The Term Structure of Securities Lending Fees

FRANÇOIS COCQUEMAS*

This version: November 1, 2017

ABSTRACT

Stock lending is typically an overnight agreement where short sellers pay a fee for borrowing a security. The lending is subject to rerating and recall risk, which may prevent them from holding their position open until it pays off. An alternative is to construct a synthetic short position using options. The two markets are linked by arbitrage. I jointly estimate the term structure of implied securities lending fees and implied volatility from options data. I find that the implied lending fees co-vary with the spot fee. They include a premium indicative of large, low-probability jump risk. Implied lending fees and implied volatility are positively related; however, the estimated term structure of implied volatility is on average flat across horizons. This suggests the volatility term structure may be less useful to model than the lending fee term structure. Finally, I find a median lending fee risk premium of 2% per annum. It is much higher for hard-to-borrow stocks and shorter maturities. Close to two-thirds of the risk premium can be predicted using the term structure of implied lending fees.

Please find the latest version at this link:

https://www.cocquemas.com/files/de2b/JMP.pdf

JEL classification: G12, G13, G14

Keywords: option pricing, securities lending, short selling, term structure

*Vanderbilt University, Owen Graduate School of Management. francois.cocquemas@owen.vanderbilt.edu. I thank Bob Whaley for his guidance, and I am grateful for conversations and comments from Peter Haslag, Sebastian Infante, Abraham Lioui, Miguel Palacios, Tom Smith, and Hans Stoll. This research was supported by the Vanderbilt Financial Markets Research Center, and computations were conducted in part using a grant from Amazon Web Services.

The ability to sell assets short underpins much of financial theory. Given the prohibition of "naked" short selling, it depends on the existence of a securities lending market. Without it, short sellers could not borrow shares to sell, and could not set up their position. It would be much harder for asset prices to adjust and reflect available information. Liquidity would also be dramatically impacted. It may thus be surprising that the securities lending market is opaque and full of frictions. Indeed, this market is over-the-counter and tiered. Borrowers do not get access to the same pool of assets. They do not pay the same fees for the same assets. No market rate is available[1].

Securities lending is compensated by a lending fee. It is a stochastic process linked to loan supply ("shortability," per D'Avolio, 2002), hardness-to-borrow ("specialness," ibid.), and recall risk. Through these three channels, short selling strategies are risky: the position may have to be closed before it pays off (see for instance Engelberg, Reed, and Ringgenberg, forthcoming). The stock may become prohibitively expensive to borrow, or be recalled. At the same time, the supply might dry up, and opening a new short would become impossible.

As Duffie, Gârleanu, and Pedersen (2002) point out, "lending fees reflect the expectation of future shorting demand." For most borrowers, the lending fee can typically be adjusted daily by the lender, according to supply and demand. When option market makers delta-hedge by selling in the spot market, they incur this borrowing cost. They are exposed to changes in the fee over the life of the options. Therefore, they need to take that cost into account when setting their spreads.

This paper argues that lending fees should enter, together with payouts, into the net cost of carry that affect option valuation. This is easy to see for European options, which can be used to construct a synthetic short position through put-call parity. Conversely, if one observes option prices, then it should be possible to extract implied lending rates at different maturities, corresponding to an expected average fee that is locked in over the time horizon. This implied fee needs to incorporate jump risk in the spot lending fee.

In this paper, I estimate the term structure of implied lending fees and show that it is consistent with a lending jump risk premium. Option markets imply that lending fees have a small probability of jumping high, with a somewhat rapid reversal. This is reflected in a downward sloping term structure. Indeed, a large jump would have time to revert for longer-dated options, and be averaged out. For shorter maturities, it may not.

[1]Due to the opaqueness of the market, it is hard to estimate formally how much of these differences stem from counterparty risk. Anecdotal evidence suggests that it is not the only factor. The lack of automation in many segments of the market prevents larger agent banks from engaging in transactions with a broader client base, above and beyond counterparty risk.

This matches realized dynamics of the spot lending fee. The magnitude of the implied is higher, however, in line with a tail risk premium. I jointly estimate the term structure of volatility and find that, unconditionally, it is on average flat across horizons. This suggests that, to explain observed option prices at different horizons, it might be preferable to model stochastic lending fees over stochastic volatility (or to model both).

The securities lending transaction has parallels to an overnight repurchase agreement: the lending rate can change from day to day (rerating of the loan), and the lender can initiate a recall forcing the return of the security by T+3 (or T+6 for market makers)[2]. This can turn into a problem if lending fees and recalls spike right as the short position is about to pay off, compromising the ability to profit from the bet. On the other hand, options allow participants to lock in a certain lending rate to maturity as part of their quotes. That rate should therefore embed a premium for the market maker's assessment of the lending fee risk.

Indeed, even the easiest-to-borrow stocks (general collateral, or G.C. stocks henceforth) face a "peso problem." However infrequently, G.C. stocks become "special," most often as a response to negative events and increased short interest. The jump can be drastic. It can take lending fees from the lower to the top decile from one day to the next. Option market makers who write synthetic shorts would gain a long exposure. They can hedge by short selling the security[3]. Under Regulation SHO, they cannot engage in naked short selling. They would then have to pay the lending fee, which can evolve over time until the options mature. They therefore need to consider that risk into their bid-ask spread. Empirically, this has been shown to be the case during the 2008 short-sale ban on financial stocks (Battalio and Schultz, 2011; Grundy, Lim, and Verwijmeren, 2012). Market makers, unable to hedge, dramatically adjusted their quotes to discourage investors from creating synthetic shorts.

Given most single-name equity options are American, put-call parity will be an inequality and will not enable traders to construct a synthetic short as such. However, the lending rate should still be reflected in the convenience yield of derivatives (after accounting for discrete dividends). To back out the implied lending fee, I develop the following approach: for a given maturity, I take a put-call pair with the same strike and jointly estimate the implied volatility and implied lending fee that best match observed prices. I use the bid price for the call and the ask price of the put, as well as the ask price for the spot. Using two options allows me to disentangle the implied volatility

[2]Or, failing that, a buy-in.

[3]This is in contrast with markets with liquid futures, such as index options.

and the lending rate.

I find that the estimated term structure of lending fees significantly co-moves with the spot rate, supporting the methodology. The spot lending rate alone explains up to 34% of the term structure rates, depending on the horizon. The implied rates are higher for the shorter maturities, and they converge to the spot rate for longer-dated options. They are also higher than the realized average rate for the period they cover. This is consistent with the existence of a risk premium. The median lending fee risk premium is around 2%, but it can be significantly larger for stocks that are harder to borrow and for shorter maturities.

This paper contributes to a growing literature on the functioning of the securities lending market and its relevance to a number of anomalies. It is most closely related to Muravyev, Pearson, and Pollet (2016), who extract a proxy for the spot lending rate from options. They do not find a lending fee risk premium. This contrasts with my findings, likely due to differences in data and methodology. It also relates to Kalay, Karakaş, and Pant (2014), who consider a similar methodology to try and extract the value of corporate voting rights. I do not look specifically at voting, but it is one of the components that should be compensated by the lending rate. The methodology I use differs from both papers. They rely on an (inexact) put-call parity to obtain their measures, which I do not. I focus on obtaining results at different horizons. I also jointly estimate a term structure of volatility. Like these papers, however, I use at-the-money options to derive my estimates.

The securities lending market has been the subject of increasing industry and regulatory attention. Mutual funds and ETFs in particular are deriving ever greater revenues from their lending activities (Blocher, Cocquemas, and Whaley, 2017), and realizing an increasingly large share of their potential lending revenues. Some of these funds could afford to no longer charge management fees, in exchange for a larger shares of lending revenues. In line with this rise in prominence, the Securities and Exchange Commission recently introduced Form N-PORT. Funds will have to make more detailed and more frequent disclosures on securities lending activities. So far, these trends did not translate into a larger share of the stocks being available to be lent out overall. According to Markit data, the value of available securities to market capitalization ("lending capacity," or "loan supply" in Engelberg et al., forthcoming) did not display a clear trend over the 2008-2016 sample period (Table 1). Over that time, 20% to 30% of the easiest-to-borrow securities are available to lend. Securities "on special" have more variability, but no clear temporal trend is apparent.

This paper is organized as follows. Section I outlines the methodology for extract lending fees from option prices, and discusses the relevant literature and methodological concerns. Section II details the data sources and the implementation of the methodology, and presents some summary statistics. Section III examines the estimation results, confirms the pertinence of the methodology, and infers some properties of the lending rate and volatility dynamics. Section IV analyses the lending fee and volatility risk premia derived from the model. Section V concludes.

I. Extracting Lending Fees from Option Prices

A. The Term Structure of Implied Lending Fees

Derivatives pricing typically includes a cost of carry component, which takes into account the costs and benefits of holding the underlying position instead of the derivative product. For stocks, the dividend yield is factored in as the only source of income by most of the stock options literature. However, lending shares out is also a potential way to obtain income from a long position in the spot market, and should be included in the convenience yield (i.e. a negative cost of carry). Rather than using a continuous dividend yield, it is usually preferable to model discrete dividends, especially with close-to-the-money American options. Discrete dividends introduce jumps that may make early exercise optimal when it may not be with a continuous dividend yield. Then, what is left in the convenience yield is the potential revenue from lending out the security, or expected average lending rate.

In this paper, I extract the implied convenience yield and implied volatility from an option pricing model using discrete dividends, for every available maturity. This produces a joint term structure of lending fees and volatility. In order to estimate these two parameters, I need to observe the prices of two options. Selling a call and buying a put, which for European options would correspond to a synthetic short, is one possibility, but any two at-the-money options should do, as long as the bid price is used for calls, and the ask price for puts. I then find the implied volatility and convenience yield that match the observed market prices the best.

This methodology would also capture a voting rights premium, as modeled in Kalay et al. (2014). Arguably, that premium is part of the securities lending fee, since the recipient of the security also obtains voting rights. I do not make any attempt to parcel out voting rights.

Closely related to this paper, Muravyev et al. (2016) extract implied lending fees from options prices, although they are not constructing a term structure, but rather a proxy for the spot lending fee. They rely on put-call parity, which does not assume any particular option pricing model; however, it does not hold exactly for American options, and they have to apply a statistical adjustment to account for the early exercise bias. They also do not estimate implied volatility, given it does not enter put-call parity[4]. Finally, they use midpoints, which can be quite different from the actual quotes a synthetic shorter would have to pay. Given this setup, they find no evidence of a lending fee risk premium, but do conclude that the predictability of returns based on option spreads and skews disappears in favor of their lending fee proxy, suggesting hardness-to-borrow may be the source of the predictability.

This also relates to the literature on the cost of carry/convenience yield for derivatives valuation. While often considered exogenous in the pricing of derivatives, the large fluctuations in the convenience yield across time for many assets suggest that it should be derived in equilibrium. Jarrow (2010) proposes a useful characterization of these additional premia, over and beyond the more obvious direct costs and benefits of storing a commodity, as two embedded options: a scarcity option, which essentially corresponds to potential lending revenues, and a usage option, corresponding to potential cash flows from using the commodity, for instance as an input to production. In the case we are concerned with, stocks, only the scarcity option is relevant: ultimately, borrowing securities is costly because their supply is limited (and stochastic).

The idea that the convenience yield is stochastic goes back to Geske (1978) introducing a stochastic dividend yield into the framework of Black and Scholes (1973). However, the focus on the cost of carry has been mostly in the commodities strand of the literature, where the concept has a more direct meaning. For derivatives on equities, the main focus has been to model stochastic volatility, notably as a way to better match the empirical distribution of stock prices (and its departure from log-normality). For American options in particular, few papers have looked at a stochastic convenience yield, and surprisingly, even fewer have recognized lending revenues as a necessary component of the net cost of carry. Even typical G.C. rates of 25bps per annum are large in a low interest rate context, and lending fees can sometimes jump one or two orders of magnitude.

Some recent papers have attempted to fill this gap. Avellaneda and Lipkin (2009) model the buy-in risk for hard-to-borrow stocks as a Poisson process, which Ma and Zhu (2017) develop into an American option pricing model. Jensen and Pedersen (2016) explicitly models "severe frictions" including short-sale costs, funding costs, and spot transaction costs. They find that these frictions, and the lending fee in particular, can explain a significant amount of early exercises, especially for shorter maturities. Atmaz and Basak (2017) propose a pricing model for the bid and ask of

[4]The implicit assumption is that a call and a put with the same strike have the same implied volatility. This is an explicit assumption in my methodology.

European options under short-selling costs or ban. The lending rate enters the cost of carry, and they include a parameter for partial lending. However, they do not model dynamics of the lending fee or early exercise.

This paper does not develop or rely on a specific framework for pricing options with shorting costs. Instead, within a standard American option pricing model, I consider the cost of carry to be the risk-free rate minus the lending fee. Discrete dividends are accounted for separately. I allow the fee (and the volatility, and the risk-free rate) to be different at each maturity, so that I can construct a term structure. The lending fee represents an average expected fee that is locked into the option price when it is purchased. Those forward implied fees can then be compared either to the spot (overnight) lending rate, or to the realized rate over the life of the option.

B. The Term Structure of Implied Volatility

In the process of estimating a term structure of implied lending fees, I also estimate a term structure of volatility (for at-the-money options). There is a large literature on estimating and analyzing the term structure of implied volatility, and in fact the volatility surface, where strikes are another dimension.

A considerable number of approaches has been proposed to model the dynamics of implied volatility, mostly on European options, and often on index options (see for instance Stein, 1989; Harvey and Whaley, 1991; Heynen, Kemna, and Vorst, 1994; Xu and Taylor, 1994; Cont and da Fonseca, 2002; Cont, Fonseca, and Durrleman, 2002; Fengler, Härdle, and Villa, 2003; Fengler, Härdle, and Mammen, 2007; Andersen, Fusari, and Todorov, 2015). However, few papers tackle the cross-section of equity options. Christoffersen, Fournier, and Jacobs (2017) is an exception, proposing a factor analysis of the term structure of equity options' implied volatility (on 29 stocks), developing a factor-model for valuing the options. Şerban, Lehoczky, and Seppi (2008) studies a multivariate stochastic volatility model with systemic factors, and estimate it on a cross-section of options on the index and 13 stocks. Empirically, Elkamhi and Ornthanalai (2010) find a 3% market jump risk premium embedded in the cross-section of options on the 32 largest firms in the S&P 500.

The cross-section in this paper is much larger, with a total of 792 stocks. However, this means that some estimates for some stock-dates are missing (usually because of missing options data), which makes most of the analyses of these papers (such as principal component analysis) difficult without modifications. I therefore mostly rely on panel regression techniques.

Next, I describe the data and the implementation of the estimation methodology.

II. Data and Implementation of Methodology

A. Data Sources

Options data comes from OptionMetrics. The sample covers January 1996 through April 2016, but it is restricted to 2008 forward. This is to match the securities lending data, and also for regulatory reasons. Option market makers were initially exempted from Regulation SHO, and profited from strategic failure-to-delivers (Evans, Geczy, Musto, and Reed, 2009). Since 2008, this is no longer the case, and market makers cannot engage in naked short selling. Because computational costs are high, the analysis is focused on the stocks that have one of the 100 highest dollar open interests across options on at least one day of the sample. This comes to a total of 792 stocks (identified by their unique CRSP permno) in the panel.

Data on the spot market, in particular stock bid-ask spreads and distributions, comes from CRSP (accessed through WRDS). It is matched to OptionMetrics using the multipronged script proposed by WRDS, which uses fuzzy name matching when other identifiers have failed. Finally, data on interest rates comes from the Federal Reserve Board website (H.15 Daily Release).

Securities lending data comes from Markit's Buyside Premium Data Feed and starts in 2008. There are two main variables for the indicative fees. The Daily Cost of Borrow Score (DCBS) classifies the fee charged by agent lenders in ten bins, from 1 (cheapest to borrow) to 10 (most expensive to borrow). On the other end, the SAF variable is the simple average of fees on borrow transactions from hedge funds, and is a numerical variable. Note that hedge funds may not be representative of the market as a whole; the tiered nature of the relationships could make the rates diverge significantly. Furthermore, using a simple average rather than a (value-)weighted average may introduce some biases in this context.

From Markit data, I use not only the SAF variable and the DCBS categories, but also a few other variables. Utilization is the value of assets on loan over total lendable assets. I also construct a variable for the percentage of market capitalization available to loan, which gives a relative size of the pool to loan. These two measures proxy for shortability. Tenure is the weighted average number of days for open transactions. I also look at the number of open loan transactions, concentration of value on loan among lenders, concentration of value on loan among brokers as controls, which proxy for both liquidity and divergence of opinions.

The main variable for lending fees, SAF, is missing for 12% of observations, whereas DCBS is missing for 0.3%. I impute the missing SAF observations using several categories of predictors:

1. **Securities lending:** DCBS score, utilization, tenure (weighted average number of days for open transactions), number of open loan transactions, concentration of value on loan among lenders, concentration of value on loan among brokers;

2. **Stock characteristics:** stock permno (categorical), SIC industry code (categorical);

3. **Daily market data:** log market capitalization, daily trade volume to market capitalization ratio;

4. **Intraday spreads:** quoted spread (time-weighted), effective spread (value-weighted, Lee-Ready signed), price impact (value-weighted, Lee-Ready signed).

The intraday spread indicators are derived from NYSE TAQ data. Securities lending data is from Markit. Other data is from CRSP. I do not include any volatility measure, as the imputed SAF variable will be related to implied volatility in later statistical analyses.

Imputation is performed using the Multivariate Imputation via Chained Equations approach (MICE, see van Buuren and Groothuis-Oudshoorn, 2011), which works iteratively to fill predictive variables with missing data[5].

B. Summary Statistics

Table I shows basic summary statistics for the combined data sets. Panel A reports the mean and some quantiles of each measure. The spot lending fees, proxied by SAF, are unsurprisingly very low; likewise, the DCBS score is greater than 1 only for one eighth of the sample (88% of the sample is G.C.). Due to our sample selection procedure, market capitalization is fairly large among the 792 stocks, with a median of $9.3bn; the first percentile is only $236m. Shorting risk probably matters particularly for small stocks; unfortunately, these do not typically have liquid options to perform the analysis reliably. In spite of this, the sample includes observation across the whole spectrum of hardness-to-borrow.

Average turnover ratio is 2%. Relative bid-ask spreads for the underlying asset are all sub-penny, as we are dealing with very liquid stocks. The lending capacity (value available to loan to

[5]The method uses the Predictive Mean Matching technique for numeric variables, a polytomous logistic regression for categorical variables (stock identifier and industry) and a proportional odds model for the (ordered) DCBS score. The assumption is that the missing data is missing at random, which may or may not be the case.

market capitalization) is 23% on average. Utilization of that capacity is 18% on average. Those two measures show large inter-quantile ranges. Next, Markit's three measures of concentration are used: inventory, loans outstanding, and broker demand, standing at 0.16, 0.28 and 0.24. A higher measure means fewer lenders/brokers, and a measure of 1 would mean a single one. The average tenure is the weighted length in days of open positions, which has a median of 50 days and a mean of 65 days. Finally, the number of open loans reported to Markit is shown. The median is 173 and the average is 331.

Panel B reports the correlation matrix between the measures. Only the lower triangular part in shown. All correlation coefficients are significantly different from 0 at the 0.1% level. SAF and DCBS have an 86% correlation (using for simplicity DCBS as a continuous variable), which may not be as high as one would expect. Markit does not detail the construction of its DCBS score, and the SAF measure is imperfect, being a simple average of hedge funds lending rates. SAF also has a 0.5 correlation with utilization, and a -0.2 correlation with the lending capacity: more supply translates into a lower rate, and vice versa. Inventory concentration is positively related to the spot rate, and loan and broker demand concentrations negatively related to it, indicating potential pricing power when concentration on either side gets high. Longer average tenure and a greater number of open loans both correlate with a higher fee.

