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Is There a Risk Premium in the Stock Lending Market? Evidence from Equity Options

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Is There a Risk Premium in the Stock Lending Market? Evidence from Equity Options☆

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April 29, 2016

Abstract

A recent literature suggests that uncertainty about future stock lending fees is an impediment to short-selling and this risk explains part of the returns to shorting. However, an investor can use the option market to establish a synthetic short position that embeds a fixed lending fee and avoids exposure to lending fee risk. This option-implied lending fee can be computed from a pair of option prices. For each set of options, the difference between the option-implied fee and the average realized lending fee during the life of the option is an estimate of the risk premium for bearing lending fee risk. We find that the average of these estimates is approximately zero, and therefore, the equity lending market does not exhibit a substantial risk premium. In addition, the option implied lending fee predicts future realized lending fees and stock returns better than actual lending fees. When we include both the option-implied lending fee and the implied volatility spread and skew in predictive regressions the option-implied lending fee predicts stock returns, but implied volatility spread and skew do not.

JEL Classification: G12, G13, G14

Keywords: Stock lending, short sales, lending fee, equity options

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Abstract

A recent literature suggests that uncertainty about future stock lending fees is an impediment to short-selling and this risk explains part of the returns to shorting. However, an investor can use the option market to establish a synthetic short position that embeds a fixed lending fee and avoids exposure to lending fee risk. This option-implied lending fee can be computed from a pair of option prices. For each set of options, the difference between the option-implied fee and the average realized lending fee during the life of the option is an estimate of the risk premium for bearing lending fee risk. We find that the average of these estimates is approximately zero, and therefore, the equity lending market does not exhibit a substantial risk premium. In addition, the option implied lending fee predicts future realized lending fees and stock returns better than actual lending fees. When we include both the option-implied lending fee and the implied volatility spread and skew in predictive regressions the option-implied lending fee predicts stock returns, but implied volatility spread and skew do not.

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1. Introduction

A growing literature emphasizes that borrowing stock and selling it short is risky. One possibly important risk stems from the stock lending market practice that stock loans may be recalled at any time. A recall forces market participants to either cover (close out) their short positions and return the borrowed stock, or else to reestablish their stock loans at a possibly much higher lending fee. Due to this, the lending fee for any period longer than a day is uncertain. In the theoretical model of Duffie, Garleanu, and Pedersen (2002) stock lending fees and share availability depend on the differences in the beliefs of different investors, and lending fees change as the marginal buyer of shares evolves. D'Avolio (2002, p. 279) emphasizes the implication of his model that "…a short seller is concerned not only with the level of fees, but also with fee variance," while in a recent empirical paper Engelberg et al. (2015) argue that the risk of lending fee increases is an important impediment to short-selling and explains a large fraction of the returns to shorting. They interpret their results to imply "that uncertainty regarding future short sale constraints is a significant risk, and we show that this risk affects trading and asset prices" (Engelberg et al. 2015, page 2). Prado, Saffi, and Sturgess (2014) also interpret their results as being consistent with the hypothesis that the risk of changes in future lending fees is an impediment to shorting. Focusing on a different risk, Drechsler and Drechsler (2014) argue that short-sellers have concentrated portfolios and that the abnormal returns to stocks with high lending fees are the compensation that short sellers require for bearing the risk of the concentrated short positions.

An investor who wants establish a short position can "lock in" the lending fee and avoid the risk of future lending fee increases by establishing a synthetic short position in the option market. In this case the option market maker will borrow and short-sell the shares to hedge his synthetic long position, and the option market maker will pay the lending fee and bear the risk of increases in the lending fee. The expected lending fee over the life of the option, and any risk premium associated with future lending fee changes, will be reflected in the option prices and thereby passed through to the investor who uses the option market to establish a synthetic short position. This option-implied lending fee, which is equal to the average daily lending fee over the life of the option plus any risk premium required by the option market maker, can be computed from the option prices. Computing these option-implied lending fees for a large set of options, the average difference between the option-implied lending fees and the realized lending fees over the lives of the options provides an estimate of the risk premium for bearing the risk of lending fee changes. This idea is similar to that in the literature on the variance risk premium, where the variance risk premium is estimated as the average difference between so-called "model-free" option-implied variances and realized variances over the option lives (Carr and Wu 2009).

We carry out this exercise and estimate the risk premium using intraday option prices obtained from a large proprietary database and the Markit Securities Finance lending fee data, which covers the vast majority of actively traded U.S. stocks. We find that, on average, the option-implied lending fees are equal to the realized lending fees over the lives of the options from which they were computed. This equality between the average option-implied and realized lending fees implies that the risks of borrowing stock are not important enough to create a risk premium reflected in the prices of one important class of securities, exchange-traded options. Our use of intraday option prices allow us to minimize the impact of option market microstructure "noise" stemming from wide option bid-ask spreads by computing the option-implied lending fees throughout the day and obtaining daily estimates by averaging the many intraday estimates computed for each underlying stock and date. We also compute the lending fees using data from OptionMetrics, which for most underlying stocks on most dates provides data for a larger cross-section of option strike prices than are available in our intraday data because for each date the intraday option data include only the bid and ask quotes for the options that trade on that date.

As expected, the option-implied lending fees that we compute predict the realized actual lending fees over the lives of the options. Further, the option-implied lending fee, in conjunction with the current actual lending fee, predict changes in the actual lending fee. These results are evidence that the option-implied lending fees we are useful forward-looking estimates of the actual lending fees over the lives of the options used to compute them.

If the option-implied lending fees are forward-looking estimates of the actual lending fees then they also should predict future stock returns. We estimate predictive regressions using the option-implied lending fee and other covariates and find that option-implied lending fees predict stock returns over one-week and one-month horizons. The coefficient on the option-implied lending fee remains highly significant even when other variables such as the actual lending fee, loan utilization, short interest, and the short fee risk measure proposed by Engelberg et al. (2015)

are included in the regressions. Of all of the variables we include in the regression models, the option-implied lending fee is the most significant predictor of stock returns. In the subsample of hard-to-borrow stocks it is the only significant predictor. In additional analyses we find that the short fee risk measure predicts returns in a univariate regression model, but becomes insignificant when any one or more of the variables loan utilization, actual lending fee, or option-implied lending fee are included in the regression model.

Our finding that the option-implied lending fee is on average equal to the realized actual lending fee over the lives of the options used to compute the implied lending fee indicates that the risk of changes in the lending fee is not a “priced” risk, that is there is no risk premium for bearing this risk. The lack of a risk premium does not, by itself, contradict the arguments in D’Avolio (2002) and Engelberg et al. (2015) that uncertainty about future stock lending fees might be an impediment to short sales because the risk of changes in the lending fee can be an impediment to short-selling even if this risk does not carry a risk premium. However, we also find that the short fee risk measure does not predict stock returns once we include other variables in the predictive regressions, and the option-implied lending fee does. Thus, the evidence suggests that the risk of lending fee changes is not the impediment to arbitrage that causes measures of shorting demand and the supply of lendable shares to predict stock returns. Instead, the option-implied lending fee predicts stock returns because it is a proxy for expected future lending fees.

We also present results that bear on the existing literature showing that differences between certain option implied volatilities predict underlying stock returns. For example, Cremers and Weinbaum (2010) find that the implied volatility spread, defined as the difference between the implied volatilities of at-the-money (ATM) calls and puts, positively predicts returns, while Xing et al. (2010) find that the implied volatility skew, defined as the difference between the implied volatility of an out-of-the-money put and an ATM call, is a negative predictor of returns. When we estimate predictive regressions that include the option-implied lending fee and these other option-based predictors we obtain significant coefficients on the option-implied lending fee and insignificant coefficients on both the implied volatility spread and the implied volatility skew.

These results suggest that the implied volatility spread and skew predict returns because they proxy for the option-implied lending fee. The volatility spread and skew measures in

Cremers and Weinbaum (2010) and Xing et al. (2010) are based on OptionMetrics implied volatities, which are computed ignoring any lending fee, that is by treating the lending fee as zero. Because the impact of the lending fee on option values is the same as the impact of a dividend yield, OptionMetrics' failure to reflect the lending fee in their implied volatility calculations causes call and put implied volatilities to be lower and higher, respectively, than they would have been had OptionMetrics computed implied volatilities that reflected the lending fee. Thus, the implied volatility spread in Cremers and Weinbaum (2010) and implied volatility skew in Xing et al. (2010) are low and high, respectively, when the lending fee is high. Our finding that the implied volatility spread and skew become insignificant once we included the option-implied lending fee in the predictive regressions indicates that these variables predict returns because they proxy for the option-implied lending fee; once we include the option implied lending fee in the predictive regressions, these other variables computed from option prices no longer predict stock returns.

Our regression results in which we use the option-implied lending fee to predict stock returns are also related to the large literature that uses measure of lending fees, shorting activity, or the demand for and supply of lendable shares to predict stock returns. For example, Geczy, Musto and Reed (2002), Ofek, Richardson, and Whitelaw (2004), Cohen, Diether, and Malloy (2007), and Drechsler and Crechsler (2014) present evidence that lending fees negatively predict stock returns. Our results suggest that the option-implied lending fee is a better measure of shorting costs than the actual lending fees used in the literature because the option-implied lending fee is a proxy for expected future lending fees. However, our results do not have important implications for the interpretation of the results in these papers.

