markets to short stocks. The "Late Regime" is Sept 2013 to Dec 2015 and represents the current state. July-Nov 2008 and August 2013 are omitted. Hard-to-borrow is defined as 19 days (or more) above 100 bps, 200 bps or the 95th percentile in Panel A, B, and C, respectively. Returns listed are Fama-French 3 factor abnormal returns (raw return less portfolio return), and are measured in the subsequent month after hard-to-borrow is defined. The sample includes stocks with traded options or not as indicated. Differences are between hard-to-borrow and easy-to-borrow stocks.

Panel A: Hard-to-borrow defined as 19 days in a month with fees 100 bps or more.

		Hard-to-Borrow		Easy-to-Borrow		Difference	T-statistic	p value
Loans Only	Late	-0.38%	10,373	0.46%	16,246	0.84%	2.76	0.0059
	Middle	-0.50%	15,576	0.75%	47,976	1.25%	5.96	<.0001
	Early	-1.10%	2,902	-0.10%	18,798	1.00%	2.83	0.0046
Opts + Loans	Late	-1.94%	5,180	-0.13%	44,476	1.80%	6.95	<.0001
	Middle	-0.34%	8,584	0.21%	77,587	0.55%	2.72	0.0066
	Early	-2.12%	1,763	0.05%	20,799	2.17%	5.14	<.0001

Panel B: Hard-to-borrow defined as 19 days in a month with fees 200 bps or more.

		Hard-to-Borrow		Easy-to-Borrow		Difference	T-statistic	p value
Loans Only	Late	-0.64%	7,503	0.58%	25,178	1.22%	3.24	0.0012
	Middle	-0.75%	11,437	0.92%	68,473	1.66%	6.48	<.0001
	Early	-1.49%	1,529	-0.22%	29,073	1.27%	2.46	0.0139
Opts + Loans	Late	-2.52%	3,431	-0.18%	47,735	2.34%	7.14	<.0001
	Middle	-0.63%	5,305	0.24%	84,468	0.86%	3.07	0.0022
	Early	-1.78%	937	-0.09%	24,256	1.69%	2.84	0.0046

Panel C: Hard-to-borrow defined as avg monthly fee above the 95th pctile.

		Hard-to-Borrow		Easy-to-Borrow		Difference	T-statistic	p value
Loans Only	Late	-0.60%	5,711	0.49%	26,970	1.09%	2.32	0.0205
	Middle	-0.34%	16,523	0.94%	63,387	1.28%	5.97	<.0001
	Early	-0.60%	5,435	-0.22%	25,167	0.38%	1.28	0.2022
Opts + Loans	Late	-2.61%	2,468	-0.22%	48,698	2.39%	6.11	<.0001
	Middle	-0.49%	6,186	0.23%	83,587	0.73%	2.76	0.0058
	Early	-1.80%	1,950	-0.02%	23,243	1.79%	4.42	<.0001

Table IX
Multivariate Specification of Return Predictability by Regulatory Regime.

The "Early Regime" is pre-July 2008 when the OMM Exception was in place. The "Middle Regime" is between November 2008 and July 2013 when reverse conversions were the only method to use option markets to short stocks. The "Late Regime" is Sept 2013 to Dec 2015 and represents the current state. Omitted months are July-Oct 2008 and August 2013. The dependent variable in all specifications is the t+1 monthly return in excess of the risk free rate. Special is defined as avg monthly fee above the 95th pctile. All control variables are computed at time t, all except return are logged. Book to Market is the book value of equity divided by the market value of equity. Market Cap is market capitalization. Spread is the spread divided by the midpoint. Volatility is computed over the previous 21 days, annualized. Lag Returns is the time t stock return. The specification follows Fama and MacBeth (1973) and includes 109 monthly cross-sectional regressions summarized below. T-statistics are in parentheses. ***, **, * indicates significance at the 1%, 5%, and 10% levels, respectively.