[Table I about here.]

Table II shows the transition matrix between specialness categories, as proxied by Markit's Daily Cost of Borrow Score. The values indicate the frequency (Panel A) or relative frequency (Panel B) that a firm is in the row i on a certain day moves to column j on the next day. The absolute frequencies are very skewed due to the vast majority (88%) of observations being G.C./DCBS 1. However, there is a non-zero amount of jumps from G.C. to special, including straight from DCBS 1 to DCBS 10. This is consistent with the idea that there might be a risk of large, infrequent jumps which has to be embedded in the term structure of lending fees as market makers price their options.

Panel B clearly shows strong daily persistence of hardness-to-borrow. Almost 100% of G.C. stocks remain in that category the following day. There is significantly more variation for stocks on special, but they also tend to remain in the same specialness category (between 81% and 86%, except for the highest DCBS, where it is up to 95%).

[Table II about here.]

Table III shows the serial autocorrelation of the spot lending fee, computed for lags 1 through 360, with only some select lags reported. As apparent in Panel A, daily autocorrelation is high and persistent. The median autocorrelation is still at 11% after 90 lags, and 4% after 180 lags. Panel B shows the daily partial autocorrelation, i.e. the autocorrelation controlling for all shorter lags. The partial autocorrelation falls much faster, as could be expected; however, for the median observation, it is still not zero after thirty lags. This confirms the high persistence in lending fees for the sample, in line with the literature on short selling constraints (e.g. Asquith, Pathak, and Ritter, 2005; Blocher and Zhang, 2017).

[Table III about here.]

Table IV shows the transitions between specialness categories *conditional* on a transition having occurred in the previous period (from any DCBS to any other DCBS). Diagonal values are still high: after one day, between 59% and 70% of stocks have jumped to a DCBS between 2 and 9 stay in that same category. For stocks having moved to DCBS 1 and 10, it is up to 79% and 76% respectively. However, the effect slowly fades away after 10 and 20 trading days, as shown in Panel B and C. Only stocks in DCBS 1 mostly resist this effect (still at 74% after 20 days), consistent with the idea that for most stocks, G.C. is the long-term state they revert to. Looking off the diagonal, it appears that for stocks not staying in the same category, more than half fall back to a lower category, but a large minority instead climb to a higher category. There appears to be a stronger reversion effect towards G.C., but it is balanced by some further upward jumps. The jump process seems to be self-exciting, where previous jumps make further jumps more likely.

[Table IV about here.]

Table V looks at the persistence of specialness *conditional* on a jump from G.C. (DCBS 1) to special (DCBS $\geq$ 2). Overall, stocks jumping from G.C. to special are back in G.C. after just one day in 41% of case. More than two thirds are back in G.C. after ten trading days. There is therefore a lot of quick reversals after a jump, but also a fair amount of persistence. After one day, the second most likely outcome (or the most likely for DCBS 2, which is the bulk of jumps from DCBS) is not a reversal, but a continuation in the same category, as visible on the diagonal. However, that diagonal largely disappears after 10 periods, and almost completely after 20. It is worth noting that there are few cases of stocks jumping directly from DCBS 1 to a DCBS greater than 4, as was already apparent in Table II.

[Table V about here.]

The time series of the lending capacity, i.e. the share of market capitalization available to lend, is shown in Figure 1. The measure is remarkably stable for G.C. stocks, except for a drop around the end of 2008. It is more variable for stocks on special, but without displaying any clear trend. Stocks with DCBS 4 and 5 appear to display the most variation day-to-day. For stocks in the 25th percentile with a DCBS between 2 and 5, it appears that it is not infrequent for the ratio to fall to zero, which would likely mean the supply of shares to loan disappears entirely.

[Figure 1 about here.]

C. Implementation of Methodology

For each day and security, I pick the options that are closest to the money, as they tend to be the most liquid[6]. I find the convenience yield and volatility that minimize the sum of squared errors between the observed option prices and their theoretical value. To compute theoretical prices for the American options, I use a finite difference lattice following the Crank-Nicolson method, which works well for discrete dividends (see for instance Achdou and Pironneau, 2005). I use the bid price for the call and the ask price of the put, as well as the ask price for the spot[7].

For distributions, I assume perfect foresight of regular dividends, and of special dividends only if they have been announced prior to the estimation date. A vast amount of corporate finance literature studies the persistence of regular dividends, seemingly because cutting them would send a costly negative signal. I do not have a way to deal with the risk of dividends being cut, which in some rare cases (if there is prior expectation of it happening) might be a problem. The case of special dividends that would be announced after the current date is also quite difficult to handle, as there might be some prior expectation of them built into prices. For lack of a way to tease them out, they are assumed away[8].

A few filters on the data are applied along the way. I drop securities that could not be match between OptionMetrics and Markit using CUSIP. I then eliminate option series where OptionMetrics

[6]For robustness, I used several options within some moneyness bounds instead, over a subsample. The resulting implied fees and volatilities were similar, but the computing time increases linearly with the number of option series, which was cost-prohibitive.

[7]In robustness checks (available upon request), I used the midpoint for both the options and the underlying stock; the implied lending fees still appear to track the observed spot lending fees quite well, but their magnitude is higher.

[8]The general monotonicity of the estimated term structures seems to confirm ex post that this is rarely an issue: otherwise we would observe a jump between maturities straddling the special dividend.

was not able to compute an implied volatility rate, which indicates some underlying data error. I do not actually use their implied volatility variable outside of this filter, as I estimate it together with the securities lending rate.

Computationally, this is an "embarrassingly parallel" optimization problem, but it does require a significant amount of processing power.The differential evolution algorithm (Price, Storn, and Lampinen, 2006) was used for optimization, as a good trade-off between speed and accuracy with no dependence on initial values. The sum of squared errors is minimized, although another norm would likely work just as well.

D. Methodological Questions

D.1. Spot Dynamics

How variable are lending rates? The vast majority of stocks are lent out at the G.C. rate, in transactions that are in effect collateralized financing transactions (typically, lenders receive 104% of the value of the stock in cash, in exchange for a rebate). However, even these stocks occasionally become more expensive, sometimes significantly so.

Blocher and Zhang (2017) document persistence across time of securities lending fees, for both G.C. and special stocks. Stocks tend to remain in the "expensiveness" category over sustained periods of time. I perform a similar analysis, although on daily data rather than smoothed over a month, using the Daily Cost of Borrow Score (DCBS) categories from Markit in Table II, detailed in Section II. I also look at the autocorrelation of the spot lending fee in Table III. Very large day-to-day jumps appear to be infrequent, but they do happen, much more frequently when a previous jump already occurred, as shown in Table IV and Table V.

The dynamics of the lending fee seem to be affected by a few key variables. Blocher, Reed, and Wesep (2013) find that changes in supply can matter for firms "on special" even when utilization (i.e. the number of lent out securities relative to the supply) is on the low side. In a rare real-life experiment, Kaplan, Moskowitz, and Sensoy (2013) manipulate the supply of lendable shares. They observe a reaction on the lending fee and the quantity lent, but find no evidence of it affecting returns, volatility, skewness or spreads.

All in all, the spot dynamics amply justify turning to the option markets to look into a possible risk premium to compensate for a potential jump risk.

D.2. Utilization Ratio

Holding a long position in a security allows for *potential* revenue from lending it out. However, there is rarely demand for 100% (or more) of a security to be lent out for short selling. Even if lenders were picked at random (and they are not, since this is an over-the-counter, tiered market), you could not expect to consistently lend out all of your portfolio and maximize lending revenue.

There is therefore an argument for adjusting the lending fee by some factor to take into account actual demand for the stock. One such factor is utilization, i.e. the ratio of securities lent out to those "available to lend" (which can be hard to determine). However, the spot lending rate is the income rate of the security *conditional on being lent out*.

Jensen and Pedersen (2016) point out it is possible that "the lender earns less than the short-seller pays since the difference is lost to intermediaries (custodians and brokers) and search costs and delays." I follow their argument. This is a major problem in available data on securities lending costs anyway: the rates that are available are only an approximation of what any borrower would pay, and are in no way a market-wide rate. The main source for lending rates in academic papers, Markit, only provides an equal-weighted rate for hedge funds, and no longer provides disaggregated positions to researchers. Data from individual brokers is not only difficult to obtain, it will also only ever be fragmentary. Finally, for most lenders, there is simply no public data on which fraction of their inventory they are successfully lending out (their *private* utilization ratio).

Given these limitations, and for simplicity of interpretation, I do not apply a utilization ratio to the spot lending rate. It should be kept in mind that estimates of the realized lending income will be biased upward because of this, and that as a consequence the risk premia could be larger than estimated.

D.3. Liquidity

There are reasons to worry about option liquidity, particular at the two ends: towards expiration and at the longest horizons. There is a wide literature on option-expiration anomalies (for early examples, see e.g. Feinstein and Goetzmann, 1988; Herbst and Maberly, 1990; Stoll and Whaley, 1997). Some mispricing phenomena have been documented with options that are about to expire, at least in part due to strategies being rolled over. Among the effects, abnormal trading and volatility in the underlying are widely reported (e.g., Ni, Pearson, and Poteshman, 2005).

The lack of liquidity at certain maturities, particularly longer ones, is likely related to the uncertainly about expected lending fees. Christoffersen, Goyenko, Jacobs, and Karoui (forthcoming) find risk-adjusted return spreads of 2.5% to 3.4% *per day* for illiquid vs liquid at-the-money options, consistent with equity options market makers holding risky net long positions. This is in line with the idea developed earlier that market makers wanting to hedge would have to incur securities lending costs, and need to factor in that risk into their prices. However, they use intraday effective spreads, i.e. the distance between the trading price and the quotes midpoint, to proxy for option illiquidity. In other words, if trades generally occur at one of the prevailing quotes, then the effective spread would be very closely related to the quoted spread at trading times.

In other words, at least for at-the-money option, it is likely that the identified option illiquidity is closely linked to the shorting risk in the spot: if the underlying stock becomes harder to borrow, the quoted bid-ask spread (and thus the effective spread) should widen[9]. The results of Christoffersen et al. (forthcoming) may therefore need to be viewed with that interpretation in mind. A more traditional take on illiquidity could likely be observed from the hedged returns of options that are further in-the-money or out-of-the-money, or perhaps from realized spreads and price impacts.

All in all, I do not specifically deal with illiquidity other than by applying the filters described above. For the reason just mentioned, it is likely that there is a fair amount of conceptual (and practical) overlap between shorting costs and traditional measures of illiquidity.

D.4. Recalls

In the absence of frictions or supply constraints in the securities lending market and the underlying spot market, recall risk should not be priced. In effect, if the lender needs the shares back, she can just borrow instead, even for a high fee, since she can pass it through by readjusting the fee for her outstanding contract to match. Likewise, the borrower would be indifferent to a recall, since he would be able to find another security at the same market rate. In equilibrium, then, there would be no recalls, especially given the three-day (or five-day) delay on delivery.

Why, then, would a lender initiate a recall, rather than use the alternatives? There must be another motive for this action. There is some evidence that active funds monitor the value of their corporate votes and recall if they believe it more valuable than the lending income (Kalay et al., 2014; Aggarwal, Saffi, and Sturgess, 2015). They could presumably borrow shares themselves instead of recalling, where delivery would not be at T+3 (or T+6) like a recall; but it may have

[9]One solution would be to compute a spread from option pairs instead, comparing the long and short synthetic underlying, or an approximation thereof for American options.

become difficult to locate more shares as the supply is finite, especially for funds owning a large share in a company. That would be the precise situation when the voting rights are most valuable to the fund, but maybe not as much to dispersed holders of the lent out securities. Still, they could raise the rate on their lent out securities to match their private value, which could drive some of the beneficial owners to close out their positions.

Overall, the recall has to be the consequence of frictions in the securities lending market. The rebate rate should adjust accordingly, but there are conceivably situations where the supply may disappear, no matter the price. This is markedly more likely in a tiered, over-the-counter market where not all participants are trading with each other. In this type of setting, it is also possible that relationship considerations may come into play. For instance, the lender may close the position of a particular borrower in order to favor another; this type of motives (and perhaps a few more nefarious ones) may not be priced through the rebate rate, but instead correspond to non-financial and/or longer-term reputation or repeated interaction benefits.

In light of this, it is not crucial to model recalls separately. They are akin to the lending fee becoming infinite (for certain participants) as available supply disappears.

In the next section, I turn to the estimation result for the term structures of implied lending fees and volatility.

III. Estimation Results

A. Estimated Term Structure of Implied Lending Fees

In this section, I analyze the results from the estimation. To make the maturities more comparable, I interpolate between available maturities using linear splines. This does not seem like a problematic assumption given the estimated term structures are almost always monotonic.

Table VI shows summary statistics for the implied lending fees extracted from the at-the-money option quotes at various maturities. Overall, the median fee is 2.4%, with some large outliers bringing the mean up to 10%. Panel A shows the implied lending fee by maturity. It appears that across the board, the fees are getting closer to zero as the maturity increases. The median fee is as high as 31% for options maturing within the week, which may reflect an expiration effect, or accounting for the (small) risk of a (high) jump that would not have time to be smoothed out over a longer period (or effectively trigger early exercises). The fact that the decreasing term structure pattern is consistent would lend more credence to the latter, although they are not exclusive.

Panel B distinguishes lending fees by specialness instead. Unsurprisingly, the implied fees increase with the specialness category (proxied by DCBS from Markit). The easiest-to-borrow stocks have a median implied fee of 2%, while the hardest are as high as 61%.

There is a number of negative lending fees in lower percentiles. They are rare, and Panel B shows they are also concentrated in the cheaper-to-borrow stocks (mostly G.C. and DCBS lower than 3). There is no way to rule out issues with the data or microstructure frictions, but there is another possible explanation. A lot of the securities lending activity at the G.C. rate is not in itself very profitable for the lenders, especially after accounting for operational costs. One of the reason to lend out cheap stocks, then, is as a financing operation to receive cash collateral (in the bond market, see Foley-Fisher, Narajabad, and Verani, 2016; Huh and Infante, 2017). A lender could accept a negative fee if they need cash for financing other operations.

Finally, Panel C crosses the maturity and specialness categories for the median fee. The previous patterns still hold; the fees increase with specialness and decrease with maturity. Once again, it appears that options expiring within the week have extremely high implied fees. Harder-to-borrow stocks have the highest fees. This reveals an expectation that stocks already under shorting pressure will continue to be, and are more likely to undergo further upward jumps in the lending rate.

[Table VI about here.]

Figure 2 shows the estimated implied lending fee over the spot lending fee (SAF from Markit), computed as $i_{0,t} - i_0$, where i_0 is the continuous spot rate and $i_{0,t}$ $(t \geq 1)$ is the implied continuous rate estimated from options with maturity t. The term structure is generally decreasing, and above the spot rate, although there are some exceptions. The most central estimates appear to converge towards the spot rate as the maturity increases. There is a sometimes significant wedge between the implied fee and the spot fee for shorter maturities.

The option prices lock in an average lending fee, so they have to account for the probability of jumps. The observed shape of the term structure is therefore consistent with a small risk of large jumps in the lending fee. The short rates are higher presumably because a jump would not have time to be averaged out before the expiration of the option, but also because it is more likely to make early exercise profitable (Jensen and Pedersen, 2016). The longer rates are lower because even if there is a jump, it will be smoothed out over time, and early exercise is less likely to be preferable to keeping the option open.

[Figure 2 about here.]

Figure 3 separates out different categories of specialness (as proxied by the DCBS). The pattern is robust across the groups, also it does appear flatter and more dispersed as the stock becomes harder to borrow. This flatter pattern reveals a higher expected persistence for stocks that are harder to borrow, i.e., conditional on a jump in lending fee, the return to the initial fee will be slower. The greater inter-quantile dispersion indicates that either the jump is expected to be bigger for stocks already on special or, possibly, the arrival intensity of jumps is higher. We tease apart these interpretations in the next section.

[Figure 3 about here.]

These visual observations are confirmed more formally using regressions. Table VII shows panel regressions of the implied lending fees for the different maturities on the spot lending fee. In Panel A, which does not include any control, we observe that the term structure overreacts to changes in the spot rate (coefficient for SAF greater than 1), all the more that the maturity is close. This reflects the decreasing shape of the term structure observed in Figures 2 and 3. For maturities shorter than a week, the coefficient for SAF is 3.9, meaning that for a percentage point increase in the spot rate, the short implied rate increases by almost 4 percentage points. The level of reaction progressively goes down as the maturity increases, reaching 1.1 for maturities greater than a year.

Given no other controls, the explanatory power of the spot rate is non negligible, at least for maturities greater than two weeks (R^2 over 25%), but a large part of the variation is not explained by it alone. Adding firm-fixed effects (Panel B) increases the adjusted R^2 of the regressions to around 45%, consistent with the idea that fees are persistent within stocks. It also lowers the coefficient on the spot rate, but it is still close to 2 for the shorter horizons, and falls below 1 after six months. Adding time-fixed effects increases the R^2 to above 50% at almost all horizons, but does not change the qualitative interpretation.

[Table VII about here.]

Figure 4 shows the time series of the implied lending fee and volatility over the estimation sample. For each day and firm, the median of the rates at each horizon is taken. The plots shows the twenty-fifth percentile, median and seventy-fifth percentile across firms for that day. It appears that the implied lending rate has some spikes during the sample, particularly at the end of 2008, at the end of 2013 and since the end of 2014. The patterns look consistent with mean reversion, and possibly multiple regimes. Turning to the time series of implied volatility, some similar patterns are observed, with spikes largely matching that of the implied lending rate, although they appear proportionally less extreme, especially comparing the seventy-fifth percentiles.

[Figure 4 about here.]

Figure 5 and Figure 6 decompose these series according to the specialness category (DCBS). For both the implied rate and the implied volatility, the median level is higher as the stocks are harder to borrow, and there appears to be more volatility in the day-to-day patterns, with bigger, more frequent spikes.

[Figure 5 about here.]

[Figure 6 about here.]

B. Estimated Term Structure of Implied Volatility

Next, we examine the estimated term structure of implied volatility, which was estimated jointly with the term structure of implied lending fees.

Table VIII shows summary statistics for implied volatility. Overall, the median implied volatility is 35% and the mean is 41%. Looking at maturities in Panel A, it appears that implied volatility is very flat between 33% and 37% at the median (possibly with a slightly positive trend). The mean is between 39% and 42% with no clear trend. Turning to hardness-to-borrow in Panel B, implied volatility is increasing with specialness. The median observation for the easiest-to-borrow stocks is 34%, which goes up to 89% for the hardest-to-borrow. Looking at inter-percentile ranges, there is however a lot of overlap between each specialness category. Panel C reports the median implied volatility across maturity and specialness categories. The previous patterns are confirmed. For each DCBS, the median implied volatility is flat across horizons, and it increases as the DCBS increases.

[Table VIII about here.]

Figure 7 shows the general shape of the term structure. As before, to ease the averaging as maturities slide from day to day, I interpolate between two maturities using linear splines. Except for the very short maturities, the term structure appears to be flat. Remember that each maturity is estimated separately, so there are not inherent constraints in the methodology that would force volatilities across maturities to be so close to each other. Given that it has been estimated jointly with the lending fee, this may indicate that, as far as option pricing is concerned, it might be more important to model a stochastic implied fee rather than stochastic volatility.

It is not obvious why the shortest maturities (less than a week) are a little higher (or much higher at the highest percentiles). It may be linked to pricing anomalies have been reported in the option market right before expiration, as contracts are being rolled over into the next-to-expire maturity.