The balance of the paper is as follows. Section 2 describes the option and stock lending fee data we use. Section 3 discusses the option implied lending fee and how we compute it. This section also contains the results showing that the option-implied lending fee predicts future lending fees and that the lending fee risk premium is zero. Section 4 presents results of regressions in which we use the option-implied lending fee and other variables to predict stock returns. Including the option-implied lending fee, together with utilization, in the regressions makes the other variables insignificant. Section 5 presents the regression results showing that the implied volatility spread and skew no longer predict stock returns once we include the option-implied lending fee in the predictive regressions. Section 6 briefly concludes.

2. Data and summary statistics

We obtained stock and options data from Nanex, a firm specializing in high-quality data feeds. In turn, Nanex obtains its data from standard sources: the Option Price Reporting Authority (OPRA) for options and the Securities Information Processor (SIP) for equities (for example, TAQ data also are from SIP). Our data include intraday quoted bid and ask prices at one minute frequency for both options and the underlying equity market, and the timestamps are synchronized across markets. The data cover the sample period from January 2004 to April 2013. For options, we also observe the top of the limit order book for each of the option exchanges. To eliminate illiquid options, only option contracts with at least one trade during a given day are included in the data. Even with these constraints intended to reduce the size of the data, the data are still very large and require more than ten terabytes of space after compression. Stock returns and volumes are from CRSP.

The stock lending fee data and other stock lending data come from the Markit Securities Finance Buy Side Analytics Data Feed available from Markit, Ltd. The data cover the sample period from July 2006 to December 2014. The intersection of this and the period covered by the intraday option data from Nanex is July 2006 to April 2013, which is the sample period used in the analysis.

The main variable we use from the Markit data is "IndicativeFee," which is Markit's estimate of the "The expected borrow cost, in fee terms, for a hedge fund on a given day" (Markit 2012). This is an indicative fee paid by the borrower for a new stock loan, based on "both borrow costs between Agent Lenders and Prime Brokers as well as rates from hedge funds to produce an indication of the current market rate."[1] Markit also offers a sell-side database, which includes the average fee received by lenders.[2] Key advantages of the fee data from the buy-side database compared to the fee data in the sell-side database are that first that the fee data in the buy-side database are the indicative fees for a new loan, while the fee data in the sell-side database are the average fees on currently outstanding loans, most of which have been in place

[1] The full description of the data item is "The expected borrow cost, in fee terms, for a hedge fund on a given day. This is a derived rate using Data Explorers proprietary analytics and data set. The calculation uses both borrow costs between Agent Lenders and Prime Brokers as well as rates from hedge funds to produce an indication of the current market rate. It should not be assumed that the indicative rate is the actual rate a Prime Broker will quote or charge but rather an indication of the standard market cost" (Markit 2012).

[2] At the time we licensed the data (2015), Markit refused to license both the buy-side data and sell-side data to the same researcher or group of researchers.

for more than one day and some of which have been outstanding for an extended period of time. Thus, the fee data in the sell-side database do not reflect the fees on new stock loans. Second, the fee data in the sell-side database are the fees received by stock lenders, which can differ from the fees paid by stock borrowers due to spreads charged by brokers. Third, the coverage of the buy-side fee data is more complete than the coverage of the sell-side fee data due to the limited number of stock lenders who provide fee data to Markit.

The Markit Securities Finance database also includes the indicative rebate (IndicativeRebate), the quantity of stock available to be lent (LendableQuantity), the total quantity on loan (QuantityOnLoan), the utilization rate (Utilization), defined as the ratio of the quantity on loan to the lendable quantity, which we use, and other data we do not use. In addition, we also use end-of-day option prices from OptionMetrics in one analysis.

Table 1 Panel A reports various percentiles of the distributions of the Markit stock lending data we use, and also of several variables we compute from the Markit data. The first row of the table reveals that the mean lending fee is 1.23% per year, and that this variable is positively skewed. The lending fee is 0.25% at the first percentile, 0.375% at both the 10th and 50th percentiles, and then reaches 1% at the 90th percentile and 19% at the 99th percentile. The rebate is negatively skewed, being –18.84% at the 99th percentile (note that large negative rebates correspond to large positive fees), –0.575% at the 90th percentile, and –0.175% at the 50th percentile, with a mean value of 0.375%. From the fee data we construct the forward average fee for each date and call-put pair in our option data, where the forward average fee for a date and call-out pair is defined as the average fee from the date to the option expiration date. For each stock-date we compute the median of these across the call-put pairs on that date, and the table reports the statistics for the stock-date medians. These forward average fees are slightly larger than the fees, being 0.384% at the 50th percentile and 20.94% at the 99th percentile. The table also reports the statistics of the forward average rebate, which is defined similarly to the forward average fee, and the forward fee standard deviation, equal to the standard deviation of the daily fees over the remaining life of the option. This last variable is constructed by first computing, for each call-put pair, the standard deviation of the daily fees from the current date to the option expiration date. For each stock-date we then compute the median of these across the call-put pairs on that date, and the table reports the statistics for the stock-date medians.

The next three rows of the Panel A reports statistics of utilization, which has a mean value of 21.9% and a 50^{th} percentile of 12.68%, short interest, which has a mean value of 6.09% and a median of 3.22%, and days to cover, which has a mean value of 4.17 days and a median value of 2.49 days. The next two rows report information about the short fee risk measure introduced by Engelberg et al. (2015). This variable is defined as the natural log of the variance of the daily fee over the preceding 12 months, and has mean and median values of 4.43 and 3.89, respectively.

The next section of the table headed "Market Capitalization" provides some information about the market capitalization of the underlying stocks. The typical stock is in the ninth NYSE size decile, with mean and median market capitalizations of $14.51 billion and $4.46 billion, respectively. The sample stocks tend to be large because the sample includes only optionable stocks and stock-dates for which both members of at least one put-call pair traded.

The last part of the table contains information about the option-implied lending fee, the computation of which is described in the next section. As in the other sections of the table, the unit of observation is a stock-date. Our main sample consists of all combinations of optionable stocks and trading dates for which both members of at least one call-put pair traded on the date, the dividend yield is less than or equal to 5%, the sum of the call and put bid-ask spreads divided by the stock price is less than or equal to 5%, the put moneyness K/S is less than or equal to 1.1, and the stock price is greater than $5. We use the option data to compute the option-implied lending fee for each date and call-put pair with between 15 and 90 days remaining to expiration, and then for each stock date we compute the mean and median option-implied fees across the call-put pairs on that date. We then adjust the option-implied lending fees for early exercise as described in the next section.

The first row of this part of the table contains information about the option-implied lending fee, which is adjusted for early exercise as described in the next section of the paper. The mean and median, 1.21% and 0.41%, are similar to the means and medians of both the lending fee and forward lending fee reported in the top part of the table. The distribution of the option-implied fees is more disperse than the distribution of the actual fees or the forward fees, with the 90^{th} percentile being 4.37% and the 10^{th} percentile actually being negative, −1.01%. This dispersion reflects the fact that the option-implied lending fees are estimated with error, some of which is microstructure "noise" stemming from the wide bid-ask spreads in the option market. Because of these errors, many of analyses in the paper will impose criteria to select subsamples of options and option-implied fees where these estimation errors are smaller.

The next two rows of the table report the statistics of the median and mean unadjusted option-implied lending fees. The distributions of the means and medians are similar except that the distribution of the medians is less disperse. This suggests that the choice to use means or means is not important but that the median is slightly preferred, and we use the medians of the adjusted spreads in subsequent analyses.

Table 2 reports the same set of statistics for the subsample of stock-dates on which the stock are hard-to-borrow, where a stock is defined to be hard-to-borrow on a date if the utilization is greater than 60%. This subsample is interesting because if there is a risk premium for bearing the risk of changes in the lending fee this is the subsample in which it is likely to be found because this is the subsample of stock-dates for which relatively high demand is more likely to generate lending constraints now or in the near future. As expected, the lending fees for these stocks are higher, with the mean and median lending fees being 7.40% and 3.00% per year, respectively. The 90th percentile lending fee is 18%, and the 99th percentile lending fee is 60%. The lending fees are also more volatile, the short ratio and days-to-cover are larger, and the loan length (average time that loans have been outstanding) is also generally larger, though not at the 99th percentile. The short fee risk measure introduced by Engelberg et al. (2015) is also larger.

In the next section of the table the market capitalizations of the hard-to-borrow stocks are smaller than in the full sample, and the mean NYSE decile is 7.47 in contrast to 8.94 in the full sample.

As expected, the option-implied lending fees are also larger than in the full sample, with mean and median values of 6.98% and 2.87%, respectively, in contrast to the mean and median of 1.21% and 0.41% in the full sample. As was the case in the full sample, the option-implied lending fees for the hard-to-borrow subsample are in line with the actual lending fees from Markit. For example, the mean and median option-implied lending fees of 6.98% and 2.87% are reasonably close to the mean and median actual lending fees of 7.40% and 3.00%. This similarity extends out to the 90th and 99th percentiles, where the option-implied lending fees are 19.32% and 61.01%, respectively, which are close the 90th and 99th percentile actual lending fees of 18.00% and 60.00%.