	Early Regime		Middle Regime		Late Regime	
	(1)	(2)	(3)	(4)	(5)	(6)
	Returns	Returns	Returns	Returns	Returns	Returns
Special	-0.0088***	-0.0068***	-0.0159***	-0.0176***	-0.0179***	-0.0124**
	(-4.35)	(-3.65)	(-5.17)	(-7.04)	(-3.04)	(-2.51)
Book to Market	-0.0165***	-0.0173***	-0.0149***	-0.0160***	-0.0151***	-0.0171***
	(-7.78)	(-8.35)	(-11.09)	(-11.66)	(-5.64)	(-6.51)
Market Cap	-0.0007	-0.0019	-0.0049***	-0.0044***	-0.0025**	-0.0032*
	(-0.78)	(-1.46)	(-4.79)	(-4.45)	(-2.27)	(-2.01)
Stock Spread		-0.0005		-0.0002		0.0021
		(-0.21)		(-0.09)		(0.99)
Volatility		-0.0089**		0.0051		-0.0171***
		(-2.28)		(0.76)		(-3.41)
Lag Returns		-0.0312		-0.0436***		-0.0302**
		(-1.39)		(-3.95)		(-2.14)
Observations	78,633	78,353	194,313	193,809	58,665	58,337
R Squared	0.02	0.04	0.02	0.05	0.03	0.06

Table X
Comparing Return Predictability by Regulatory Regime.

The "Early Regime" is pre-July 2008 when the OMM Exception was in place. The "Middle Regime" is between November 2008 and July 2013 when reverse conversions were the only method to use option markets to short stocks. The "Late Regime" is Sept 2013 to Dec 2015 and represents the current state. Omitted months are July-Oct 2008 and August 2013. Models 1-4 are on the subsample of stocks with options, Models 5-8 on those with no options. The dependent variable in all specifications is the t+1 monthly return in excess of the risk free rate. Regime indicators are set for that regime, and zero for the Early Regime only, missing for third regime. Special is defined as avg monthly fee above the 95th pctile. All control variables are computed at time t, all except return are logged. Book to Market is the book value of equity divided by the market value of equity. Market Cap is market capitalization. Spread is the spread divided by the midpoint. Volatility is computed over the previous 21 days, annualized. Lag Returns is the time t stock return. Firm fixed effects included, standard errors clustered by firm and month. T-statistics are in parentheses. ***, **, * indicates significance at the 1%, 5%, and 10% levels, respectively.

	Stocks with Options				Stocks with No Options			
	Middle vs Early		Late ve Early		Middle vs Early		Late ve Early	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Returns	Returns	Returns	Returns	Returns	Returns	Returns	Returns
Special # Regime	-0.0240**	-0.0230**	-0.0344***	-0.0313**	-0.0174***	-0.0194***	-0.0088	-0.0098
	(-2.26)	(-2.25)	(-2.96)	(-2.60)	(-2.75)	(-3.11)	(-0.94)	(-0.99)
Special	0.0170*	0.0167*	0.0209**	0.0201**	-0.0001	0.0010	0.0017	0.0034
	(1.99)	(1.86)	(2.38)	(2.33)	(-0.01)	(0.17)	(0.33)	(0.67)
Regime	0.0086	0.0092	0.0180	0.0146	-0.0041	-0.0023	0.0151*	0.0142
	(0.70)	(0.66)	(1.43)	(1.19)	(-0.40)	(-0.23)	(1.69)	(1.61)
Book To Market	-0.0420***	-0.0432***	-0.0312***	-0.0323***	-0.0468***	-0.0483***	-0.0406***	-0.0420***
	(-6.55)	(-6.69)	(-5.34)	(-5.57)	(-9.25)	(-8.95)	(-6.76)	(-7.06)
Market Cap	-0.0679***	-0.0706***	-0.0422***	-0.0448***	-0.0841***	-0.0921***	-0.0680***	-0.0715***
	(-4.52)	(-6.92)	(-6.84)	(-6.95)	(-7.07)	(-8.75)	(-10.20)	(-11.28)
Spread		-0.0003		-0.0027		-0.0052		-0.0041
		(-0.04)		(-0.76)		(-1.30)		(-1.18)
Volatility		-0.0047		-0.0082		-0.0086		-0.0120**
		(-0.34)		(-1.04)		(-0.93)		(-2.41)
Lag Return		-0.0408		-0.0702***		-0.0581***		-0.0903***
		(-1.28)		(-3.27)		(-3.14)		(-5.46)
Observations	153,681	153,629	82,370	82,328	118,851	118,094	54,491	53,885
R Squared	0.07	0.08	0.08	0.09	0.09	0.10	0.11	0.12
Firm Clusters	3,244	3,244	3,371	3,371	3,955	3,905	3,615	3,551
Time-Ind Clusters	81	81	52	52	81	81	52	52