On top of the stability of implied volatility across horizons, it is also interesting to look at levels. For most of the days and firms, it appears that the implied volatility is significantly higher than the trailing realized volatility.

[Figure 7 about here.]

Figure 8 decomposes the implied volatility by hardness-to-borrow (along the Daily Cost of Borrow Score from Markit). The pattern looks almost identical along specialness categories. However, the levels of implied volatility get higher as the stocks become harder to borrow. This makes intuitive sense: stocks that are hard-to-borrow tend to have significant short interest, and a higher likelihood of a subsequent price decrease, which often translates into higher volatility. Option market makers therefore incorporate a larger implied volatility for securities on special compared to the trailing realized volatility.

[Figure 8 about here.]

Next, I analyze the joint term structure of lending fees and volatility.

C. Estimated Joint Term Structure of Lending Fees and Volatility

In the estimation phase, both the implied lending fee and implied volatility were estimated at the various maturities.

Table IX shows the panel regressions of the implied lending rate over implied volatility. It appears that the two measures are significantly and positively related. Changes in implied volatility explain more around 25% of changes in the implied lending fee at the various maturities. The coefficients decrease as the maturity increases, which is consistent with the idea that more volatile stocks are more likely to become in high shorting demand. A higher implied volatility at a long horizon seems to have less impact on the lending fee than at shorter ones.

Adding firm-fixed effects again increases the R^2 to between 40% and 45%, except for the longest maturities (35%). It also lowers the coefficients on the implied volatility. Combining time- and firm-fixed effects lowers them even more for the shorter maturities, but increases them for the longer ones, making them somewhat flatter. In all cases, there is still a significant effect of the implied volatility on the jointly estimated lending fee. This stresses the importance of jointly modelling these two variables.

[Table IX about here.]

Table X shows the panel regressions of the implied lending rate over the spot lending rate and implied volatility. Compared to the previous tables, both variables are still significant and most of the interpretations are still the same. The shortest implied lending rate becomes lower than the second shortest, possibly indicating that implied volatility is a better predictors of implied lending rate jump at that horizon. The R^2 are higher but in line with previous tables.

Panel C introduces a number of controls instead of the time- and firm- fixed effects. The spot lending fee (proxied by SAF) still has more impact at shorter maturities than longer ones, except for the shortest (7 days or less). The effect of implied volatility also decreases as the maturity gets longer. Trailing realized volatility is not significant for the shortest maturities (up to 15 days), but comes in negatively beyond that. It thus appears that, controlling for implied volatility, a higher level of past volatility results in a lower implied lending fee after two weeks, possibly because of mean reversion in volatility (and it being correlated to lending fees). Surprisingly, after controlling for the spot fee, utilization is negative and significant, although the magnitude is very small. A 1pp increase in the utilization ratio translates into less than 0.2pp (down to 0.02pp) decrease in implied fees. The higher the inventory concentration, the higher the implied fee, with a much larger impact at shorter horizons[10] The lender concentration for the value actually on loan comes in positive and significant for the shortest maturity, but is not significant at any other horizon. Neither is the concentration of broker demand. Finally, the larger the market capitalization, the lower the implied fee, though again the effect appears to have a much larger magnitude the shorter the maturity[11].

[Table X about here.]

[10]Markit does not detail the concentration formulas, except to say it is related to the sum of squared market shares and that smaller numbers indicate a large number of lenders/brokers, and 1 means a single one. That makes the interpretation of the regression coefficients less precise.

[11]In the interest of space, regressions with only one control at a time are relegated to the Online Appendix.

[Table X (cont.) about here.]

Having discussed the estimated implied lending and volatility rates, I now turn to the analysis of the risk premia by comparing the expected to realized values.

IV. Risk Premia

A. Lending Fee and Volatility Risk Premia

So far, we have looked at the term structure of implied lending fees and volatility as they relate to contemporaneous or trailing spot counterparts, but not realized lending income and volatility. In this section, I consider the risk premia implied by the forward estimates of the lending and volatility rates.

The volatility risk premium (and the variance risk premium) have been the subject of a lot of literature (see for instance Bollerslev, Gibson, and Zhou, 2011, and references therein). It is typically defined as the difference between implied and realized volatility over a certain horizon. Muravyev et al. (2016) propose to compute a lending income risk premium, using an analogous definition, as the difference between the implied and realized lending income rates, defined as the average spot lending rate (SAF from Markit) over the life of each option. I follow this definition in this section. However, likely due to differences in methodology, I do reach a vastly different conclusion.

Table XI shows some summary statistics for the lending fee and volatility risk premia across horizons. Over all maturities, the estimated lending fee risk premium is 8.2% per annum on average, with a median of 1.8%. The median lending fee risk premia are mostly decreasing with the horizon, starting at 29% for the shortest maturities down to less than 3% for maturities greater than a month. The mean is larger (reaching 56% annually for maturity less than a week), driven by some large outliers.

The median implied volatility risk premia are extremely consistent across maturities, between 17.5% and 18.5%, and slightly higher at 20.2% for contracts expiring within the week. Means are about 4-6pp higher across the board. The overall median is 18.4%, and the average 22.8%.

[Table XI about here.]

Table XII shows the same statistics, this time computed across all maturities but separated by specialness (as proxied by Markit's DCBS). Moving from G.C. (DCBS 1) to special, the median lending fee risk premia increase from 1.8% to 18% per annum for DCBS 9 and even 31% for the hardest-to-borrow category, DCBS 10. Again due to some large outliers, the mean lending fee risk premia are much higher, reaching 54% for the hardest-to-borrow stocks.

Similarly, the volatility risk premia increase as stocks get harder to borrow. Just jumping from G.C. to the cheapest category of specialness, the median volatility risk premium doubles from 17% to 34% per annum, and climb to 72% for the hardest to borrow stocks.

[Table XII about here.]

Table XIII shows the median risk premia only, but cross-tabulated along maturity and specialness categories. Looking at the lending fee risk premia (Panel A), it is first noticeable how large the premia are for the shortest maturity (less than seven days), across levels of specialness. This can be explained several (non-exclusive) ways. First, the jump probability in the spot lending fee is low, but conditional on the jump, the effect can be large. This is more likely to have an impact at shorter maturities, in part because there is less time for the jump to revert and its effect to be smoothed out, in part because it might affect the optimality of the early exercise of the American options. The second possibility is there is mispricing for options close to expiry.

Turning to median volatility risk premia, they appear to be strikingly flat across maturities within each specialness category, in line with previous results. The levels increase considerably with hardness-to-borrow, going from 16-18% for G.C. stocks to 71-75% annually for the hardest-to-borrow stocks. The maturity-week volatility premia do appear somewhat higher than other maturities, but the gap is rather small.

[Table XIII about here.]

Table XIV shows the panel regressions of the realized lending income over the implied lending fee at each maturity. Looking at Panel A (no controls), it appears that the implied lending rate is strongly related to the realized rate. However, the realized rate is smaller in magnitude. For instance, for options maturing in more than 31 and less than 60 days, a 1pp increase in the implied lending fee corresponds to an 11bp increase in the realized rate. The coefficient tends to increase with maturity (except for horizons longer than a year), which should be viewed in relation with the decreasing lending fee term structure. Without controls, the implied lending fee explain up to 33% of changes in the realized rate, explaining the most for maturities between 31 days and a year.

Time-fixed effects (Panel C) do not increase the R^2 much, but firm-fixed effects bring them to the 52%-64% range.

Note that these are not predictive regressions, since we use the term structure on day t to explain the realized lending fee until maturity, including day t. However, especially for longer maturities, it is unlikely that day t holds much weight. The predictive regressions using the lagged term structure are shown in the next subsection.

[Table XIV about here.]

Table XV adds implied volatility as a predictor in the previous regressions at each maturity. It appears to be positively and significantly related to the realized lending rate in almost all cases. However, it does not not seem to increase the adjusted R^2 much over and beyond the implied lending fee. This is another argument to focus on modeling the implied lending fee dynamics when concerned about the term structure of options[12].

[Table XV about here.]

Table XVI adds the spot lending fee (SAF) to the regressions of Table XIV. Given the persistence of the spot lending fee, documented earlier in this paper, it is unsurprisingly a very good predictor of the realized rate[13]. For shorter maturities, the coefficient is close to 1, dropping as maturity increases (still at 0.76 for maturities above a year). However, the implied lending fee is still positive and significant in all cases, with or without fixed effects. Even without fixed effects, the R^2 reaches 98% for the shorter maturities, and goes down to 90% for 31- to 60-day maturities and 66% for maturities greater than a year.

[Table XVI about here.]

B. Risk Premia Dynamics Over Time

The dynamic of the lending fee risk premia over time, shown in Figure 9, largely seem to track those of the implied lending fee. Given there are more maturities within a short horizon, this may partly be a byproduct of picking the median value across the term structure, as they tend to be much

[12]Explaining the cross-section of strikes, and the smirk/smile, probably requires including volatility dynamics, too.

[13]Note that, once again, the spot rate enters the calculation of the realized rate, to the proportion of one day out of remaining days to maturity.

higher than the realized rates. The time series for the volatility risk premia are also interesting, with the medium dipping into the negative in the second half of 2008 and again more briefly in the second half of 2011.

[Figure 9 about here.]

Figure 10 and Figure 11 decompose the risk premia into specialness categories. The patterns appear roughly similar, although it appears that the lending fee risk premia can often become negative (particularly for the 25^{th} percentile), especially as the stocks are harder to borrow.

[Figure 10 about here.]

[Figure 11 about here.]

Overall, these analyses point to the existence of an at-times large and time-varying lending fee risk premium, which is greater for shorter maturities and for harder-to-borrow stocks. Next, I look at whether the term structure can help predict the realized income.

C. Predicting Realized Lending Fees

In this subsection, I consider whether it is possible to predict the realized lending income between the next day and each option's maturity, from variables known today, mainly the spot and implied lending fees.

In order to do this, I reproduce the panel regressions from the previous subsection, this time using lagged predictors to ensure no look-ahead bias. Table XVII shows the regression of the realized income rate over the lagged implied lending fee other lagged controls. Despite the lag, unsurprisingly the results are largely unchanged. The imply lending fee is still a significant predictor of the realized lending fee, even though the spot rate contributes much more predictive power due to persistence. Implied volatility comes in significantly, but barely seems to increase the explanatory power of the regression.

Looking at regressions with all controls in Panel E, it appears that the spot lending fee, the implied volatility, utilization, and the log of the trailing 250-day variance of utilization are significant at all horizons. The implied lending fees remain significant at all maturities except the shortest (less than a week). The log of the trailing 250-day variance of spot fees (related to the shorting risk of Engelberg et al., forthcoming) is only significant for two of the longer maturities. It does not seem that adding all of these variables contributes much over and beyond the spot lending rate alone.

Overall, it seems easy to predict a large share of the realized lending rate at the various points of the term structure using just the spot rate, and other variables do not help much, including the implied lending fees. This is a byproduct of the extremely high persistence of the spot lending fees.

[Table XVII about here.]

[Table XVII about here.]

D. Predicting Lending Fee Risk Premia

Finally, Table XVIII shows a similar analysis of the lending fee risk premia as predicted by lagged variables such as implied and spot lending rates. The role of these two lagged variables is inverted compared to the previous subsection. While both are positive and significant predictors of the risk premia on their own at each maturity, the implied lending fee explains 55% to 69% (Panel A), while the spot lending fee only explains 2% to 16% (Panel B). Combining both variables does not increase the explanatory power much beyond the implied lending (Panel C), but interestingly, the spot lending rate now has a negative coefficient. This makes sense since the risk premium is the implied minus the realized spot rate; however, in Panel B, the spot rate served to capture the level of the risk premium, which the implied lending rate does in Panel C (as well as D and E).

Turning to the regressions with all controls in Panel E, it is once again noticeable that the R^2 are left largely unchanged. The implied and spot lending fees are consistently significant across horizons, as is the log market capitalization. Implied volatility and average tenure are significant for all maturities but one. Utilization is significant for maturities longer than 31 days, while the log of the trailing 250-day variance of utilization is significant for maturities less than 90 days, as is inventory concentration. The log of the trailing 250-day variance of spot fees (related to the shorting risk of Engelberg et al., forthcoming) is again only significant for longer maturities, this time above 61 days.

[Table XVIII about here.]

[Table XVIII (cont.) about here.]

While predicting the lending fee risk premia is more difficult than the realized lending fees, it is still possible to forecast close to two thirds of it, most of it using the lagged implied lending fees alone.

V. Conclusion

Securities lending is subject to overnight rerating and recall risk. This may make it impossible to hold positions open until they pay off. Synthetic short positions using options do not face the same overnight risks, but their prices must linked to the lending market through arbitrage. In this paper, I jointly estimate the term structure of implied securities lending fees and implied volatility from options data, and find that the implied lending fees co-vary with the spot fee. They include a premium indicative of large, low-probability jump risk. Implied lending fees and implied volatility are positively related. The estimated term structure of implied volatility, however, is on average flat across horizons. This suggests the volatility term structure puzzle may be better viewed as a lending fee term structure puzzle. Finally, I find a positive lending fee risk premium, with a median value of 2%, but higher in the shorter maturities and increasing with hardness-to-borrow. Close to two-thirds of the risk premium can be predicted using the term structure of implied lending fees.

Bibliography

Achdou, Yves, and Olivier Pironneau, 2005, *Computational Methods for Option Pricing*, volume 30 of *Frontiers in Applied Mathematics* (Society for Industrial and Applied Mathematics (SIAM), Philadelphia, PA).

Aggarwal, Reena, Pedro A. C. Saffi, and Jason Sturgess, 2015, The Role of Institutional Investors in Voting: Evidence from the Securities Lending Market, *The Journal of Finance* 70, 2309–2346.

Andersen, Torben G., Nicola Fusari, and Viktor Todorov, 2015, The Risk Premia Embedded in Index Options, *Journal of Financial Economics* 117, 558–584.

Asquith, Paul, Parag A. Pathak, and Jay R. Ritter, 2005, Short Interest, Institutional Ownership, and Stock Returns, *Journal of Financial Economics* 78, 243–276.

Atmaz, Adem, and Suleyman Basak, 2017, Option Prices and Costly Short-Selling, Working Paper.

Avellaneda, Marco, and Mike Lipkin, 2009, A Dynamic Model for Hard-to-Borrow Stocks, *Risk* 92–97.

Battalio, Robert, and Paul Schultz, 2011, Regulatory Uncertainty and Market Liquidity: The 2008 Short Sale Ban's Impact on Equity Option Markets, *The Journal of Finance* 66, 2013–2053.

Black, Fischer, and Myron Scholes, 1973, The Pricing of Options and Corporate Liabilities, *Journal of Political Economy* 81, 637–654.

Blocher, Jesse, François Cocquemas, and Robert E. Whaley, 2017, Passive Investing: The Potential Profitability of Securities Lending, Working Paper.

Blocher, Jesse, Adam V. Reed, and Edward D. Van Wesep, 2013, Connecting Two Markets: An Equilibrium Framework for Shorts, Longs, and Stock Loans, *Journal of Financial Economics* 108, 302–322.

Blocher, Jesse, and Chi Zhang, 2017, Short Constraints are Persistent Constraints, Working Paper.

Bollerslev, Tim, Michael Gibson, and Hao Zhou, 2011, Dynamic Estimation of Volatility Risk Premia and Investor Risk Aversion from Option-Implied and Realized Volatilities, *Journal of Econometrics* 160, 235–245, Realized Volatility.

Christoffersen, Peter, Mathieu Fournier, and Kris Jacobs, 2017, The Factor Structure in Equity Options, *The Review of Financial Studies* hhx089.

Christoffersen, Peter, Ruslan Goyenko, Kris Jacobs, and Mehdi Karoui, forthcoming, Illiquidity Premia in the Equity Options Market, *The Review of Financial Studies* .

Cont, Rama, and José da Fonseca, 2002, Dynamics of Implied Volatility Surfaces, *Quantitative Finance* 2, 45–60.

Cont, Rama, Jose da Fonseca, and Valdo Durrleman, 2002, Stochastic Models of Implied Volatility Surfaces, *Economic Notes* 31, 361–377.

D'Avolio, Gene, 2002, The Market for Borrowing Stock, *Journal of Financial Economics* 66, 271–306.

Duffie, Darrell, Nicolae Gârleanu, and Lasse Heje Pedersen, 2002, Securities Lending, Shorting, and Pricing, *Journal of Financial Economics* 66, 307–339, Limits on Arbitrage.

Elkamhi, Redouane, and Chayawat Ornthanalai, 2010, Market Jump Risk and the Price Structure of Individual Equity Options, Working Paper.

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

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

Feinstein, Steven P., and William N. Goetzmann, 1988, The Effect of the ”Triple Witching Hour” on Stock Market Volatility, *Economic Review* .

Fengler, Matthias R., Wolfgang K. Härdle, and Enno Mammen, 2007, A Semiparametric Factor Model for Implied Volatility Surface Dynamics, *Journal of Financial Econometrics* 5, 189–218.

Fengler, Matthias R., Wolfgang K. Härdle, and Christophe Villa, 2003, The Dynamics of Implied Volatilities: A Common Principal Components Approach, *Review of Derivatives Research* 6, 179–202.

Foley-Fisher, Nathan, Borghan Narajabad, and Stephane Verani, 2016, Securities Lending as Wholesale Funding: Evidence from the U.S. Life Insurance Industry, Working Paper 22774, National Bureau of Economic Research.

Geske, Robert, 1978, The Pricing of Options with Stochastic Dividend Yield, *The Journal of Finance* 33, 617–625.

Grundy, Bruce D., Bryan Lim, and Patrick Verwijmeren, 2012, Do Option Markets Undo Restrictions on Short Sales? Evidence from the 2008 Short-Sale Ban, *Journal of Financial Economics* 106, 331–348.

Harvey, Campbell R., and Robert E. Whaley, 1991, S&P 100 Index Option Volatility, *The Journal of Finance* 46, 1551–1561.

Herbst, Anthony F., and Edwin D. Maberly, 1990, Stock Index Futures, Expiration Day Volatility, and the “Special” Friday Opening: A Note, *Journal of Futures Markets* 10, 323–325.

Heynen, Ronald, Angelien Kemna, and Ton Vorst, 1994, Analysis of the Term Structure of Implied Volatilities, *Journal of Financial and Quantitative Analysis* 29, 31–56.

Huh, Yesol, and Sebastian Infante, 2017, Bond Market Intermediation and the Role of Repo, Working Paper.

Jarrow, Robert A., 2010, Convenience Yields, *Review of Derivatives Research* 13, 25–43.

Jensen, Mads Vestergaard, and Lasse Heje Pedersen, 2016, Early Option Exercise: Never Say Never, *Journal of Financial Economics* 121, 278 – 299.

Kalay, Avner, Oğuzhan Karakaş, and Shagun Pant, 2014, The Market Value of Corporate Votes: Theory and Evidence from Option Prices, *The Journal of Finance* 69, 1235–1271.

Kaplan, Steven N., Tobias J. Moskowitz, and Berk A. Sensoy, 2013, The Effects of Stock Lending on Security Prices: An Experiment, *The Journal of Finance* 68, 1891–1936.

Ma, Guiyuan, and Song-Ping Zhu, 2017, Pricing American Call Options Under a Hard-to-Borrow Stock Model, *European Journal of Applied Mathematics* 1–21.

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

Ni, Sophie Xiaoyan, Neil D. Pearson, and Allen M. Poteshman, 2005, Stock Price Clustering on Option Expiration Dates, *Journal of Financial Economics* 78, 49–87.