3. Option-implied fees and the risk premium in the stock lending market

Consider an investor who uses the option market to take a synthetic short position in an underlying stock by buying a put option and writing a call option. For simplicity, we assume that the options are of the European type, the interest rate is constant, and the stock does not pay a dividend before the expiration of the options. An option market maker is on the other side of the trade, and thus writes the put and buys the call. To hedge her option position the market maker will short-sell the underlying stock, and thus must pay the stock lending fee. We assume that the market maker is well-capitalized relative to the short position and does not need to post additional collateral to maintain the short position. Assuming that the proportional lending fee is expressed on a continuously compounded basis, the total lending fees paid are

$$\int_t^T h(s)S(s)ds \,.$$

This quantity is random because future values of the lending fee are unknown as of the initial time *t*. The initial cash flow of the position is $S(t)+P(t)-C(t)$.The payoff of the combined positions of written put, purchased call, and short stock is

$$-S(T)-\int_t^T h(s)S(s)ds-\max\left[K-S(T),0\right]+\max\left[S(T)-K,0\right]$$

Simplifying, this is

$$-\int_t^T h(s)S\left(s\right)ds-K \,.$$

The time *t* value of this cash flow is

$$=-PV\left(\int_t^T h(s)S\left(s\right)ds\right)-PV\left(K\right).$$

Where we define $PV(\bullet)$ as the (risk-adjusted) present value operator. The second term in this expression is straightforward to calculate. Combining this expression with the time *t* cash flow of $S(t)+P(t)-C(t)$, for the market maker to be willing to enter into this transaction it must be that

$$S(t)+P(t)-C(t)-PV\left(K\right)-PV\left(\int_t^T h(s)S\left(s\right)ds\right)\geq 0 \,.$$

Rearranging,

$$S(t) - PV\left(\int_t^T h(s)S(s)\,ds\right) \geq C(t) - P(t) + PV(K). \tag{1}$$

Assuming that option market making is competitive, then the weak inequality (1) should hold with equality. Define the option-implied lending fee rate, h_{imp}, as the quantity that satisfies

$$S(t)e^{-h_{imp}(T-t)} = S(t) - PV\left(\int_t^T h(s)S(s)\,ds\right).$$

Based on this definition and competitive market making,

$$S(t)e^{h_{imp}(T-t)} = C(t) - P(t) + PV(K).$$

Rearranging again,

$$h_{imp} = \frac{1}{T-t}\ln\left(\frac{S(t)}{C(t) - P(t) + PV(K)}\right) \tag{2}$$

The risk premium is the difference between the option implied lending fee and the average actual lending fee over the life of the option,

$$h_{imp} - \frac{1}{T-t}\int_t^T h(u)\,du. \tag{3}$$

3.1 Computation of the option-implied lending fee

In computing the option-implied lending fee we must take account of the dividends on the stocks. Thus, we compute the option-implied lending fee using the version of the put-call parity relation that incorporates dividends,

$$C(t) - P(t) = S(t)e^{h_{imp}(T-t)} - PV(D) - PV(K).$$

Solving for the implied lending fee,

$$h_{imp} = -\frac{1}{T-t}\ln\left(\frac{S(t)}{C(t) - P(t) - PV(D) + PV(K)}\right).$$

where $C(t)$ and $P(t)$ are the midpoints of quoted call and put quote prices, $PV(D)$ is the present value of dividends with ex-dividend dates before the expiration date, $T - t$ is the time to expiration, $S(t)$ is the current stock price, and K is the option strike price. For each stock and day, we use the median of the lending fee estimates from individual call-put pairs to reduce the impact of microstructure noise. We also restrict attention to options for which the sum of the call and put bid-ask spreads divided by the stock price is less than or equal to 5% and the stock price is greater than $5.

Actual equity options have American, not European, style exercise, and often their underlying stocks pay dividends. As described in Section 2, we address this by using only options that are near the money and whose underlying stocks do not pay large dividends during the lives of the options in order to minimize the impact of the possible early exercise of American options and the biases created by this and our use of the European put-call parity relation. We also restrict attention to options that have between 15 and 90 calendar days to expiration.

These sample restrictions do not address the fact that, when it is large, the lending fee itself can make early exercise of an American call optimal even when the stock does not pay any dividends during the life of the option. This impacts the value of an American call option, and causes the option-implied lending fees we compute using the European put-call parity relation to be downward-biased. We assess the magnitude of the bias by using the binomial model to compute American option prices for a grid of lending fees and option volatilities, and then use the European put-call parity relation to compute the option-implied lending fees. Doing this, we discover that the bias due to the use of the European put-call parity relation can be important when the lending fee is large and the moneyness $\ln(K/S)$ is small so that call options are well in-the-money . Using the estimates of the bias for a grid of lending fees and option volatilities, we find that the bias is not sensitive the option volatility and is well explained by a linear function of the interaction term $\min(h\times\ln(K/S), 0)$,where h is the quoted lending fee from Markit. We estimate this linear function using ordinary least squares and add the adjustment to the option-implied lending fees computed using the European put-call parity relation. We use these resulting adjusted option-implied lending fees in the rest of the analysis.

After computing the (adjusted) option-implied lending fee we estimate the stock lending risk premium as

$$Risk\ Premium = h_{imp} - \frac{1}{T-t}\sum_{u=t}^{T} h(u),$$

where $h(u)$ is the actual lending fee on date u. This approach is similar to how the volatility risk premium is often measured as the difference between implied and future realized volatilities (e.g, in Carr and Wu 2009).

3.2 Option-implied lending fee predicts future actual lending fees and changes in actual lending fees

We begin by showing that the option-implied lending fees predict both the average values of future actual lending fees over the lives of the options used to compute the option-implied fees and the future changes in actual lending fees. This verifies that the estimates of the option-implied lending fee are reasonable. We construct the estimates of the option-implied lending fees used in the regressions as follows.

The unit of observations in the regressions is a stock-date. For each combination of stock and date, we compute the option-implied lending fee for each call-put pair with remaining time-to-expiration of between 15 and 90 days (inclusive) at 1-minute frequency throughout the day and average the estimates, resulting in a daily estimate of the option-implied lending fee for each call put pair. For each stock and date we then take the median of the option-implied lending fees for the call-put pairs, resulting in an estimate of the implied lending fee for each stock and date. The average actual lending fee is computed similarly—it is the median across all call-put pairs.[3] The current actual fee for each stock and date is taken directly from the Market Securities Finance database.

Table 3, Panel A reports the results of regressions in which the average future actual lending fees are regressed on the option-implied lending fee and the actual quoted lending fee taken from the Markit Securities Finance data for the full sample and the subset of stock-date combinations on which the stock is hard-to-borrow, where a stock is considered to be hard-to-borrow on a date if its utilization rate is greater than 60% on that date. The results show that the both the actual quoted lending fee and option-implied lending fee predict the average future lending fee, separately and in combination. The coefficients on the option-implied lending fee are larger in the subsample of hard-to-borrow stocks, which is unsurprising because in this subsample the actual lending fee is larger relative to the errors in estimating it. When both variables are included in the regression specification the coefficient on the actual lending fee is considerably larger than the coefficient on the option-implied fee, and both are highly significant.

Panel B reports the results for a clean subsample for which errors in estimating the option-implied lending fee are likely to be less severe. This subsample consists of the set of

[3] The average actual lending fee is the same for all call-put pairs with the same maturity.

stock-dates for which the sum of the call and put bid-ask spread is less than 2% of the stock price and the dividend yield during the life of the option is zero. As in Panel A, the regressions are estimated using both the entire clean sample and the subset of stock-date combinations on which the stock is hard-to-borrow. Both the actual and option-implied lending fees continue to predict the average future lending fee. The estimates coefficients on the actual lending fee in the various specifications are smaller than in the corresponding regression in Panel A, while the coefficient on option-implied lending fee is larger in three of the four specifications in which this variable appears.

Panels A and B of Table 4 report the results of regressions that show that the current actual lending fee and the option-implied lending fee predicts the difference between the average future lending fee and the current quoted lending fee, that is these variables predict changes in the lending fee. The coefficients on the quoted lending fee are all negative, reflecting the mean reversion in quoted lending fees. The coefficient on the option-implied lending fee is positive when this variable is included in the regression specification along with the actual lending fee, indicating that the option-implied lending fee contains useful information about future changes in the lending fee.

3.3 Lending fee risk premium

Table 5 provides evidence about the magnitude of the lending fee risk premium by reporting the mean and median of the risk premium, defined as the difference between the option-implied lending fee and the realized actual lending fee, for various samples. The unit of observation is a stock-date. For each combination of stock and date, we compute the option-implied lending fee for each call-put pair with remaining time-to-expiration of between 15 and 90 days (inclusive) at one-minute frequency throughout the day. For each option, we also compute the average lending fee over the remaining life of the option; for each option the realized risk premium is then the difference between the option-implied lending fee and the average actual lending fee. The first row of Panel A reports the mean and median of the realized risk premium and also the standard deviation of the risk premium for the full sample and two subsample of easy-to-borrow and hard-to-borrow stocks. The standard error of the mean risk premium is in the next row. The table also reports the mean and median values of the risk premium computed from option-implied lending fees that are not adjusted for early exercise ("Lending fee risk premium (unadjusted)"), the adjusted and unadjusted option-implied lending fees, where the option-implied lending fees are computed as described above, and the actual lending fee. Panel B reports the same statistics for the clean sample of low dividend stocks.