Price, Kenneth V., Rainer M. Storn, and Jouni A. Lampinen, 2006, *Differential Evolution - A Practical Approach to Global Optimization*, Natural Computing (Springer-Verlag), ISBN 540209506.

Şerban, Mihaela, John Lehoczky, and Duane Seppi, 2008, Cross-Sectional Stock Option Pricing and Factor Models of Returns, Working Paper.

Stein, Jeremy, 1989, Overreactions in the Options Market, *The Journal of Finance* 44, 1011–1023.

Stoll, Hans R., and Robert E. Whaley, 1997, Expiration-Day Effects of the All Ordinaries Share Price Index Futures: Empirical Evidence and Alternative Settlement Procedures, *Australian Journal of Management* 22, 139–174.

van Buuren, Stef, and Karin Groothuis-Oudshoorn, 2011, mice: Multivariate Imputation by Chained Equations in R, *Journal of Statistical Software* 45, 1–67.

Xu, Xinzhong, and Stephen J. Taylor, 1994, The Term Structure of Volatility Implied by Foreign Exchange Options, *Journal of Financial and Quantitative Analysis* 29, 57–74.

Figure 1: Lending Capacity by Specialness

This figure shows the lending capacity, or average ratio of the value of the stock available to lend (as estimated by Markit) over the market capitalization, per specialness category (DCBS from Markit), computed over the whole sample (792 stocks over 2008-2016). DCBS 1 is the general collateral category, while a DCBS of 10 would be the hardest to borrow. Lines shows the twenty-fifth percentile, median, and seventy-fifth percentile.

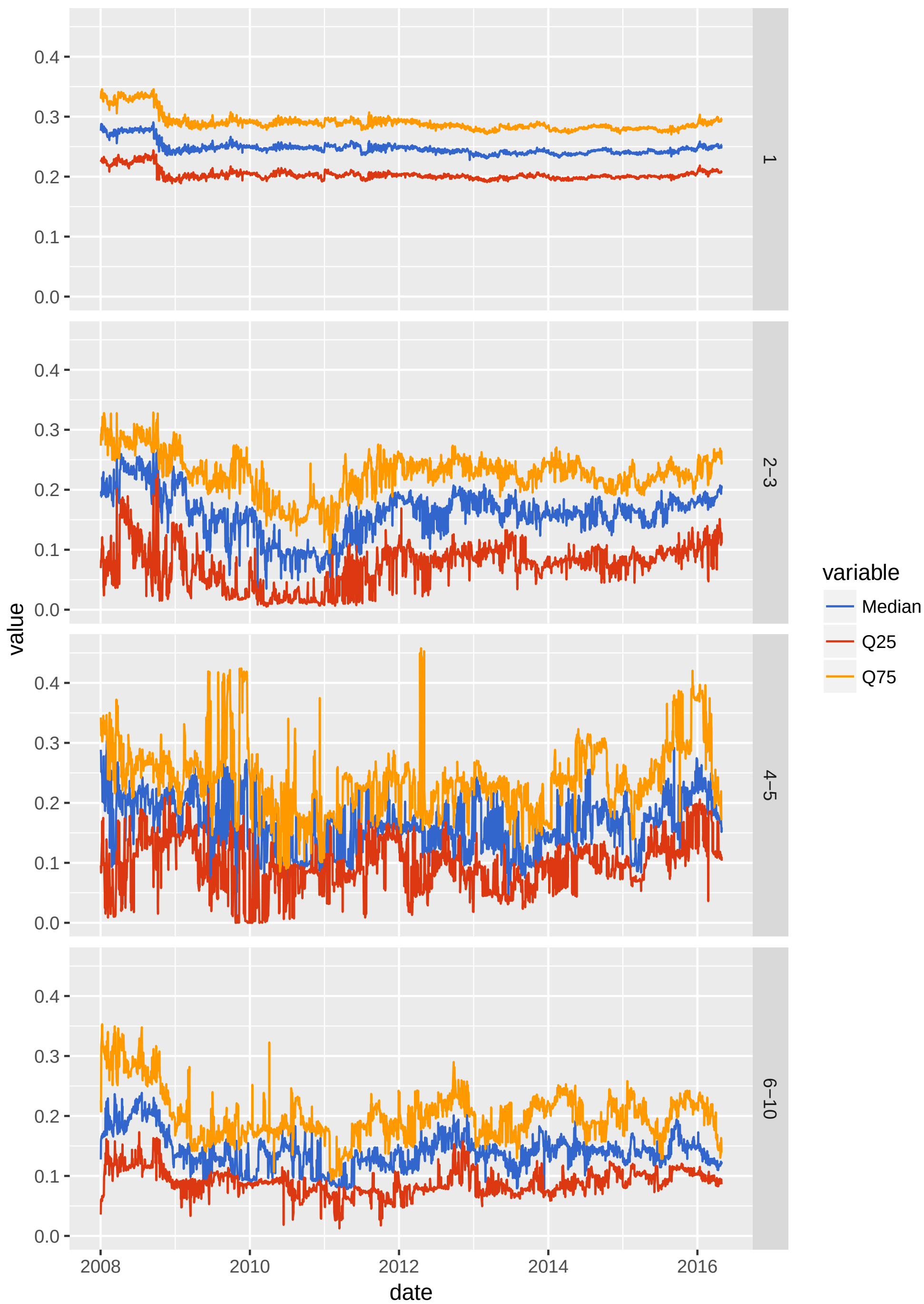
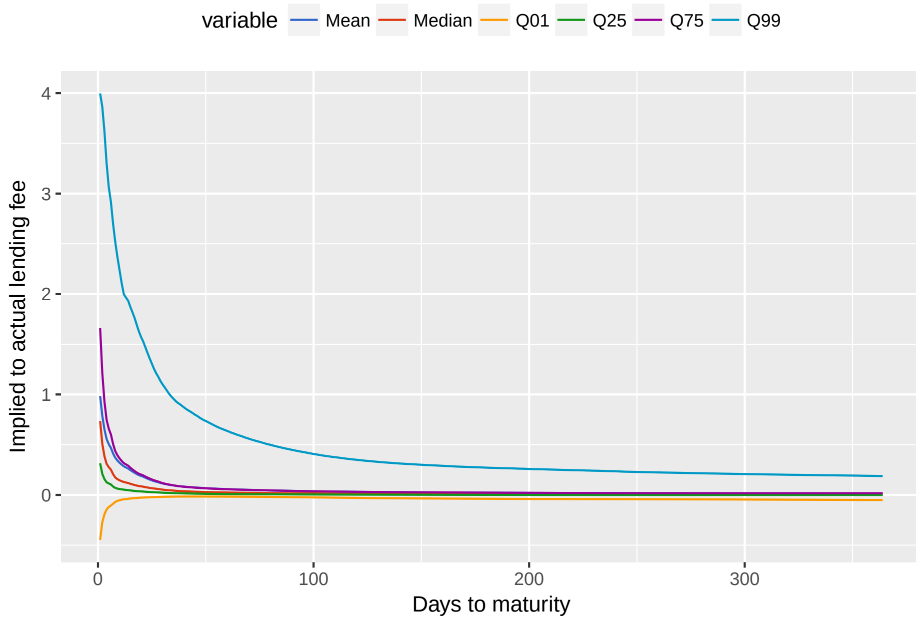


Figure 2: Implied Lending Fees over Spot Lending Fees by Day to Maturity

This figure shows the estimated implied lending fee over the spot lending fee (SAF from Markit), computed over the whole sample (792 stocks over 2008-2016). The measure is computed as $i_{0,t} - i_0$, where i_0 is the continuous spot rate and $i_{0,t}$ $(t \geq 1)$ is the continuous implied rate estimated from options with maturity t. For intermediate days to maturity without an option expiring, the rate is interpolated at the day-stock level using linear splines. Lines shows the mean, first percentile, twenty-fifth percentile, median, seventy-fifth percentile, and ninety-ninth percentile, across stocks and date. Panel A shows maturities from one to 365 days; Panel B zooms in on maturities from one to 100 days.

Panel A: One to 365-Day Maturities



Panel B: One to 100-Day Maturities

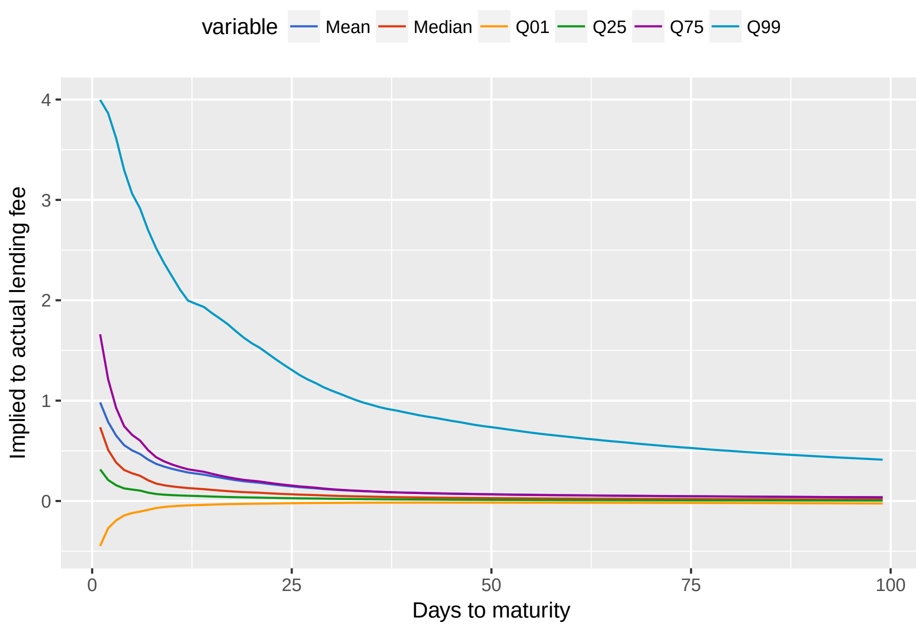


Figure 3: Implied Lending Fees over Spot Lending Fees per Specialness by Day to Maturity

This figure shows the estimated implied lending fee over the spot lending fee (SAF from Markit) per specialness category (DCBS from Markit), computed over the whole sample (792 stocks over 2008-2016). The measure is computed as $i_{0,t} - i_0$, where i_0 is the continuous spot rate and $i_{0,t}$ $(t \geq 1)$ is the continuous implied rate estimated from options with maturity t. For intermediate days to maturity without an option expiring, the rate is interpolated at the day-stock level using linear splines. DCBS 1 is the general collateral category, while a DCBS of 10 would be the hardest to borrow. Lines shows the mean, first percentile, twenty-fifth percentile, median, seventy-fifth percentile, and ninety-ninth percentile.

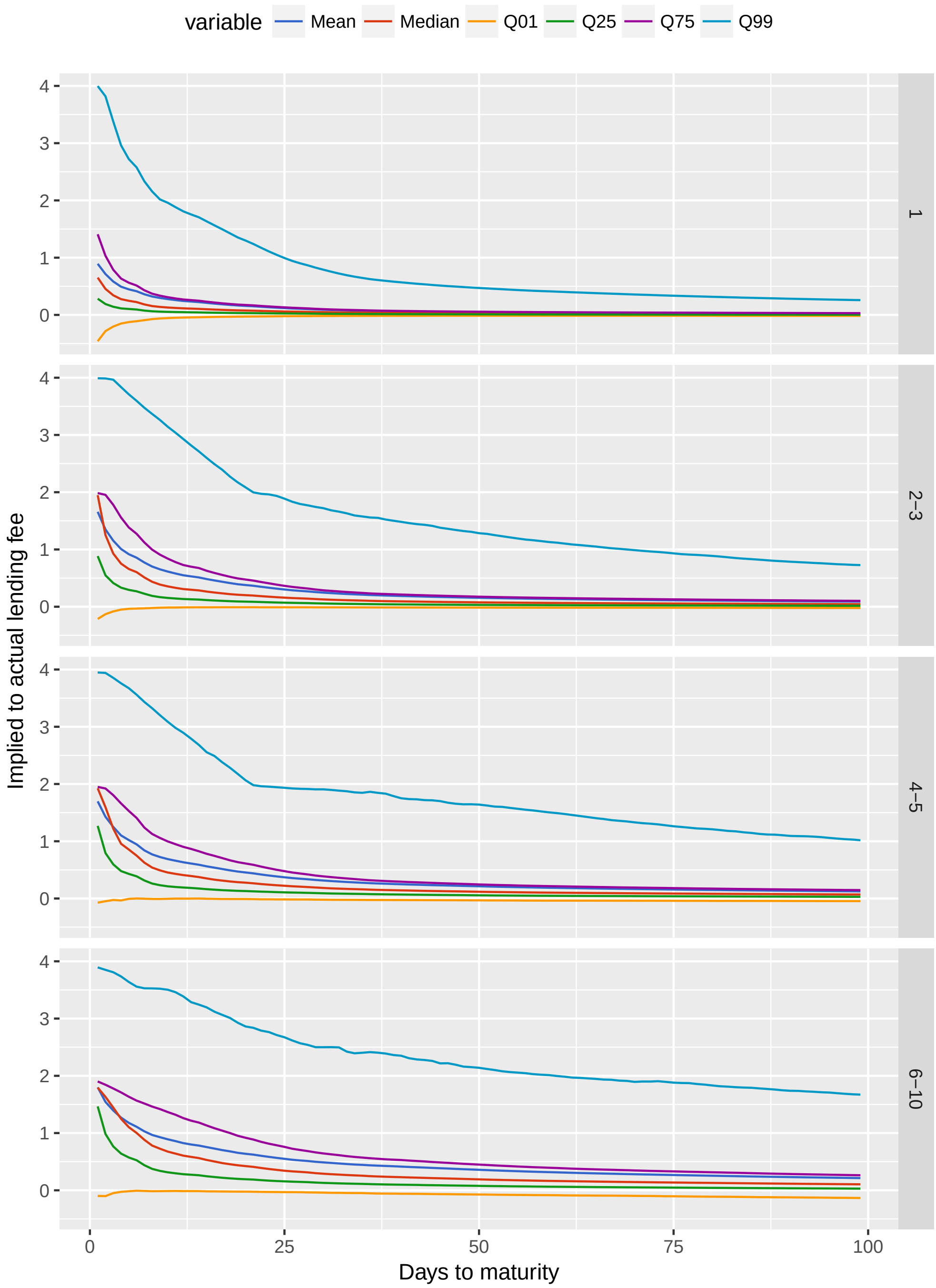


Figure 4: Estimated Implied Lending Fee and Volatility over Time

This figure shows the estimated implied lending rate and implied volatility rate over time. The medians of the two rates are first taken at the day-firm (permno) level, across the term structure. The plot then shows the twenty-fifth percentile (in red), median (in blue) and seventy-fifth percentile (in yellow) across firms.

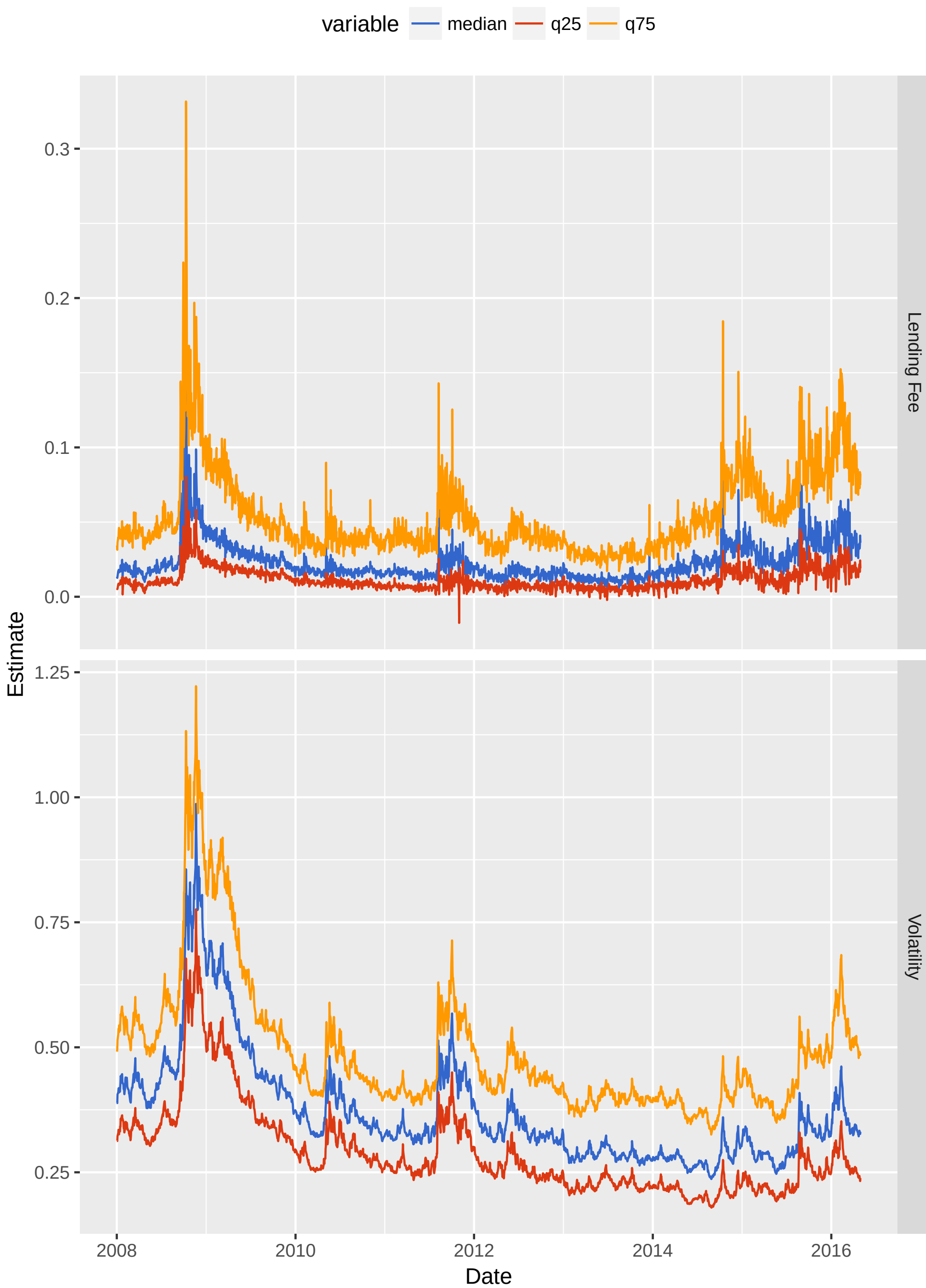


Figure 5: Estimated Implied Lending Fee over Time, by Specialness

This figure shows the estimated implied lending rate over time, by specialness (as proxied by DCBS from Markit). The median of the rate is first taken at the day-firm (permno) level, across the term structure. The plot then shows the twenty-fifth percentile (in red), median (in blue) and seventy-fifth percentile (in yellow) across firms.

Figure 6: Estimated Implied Volatility over Time, by Specialness

This figure shows the estimated implied volatility rate over time, by specialness (as proxied by DCBS from Markit). The median of the rate is first taken at the day-firm (permno) level, across the term structure. The plot then shows the twenty-fifth percentile (in red), median (in blue) and seventy-fifth percentile (in yellow) across firms, for each specialness category.

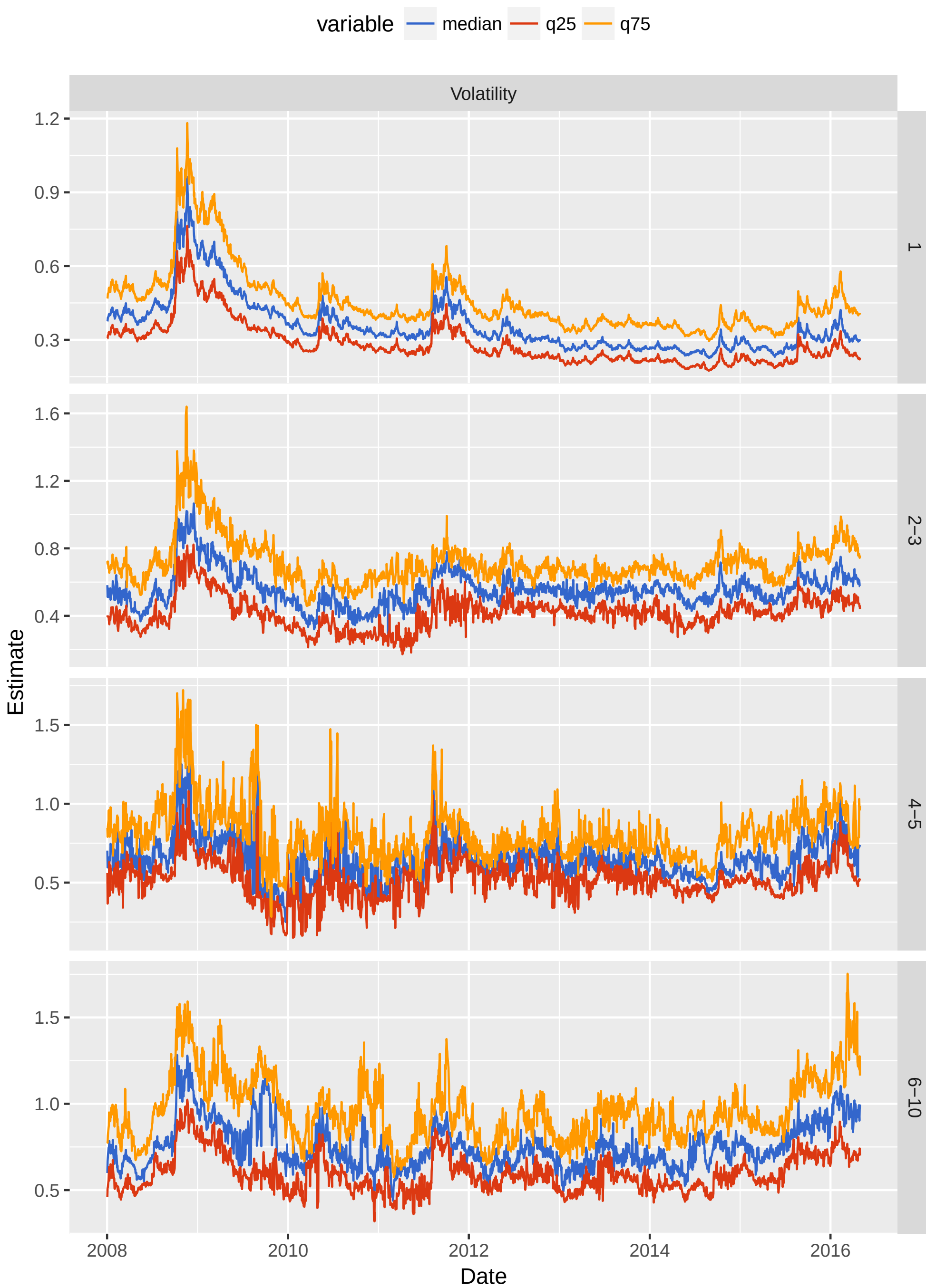
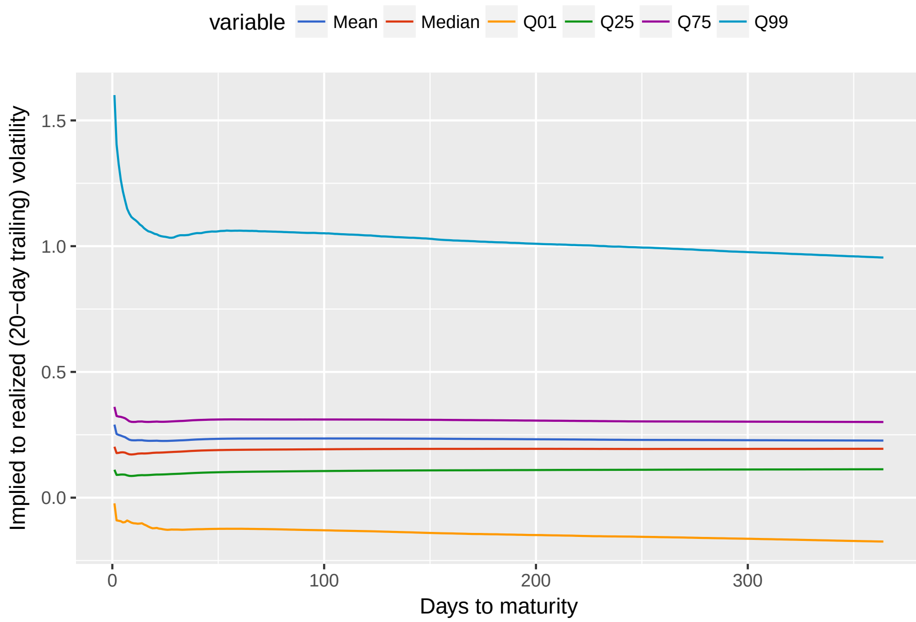


Figure 7: Implied Volatility over Trailing Realized Volatility by Day to Maturity

This figure shows the estimated implied volatility over the trailing 20-day volatility, computed over the whole sample (792 stocks over 2008-2016). The measure is computed as $\sigma_{0,t} - \sigma_0$, where σ_0 is the realized volatility (over the trailing 20 days) and $\sigma_{0,t}$ ($t \geq 1$) is the implied volatility estimated from options with maturity t. For intermediate days to maturity without an option expiring, the rate is interpolated at the day-stock level using linear splines. Lines shows the mean, first percentile, twenty-fifth percentile, median, seventy-fifth percentile, and ninety-ninth percentile, across stocks and date. Panel A shows maturities from one to 365 days; Panel B zooms in on maturities from one to 100 days.

Panel A: One to 365-Day Maturities



Panel B: One to 100-Day Maturities

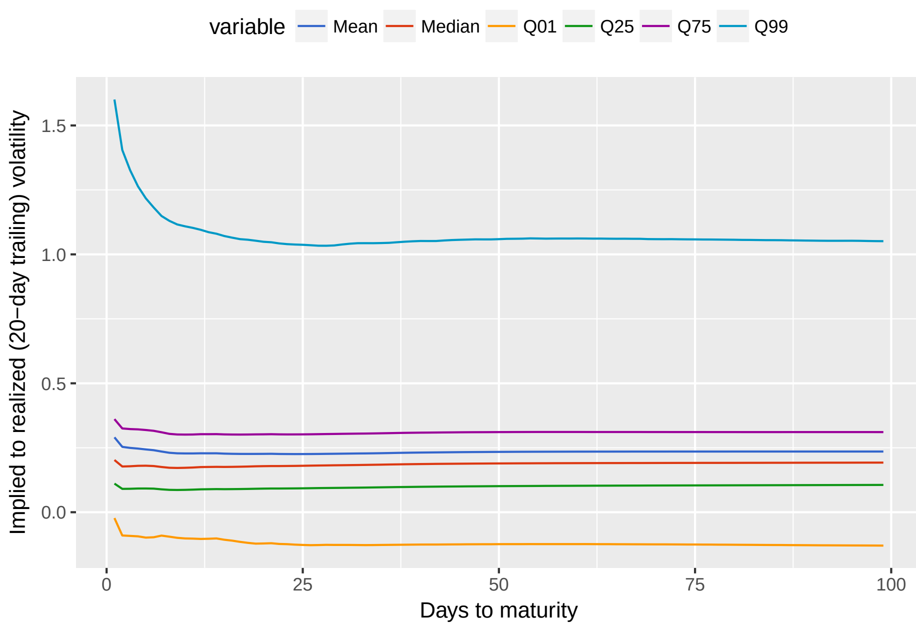


Figure 8: Implied Volatility over Trailing Realized Volatility per Specialness by Day to Maturity

This figure shows the estimated implied volatility over the trailing 20-day volatility by specialness category (DCBS from Markit), computed over the whole sample (792 stocks over 2008-2016). The measure is computed as $\sigma_{0,t} - \sigma_0$, where σ_0 is the realized volatility (over the trailing 20 days) and $\sigma_{0,t}$ ($t \geq 1$) is the implied volatility estimated from options with maturity t. For intermediate days to maturity without an option expiring, the rate is interpolated at the day-stock level using linear splines. DCBS 1 is the general collateral category, while a DCBS of 10 would be the hardest to borrow. Lines shows the mean, first percentile, twenty-fifth percentile, median, seventy-fifth percentile, and ninety-ninth percentile.

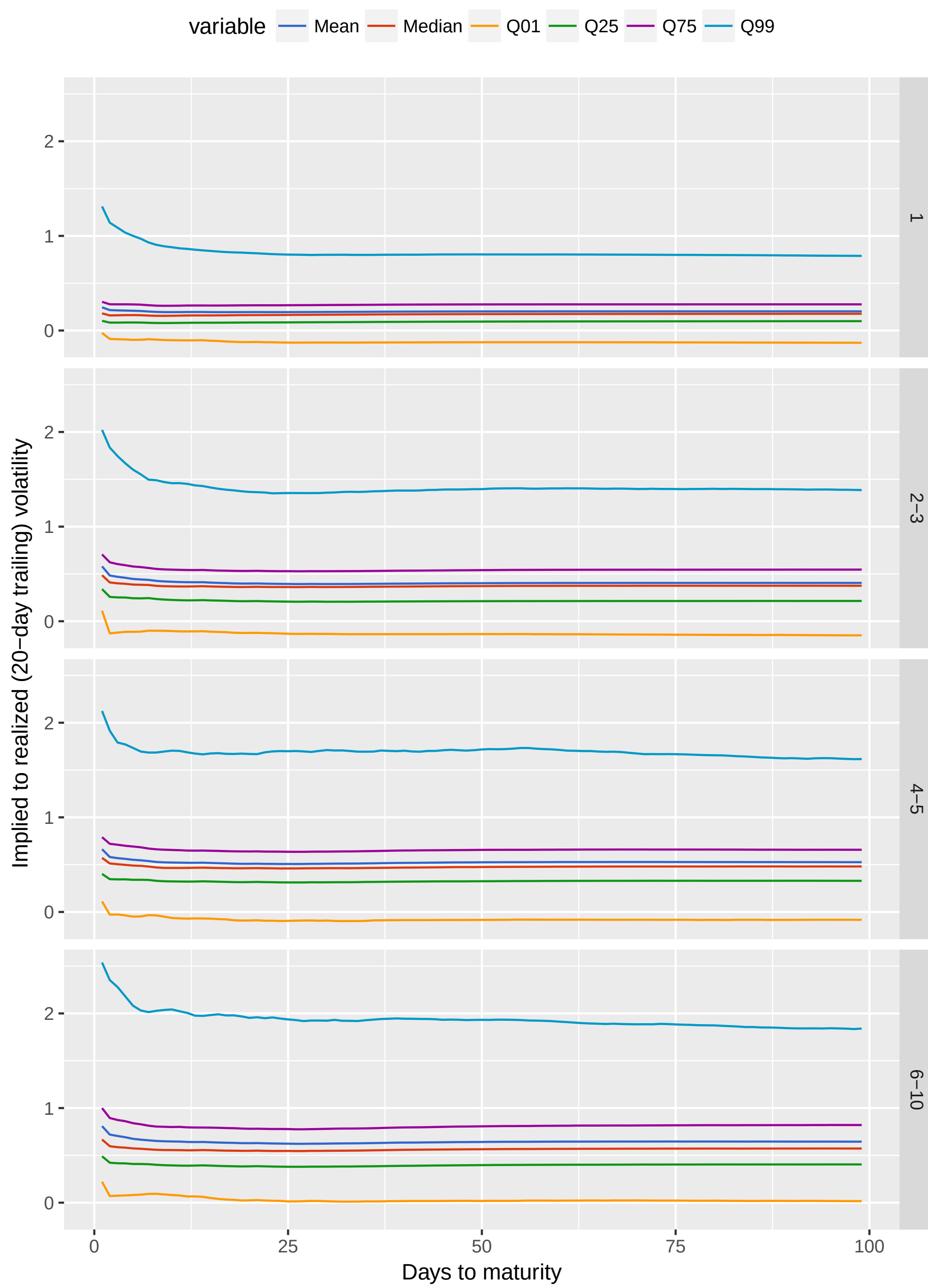


Figure 9: Lending Fee and Volatility Risk Premia over Time

This figure shows the estimated lending rate and volatility risk premia over time. The medians of the two premia are first taken at the day-firm (permno) level, across the term structure. The plot then shows the twenty-fifth percentile (in red), median (in blue) and seventy-fifth percentile (in yellow) across firms.

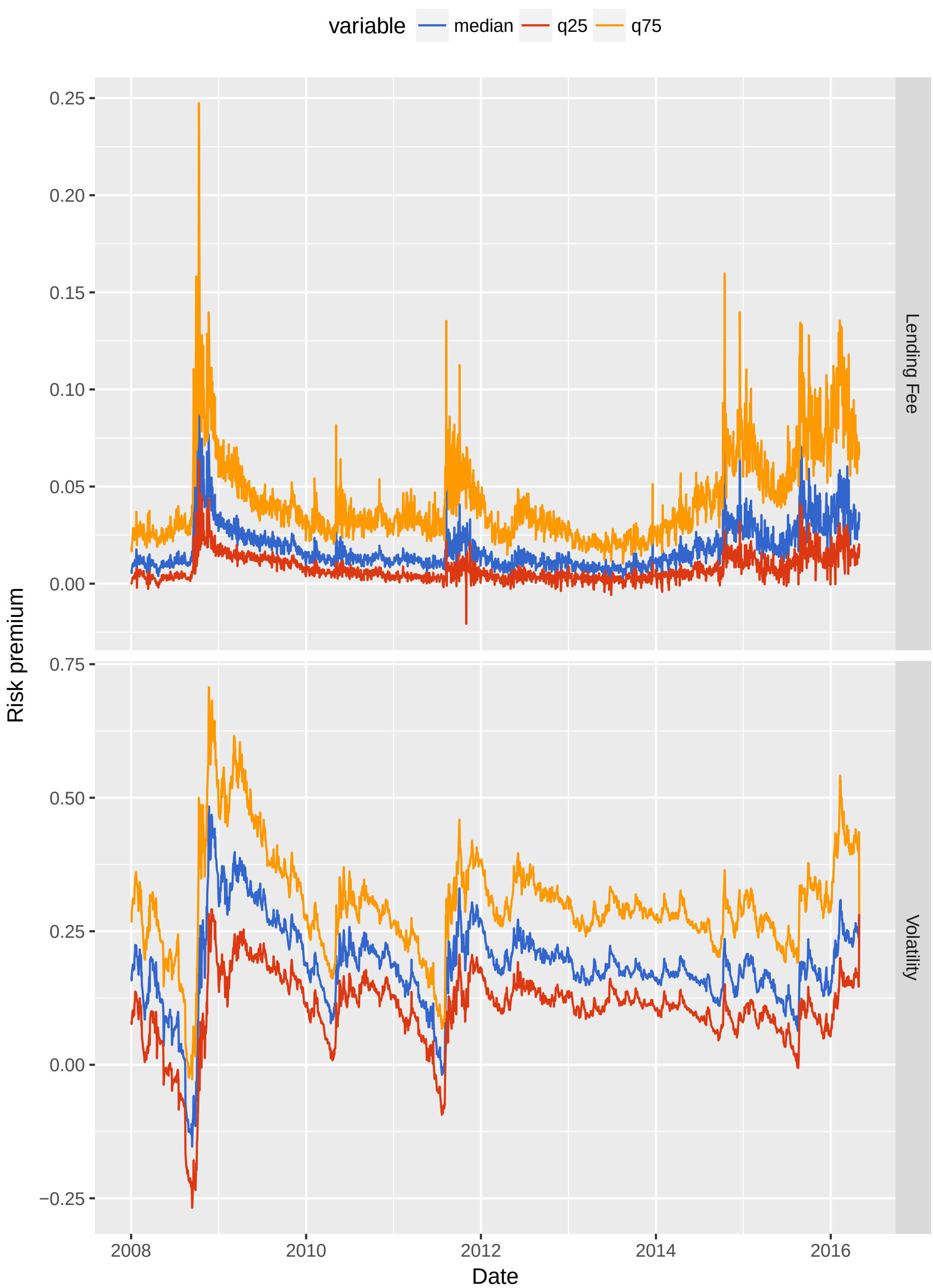


Figure 10: Lending Fee Risk Premia over Time, by Specialness

This figure shows the estimated lending rate premia over time, by specialness (as proxied by DCBS from Markit). The median of the premia is first taken at the day-firm (permno) level, across the term structure. The plot then shows the twenty-fifth percentile (in red), median (in blue) and seventy-fifth percentile (in yellow) across firms.

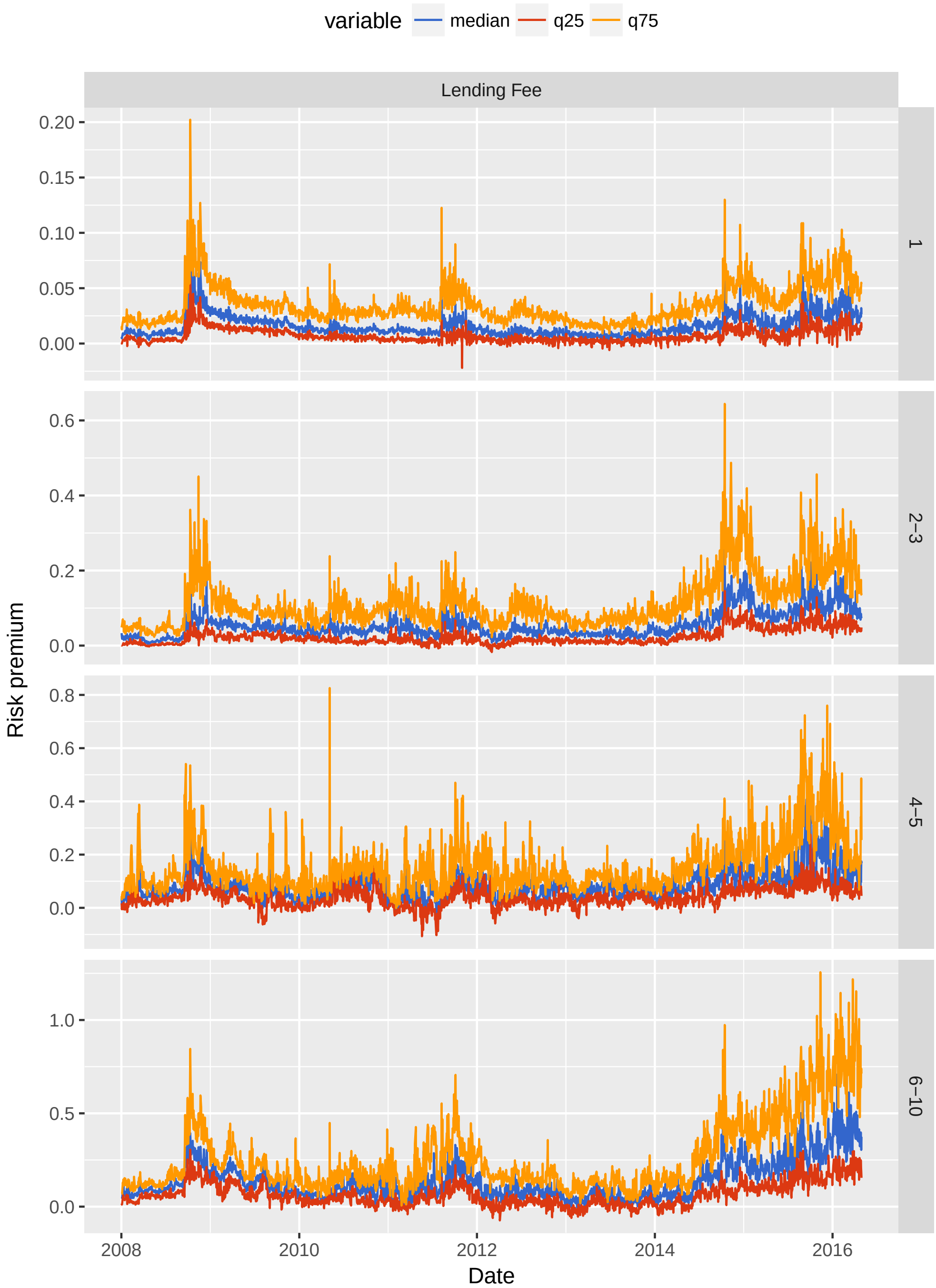


Figure 11: Volatility Risk Premia over Time, by Specialness

This figure shows the estimated volatility risk premia over time, by specialness (as proxied by DCBS from Markit). The median of the premia is first taken at the day-firm (permno) level, across the term structure. The plot then shows the twenty-fifth percentile (in red), median (in blue) and seventy-fifth percentile (in yellow) across firms, for each specialness category.