The main message of the table is that the risk premium in the stock lending market, if there is one, is close to zero. In the full sample in Panel A the mean and median risk premia are –0.04% and –0.08% per year, respectively. There are some extreme values of the realized risk premia, so the median is probably a better measure of location than the mean. In the subsample of hard-to-borrow stocks, defined as those with utilization greater than 60%, the mean and median values of the realized risk premium are –0.05% and –0.17% per year, respectively. The median of –0.17% is only –6% (= –0.17%/2.87%) of the adjusted option-implied lending fee of 2.36% per year. The subsample of hard-to-borrow stocks is the place where we would expect to find a risk premium, if there is one. This is the subsample for which constraints on supply are most likely to be binding, possibly leading to loan recalls, higher lending fees, and difficulties in reborrowing stock to replace recalled stock loans. The fact that we do not find a risk premium in this subsample is compelling evidence that the risk premium in the stock lending market, if there is one, is small.

Panel B presents the corresponding statistics for the clean sample of stocks that have no dividends and small option bid-ask spreads. The results are similar to those in the full sample, in that the risk premium is also small. The mean and median risk premia are –0.33% and 0.04% per year, respectively, where again the existence of some extreme values of the realized risk premia suggest that the median is a better estimate of location than the mean. The mean and median values of the realized risk premium in the subsample of hard-to-borrow stocks are –0.04% and 0.08% per year, respectively. The median of 0.08% is only 3% (= 0.08%/2.36%) of the adjusted option-implied lending fee of 2.36% per year. Again, the subsample hard-to-borrow stocks is the place where we would expect to find a risk premium, if there is one, so this finding is strong evidence that the risk premium in the stock lending market is small.

4. Cross-sectional return predictability

The results in Table 3 and Table 4 from the preceding section show that the implied lending fee is a strong predictor of the average lending fee during the remaining life of the option pair as well as the difference between the average lending fee during the life of the option pair and the current lending fee. Since the expected cost of a short position is likely to be a key determinant of limited arbitrage associated with short sales, we analyze the predictability of stock returns based on the implied lending fee. Table 6 presents the results of these panel regressions for various specifications.

The evidence of a predictive relation between the implied lending fee and subsequent returns is negative and significant in all specifications. While we initially focus our attention on the full sample using weekly stock returns, we also consider the subsample of stocks with high utilization that we label as hard-to-borrow (Columns 4 through 6) and stock returns during the subsequent month (Panel B). In Column 1, the *t*-statistic indicates overwhelming statistical significance of the predictive relation between the implied lending fee and stock returns during the next week in Panel A and during the next month in Panel B. Of course, it is possible that the implied lending fee only reflects the current cost determined by the lending market for the particular stock, that is, the current lending fee. Column 2 indicates that the predictive relation between the implied lending fee and subsequent returns is clearly distinct from any role associated with the current lending fee. Indeed, the current lending fee is not a significant predictor of returns in most specifications. In Column 3, we include other characteristics of the securities lending market discussed in the existing literature as well as the log of market capitalization for each particular stock. The predictive relation between the lending fee and subsequent stock returns does not change noticeably in magnitude or statistical significance.

Since the preceding section of this paper indicates that the implied lending fee does not exhibit a positive risk premium, we interpret the implied lending fee as a proxy for the expected cost of holding a short position in the particular stock. The explanation of stock return predictability using the implied lending fee readily follows from this interpretation of the implied lending fee. Essentially, the level of the expected lending fee, rather than the risk properties of the lending fee, is responsible for the observed limit to arbitrage. This explanation is clearly consistent with the basic idea that short sellers should be less likely to take large short positions whenever doing so is expensive, e.g. Miller (1977). We generalize this idea slightly because the expected cost of the short position during the subsequent week or month, rather than the current daily cost of the short position, creates the limit to arbitrage. This explanation of the results is also consistent with the evidence that the current lending fee is not significant predictor of returns in most specifications. The implied lending fee is a better proxy of the expected costs of short selling for the relevant horizon of typical short position. We conclude that the expected cost of the short position is the main limit to arbitrage. The potential riskiness of the lending fee may only be a second order consideration in terms of return predictability.

In Columns 4 through 6, we repeat our analysis for the subsample of stocks that are hard to borrow, that is, have high utilization (above 60%). To the extent that the cross-section of subsequent stock returns is influenced by the limits to arbitrage created by the properties of the lending market, these considerations should be more important for stocks where relatively high demand is more likely to generate lending constraints now or in the near future. The predictability of stock returns using the implied lending fee in this subsample is quite similar to the evidence presented in Columns 1 through 3. In addition, the coefficients on the other variables of interest in Column 5 and Column 6 are not significant for this subsample, that is, the other variables measuring activity in the lending market do not explain the cross-sectional pattern of expected returns in the subsample of interest. We also revisit all six specifications for stock returns at a monthly frequency in Panel B. The coefficient estimate for the implied lending fee is approximately three times larger compared to Panel A. The patterns of statistical significance for the predictors of monthly stock returns remain virtually unchanged compared to the analogous patterns for weekly stock returns.

Thus, it appears that the expected cost of short selling as measured by the option-implied lending fee is the dominant limit to arbitrage. In general, this finding supports the existing literature that measures of lending market activity such as lending fees, shorting interest, and the relative demand for lendable shares are typically negatively related to stock returns. The option-implied lending fee is a better summary statistic of the various forces at work in the securities lending market compared to the other measures used in the literature.

The implied lending fee used in the preceding section and in Table 5 is adjusted for the possibility of early exercise of the call option due to the level of the lending fee. This adjustment, as described in the Section 3, explicitly includes the current lending fee, and therefore, the implied lending fee is basically a convex combination of the actual lending fee and the unadjusted option implied lending fee calculated from option prices. While this adjustment for early exercise is relevant for our analysis of the risk premium, in this context it could artificially inflate or obscure the role of the implied lending fee if the current lending fee is also related to subsequent stock returns. In Table 7 we reproduce Table 6 using the unadjusted implied lending fee. In general, the coefficient magnitudes and patterns of statistical significance remain largely unaffected by the adjustment. The implied lending fee is negatively related to expected returns during the next week and the next month for the full sample and for hard-to-borrow stocks. The only modest difference of note between Table 6 and Table 7 is that the current lending fee is also a statistically significant predictor of stock returns a few of the specifications. For the full sample, there is a negative relation between the current lending fee and stock returns; however, this predictive relation disappears for hard-to-borrow stocks. Going forward, we do not adjust the option-implied lending fee for early exercise based on the current lending fee because we want to ensure that any relation between the current lending fee and expected returns is not artificially obscured by the use of the current lending fee in the adjustment.

Engelberg et al. (2015) indicates that short selling risk is relevant for the cross-section of stock returns. Essentially, this hypothesis is motivated by the observation that shorting stocks with volatile lending fees incorporates another source of idiosyncratic volatility into the returns of short positions. In the theoretical setting of De Long et al. (1991), idiosyncratic risk precludes undiversified and risk averse arbitrageurs from fully correcting any potential mispricing. The ability of a risk averse and undiversified arbitrageur to move an asset's price toward its fundamental value degrades further in the presence of high idiosyncratic volatility and the findings of Wurgler and Zhuravskaya (2002) regarding index inclusions support this theory.

The results of Engelberg et al. (2015) indicate that stocks with higher short selling risk, as measured by the estimates of lending fee volatility, tend to have lower subsequent stock returns. The authors suggest that the high volatility of the lending fee prevents short sellers from taking sufficiently large short positions to drive down the current stock price immediately and eliminate the subsequent low returns. The results in Table 8 indicate that explanations associated with lending fee volatility are second order at best.

We begin this analysis by replicating the univariate relation between short fee risk and expected returns that Engelberg et al. reports. In the absence of any other controls, there is a strong negative relation between short fee risk and stock returns next week and next month for the full sample in Column 1. The univariate results for short fee risk in Column 4 for the hard-to-borrow subsample exhibit similar statistical strength. However, this negative relation disappears after controlling for variables related to the expected costs of a short position, such as the implied lending fee, the current lending fee, and utilization in Column 2 (and Column 5).

Indeed, for the hard-to-borrow subsample, the only significant predictor of stock returns next week or next month is the implied lending fee once the other variables are included. We confirm this finding even after including other variables of potential relevance such as short interest and short supply. The results of these specifications indicate that the relation between the implied lending fee and subsequent returns is statistically important even after controlling for other variables. At the same time, the relation between short fee risk and returns in Engelberg et al. appears to be due to the omission of other variables related to the expected cost of maintaining short positions. Lending fee volatility does not have any predictive power after controlling appropriately for proxies related to expected cost of short positions.

5. Option-based predictors of stock returns

There is also an expanding literature investigating links between option markets and stock returns using various measures of implied volatility. For instance, Cremers and Weinbaum (2010) show that the difference between the implied volatilities of ATM calls and ATM puts, also known as the implied volatility spread, positively predicts stock returns. In addition, Xing et al. (2010) indicate that implied volatility skew, the difference between the implied volatility of an OTM put and an ATM call, is a negative predictor of stock returns. Both of these measures are transformations of option prices. Since the option-implied volatility used in both of these studies is not corrected for the effective dividend yield created by the lending fee, the underlying source of stock return predictability associated with these measures is an open question.

In Table 9 we begin by confirming the existence of the univariate predictive relation between each of these implied volatility measures and subsequent stock returns. Column 1 indicates that the implied volatility spread is positively related to returns next week. Column 2 shows that implied volatility skew is negatively related to returns next week. However, when we augment this approach with the option-implied lending fee and other variables related to the lending market in Column 3, the only consistently significant predictors of stock returns are the implied lending fee and utilization. The option-implied lending fee has a *t*-statistic of approximately 4. Neither the option-implied volatility spread measure from Cremers and Weinbaum (2010) nor the option-implied skew measure from Xing et al. (2010) is a significant predictor of returns next week.