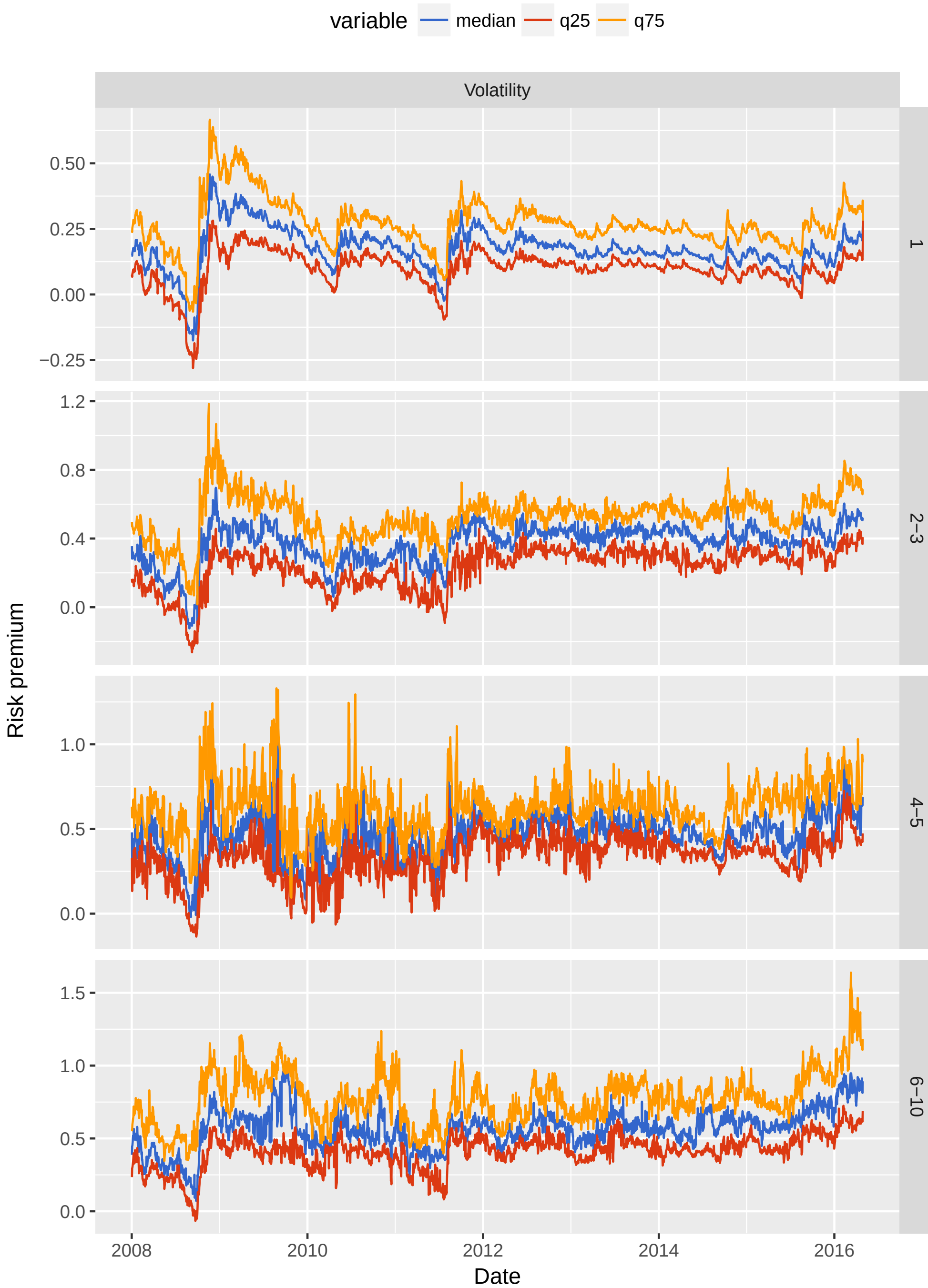


Table I: Summary statistics

This table shows summary statistics for the main variables used in the analysis. Panel A reports the number of observations, mean, first percentile, twenty-firth percentile, median, seventy-fifth percentile and ninety-ninth percentile of each measure. Panel B shows the correlation matrix between all measures. All correlation coefficients are significantly different from 0 at the 0.1% level.

Panel A: Summary Statistics

Variable	N	Mean	P01	P10	P25	Med.	P75	P90	P99
SAF (%)	6,380,919	1.0	0.0	0.2	0.2	0.3	0.3	1.0	18.2
DCBS	7,148,689	1.4	1.0	1.0	1.0	1.0	1.0	2.0	9.0
Mkt. Cap. (m)	7,157,344	27,339.4	235.8	1,201.0	3,098.4	9,333.5	25,904.7	67,980.6	250,212.9
Turnover (%)	7,157,344	1.9	0.2	0.4	0.6	1.1	1.9	3.4	16.4
B.A. Spread (%)	7,157,306	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.3
Available Ratio (%)	7,157,344	22.8	0.6	9.4	19.1	24.0	28.5	32.4	41.9
Utilization (%)	7,158,536	17.9	0.0	0.5	1.8	7.5	26.0	54.3	88.5
Inv. Concentr. (%)	7,158,536	16.4	10.0	11.6	12.5	14.1	16.9	22.4	53.3
Loan Concentr. (%)	7,158,536	27.8	10.5	14.4	17.4	22.3	31.4	48.3	100.0
Demand Concent. (%)	7,158,536	23.7	8.8	11.9	14.6	19.4	27.9	41.1	78.2
Avg. Tenure	7,157,210	64.7	5.0	18.0	30.0	50.0	81.0	120.0	286.0
Open Loans	7,158,536	331.4	11.0	38.0	75.0	173.0	414.0	820.0	2,126.0

Panel B: Correlation Coefficients

	SAF	DCBS	Mkt. Cap.	Turnover	B.A. Spread	Avail. Ratio	Util.	Inv. Con-centr.	Loan Con-centr.	Demand Con-cent.	Avg. Tenure
DCBS	0.86										
Mkt. Cap.	-0.09	-0.12									
Turnover	0.11	0.14	-0.12								
B.A. Spread	0.22	0.26	-0.13	0.06							
Avail. Ratio	-0.16	-0.20	-0.06	-0.09	-0.08						
Util.	0.49	0.64	-0.30	0.26	0.25	-0.21					
Inv. Concentr.	0.15	0.17	-0.11	0.26	0.12	-0.48	0.23				
Loan Concentr.	-0.06	-0.09	0.01	0.03	0.00	-0.33	-0.20	0.40			
Demand Concent.	-0.08	-0.10	0.01	-0.04	-0.03	-0.19	-0.21	0.19	0.52		
Avg. Tenure	0.11	0.12	-0.09	-0.02	0.09	0.10	0.23	-0.02	-0.12	-0.03	
Open Loans	0.18	0.28	-0.18	0.09	0.12	0.15	0.62	-0.10	-0.34	-0.30	0.31

Table II: Day-to-Day Transitions between Specialness Categories

This table shows the transition matrices between different levels of specialness/hardness-to-borrow (as measured by the DCBS variable from Markit). The rows indicate the initial specialness category on day t, and the columns the final category at day $t+1$. Panel A shows absolute numbers, while Panel B shows numbers relative to the initial value.

Panel A: Transition Matrix in Absolute Number of Stocks

DCBS	→1	→2	→3	→4	→5	→6	→7	→8	→9	→10
1→	1,057,105	7,512	460	84	27	23	10	5	10	4
2→	7,508	51,151	2,306	140	30	9	3	1	2	1
3→	445	2,335	19,819	1,232	94	19	5	1	2	1
4→	101	113	1,275	11,721	787	85	17	3	2	2
5→	36	37	48	841	7,129	627	53	6	4	3
6→	16	6	19	65	663	6,470	567	27	11	4
7→	15	5	6	7	40	568	7,198	492	43	19
8→	7	2	2	2	1	28	501	4,619	382	21
9→	7	0	5	3	5	10	30	400	4,734	318
10→	6	1	2	1	1	6	8	20	323	6,726
Total	1,065,240	61,151	23,953	14,106	8,784	7,848	8,393	5,565	5,512	7,094

Panel B: Transition Matrix in Relative Number of Stocks (%)

DCBS	→1	→2	→3	→4	→5	→6	→7	→8	→9	→10	Total
1→	99.2	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	100
2→	12.3	83.6	3.8	0.2	0.0	0.0	0.0	0.0	0.0	0.0	100
3→	1.9	9.7	82.7	5.1	0.4	0.1	0.0	0.0	0.0	0.0	100
4→	0.7	0.8	9.0	83.1	5.6	0.6	0.1	0.0	0.0	0.0	100
5→	0.4	0.4	0.5	9.6	81.2	7.1	0.6	0.1	0.0	0.0	100
6→	0.2	0.1	0.2	0.8	8.4	82.4	7.2	0.3	0.1	0.1	100
7→	0.2	0.1	0.1	0.1	0.5	6.8	85.8	5.9	0.5	0.2	100
8→	0.1	0.0	0.0	0.0	0.0	0.5	9.0	83.0	6.9	0.4	100
9→	0.1	0.0	0.1	0.1	0.1	0.2	0.5	7.3	85.9	5.8	100
10→	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.3	4.6	94.8	100

Table III: Daily Autocorrelation of Spot Lending Fees

This table shows summary statistics for the serial autocorrelation and partial autocorrelation of the spot lending fees per firm (permno). Lags 1 to 360 are computed, although only select lags are reported. The measures computed across firms are the mean, first percentile, twenty-firth percentile, median, seventy-fifth percentile and ninety-ninth percentile.

Panel A: Daily Autocorrelation for Selected Lags (%)

Lags	Mean	P01	P10	P25	Median	P75	P90	P99
1	66.3	0.0	3.1	55.0	77.1	92.8	98.4	100.0
2	56.9	-0.0	2.0	25.8	66.3	88.7	97.3	100.0
3	53.0	-0.1	1.2	19.9	59.8	85.7	96.4	99.9
4	53.2	-0.1	1.8	28.6	55.9	83.8	95.3	99.7
5	52.2	-0.1	1.9	26.3	55.0	81.0	94.4	99.4
10	41.8	-0.4	0.9	9.4	40.2	71.5	89.3	97.8
15	36.8	-3.6	0.5	7.1	32.0	63.6	84.2	96.1
30	26.3	-7.9	-0.1	1.7	17.8	45.0	70.0	89.2
60	15.3	-21.7	-0.7	0.4	6.5	25.0	47.7	71.4
90	8.8	-21.9	-3.1	-0.1	2.9	13.7	33.9	56.9
120	4.5	-28.7	-6.3	-1.7	0.4	7.6	25.2	50.2
180	0.3	-23.8	-9.4	-4.0	-0.4	2.6	12.4	36.3
360	-2.7	-28.6	-12.1	-5.6	-0.9	0.4	4.1	19.4

Panel B: Daily Partial Autocorrelation for Selected Lags (%)

Lags	Mean	P01	P10	P25	Median	P75	P90	P99
1	6.9	-45.4	-16.5	-3.7	5.6	21.1	32.6	55.5
2	8.1	-34.2	-5.1	0.8	8.8	18.3	24.8	39.9
3	5.4	-37.5	-8.3	0.3	6.3	17.6	26.5	44.7
4	11.0	-56.3	-8.1	-0.4	3.4	10.6	17.9	44.2
5	2.9	-34.9	-12.3	-4.0	0.9	6.4	13.0	48.5
10	-2.0	-82.4	-6.5	-1.4	1.2	5.9	15.0	29.4
15	2.1	-75.2	-6.1	-1.5	0.9	5.0	11.0	76.3
30	2.3	-63.7	-4.9	-1.4	0.3	2.8	7.0	104.0
60	-1.2	-128.3	-5.5	-2.0	-0.0	1.5	4.4	109.5
90	0.4	-118.9	-5.4	-1.5	-0.0	1.4	4.6	91.5
120	-2.7	-189.7	-5.4	-1.9	-0.2	1.2	5.6	112.8
180	-5.9	-286.3	-5.4	-1.6	-0.2	1.0	6.5	216.0

Table IV: Specialness Persistence Conditional on Jump Between Categories

This table shows the transition matrix between different special categories (proxied by DCBS from Markit) conditional on a previous jump from any to any category. Panel A shows the likelihood to end up in the DCBS at the top of each column after one trading day; Panel B, after 10 days; Panel C, after 20 days. The last line of each panel considers a jump from DCBS 1 to any DCBS greater than 1. The column titled "N" indicates the number of observations of each scenario.

Panel A: Conditional Transition Matrix After One Period

Jump to	N	→1	→2	→3	→4	→5	→6	→7	→8	→9	→10
1	8,118	78.9	19.9	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0
2	9,987	33.2	58.6	7.3	0.6	0.1	0.0	0.0	0.0	0.0	0.0
3	4,109	7.3	21.1	60.7	9.5	1.1	0.2	0.0	0.0	0.0	0.0
4	2,367	3.2	3.2	19.1	61.2	11.4	1.6	0.3	0.1	0.0	0.0
5	1,645	2.1	2.1	2.0	16.7	61.8	13.2	1.8	0.2	0.1	0.1
6	1,372	1.0	0.4	1.2	3.1	15.2	65.0	12.8	0.7	0.4	0.1
7	1,192	0.9	0.3	0.2	0.2	1.8	13.8	69.5	11.2	1.8	0.3
8	955	0.6	0.2	0.1	0.1	0.0	1.7	15.8	66.3	13.7	1.5
9	777	0.8	0.0	0.5	0.3	0.4	0.8	1.3	14.8	68.1	13.1
10	373	0.8	0.3	0.5	0.3	0.0	0.3	0.8	1.1	19.6	76.4

Panel B: Conditional Transition Matrix After 10 Periods

Jump to	N	→1	→2	→3	→4	→5	→6	→7	→8	→9	→10
1	8,054	72.1	24.7	2.5	0.4	0.1	0.1	0.0	0.0	0.0	0.0
2	9,898	54.9	34.8	8.9	1.1	0.2	0.1	0.0	0.0	0.0	0.0
3	4,071	20.0	28.8	36.4	10.8	2.0	1.2	0.3	0.2	0.1	0.1
4	2,347	8.1	8.0	26.5	35.9	11.9	5.4	2.6	0.9	0.5	0.4
5	1,637	4.2	3.8	7.4	24.9	33.8	15.3	6.7	2.0	0.9	1.0
6	1,365	3.2	1.8	3.7	7.6	22.3	34.4	17.8	4.5	2.6	2.1
7	1,180	2.3	1.3	1.8	2.7	6.6	20.7	38.9	14.0	7.4	4.4
8	939	1.9	0.6	0.7	1.4	2.0	6.1	25.1	32.6	21.4	8.1
9	769	3.0	0.9	0.4	0.9	0.9	2.3	8.3	19.8	38.0	25.5
10	369	3.8	0.3	0.5	0.5	1.1	0.8	1.9	7.0	26.0	58.0

Panel C: Conditional Transition Matrix After 20 Periods

Jump to	N	→1	→2	→3	→4	→5	→6	→7	→8	→9	→10
1	7,988	73.5	22.6	2.8	0.6	0.3	0.2	0.1	0.0	0.0	0.0
2	9,807	58.1	31.4	7.9	1.6	0.5	0.2	0.2	0.1	0.1	0.0
3	4,033	24.0	30.1	30.0	9.9	2.5	1.5	1.1	0.4	0.3	0.2
4	2,332	11.2	10.0	25.9	30.0	10.1	6.0	3.7	1.5	1.1	0.6
5	1,626	6.0	5.5	9.4	26.6	23.5	14.6	7.8	2.7	2.1	1.8
6	1,353	4.0	3.8	5.2	12.9	20.0	25.5	14.3	6.9	4.5	2.8
7	1,173	3.4	2.0	3.6	4.8	8.6	19.9	27.5	15.5	8.1	6.6
8	928	2.3	1.3	2.5	1.8	3.8	7.8	25.1	25.8	17.0	12.7
9	759	3.2	1.8	0.9	1.4	1.7	3.4	12.4	17.1	32.3	25.7
10	365	4.9	0.5	1.4	0.5	1.1	2.2	4.4	8.2	28.2	48.5

Table V: Specialness Persistence Conditional on Jump from General Collateral to Special

This table shows the transition matrix between different special categories (proxied by DCBS from Markit) conditional on a previous jump from general collateral (DCBS 1) to the DCBS indicated on each line (from 2 to 10). Panel A shows the likelihood to end up in the DCBS at the top of each column after one trading day; Panel B, after 10 days; Panel C, after 20 days. The last line of each panel considers a jump from DCBS 1 to any DCBS greater than 1. The column titled "N" indicates the number of observations of each scenario.

Panel A: Conditional Transition Matrix After One Period

Jump to	N	→1	→2	→3	→4	→5	→6	→7	→8	→9	→10
2	7,495	40.9	55.7	2.7	0.6	0.1	0.0	0.0	0.0	0.0	0.0
3	458	38.6	19.9	35.2	5.7	0.7	0.0	0.0	0.0	0.0	0.0
4	82	36.6	11.0	9.8	35.4	4.9	2.4	0.0	0.0	0.0	0.0
5	27	33.3	3.7	11.1	11.1	18.5	7.4	7.4	3.7	0.0	3.7
6	23	30.4	8.7	0.0	8.7	8.7	26.1	13.0	0.0	4.3	0.0
7	10	40.0	10.0	0.0	0.0	0.0	0.0	40.0	10.0	0.0	0.0
8	5	80.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	20.0	0.0
9	10	50.0	0.0	10.0	0.0	0.0	10.0	0.0	10.0	20.0	0.0
10	4	75.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.0
2 or more	8,114	40.7	52.8	4.6	1.3	0.2	0.1	0.1	0.0	0.1	0.0

Panel B: Conditional Transition Matrix After 10 Periods

Jump to	N	→1	→2	→3	→4	→5	→6	→7	→8	→9	→10
2	7,425	66.2	29.5	3.4	0.6	0.2	0.1	0.0	0.0	0.0	0.0
3	452	75.4	14.2	8.8	0.9	0.2	0.0	0.4	0.0	0.0	0.0
4	83	74.7	13.3	6.0	2.4	0.0	2.4	0.0	0.0	0.0	1.2
5	27	81.5	7.4	0.0	0.0	7.4	3.7	0.0	0.0	0.0	0.0
6	23	87.0	4.3	0.0	0.0	0.0	8.7	0.0	0.0	0.0	0.0
7	9	77.8	11.1	0.0	0.0	0.0	0.0	0.0	0.0	11.1	0.0
8	5	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	10	80.0	10.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0
10	4	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 or more	8,038	67.0	28.2	3.7	0.6	0.2	0.1	0.0	0.0	0.0	0.0

Panel C: Conditional Transition Matrix After 20 Periods

Jump to	N	→1	→2	→3	→4	→5	→6	→7	→8	→9	→10
2	7,366	68.4	26.5	3.4	1.0	0.3	0.2	0.2	0.0	0.0	0.0
3	452	76.5	15.0	6.4	1.1	0.4	0.2	0.2	0.0	0.0	0.0
4	83	75.9	9.6	7.2	3.6	1.2	1.2	0.0	0.0	0.0	1.2
5	27	74.1	11.1	7.4	0.0	0.0	7.4	0.0	0.0	0.0	0.0
6	23	73.9	13.0	4.3	0.0	4.3	0.0	0.0	4.3	0.0	0.0
7	10	90.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	10.0	0.0
8	5	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	10	60.0	30.0	0.0	0.0	0.0	0.0	10.0	0.0	0.0	0.0
10	4	100.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 or more	7,980	69.1	25.5	3.6	1.0	0.3	0.2	0.2	0.0	0.0	0.0

Table VI: Summary Statistics of the Estimated Implied Lending Fee by Maturity and Specialness

This table shows the summary statistics for the estimated implied lending fee by maturity range (Panel A) and specialness (Panel B). The measures reported are the mean, median, first percentile, tenth percentile, twenty-firth percentile, seventy-fifth percentile, ninetieth percentile, and ninety-ninth percentile. All measures are in percent. Panel C shows the median across maturity and specialness.

Panel A: Implied Lending Fee by Maturity (%)

Maturity	Mean	P01	P10	P25	Median	P75	P90	P99
Less than 7	60.2	-14.4	3.6	12.1	31.4	79.0	177.4	396.3
8 to 15	25.0	-2.8	1.9	4.9	11.3	26.0	60.3	200.0
16 to 30	14.2	-1.6	0.9	2.5	5.9	13.7	32.1	156.6
31 to 60	8.9	-1.0	0.5	1.5	3.5	8.2	19.7	98.2
61 to 90	5.4	-1.2	0.1	0.7	1.9	4.8	12.1	62.6
91 to 180	4.0	-1.3	0.1	0.5	1.4	3.6	9.2	46.1
181 to 360	3.1	-1.6	-0.1	0.3	1.0	2.8	7.2	35.4
More than 361	3.5	-1.0	0.1	0.6	1.5	3.2	7.2	35.7
All	10.0	-1.7	0.1	0.8	2.4	7.3	21.8	155.9

Panel B: Implied Lending Fee by Specialness (%)

DCBS	Mean	P01	P10	P25	Median	P75	P90	P99
1	7.5	-1.9	0.1	0.7	2.0	5.5	15.2	112.8
2	17.9	-0.5	1.1	2.6	6.2	15.5	40.6	200.0
3	24.2	-0.1	2.3	4.9	9.8	22.3	56.3	200.0
4	28.1	0.7	4.2	7.3	13.2	27.5	64.9	200.0
5	30.0	1.4	5.7	9.0	15.2	30.0	67.6	200.0
6	33.1	1.6	6.6	10.7	17.8	33.4	73.2	201.1
7	41.8	2.1	8.8	13.9	22.9	43.5	97.0	256.0
8	52.6	3.8	11.3	17.4	28.7	59.2	136.0	318.5
9	58.3	5.1	14.6	22.7	37.1	68.0	136.6	298.0
10	86.5	8.7	21.8	34.9	61.2	115.3	200.0	390.0
All	10.0	-1.7	0.1	0.8	2.4	7.3	21.8	155.9

Panel C: Median Implied Lending Fee by Maturity and Specialness (%)

Mat.\DCBS	1	2	3	4	5	6	7	8	9	10
Less than 7	27.4	70.9	84.4	99.2	100.5	98.6	121.0	151.4	167.9	200.0
8 to 15	9.8	25.9	34.7	41.1	40.7	45.6	57.9	73.8	87.8	144.8
16 to 30	5.0	14.4	20.2	25.2	25.5	29.0	38.5	52.7	64.7	109.3
31 to 60	3.0	9.0	13.4	17.3	19.3	22.1	29.7	38.0	48.7	81.1
61 to 90	1.6	5.6	8.9	12.3	14.8	17.3	23.0	28.3	37.8	60.1
91 to 180	1.2	4.3	7.1	10.1	12.0	14.3	18.9	23.2	30.6	47.2
181 to 360	0.8	3.4	6.0	8.1	9.6	11.6	15.7	18.9	24.6	37.3
$\geq$ 361	1.3	3.5	5.7	7.5	8.8	10.0	12.7	14.9	18.9	30.8

Table VII: Panel Regressions of the Implied Lending Fees over Spot Lending Fees

This table shows the panel regressions of the estimated implied lending rate on the spot lending rate (SAF from Markit). Columns (1) through (8) show the regression for rates with maturities of less than 7 days, 8 to 15 days, 16 to 30 days, 31 to 60 days, 61 to 90 days, 91 to 180 days, 181 to 360 days, and more than 361 days. Panel A shows the regression without controls. Panel B adds firm-fixed effects, Panel C time-fixed effects. Panel D combines time- and firm-fixed effects. Standard errors are clustered by time (year-month) and firm.

Panel A: Without Controls

Days to	≤ 7	8-15	16-30	31-60	61-90	91-180	181-360	≥ 361
Maturity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	0.522***	0.188***	0.095***	0.054***	0.029***	0.020***	0.015***	0.022***
	(0.026)	(0.010)	(0.006)	(0.003)	(0.002)	(0.002)	(0.001)	(0.001)
SAF	4.643***	4.053***	3.346***	2.717***	1.973***	1.628***	1.380***	1.158***
	(0.355)	(0.281)	(0.232)	(0.183)	(0.144)	(0.124)	(0.115)	(0.104)
Obs.	332,223	415,854	749,903	1,144,243	389,076	1,133,789	1,074,024	1,141,807
Adj. R^2	0.063	0.167	0.249	0.296	0.311	0.322	0.340	0.210

Panel B: With Firm Fixed Effects

Days to	≤ 7	8-15	16-30	31-60	61-90	91-180	181-360	≥ 361
Maturity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SAF	2.690***	2.929***	2.574***	2.154***	1.689***	1.412***	1.207***	0.952***
	(0.405)	(0.282)	(0.253)	(0.204)	(0.164)	(0.139)	(0.137)	(0.129)
Obs.	332,223	415,854	749,903	1,144,243	389,076	1,133,789	1,074,024	1,141,807
Adj. R^2	0.390	0.455	0.477	0.479	0.479	0.465	0.470	0.327

Panel C: With Time Fixed Effects

Days to	≤ 7	8-15	16-30	31-60	61-90	91-180	181-360	≥ 361
Maturity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SAF	4.718***	4.034***	3.336***	2.703***	1.976***	1.627***	1.378***	1.148***
	(0.331)	(0.269)	(0.222)	(0.176)	(0.138)	(0.120)	(0.111)	(0.101)
Obs.	332,223	415,854	749,903	1,144,243	389,076	1,133,789	1,074,024	1,141,807
Adj. R^2	0.263	0.219	0.287	0.325	0.337	0.345	0.362	0.243

Panel D: With Time and Firm Fixed Effects

Days to	≤ 7	8-15	16-30	31-60	61-90	91-180	181-360	≥ 361
Maturity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
SAF	2.527***	2.826***	2.535***	2.133***	1.689***	1.413***	1.207***	0.944***
	(0.363)	(0.257)	(0.226)	(0.189)	(0.153)	(0.133)	(0.131)	(0.126)
Obs.	332,223	415,854	749,903	1,144,243	389,076	1,133,789	1,074,024	1,141,807
Adj. R^2	0.579	0.516	0.521	0.511	0.504	0.488	0.491	0.358

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

Table VIII: Summary Statistics of the Estimated Volatility by Maturity and Specialness

This table shows the summary statistics for the estimated implied volatility by maturity range (Panel A) and specialness (Panel B). The measures reported are the mean, median, first percentile, tenth percentile, twenty-firth percentile, seventy-fifth percentile, ninetieth percentile, and ninety-ninth percentile. Panel C shows the median across maturity and specialness.

Panel A: Volatility by Maturity (%)

Maturity	Mean	P01	P10	P25	Median	P75	P90	P99
Less than 7	40.94	10.73	17.07	22.93	33.11	49.23	73.31	153.85
8 to 15	39.31	11.14	16.94	22.80	32.65	47.74	68.90	136.26
16 to 30	39.33	11.54	17.29	23.29	33.21	47.85	68.01	130.51
31 to 60	41.07	12.39	18.60	24.81	35.00	49.58	70.06	133.97
61 to 90	41.72	12.94	19.09	25.18	35.41	50.15	71.51	136.76
91 to 180	42.22	13.62	20.25	26.42	36.60	50.45	70.51	132.38
181 to 360	41.28	14.13	20.63	26.52	36.08	49.12	68.01	124.00
More than 361	41.21	14.80	21.82	27.60	36.57	48.53	65.90	116.48
All	41.06	12.59	19.34	25.54	35.41	49.18	68.94	130.04

Panel B: Volatility by Specialness (%)

DCBS	Mean	P01	P10	P25	Median	P75	P90	P99
1	37.65	12.51	18.90	24.67	33.50	45.14	60.38	109.45
2	57.28	14.15	26.96	38.37	52.66	69.41	91.74	160.06
3	64.50	11.86	31.87	44.55	58.80	77.57	103.47	177.40
4	69.64	12.40	36.33	48.19	64.02	83.06	109.05	189.49
5	71.83	24.84	40.75	50.74	64.59	84.07	111.62	192.67
6	74.75	25.28	42.31	52.27	67.24	88.67	114.77	202.51
7	77.42	28.15	43.96	53.95	68.91	91.43	122.42	203.75
8	82.33	28.31	45.99	56.57	73.42	100.51	129.10	208.79
9	87.19	28.47	47.79	59.77	78.89	105.94	135.96	220.66
10	96.96	27.23	56.04	70.45	88.98	114.26	148.64	225.96
All	41.06	12.59	19.34	25.54	35.41	49.18	68.94	130.04

Panel C: Median Volatility by Maturity and Specialness (%)

Mat.\DCBS	1	2	3	4	5	6	7	8	9	10
Less than 7	31.0	52.9	58.4	63.7	64.2	67.6	67.7	71.3	75.1	89.6
8 to 15	30.6	51.2	56.8	61.8	62.0	66.5	67.5	70.5	75.5	87.9
16 to 30	31.1	51.6	56.7	61.6	62.3	65.9	66.1	70.9	77.0	86.6
31 to 60	32.9	52.9	59.1	64.2	64.3	68.0	68.2	72.7	80.1	88.4
61 to 90	33.4	53.4	60.6	67.8	66.1	69.9	72.9	76.3	81.9	90.9
91 to 180	34.6	53.8	59.9	65.7	66.9	69.7	70.6	75.6	80.7	90.1
181 to 360	34.3	52.1	58.9	64.0	65.3	64.6	69.3	72.0	77.1	88.8
$\geq$ 361	35.1	52.6	58.9	63.3	64.1	66.7	68.3	75.7	79.6	89.6

Table IX: Panel Regressions of the Implied Lending Fees over Implied Volatility

This table shows the panel regressions of the estimated implied lending rate to the implied volatility rate. Columns (1) through (8) show the regression for rates with maturities of less than 7 days, 8 to 15 days, 16 to 30 days, 31 to 60 days, 61 to 90 days, 91 to 180 days, 181 to 360 days, and more than 361 days. Panel A shows the regression without controls. Panel B adds firm-fixed effects, Panel C time-fixed effects. Panel D combines time- and firm-fixed effects. Standard errors are clustered by time (year-month) and firm.

Panel A: Without Controls

Days to	≤ 7	8-15	16-30	31-60	61-90	91-180	181-360	≥ 361
Maturity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	0.053^{**}	-0.096^{***}	-0.099^{***}	-0.082^{***}	-0.069^{***}	-0.060^{***}	-0.054^{***}	-0.055^{***}
	(0.021)	(0.012)	(0.012)	(0.010)	(0.006)	(0.006)	(0.006)	(0.007)
Impl. Vol.	1.341^{***}	0.880^{***}	0.614^{***}	0.415^{***}	0.296^{***}	0.237^{***}	0.205^{***}	0.217^{***}
	(0.061)	(0.043)	(0.041)	(0.032)	(0.021)	(0.017)	(0.019)	(0.020)
Obs.	357,250	457,237	826,527	1,284,417	440,277	1,300,282	1,223,607	1,268,939
Adj. R^2	0.257	0.288	0.276	0.257	0.284	0.264	0.260	0.221

Panel B: With Firm Fixed Effects

Days to	≤ 7	8-15	16-30	31-60	61-90	91-180	181-360	≥ 361
Maturity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Impl. Vol.	0.975^{***}	0.662^{***}	0.460^{***}	0.311^{***}	0.243^{***}	0.199^{***}	0.179^{***}	0.212^{***}
	(0.063)	(0.036)	(0.031)	(0.025)	(0.020)	(0.019)	(0.024)	(0.026)
Obs.	357,250	457,237	826,527	1,284,417	440,277	1,300,282	1,223,607	1,268,939
Adj. R^2	0.466	0.496	0.472	0.443	0.437	0.413	0.414	0.347

Panel C: With Time Fixed Effects

Days to	≤ 7	8-15	16-30	31-60	61-90	91-180	181-360	≥ 361
Maturity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Impl. Vol.	1.308^{***}	0.941^{***}	0.685^{***}	0.487^{***}	0.341^{***}	0.275^{***}	0.239^{***}	0.249^{***}
	(0.065)	(0.048)	(0.042)	(0.033)	(0.022)	(0.018)	(0.020)	(0.020)
Obs.	357,250	457,237	826,527	1,284,417	440,277	1,300,282	1,223,607	1,268,939
Adj. R^2	0.398	0.320	0.312	0.302	0.320	0.306	0.310	0.279

Panel D: With Time and Firm Fixed Effects

Days to	≤ 7	8-15	16-30	31-60	61-90	91-180	181-360	≥ 361
Maturity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Impl. Vol.	0.771^{***}	0.657^{***}	0.511^{***}	0.390^{***}	0.315^{***}	0.277^{***}	0.266^{***}	0.304^{***}
	(0.065)	(0.045)	(0.039)	(0.035)	(0.031)	(0.028)	(0.034)	(0.033)
Obs.	357,250	457,237	826,527	1,284,417	440,277	1,300,282	1,223,607	1,268,939
Adj. R^2	0.605	0.529	0.500	0.470	0.460	0.443	0.455	0.400

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table X: Panel Regressions of the Implied Lending Fees over Spot Lending Rate and Implied Volatility

This table shows the panel regressions of the estimated implied lending rate to the spot lending rate and implied volatility rate. Columns (1) through (8) show the regression for implied rates with maturities of less than 7 days, 8 to 15 days, 16 to 30 days, 31 to 60 days, 61 to 90 days, 91 to 180 days, 181 to 360 days, and more than 361 days. Panel A shows the regression without controls. Panel B time- and firm-fixed effects. Panel C combines a number of controls and time- and firm-fixed effects. Standard errors are clustered by time (year-month) and firm.

Panel A: Without Controls

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Intercept	0.068^{***}	-0.060^{***}	-0.065^{***}	-0.056^{***}	-0.051^{***}	-0.043^{***}	-0.039^{***}	-0.038^{***}
	(0.023)	(0.012)	(0.009)	(0.007)	(0.005)	(0.005)	(0.005)	(0.006)
SAF	1.940^{***}	2.535^{***}	2.415^{***}	2.104^{***}	1.502^{***}	1.282^{***}	1.095^{***}	0.850^{***}
	(0.224)	(0.224)	(0.199)	(0.159)	(0.120)	(0.107)	(0.102)	(0.084)
Impl. Vol.	1.208^{***}	0.693^{***}	0.448^{***}	0.293^{***}	0.211^{***}	0.165^{***}	0.141^{***}	0.156^{***}
	(0.072)	(0.043)	(0.034)	(0.025)	(0.017)	(0.014)	(0.015)	(0.016)
Obs.	332,223	415,854	749,903	1,144,243	389,076	1,133,789	1,074,024	1,141,807
Adj. R^2	0.252	0.327	0.379	0.408	0.441	0.435	0.444	0.309

Panel B: With Time and Firm Fixed Effects

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
SAF	1.733^{***}	2.188^{***}	2.094^{***}	1.802^{***}	1.411^{***}	1.199^{***}	0.996^{***}	0.702^{***}
	(0.279)	(0.199)	(0.187)	(0.158)	(0.124)	(0.108)	(0.100)	(0.079)
Impl. Vol.	0.689^{***}	0.520^{***}	0.380^{***}	0.295^{***}	0.247^{***}	0.221^{***}	0.215^{***}	0.253^{***}
	(0.067)	(0.045)	(0.033)	(0.028)	(0.026)	(0.025)	(0.030)	(0.033)
Obs.	332,223	415,854	749,903	1,144,243	389,076	1,133,789	1,074,024	1,141,807
Adj. R^2	0.608	0.552	0.555	0.548	0.557	0.544	0.557	0.434

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table X (cont.): Panel Regressions of the Implied Lending Fees over Spot Lending Rate and Implied Volatility

Panel C: With Controls but No Fixed Effects

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Intercept	4.024***	1.670***	0.770***	0.397***	0.220***	0.133***	0.074***	0.020
	(0.240)	(0.143)	(0.091)	(0.058)	(0.039)	(0.028)	(0.027)	(0.037)
SAF	1.354***	2.315***	2.324***	2.053***	1.493***	1.266***	1.093***	0.841***
	(0.234)	(0.231)	(0.213)	(0.170)	(0.129)	(0.117)	(0.112)	(0.096)
Impl. Vol.	0.770***	0.497***	0.364***	0.270***	0.201***	0.160***	0.144***	0.167***
	(0.080)	(0.046)	(0.035)	(0.027)	(0.020)	(0.017)	(0.020)	(0.025)
RV (20 days)	0.200*	−0.066	−0.089**	−0.110***	−0.066***	−0.053***	−0.054***	−0.046***
	(0.110)	(0.055)	(0.036)	(0.028)	(0.018)	(0.015)	(0.017)	(0.016)
Utilization	−0.002***	−0.001***	−0.001***	−0.001***	−0.001***	−0.0003***	−0.0003***	−0.0003***
	(0.001)	(0.0004)	(0.0003)	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Available Ratio	−0.129	−0.234***	−0.156***	−0.098***	−0.061***	−0.036**	−0.026**	−0.035***
	(0.162)	(0.089)	(0.057)	(0.034)	(0.021)	(0.015)	(0.011)	(0.014)
Avg. Tenure	0.001***	0.0003***	0.0002***	0.0001***	0.0001***	0.00005***	0.00004***	0.00004***
	(0.0001)	(0.0001)	(0.0001)	(0.00004)	(0.00002)	(0.00001)	(0.00001)	(0.00001)
Inv. Concentr.	0.455**	0.318***	0.247***	0.166***	0.084***	0.059***	0.050***	0.071***
	(0.207)	(0.108)	(0.073)	(0.046)	(0.021)	(0.016)	(0.013)	(0.020)
Loan Concentr.	0.120**	0.030	0.016	0.005	0.001	0.002	0.004	−0.003
	(0.047)	(0.024)	(0.015)	(0.009)	(0.006)	(0.004)	(0.004)	(0.004)
Demand Concentr.	−0.006	0.009	−0.004	−0.003	−0.004	0.001	−0.002	−0.001
	(0.040)	(0.024)	(0.016)	(0.010)	(0.007)	(0.005)	(0.004)	(0.004)
Log(Mkt. Cap.)	−0.166***	−0.071***	−0.034***	−0.018***	−0.011***	−0.007***	−0.005***	−0.002*
	(0.009)	(0.005)	(0.003)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Obs.	332,073	415,599	749,432	1,143,411	388,743	1,132,945	1,073,309	1,141,231
Adj. R^2	0.340	0.386	0.415	0.436	0.461	0.451	0.458	0.320

*p<0.1; **p<0.05; ***p<0.01

Table XI: Summary Statistics of the Lending Fee and Volatility Risk Premia by Maturity

This table shows the median lending fee and volatility risk premia for each maturity range. The risk premia are computed as the difference between the implied risk premium and the realized risk premium until the maturity. The measures reported are the mean, median, first percentile, twenty-firth percentile, seventy-fifth percentile and ninety-ninth percentile.