Following our typical practice, we revisit these specifications for stock returns during the next month. In Column 5 and Column 6 we verify the presence of a univariate relation between each option-implied volatility spread measure and stock returns next month. Once again, if we include the other variables of interest in Column 7, the only two clearly significant predictors of returns are the option-implied lending fee and utilization. The option-implied volatility spread measure is not significant in this specification and the coefficient estimate changes sign relative to the univariate relation. The option-implied skew measure from Xing et al. (2010) is only marginally significant predictor of returns and the magnitude of the coefficient estimate for falls by more than 60% compared to the estimate in Column 6.

Lastly, in Column 4 and Column 8, we replace the our main measure of the option-implied lending fee based on intraday data with an analogous measure based on daily option data from Option Metrics. While we think this alternative measure based on daily option prices is likely to contain more noise, it may still be useful for research purposes because it is available for a considerably longer time period. Indeed, it is possible that this measure of short sale constraint may exist before data regarding lending fees, short interest, and utilization becomes available. We find a qualitatively similar pattern of results using this alternative measure of the implied lending fee. The option-implied lending fee is a strong predictor of subsequent stock with a *t*-statistic greater than 4. The coefficient estimate for the option-implied volatility spread is attenuated and insignificant in Column 4 or changes sign in Column 8 compared to the baseline univariate estimate. The estimate for the option-implied volatility skew is attenuated and insignificant for returns next week and next month. Column 4 or changes sign in Column 8 compared to the relevant univariate estimate. In general, these results indicate that the implied volatility variables largely predicted returns because they served as proxies for the implied lending fee.

6. Conclusion

While selling a stock short may expose investors to lending fee risk, this risk does not appear to command a risk premium on average. Investors can establish a synthetic short position in the option market with a fixed lending fee for the life of the options. The average difference between the option-implied lending fee and the average daily lending fee during the life of the pair of options is an estimate of the risk premium for the lending fee. In general, we find that the option-implied lending fees are approximately equal to the relevant realized daily lending fees.

This result implies that the risk of borrowing stock is not substantial enough to create a risk premium reflected in the prices of exchange-traded options. The finding is consistent with the possibility that lending fee risk for individual stocks is diversifiable and the options market is sufficiently competitive and well-capitalized to distribute this risk effectively.

In the absence of a risk premium, it should be the case that the option-implied lending fee is closely related to future daily lending fees. In addition, the option implied lending fee should predict the changes in the daily lending fee during the life of the option. Indeed, we find that the option-implied lending fee is a strong predictor of realized lending fees and changes in realized lending fees. This finding is evidence that the option-implied lending fees we are useful forward-looking estimates of the actual lending fees during the lives of the options. Since option prices are public information, as compared to proprietary data about daily lending fees or short interest that could be considered private information, these results also indicate that one valid measure of the expected cost of short selling is public information.

If the option-implied lending fee is a forward-looking estimate of the actual lending fees and the expected cost of short selling is a limit to arbitrage, then this measure should predict future stock returns. We estimate predictive regressions using the option-implied lending fee and find that option-implied lending fees predict stock returns next week and next month. This relation is highly significant even when other variables such as the actual lending fee, loan utilization, short interest, and the short fee risk are included. Indeed, aside from loan utilization, these other measures of lending market activity are typically not significant predictors especially for hard-to-borrow stocks. Our results suggest that the option-implied lending fee is a better measure of expected costs of shorting than the actual lending fees and short interest commonly used in the literature. In all likelihood, this superior performance is due to the fact that the option-implied lending fee is a better measure of future lending fees during the holding period of the typical short position. In closely related analyses, we find that the short fee risk predicts returns in a univariate regression model, but becomes insignificant when the variables loan utilization and option-implied lending fee are included. This evidence suggests that the risk of lending fee changes is not the main source of the limit to arbitrage. Instead, the option-implied lending fee predicts stock returns because it is a proxy for expected future lending fees.

We also find that the option-implied lending fee is related to the literature relating option-implied volatility measures to the subsequent stock returns. Cremers and Weinbaum (2010) find that the implied volatility spread is positively relate to stock returns and Xing et al. (2010) show that the implied volatility skew is negatively related to returns. If we include the option-implied lending fee and these other option-based predictors in predictive regressions, we obtain significant coefficients on the option-implied lending fee and insignificant coefficients on both the implied volatility spread and the implied volatility skew. This pattern suggests that the implied volatility measures only predict returns because they proxy for the option-implied lending fee. This result may have important implications for any potential explanations of these existing findings in the literature. For example, the explanation proposed by Xing et al. is that informed traders use out-of-the-money put options to exploit an informational advantage. This seems to be quite distinct from the limit to arbitrage explanation generated by the expected costs of short selling.

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Table 1

Summary statistics

Summary statistics of selected stock lending data, stock characteristics, and option-implied lending fees. The sample period is July 2006 to December 2013. The unit of observation is a stock-date, and the data are for all combinations of optionable stocks and trading dates for which both members of at least one call-put pair traded on the date, the dividend yield is ≤ 5%, the sum of the call and put bid-ask spreads divided by the stock price is ≤ 5%, the put moneyness $K/S \leq 1.1$, and the stock price is greater than $5. The lending fee, rebate, utilization, and loan length, which is the average time that existing stock loans have been outstanding, are from the Markit Securities Finance database. The short ratio and days to cover are computed using short interest from the Markit data and shares outstanding and average daily trading volume (over the previous month) from the CRSP database. Short fee risk is the natural log of the variance of the daily loan fee over the previous 12 months, following Engelberg et al. (2015). The daily stock price is from CRSP and market capitalization is the product of the stock price and shares outstanding, both from CRSP. The NYSE size deciles are determined using the breakpoints from Kenneth French's data library (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html#Breakpoints). The option-implied lending fees are computed from the Nanex intra-day option and stock prices. The computation of these option-implied lending fees and the adjustment of the option-implied lending fee to take account of early exercise are described in Section 3.

					Percentiles				
	No. obs.	Mean	Standard deviation	Skewness	1%	10%	50%	90%	99%
Stock lending data									
Lending fee	1,506,082	1.23%	4.54%	10.7	0.250%	0.375%	0.375%	1.000%	19.000%
Rebate	1,506,082	0.37%	5.03%	-8.1	-18.840%	-0.575%	-0.175%	4.875%	4.938%
Average fee to option expiration	1,511,298	1.26%	4.56%	10.3	0.257%	0.337%	0.385%	1.096%	20.938%
Average rebate to option expiration	1,511,298	0.31%	5.04%	-7.9	-19.451%	-0.600%	-0.170%	4.840%	4.898%
Volatility of future lending fee	1,511,298	0.21%	0.98%	15.6	0.000%	0.000%	0.050%	0.261%	3.373%
Utilization	1,505,049	21.93%	23.37%	1.25	0.09%	1.11%	12.68%	59.52%	89.68%
Short ratio	1,507,475	6.09%	7.61%	3.1	0.040%	0.327%	3.223%	15.883%	32.531%
Days to cover	1,507,475	4.2	9.2	25.4	0.1	0.4	2.5	9.6	19.9
Loan length (days)	1,506,364	68.6	79.3	9.6	5.3	18.6	53.0	121.6	352.4
Short fee risk (ERR 2015)	1,506,237	4.4	3.8	-2.4	-0.47	1.47	3.89	9.64	13.97
Stock market capitalization									
Market capitalization (mm)	1,511,276	$14,513	$32,817	6.33	$262	$748	$4,462	$32,490	$174,932
NYSE size decile	1,484,877	8.94398	1.381393	-1.6	4	7	9	10	10

Option-implied lending fee									
Option-implied lending fee (median, adjusted)	1,511,298	1.21%	5.38%	6.0	-7.44%	-1.01%	0.41%	4.37%	22.01%
Option-implied lending fee (median, unadjusted)	1,511,298	1.02%	4.66%	4.6	-7.56%	-1.07%	0.35%	4.20%	18.57%
Option-implied lending fee (mean, unadjusted)	1,511,298	1.01%	4.92%	5.1	-7.83%	-1.25%	0.36%	4.17%	19.02%
Number of call-put pairs used to estimate implied lending fee	1,511,298	3.81	4.67	6.9	1	1	2	8	21
Option parameters									
Days to option expiration	1,511,298	41.10	12.91	0.7	16	26	39	58	80
(sum of call & put bid-ask spreads)/S	1,511,298	1.18%	0.94%	1.5	0.12%	0.28%	0.90%	2.52%	4.34%
Sum of call & put bid-ask spreads	1,511,298	$0.37	$0.40	30.5	$0.03	$0.11	$0.30	$0.67	$1.70
Dividend yield (dividends through option expiration)	1,511,298	0.17%	0.41%	4.2	0.00%	0.00%	0.00%	0.58%	2.01%
PV(dividends through option expiration)	1,511,298	$0.07	$0.17	5.4	$0.00	$0.00	$0.00	$0.25	$0.73

Table 2

Summary statistics for hard-to-borrow (high utilization) stocks

Summary statistics of selected stock lending data, stock characteristics, and option-implied lending fees for the subsample of high utilization stocks. The sample period is July 2006 to December 2013. The unit of observation is a stock-date, and the data are for all combinations of optionable stocks and trading dates for which both members of at least one call-put pair traded on the date, the dividend yield is ≤ 5%, the sum of the call and put bid-ask spreads divided by the stock price is ≤ 5%, the put moneyness $K/S \leq 1.1$, the stock price is greater than $5, and the utilization was greater than 60%. The lending fee, rebate, utilization, and loan length, which is the average time that existing stock loans have been outstanding, are from the Markit Securities Finance database. The short ratio and days to cover and computed using short interest from the Markit data and shares outstanding and average daily trading volume (over the previous month) from the CRSP database. Short fee risk is the natural log of the variance of the daily loan fee over the previous 12 months, following Engelberg et al. (2015). The daily stock price is from CRSP and market capitalization is the product of the stock price and shares outstanding, both from CRSP. The NYSE size deciles are determined using the breakpoints from Kenneth French's data library (http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html#Breakpoints. The option-implied lending fees are computed from the Nanex intra-day option and stock prices. The computation of these option-implied lending fees and the adjustment of the option-implied lending fee to take account of early exercise are described in Section 3.

			Standard				Percentiles		
Variable	No. obs.	Mean	deviation	Skewness	1%	10%	50%	90%	99%
Stock lending data									
Lending fee	149,883	7.40%	11.81%	3.6	0.375%	0.500%	3.000%	18.000%	60.000%
Rebate	149,883	-5.26%	12.41%	-3.4	-59.840%	-17.000%	-1.750%	4.750%	4.875%
Average fee to option expiration	153,783	7.53%	11.72%	3.5	0.375%	0.455%	3.244%	19.170%	59.010%
Average rebate to option expiration	153,783	-5.47%	12.30%	-3.2	-58.538%	-17.877%	-1.876%	4.640%	4.868%
Volatility of future lending fee	153,783	1.22%	2.54%	6.0	0.000%	0.050%	0.449%	2.890%	13.025%
Utilization	147,534	75.11%	10.07%	0.43	60.25%	62.54%	73.93%	89.80%	98.69%
Short ratio	149,960	17.36%	10.98%	0.7	0.101%	2.862%	16.798%	31.686%	45.472%
Days to cover	149,960	8.9	7.4	12.6	0.1	1.9	7.8	16.9	28.5
Loan length (days)	149,935	83.2	53.7	3.7	7.9	30.6	74.5	141.5	250.1
Short fee risk (ERR 2015)	149,845	9.4	3.4	-0.3	3.27	4.06	10.14	13.39	15.61
Stock market capitalization									
Market capitalization (mm)	153,772	$2,360	$4,730	8.16	$161	$366	$1,132	$4,710	$21,101
NYSE size decile	149,435	7.47	1.73	-0.7	3	5	8	10	10

Option-implied lending fee									
Option-implied lending fee (median, adjusted)	153,783	6.98%	12.26%	3.1	-7.92%	-0.34%	2.87%	19.32%	61.01%
Option-implied lending fee (median, unadjusted)	153,783	5.66%	10.00%	2.7	-8.49%	-0.53%	2.44%	15.98%	47.46%
Option-implied lending fee (mean, unadjusted)	153,783	5.61%	10.04%	2.8	-8.93%	-0.62%	2.44%	15.94%	47.00%
Number of call-put pairs used to estimate implied lending fee	153,783	3.45	4.11	4.8	1	1	2	7	21
Option parameters									
Days to option expiration	153,783	40.39	12.91	0.7	16	25	39	57.2	81
(sum of call & put bid-ask spreads)/S	153,783	1.88%	1.08%	0.8	0.26%	0.68%	1.66%	3.51%	4.73%
Sum of call & put bid-ask spreads	153,783	$0.43	$0.37	5.6	$0.04	$0.18	$0.35	$0.74	$1.78
Dividend yield (dividends through option expiration)	153,783	0.16%	0.53%	4.5	0.00%	0.00%	0.00%	0.44%	2.75%
PV(dividends through option expiration)	153,783	$0.05	$0.18	7.3	$0.00	$0.00	$0.00	$0.12	$0.84

Table 3

Determinants of the future lending fee

Results of regressions that use the current lending fee and the option-implied lending fee to explain the average lending fee over the lives of the options. The sample period is July 2006 to December 2013. The unit of observation is a stock-date, and the data are for all combinations of optionable stocks and trading dates for which both members of at least one call-put pair traded on the date, the dividend yield is ≤ 5%, the sum of the call and put bid-ask spreads divided by the stock price is ≤ 5%, the put moneyness $K/S \leq 1.1$, and the stock price is greater than $5. Panel B uses the set of stock-dates for which the sum of the call and put bid-ask spread is less than 2% of the stock price and the dividend yield during the life of the option is zero. Models 4-6 use the set of stock-dates for which utilization is greater than 60%. *t*-statistics based on standard errors clustered by stock are in brackets below the coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Full Sample

	All stock-dates			Hard-to-borrow (utilization > 60%)		
Model	1	2	3	4	5	6
Lending Fee	0.9491***		0.8949***	0.9315***		0.8220***
	[123.1]		[85.7]	[97.4]		[48.2]
Option-implied lending fee		0.6203***	0.0624***		0.7739***	0.1287***
		[23.6]	[9.6]		[30.9]	[9.9]
Constant	0.0008***	0.0050***	0.0007***	0.0075***	0.0213***	0.0064***
	[9.9]	[19.4]	[9.2]	[11.3]	[14.5]	[10.3]
R^2	0.90	0.53	0.91	0.88	0.66	0.89
No. of obs.	1,506,082	1,511,298	1,506,082	149,883	153,783	149,883
No. of clusters	3,295	3,296	3,295	1,400	1,466	1,400

Panel B: Clean Sample

	All stock-dates			Hard-to-borrow (utilization > 60%)		
	1	2	3	1	2	3
Lending Fee	0.9191***		0.8670***	0.8992***		0.7768***
	[73.5]		[55.3]	[62.4]		[30.5]
Option-implied lending fee		0.6261***	0.0614***		0.8358***	0.1482***
		[18.1]	[7.5]		[29.1]	[7.0]
Constant	0.0008***	0.0015***	0.0005***	0.0064***	0.0097***	0.0049***
	[8.0]	[5.6]	[5.4]	[9.0]	[7.5]	[7.0]
R^2	0.9	0.54	0.9	0.87	0.71	0.88
No. of obs.	853,918	856,791	853,918	75,923	78,354	75,923
No. of clusters	2,751	2,752	2,751	1,024	1,082	1,024

Table 4

Determinants of the change in the lending fee

Results of regressions that use the current lending fee and the option-implied lending fee to explain the change in the lending fee, where the change is the difference between the average lending fee over the option life and the current lending fee. The sample period is July 2006 to December 2013. The unit of observation is a stock-date, and the data are for all combinations of optionable stocks and trading dates for which both members of at least one call-put pair traded on the date, the dividend yield is ≤ 5%, the sum of the call and put bid-ask spreads divided by the stock price is ≤ 5%, the put moneyness $K/S \leq 1.1$, and the stock price is greater than $5. Panel B uses the set of stock-dates for which the sum of the call and put bid-ask spread is less than 2% of the stock price and the dividend yield during the life of the option is zero. Models 4-6 use the set of stock-dates for which utilization is greater than 60%. *t*-statistics based on standard errors clustered by stock are in brackets below the coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Full Sample

	All stock-dates			Hard-to-borrow (Utilization > 60%)		
Model	1	2	3	4	5	6
Lending Fee	-0.0509***		-0.1051***	-0.0685***		-0.1780***
	[-6.6]		[-10.1]	[-7.2]		[-10.4]
Option-implied lending fee		-0.0028	0.0624***		-0.0102	0.1287***
		[-0.7]	[9.6]		[-1.5]	[9.9]
Constant	0.0008***	0.0002***	0.0007***	0.0075***	0.0032***	0.0064***
	[9.9]	[6.1]	[9.2]	[11.3]	[8.1]	[10.3]
R^2	0.03	0.00	0.05	0.04	0.00	0.09
No. of obs.	1,506,082	1,506,082	1,506,082	149,883	149,883	149,883
No. of clusters	3,295	3,295	3,295	1,400	1,400	1,400

Panel B: Clean Sample

	All stock-dates			Hard-to-borrow (Utilization > 60%)		
	1	2	3	1	2	3
Lending Fee	-0.0809***		-0.1330***	-0.1008***		-0.2232***
	[-6.5]		[-8.5]	[-7.0]		[-8.8]
Option-implied lending fee		-0.0251***	0.0614***		-0.0490***	0.1482***
		[-3.3]	[7.5]		[-3.9]	[7.0]
Constant	0.0008***	0.0003***	0.0005***	0.0064***	0.0035***	0.0049***
	[8.0]	[4.0]	[5.4]	[9.0]	[5.9]	[7.0]
R^2	0.06	0.01	0.09	0.08	0.02	0.12
No. of obs.	853,918	853,918	853,918	75,923	75,923	75,923
No. of clusters	2,751	2,751	2,751	1,024	1,024	1,024

Table 5

Estimates of the lending fee risk premium

Estimates of the lending fee risk premium based on adjusted and unadjusted option-implied lending fees. The sample period is July 2006 to December 2013. The unit of observation is a stock-date, and the data are for all combinations of optionable stocks and trading dates for which both members of at least one call-put pair traded on the date, the dividend yield is ≤ 5%, the sum of the call and put bid-ask spreads divided by the stock price is ≤ 5%, the put moneyness defined as $K/S \leq 1.1$, and the stock price is greater than \$5. The lending fee risk premium is the difference between the option-implied lending fee and the average realized lending fee over the options' lives, and is described more completely in Section 3. Panel B uses the set of stock-dates for which the sum of the call and put bid-ask spread is less than 2% of the stock price and the dividend yield during the options' lives is zero. *t*-statistics testing the hypothesis that the mean lending fee risk premium is zero are in brackets below the sample means, and are based on standard errors clustered by stock. The table also reports the means, medians, and standard deviations of the adjusted and unadjusted option-implied lending fees and the actual lending fee.

Panel A: Full Sample

	All stock-dates				Easy-to-borrow (utilization ≤ 60%)				Hard-to-borrow (utilization > 60%)			
	No. obs.	Mean	Median	Standard deviation	No. obs.	Mean	Median	Standard deviation	No. obs.	Mean	Median	Standard deviation
Lending fee risk premium (adjusted)	1,511,298	-0.04%	-0.08%	3.76%	1,357,515	0.01%	-0.07%	3.05%	153,783	-0.52%	-0.17%	7.53%
		[-1.6]				[0.8]				[-3.7]		
Lending fee risk premium (unadj.)	1,511,298	-0.24%	-0.13%	3.87%	1,357,515	-0.05%	-0.12%	3.05%	153,783	-1.88%	-0.60%	7.86%
		[-8.5]				[-2.7]				[-11.0]		
Option-implied lending fee (adj.)	1,511,298	1.21%	0.41%	5.38%	1,357,515	0.56%	0.33%	3.31%	153,783	6.98%	2.87%	12.26%
Option-implied lending fee (unadjusted)	1,511,298	1.02%	0.35%	4.66%	1,357,515	0.49%	0.29%	3.19%	153,783	5.66%	2.44%	10.00%
Lending fee	1,506,082	1.23%	0.38%	4.54%	1,356,199	0.55%	0.38%	1.68%	149,883	7.40%	3.00%	11.81%

Panel B: Clean Sample

	All stock-dates				Easy-to-borrow (utilization ≤ 60%)				Hard-to-borrow (utilization > 60%)			
	No. obs.	Mean	Median	Standard deviation	No. obs.	Mean	Median	Standard deviation	No. obs.	Mean	Median	Standard deviation
Lending fee risk premium (adjusted)	856,791	0.33%	0.04%	2.53%	778,437	0.37%	0.03%	2.15%	78,354	-0.04%	0.08%	4.90%
		[20.8]				[28.8]				[-0.4]		
Lending fee risk premium (unadjusted)	856,791	0.20%	-0.02%	2.63%	778,437	0.32%	-0.01%	2.16%	78,354	-0.96%	-0.20%	5.24%
		[10.0]				[25.0]				[-6.6]		
Option-implied lending fee (adjusted)	856,791	1.27%	0.49%	3.68%	778,437	0.83%	0.44%	2.33%	78,354	5.57%	2.36%	8.57%
Option-implied lending fee (unadjusted)	856,791	1.14%	0.44%	3.20%	778,437	0.79%	0.39%	2.27%	78,354	4.66%	2.09%	6.88%
Lending fee	853,918	0.94%	0.38%	3.22%	777,995	0.47%	0.38%	1.07%	75,923	5.67%	1.88%	8.96%

Table 6

Stock return predictability using the adjusted option-implied lending fee

Panel A presents the results of regressions to predict stock returns for the next week (from the close on trading day t+1 to the close on trading day t+6) using the option-implied lending fee, the current lending fee, short interest, short utilization, short fee risk, and market capitalization. The sample period is July 2006 to December 2013. The unit of observation is a stock-date, and the data are for all combinations of optionable stocks and trading dates for which both members of at least one call-put pair traded on the date, the dividend yield is ≤ 5%, the sum of the call and put bid-ask spreads divided by the stock price is ≤ 5%, the put moneyness $K/S \leq 1.1$, and the stock price is greater than $5. The option-implied lending fees are computed from the Nanex intra-day option and stock prices. The computation of these option-implied lending fees and the adjustment of the option-implied lending fee to take account of early exercise are described in Section 3. Short interest is from the Markit data. Short fee risk is the natural log of the variance of the daily loan fee over the previous 12 months, following Engelberg et al. (2015). The daily stock return is from CRSP and market capitalization is the product of the stock price and shares outstanding, both from CRSP. Panel B predicts stock returns for the next month (from the close on trading day t+1 to the close on trading day t+26. Models 4-6 use the set of stock-dates for which utilization is greater than 60%. t-statistics based on standard errors clustered by stock are in brackets below the coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Stock returns for the next week

		Full Sample			Hard-to-borrow (Utilization > 60%)	
Model	1	2	3	4	5	6
Option-implied lending fee	-0.0223***	-0.0194***	-0.0179***	-0.0191***	-0.0257***	-0.0255***
	[-6.1]	[-4.5]	[-4.2]	[-3.5]	[-2.7]	[-2.6]
Current lending fee		-0.0053	0.0004		0.0085	0.0122
		[-1.0]	[0.1]		[0.9]	[1.2]
Short Interest			-0.0034			-0.0001
			[-1.1]			[-0.0]
Short utilization			-0.0000***			0.0000
			[-2.9]			[0.3]
Short fee risk			0.0000			-0.0002
			[0.4]			[-1.0]
Market cap.			-0.0000***			0.0000
			[-3.8]			[1.3]
Constant	0.0005***	0.0005***	0.0013***	-0.0016***	-0.0019***	-0.0018
	[5.2]	[5.1]	[8.2]	[-3.3]	[-3.6]	[-0.5]
No. of obs.	1,511,247	1,506,038	1,503,765	153,768	149,875	147,420
No. of clusters	3,296	3,295	3,282	1,466	1,400	1,380

Panel B: Stock returns for the next month

	Full Sample			Hard-to-borrow (Utilization > 60%)		
Model	1	2	3	4	5	6
Option-implied lending fee	-0.0806***	-0.0514***	-0.0469***	-0.0734***	-0.0735***	-0.0743***
	[-6.6]	[-4.3]	[-4.0]	[-4.0]	[-2.8]	[-2.8]
Current lending fee		-0.0484***	-0.0310		0.0004	0.0099
		[-2.7]	[-1.6]		[0.0]	[0.3]
Short interest			-0.0092			0.0044
			[-0.8]			[0.3]
Short utilization			-0.0001***			-0.0002
			[-2.8]			[-1.2]
Short fee risk			0.0001			0.0001
			[0.8]			[0.1]
Market cap.			-0.0000***			0.0000
			[-3.8]			[1.3]
Constant	0.0015***	0.0017***	0.0044***	-0.0066***	-0.0071***	0.0057
	[4.5]	[4.8]	[7.3]	[-3.6]	[-3.6]	[0.4]
No. of obs.	1,511,247	1,506,038	1,503,765	153,768	149,875	147,420
No. of clusters	3,296	3,295	3,282	1,466	1,400	1,380

Table 7

Stock return predictability using the unadjusted option-implied lending fee

Panel A presents the results of regressions to predict stock returns for the next week (from the close on trading day t+1 to the close on trading day t+6) using the option-implied lending fee, the current lending fee, short interest, short utilization, short fee risk, and market capitalization. The sample period is July 2006 to December 2013. The unit of observation is a stock-date, and the data are for all combinations of optionable stocks and trading dates for which both members of at least one call-put pair traded on the date, the dividend yield is ≤ 5%, the sum of the call and put bid-ask spreads divided by the stock price is ≤ 5%, the put moneyness $K/S \leq 1.1$, and the stock price is greater than \$5. The option-implied lending fees are computed from the Nanex intra-day option and stock prices. The computation of these option-implied lending fees is described in Section 3, but in this table the option-implied lending fee is not adjusted based on the level of the current lending fee. Short interest is from the Markit data. Short fee risk is the natural log of the variance of the daily loan fee over the previous 12 months, following Engelberg et al. (2015). The daily stock return is from CRSP and market capitalization is the product of the stock price and shares outstanding, both from CRSP. Panel B predicts stock returns for the next month (from the close on trading day t+1 to the close on trading day t+26. Models 4-6 use the set of stock-dates for which utilization is greater than 60%. t-statistics based on standard errors clustered by stock are in brackets below the coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Stock returns for the next week

	Full Sample			Hard-to-borrow (Utilization > 60%)		
Model	1	2	3	4	5	6
Option-implied lending fee	-0.0242***	-0.0185***	-0.0168***	-0.0218***	-0.0229**	-0.0225**
	[-6.4]	[-4.4]	[-4.0]	[-3.4]	[-2.4]	[-2.3]
Current Lending Fee		-0.0099*	-0.0041		0.0010	0.0045
		[-2.0]	[-0.8]		[0.1]	[0.5]
Short Interest			-0.0034			-0.0004
			[-1.1]			[-0.1]
Short utilization			-0.0000***			0.0000
			[-2.8]			[0.2]
Short fee risk			0.0000			-0.0002
			[0.5]			[-0.9]
Market cap.			-0.0000***			0.0000
			[-3.8]			[1.3]
Constant	0.0004***	0.0005***	0.0013***	-0.0017***	-0.0019***	-0.0017
	[5.0]	[5.3]	[8.6]	[-3.5]	[-3.5]	[-0.5]
No. of obs.	1,511,247	1,506,038	1,503,765	153,768	149,875	147,401
No. of clusters	3,296	3,295	3,282	1,466	1,400	1,379

Panel B: Stock returns for the next month

	Full Sample			Hard-to-borrow (Utilization > 60%)		
Model	1	2	3	4	5	6
Option-implied lending fee	-0.0874***	-0.0517***	-0.0464***	-0.0858***	-0.0712***	-0.0718***
	[-7.2]	[-4.8]	[-4.3]	[-4.3]	[-2.9]	[-2.9]
Current Lending Fee		-0.0589***	-0.0414**		-0.0173	-0.0088
		[-3.3]	[-2.1]		[-0.7]	[-0.3]
Short Interest			-0.0093			0.0043
			[-0.8]			[0.3]
Short Utilization			-0.0001***			-0.0002
			[-2.8]			[-1.2]
Short Fee Risk			0.0001			0.0001
			[0.9]			[0.2]
Market Cap.			-0.0000***			0.0000
			[-3.7]			[1.1]
Constant	0.0014***	0.0018***	0.0044***	-0.0069***	-0.0069***	0.0057
	[4.3]	[4.9]	[7.3]	[-3.8]	[-3.5]	[0.4]
No. of obs.	1,511,247	1,506,038	1,502,488	153,768	149,875	147,401
No. of clusters	3,296	3,295	3,282	1,466	1,400	1,379

Table 8

Stock return predictability comparison using short fee risk and the unadjusted option-implied lending fee

Panel A presents the results of regressions to predict stock returns for the next week (from the close on trading day t+1 to the close on trading day t+6) using the option-implied lending fee, the current lending fee, short interest, short utilization, short fee risk, short supply, and days to cover. The sample period is July 2006 to December 2013. The unit of observation is a stock-date, and the data are for all combinations of optionable stocks and trading dates for which both members of at least one call-put pair traded on the date, the dividend yield is ≤ 5%, the sum of the call and put bid-ask spreads divided by the stock price is ≤ 5%, the put moneyness $K/S \leq 1.1$, and the stock price is greater than $5. The option-implied lending fees are computed from the Nanex intra-day option and stock prices. The computation of these option-implied lending fees is described in Section 3, but in this table the option-implied lending fee is not adjusted based on the level of the current lending fee. Short interest is from the Markit data. Short fee risk is the natural log of the variance of the daily loan fee over the previous 12 months, following Engelberg et al. (2015). The daily stock return is from CRSP and market capitalization is the product of the stock price and shares outstanding, both from CRSP. Panel B predicts stock returns for the next month (from the close on trading day t+1 to the close on trading day t +26. Models 4-6 use the set of stock-dates for which utilization is greater than 60%. t-statistics based on standard errors clustered by stock are in brackets below the coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Stock returns for the next week

	Full Sample			Hard-to-borrow (Utilization > 60%)		
Model	1	2	3	4	5	6
Short fee risk	-0.0002***	0.0000	0.0000	-0.0004***	-0.0002	-0.0002
	[-5.3]	[0.6]	[0.1]	[-3.0]	[-1.0]	[-0.9]
Option-implied lending fee		-0.0171***	-0.0169***		-0.0226**	-0.0223**
		[-4.1]	[-4.1]		[-2.3]	[-2.3]
Current lending fee		-0.0037	-0.0041		0.0044	0.0041
		[-0.7]	[-0.7]		[0.5]	[0.5]
Short utilization		-0.0000***	-0.0000***		0.0000	0.0000
		[-5.6]	[-2.8]		[0.2]	[0.1]
Short interest			-0.0029			-0.0039
			[-0.8]			[-0.8]
Short supply			-0.0000***			0.0000
			[-4.0]			[-1.0]
Days to cover			0.0000			0.0001*
			[-0.1]			[1.8]
Constant	0.0009***	0.0010***	0.0013***	0.0005	-0.0014	-0.0012
	[6.6]	[7.5]	[8.1]	[0.5]	[-0.4]	[-0.3]
No. of obs.	1,506,193	1,502,502	1,502,502	149,837	147,404	147,404
No. of clusters	3,289	3,282	3,282	1,399	1,379	1,379

Panel B: Stock returns for the next month

	Full Sample			Hard-to-borrow (Utilization > 60%)		
Model	1	2	3	4	5	6
Short Fee Risk	-0.0006***	0.0001	0.0001	-0.0014***	0.0001	0.0001
	[-5.0]	[0.9]	[0.9]	[-2.7]	[0.1]	[0.2]
Option-implied lending fee		-0.0472***	-0.0466***		-0.0707***	-0.0708***
		[-4.4]	[-4.3]		[-2.9]	[-2.9]
Current Lending Fee		-0.0406**	-0.0409**		-0.0099	-0.0103
		[-2.1]	[-2.1]		[-0.4]	[-0.4]
Short Utilization		-0.0001***	-0.0001***		-0.0002	-0.0002
		[-5.1]	[-2.9]		[-1.2]	[-1.3]
Short Interest			-0.0108			-0.0124
			[-0.8]			[-0.7]
Short Supply			-0.0000***			0.0000
			[-3.7]			[-0.6]
Days To Cover			0.0001			0.0006**
			[0.6]			[2.0]
Constant	0.0031***	0.0035***	0.0041***	0.0007	0.0082	0.0061
	[6.0]	[6.6]	[6.9]	[0.2]	[0.6]	[0.5]
No. of obs.	1,506,193	1,502,502	1,502,502	149,837	147,404	147,404
No. of clusters	3,289	3,282	3,282	1,399	1,379	1,379

Table 9

Stock return predictability comparison using option-implied volatility measures

The table presents the results of regressions to predict stock returns for the next week (from the close on trading day t+1 to the close on trading day t+6) or stock returns for the next month (from the close on trading day t+1 to the close on trading day t+26) using the option-implied lending fee, the current lending fee, short interest, short utilization, short fee risk, and market capitalization. The sample period is July 2006 to December 2013. The unit of observation is a stock-date, and the data are for all combinations of optionable stocks and trading dates for which both members of at least one call-put pair traded on the date, the dividend yield is ≤ 5%, the sum of the call and put bid-ask spreads divided by the stock price is ≤ 5%, the put moneyness $K/S \leq$ 1.1, and the stock price is greater than $5. The implied volatility spread is the difference between the implied volatilities of ATM calls and puts used in Cremers and Weinbaum (2010), and the implied volatility skew is the difference between the implied volatilities an and OTM and and ATM call used in Xing et al. (2010). The option-implied lending fees are computed from the Nanex intra-day option and stock prices. The computation of these option-implied lending fees is described in Section 3, but in this table the option-implied lending fee is not adjusted based on the level of the current lending fee. Short interest is from the Markit data. Short fee risk is the natural log of the variance of the daily loan fee over the previous 12 months, following Engelberg et al. (2015). The daily stock return is from CRSP and market capitalization is the product of the stock price and shares outstanding, both from CRSP. t-statistics based on standard errors clustered by stock are in brackets below the coefficient estimates. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. + in Column 4 and for Column 8 header indicates the calculation of the option-implied lending fee using daily Option Metrics data rather than intra-day Nanex data.

	Stock Returns Next Week				Stock Returns Next Month			
Model	1	2	3	4+	5	6	7	8+
Implied volatility spread	0.0214***		0.0061	-0.0093	0.0705***		-0.0078	-0.0474***
	[6.5]		[1.3]	[-1.5]	[6.3]		[-0.6]	[-2.6]
Implied volatility skew		-0.0159***	-0.0046	-0.0032		-0.0559***	-0.0209*	-0.0172
		[-5.5]	[-1.3]	[-0.9]		[-5.3]	[-1.9]	[-1.6]
Option-implied lending fee			-0.0161***	-0.0298***			-0.0450***	-0.0760***
			[-4.0]	[-4.6]			[-3.8]	[-4.4]
Current lending fee			0.0047	0.0031			-0.0279	-0.0359*
			[0.8]	[0.5]			[-1.3]	[-1.8]
Short utilization			-0.0000***	-0.0000***			-0.0001***	-0.0001***
			[-4.1]	[-4.1]			[-3.7]	[-3.7]
Option-implied volatility ATM			0.0001	0.0003			-0.0013	-0.0010
			[0.1]	[0.3]			[-0.4]	[-0.3]
Option-implied call skew			-0.0038	-0.0026			-0.028	-0.0237
			[-0.7]	[-0.5]			[-1.6]	[-1.3]
Put-call volume			0.0000*	0.0000**			0.0000*	0.0000*
			[1.9]	[2.0]			[1.9]	[1.9]
Option/stock volume ratio			-0.0002	-0.0002			-0.0002	-0.0014
			[-0.4]	[-0.5]			[-0.5]	[-0.9]
Constant	0.0004***	0.0011***	0.0010***	0.0008**	0.0013***	0.0038***	0.0043***	0.0038***
	[4.6]	[5.6]	[2.8]	[2.2]	[3.8]	[5.3]	[3.3]	[2.9]
No. of obs.	1,480,286	1,169,749	1,037,994	1,036,053	1,480,286	1,169,749	1,037,994	1,036,053
No. of clusters	3,224	2,892	2,743	2,737	3,224	2,892	2,743	2,737