Panel A: Lending Fee Risk Premia

Maturity (days)	Mean	P01	P10	P25	Median	P75	P90	P99
Less than 7	0.56	-0.15	0.03	0.11	0.29	0.73	1.66	3.64
8 to 15	0.22	-0.03	0.01	0.04	0.10	0.23	0.53	1.93
16 to 30	0.12	-0.02	0.01	0.02	0.05	0.12	0.27	1.35
31 to 60	0.07	-0.02	0.00	0.01	0.03	0.07	0.16	0.80
61 to 90	0.04	-0.03	0.00	0.00	0.01	0.04	0.09	0.46
91 to 180	0.03	-0.05	0.00	0.00	0.01	0.03	0.07	0.33
181 to 360	0.02	-0.06	0.00	0.00	0.01	0.02	0.05	0.26
More than 361	0.02	-0.08	0.00	0.00	0.01	0.03	0.06	0.27
All	0.08	-0.05	0.00	0.00	0.02	0.06	0.18	1.39

Panel B: Volatility Risk Premia

Maturity (days)	Mean	P01	P10	P25	Median	P75	P90	P99
Less than 7	0.26	-0.14	0.11	0.04	0.20	0.35	0.56	1.32
8 to 15	0.23	-0.15	0.09	0.03	0.18	0.31	0.49	1.09
16 to 30	0.22	-0.18	0.09	0.02	0.18	0.31	0.48	1.05
31 to 60	0.23	-0.18	0.09	0.03	0.19	0.31	0.49	1.08
61 to 90	0.23	-0.18	0.09	0.03	0.19	0.31	0.49	1.11
91 to 180	0.23	-0.24	0.09	0.02	0.19	0.31	0.49	1.08
181 to 360	0.22	-0.21	0.08	0.01	0.18	0.30	0.48	1.03
More than 361	0.23	-0.11	0.10	0.04	0.19	0.30	0.46	0.96
All	0.23	-0.18	0.09	0.02	0.18	0.31	0.49	1.06

Table XII: Summary Statistics of the Lending Fee and Volatility Risk Premia by Specialness

This table shows the median lending fee and volatility risk premia for specialness category. Specialness is proxied by DCBS from Markit. The risk premia are computed as the difference between the implied risk premium and the realized risk premium until the maturity. The measures reported are the mean, median, first percentile, twenty-firth percentile, seventy-fifth percentile and ninety-ninth percentile.

Panel A: Lending Fee Risk Premia

DCBS	Mean	P01	P10	P25	Median	P75	P90	P99
1	0.07	-0.03	0.00	0.00	0.02	0.05	0.14	1.03
2	0.15	-0.07	0.00	0.01	0.04	0.13	0.36	1.98
3	0.20	-0.10	-0.01	0.02	0.06	0.18	0.50	1.97
4	0.22	-0.15	-0.01	0.03	0.08	0.22	0.58	1.96
5	0.21	-0.16	-0.02	0.02	0.08	0.21	0.57	1.93
6	0.22	-0.19	-0.04	0.01	0.08	0.22	0.60	1.93
7	0.28	-0.20	-0.03	0.02	0.11	0.29	0.81	2.27
8	0.35	-0.19	-0.04	0.03	0.14	0.41	1.13	2.69
9	0.38	-0.19	-0.03	0.05	0.18	0.46	1.12	2.63
10	0.54	-0.25	-0.03	0.10	0.31	0.77	1.53	3.39
All	0.08	-0.05	0.00	0.00	0.02	0.06	0.18	1.39

Panel B: Volatility Risk Premia

DCBS	Mean	P01	P10	P25	Median	P75	P90	P99
1	0.07	-0.03	0.00	0.00	0.02	0.05	0.14	1.03
2	0.15	-0.07	0.00	0.01	0.04	0.13	0.36	1.98
3	0.20	-0.10	-0.01	0.02	0.06	0.18	0.50	1.97
4	0.22	-0.15	-0.01	0.03	0.08	0.22	0.58	1.96
5	0.21	-0.16	-0.02	0.02	0.08	0.21	0.57	1.93
6	0.22	-0.19	-0.04	0.01	0.08	0.22	0.60	1.93
7	0.28	-0.20	-0.03	0.02	0.11	0.29	0.81	2.27
8	0.35	-0.19	-0.04	0.03	0.14	0.41	1.13	2.69
9	0.38	-0.19	-0.03	0.05	0.18	0.46	1.12	2.63
10	0.54	-0.25	-0.03	0.10	0.31	0.77	1.53	3.39
All	0.08	-0.05	0.00	0.00	0.02	0.06	0.18	1.39

Table XIII: Median Lending Fee and Volatility Risk Premia by Specialness and Maturity

This table shows the median lending fee and volatility risk premia for each maturity and specialness category. Specialness is proxied by DCBS from Markit. The risk premia are computed as the difference between the implied risk premium and the realized risk premium until the maturity.

Panel A: Median Lending Fee Risk Premia

Mat.	1	2	3	4	5	6	7	8	9	10
Less than 7	0.3	0.7	0.8	0.9	0.9	0.9	1.1	1.4	1.4	1.6
8 to 15	0.1	0.2	0.3	0.3	0.3	0.3	0.4	0.6	0.7	1.0
16 to 30	0.0	0.1	0.2	0.2	0.2	0.2	0.3	0.4	0.4	0.7
31 to 60	0.0	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.3	0.5
61 to 90	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.3
91 to 180	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.2
181 to 360	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2
$\geq$ 361	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1

Panel B: Median Volatility Risk Premia

Mat.	1	2	3	4	5	6	7	8	9	10
$\leq$ 7	0.2	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.6	0.7
8 to 15	0.2	0.3	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0.7
16 to 30	0.2	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.7
31 to 60	0.2	0.4	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.7
61 to 90	0.2	0.3	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.7
91 to 180	0.2	0.3	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.7
181 to 360	0.2	0.3	0.4	0.5	0.5	0.5	0.5	0.5	0.6	0.7
$\geq$ 361	0.2	0.3	0.4	0.5	0.5	0.5	0.5	0.6	0.6	0.7

Table XIV: Panel Regressions of the Realized over Implied Lending Fee

This table shows the panel regressions of the realized lending rate to the estimated implied lending rate. Columns (1) through (8) show the regression for rates with maturities of less than 7 days, 8 to 15 days, 16 to 30 days, 31 to 60 days, 61 to 90 days, 91 to 180 days, 181 to 360 days, and more than 361 days. Panel A shows the regression without controls. Panel B adds firm-fixed effects, Panel C time-fixed effects. Panel D combines time- and firm-fixed effects. Standard errors are clustered by time (year-month) and firm.

Panel A: Without Controls

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Intercept	0.003***	0.001	0.001	0.001**	0.002***	0.003***	0.003***	0.004***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Impl. Lending Fee	0.014***	0.041***	0.075***	0.109***	0.154***	0.195***	0.238***	0.170***
	(0.002)	(0.006)	(0.010)	(0.013)	(0.018)	(0.021)	(0.028)	(0.020)
Obs.	335,860	426,393	776,844	1,207,806	417,144	1,244,795	1,193,084	1,260,540
Adj. R^2	0.064	0.166	0.257	0.306	0.316	0.324	0.330	0.194

Panel B: With Firm Fixed Effects

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Impl. Lending Fee	0.006***	0.025***	0.048***	0.073***	0.111***	0.133***	0.154***	0.080***
	(0.001)	(0.004)	(0.008)	(0.011)	(0.017)	(0.019)	(0.026)	(0.014)
Obs.	335,860	426,393	776,844	1,207,806	417,144	1,244,795	1,193,084	1,260,540
Adj. R^2	0.524	0.541	0.580	0.578	0.575	0.584	0.608	0.640

Panel C: With Time Fixed Effects

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Impl. Lending Fee	0.017***	0.043***	0.077***	0.111***	0.157***	0.198***	0.242***	0.174***
	(0.003)	(0.006)	(0.011)	(0.013)	(0.018)	(0.021)	(0.028)	(0.021)
Obs.	335,860	426,393	776,844	1,207,806	417,144	1,244,795	1,193,084	1,260,540
Adj. R^2	0.086	0.178	0.267	0.314	0.325	0.332	0.338	0.207

Panel D: With Time and Firm Fixed Effects

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Impl. Lending Fee	0.008***	0.027***	0.051***	0.076***	0.115***	0.137***	0.158***	0.083***
	(0.001)	(0.004)	(0.008)	(0.011)	(0.017)	(0.020)	(0.026)	(0.015)
Obs.	335,860	426,393	776,844	1,207,806	417,144	1,244,795	1,193,084	1,260,540
Adj. R^2	0.528	0.544	0.584	0.582	0.579	0.588	0.612	0.644

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

Table XV: Panel Regressions of the Realized over Implied Lending Fee and Volatility

This table shows the panel regressions of the realized lending rate to the estimated implied lending rate and the implied volatility rate. Columns (1) through (8) show the regression for rates with maturities of less than 7 days, 8 to 15 days, 16 to 30 days, 31 to 60 days, 61 to 90 days, 91 to 180 days, 181 to 360 days, and more than 361 days. Panel A shows the regression without controls. Panel B adds firm-fixed effects, Panel C time-fixed effects. Panel D combines time- and firm-fixed effects. Standard errors are clustered by time (year-month) and firm.

Panel A: Without Controls

Days to	≤ 7	8-15	16-30	31-60	61-90	91-180	181-360	≥ 361
Maturity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	-0.008^{***}	-0.009^{***}	-0.008^{***}	-0.005^{***}	-0.003^{**}	-0.003^{*}	-0.003^{*}	-0.009^{***}
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
Impl. Lending Fee	0.007^{***}	0.030^{***}	0.063^{***}	0.098^{***}	0.140^{***}	0.179^{***}	0.218^{***}	0.131^{***}
	(0.001)	(0.005)	(0.010)	(0.012)	(0.017)	(0.021)	(0.027)	(0.016)
Impl. Vol.	0.037^{***}	0.033^{***}	0.026^{***}	0.018^{***}	0.016^{***}	0.015^{***}	0.016^{***}	0.036^{***}
	(0.006)	(0.006)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.009)
Obs.	335,860	426,393	776,844	1,207,806	417,144	1,244,795	1,193,084	1,260,540
Adj. R^2	0.115	0.196	0.274	0.315	0.324	0.331	0.337	0.230

Panel B: With Firm Fixed Effects

Days to	≤ 7	8-15	16-30	31-60	61-90	91-180	181-360	≥ 361
Maturity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Impl. Lending Fee	0.004^{***}	0.021^{***}	0.044^{***}	0.069^{***}	0.106^{***}	0.130^{***}	0.151^{***}	0.072^{***}
	(0.001)	(0.004)	(0.008)	(0.011)	(0.017)	(0.020)	(0.027)	(0.013)
Impl. Vol.	0.015^{***}	0.016^{***}	0.015^{***}	0.012^{***}	0.009^{*}	0.006	0.005	0.013^{**}
	(0.003)	(0.005)	(0.005)	(0.004)	(0.005)	(0.004)	(0.005)	(0.006)
Obs.	335,860	426,393	776,844	1,207,806	417,144	1,244,795	1,193,084	1,260,540
Adj. R^2	0.530	0.546	0.583	0.580	0.576	0.585	0.608	0.642

Panel C: With Time Fixed Effects

Days to	≤ 7	8-15	16-30	31-60	61-90	91-180	181-360	≥ 361
Maturity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Impl. Lending Fee	0.009^{***}	0.029^{***}	0.060^{***}	0.092^{***}	0.132^{***}	0.170^{***}	0.205^{***}	0.116^{***}
	(0.002)	(0.005)	(0.009)	(0.012)	(0.017)	(0.021)	(0.026)	(0.016)
Impl. Vol.	0.045^{***}	0.048^{***}	0.040^{***}	0.031^{***}	0.028^{***}	0.027^{***}	0.030^{***}	0.055^{***}
	(0.006)	(0.007)	(0.006)	(0.004)	(0.005)	(0.005)	(0.006)	(0.009)
Obs.	335,860	426,393	776,844	1,207,806	417,144	1,244,795	1,193,084	1,260,540
Adj. R^2	0.149	0.229	0.300	0.336	0.344	0.349	0.357	0.270

Panel D: With Time and Firm Fixed Effects

Days to	≤ 7	8-15	16-30	31-60	61-90	91-180	181-360	≥ 361
Maturity	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Impl. Lending Fee	0.006^{***}	0.022^{***}	0.044^{***}	0.066^{***}	0.101^{***}	0.123^{***}	0.139^{***}	0.060^{***}
	(0.001)	(0.004)	(0.007)	(0.010)	(0.016)	(0.020)	(0.026)	(0.012)
Impl. Vol.	0.022^{***}	0.032^{***}	0.033^{***}	0.031^{***}	0.030^{***}	0.026^{***}	0.028^{***}	0.041^{***}
	(0.004)	(0.006)	(0.006)	(0.005)	(0.006)	(0.006)	(0.007)	(0.009)
Obs.	335,860	426,393	776,844	1,207,806	417,144	1,244,795	1,193,084	1,260,540
Adj. R^2	0.538	0.557	0.595	0.592	0.588	0.594	0.618	0.657

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table XVI: Panel Regressions of the Realized over Implied and Spot Lending Fee

This table shows the panel regressions of the realized lending rate to the estimated implied lending rate and the spot lending rate (proxied by SAF from Markit). Columns (1) through (8) show the regression for rates with maturities of less than 7 days, 8 to 15 days, 16 to 30 days, 31 to 60 days, 61 to 90 days, 91 to 180 days, 181 to 360 days, and more than 361 days. Panel A shows the regression without controls. Panel B adds firm-fixed effects, Panel C time-fixed effects. Panel D combines time- and firm-fixed effects. Standard errors are clustered by time (year-month) and firm.

Panel A: Without Controls

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Intercept	0.00004	−0.00002	−0.00005	0.0001	0.0004**	0.001***	0.001***	0.002***
	(0.00003)	(0.00004)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0003)	(0.0003)
Impl. Lending Fee	0.0003**	0.001***	0.006***	0.012***	0.026***	0.037***	0.057***	0.041***
	(0.0002)	(0.0002)	(0.002)	(0.003)	(0.006)	(0.008)	(0.013)	(0.007)
SAF	0.980***	0.986***	0.942***	0.904***	0.857***	0.826***	0.776***	0.766***
	(0.011)	(0.004)	(0.027)	(0.027)	(0.036)	(0.037)	(0.049)	(0.054)
Obs.	332,223	415,854	749,903	1,144,243	389,076	1,133,789	1,074,024	1,141,807
Adj. R^2	0.978	0.976	0.938	0.901	0.841	0.794	0.741	0.659

Panel B: With Firm Fixed Effects

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Impl. Lending Fee	0.0003**	0.001***	0.006***	0.013***	0.027***	0.037***	0.055***	0.030***
	(0.0001)	(0.0002)	(0.002)	(0.003)	(0.007)	(0.008)	(0.014)	(0.006)
SAF	0.960***	0.969***	0.889***	0.831***	0.752***	0.685***	0.597***	0.505***
	(0.020)	(0.006)	(0.043)	(0.037)	(0.045)	(0.041)	(0.053)	(0.056)
Obs.	332,223	415,854	749,903	1,144,243	389,076	1,133,789	1,074,024	1,141,807
Adj. R^2	0.978	0.976	0.942	0.909	0.860	0.830	0.806	0.790

Panel C: With Time Fixed Effects

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Impl. Lending Fee	0.0004**	0.001***	0.005***	0.012***	0.025***	0.037***	0.056***	0.042***
	(0.0002)	(0.0002)	(0.002)	(0.003)	(0.006)	(0.007)	(0.012)	(0.007)
SAF	0.982***	0.986***	0.948***	0.909***	0.862***	0.830***	0.782***	0.767***
	(0.010)	(0.004)	(0.022)	(0.023)	(0.031)	(0.034)	(0.045)	(0.053)
Obs.	332,223	415,854	749,903	1,144,243	389,076	1,133,789	1,074,024	1,141,807
Adj. R^2	0.981	0.977	0.943	0.905	0.846	0.798	0.746	0.663

Panel D: With Time and Firm Fixed Effects

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Impl. Lending Fee	0.0004**	0.001***	0.006***	0.012***	0.027***	0.037***	0.054***	0.030***
	(0.0002)	(0.0002)	(0.002)	(0.003)	(0.007)	(0.008)	(0.013)	(0.006)
SAF	0.964***	0.970***	0.899***	0.838***	0.760***	0.691***	0.603***	0.507***
	(0.017)	(0.006)	(0.034)	(0.031)	(0.039)	(0.037)	(0.049)	(0.055)
Obs.	332,223	415,854	749,903	1,144,243	389,076	1,133,789	1,074,024	1,141,807
Adj. R^2	0.981	0.977	0.946	0.912	0.863	0.833	0.809	0.793

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

Table XVII: Panel Regressions of the Realized over Lagged Implied Lending Fee and Other Controls

This table shows the panel regressions of the realized lending rate to the lagged estimated implied lending rate and other lagged variables. Columns (1) through (8) show the regression for rates with maturities of less than 7 days, 8 to 15 days, 16 to 30 days, 31 to 60 days, 61 to 90 days, 91 to 180 days, 181 to 360 days, and more than 361 days. Panel A shows the regression on the implied lending fee only. Panel B show the regression on the spot lending fee only (SAF from Markit). Panel C combined the implied and spot lending fees. Panel D adds the estimated implied implied volatility. Panel E adds a variety of controls. Results with fixed effects are not shown. Standard errors are clustered by time (year-month) and firm.

Panel A: Implied Lending Fee Only

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Intercept	0.002^{***}	0.001	0.001	0.001^{**}	0.002^{***}	0.003^{***}	0.003^{***}	0.004^{***}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Impl. Lending Fee	0.015^{***}	0.041^{***}	0.076^{***}	0.111^{***}	0.161^{***}	0.201^{***}	0.248^{***}	0.180^{***}
	(0.002)	(0.006)	(0.011)	(0.013)	(0.019)	(0.023)	(0.030)	(0.020)
Obs.	294,182	415,854	749,903	1,144,243	389,076	1,133,789	1,074,024	1,141,807
Adj. R^2	0.071	0.169	0.262	0.313	0.327	0.331	0.344	0.203

Panel B: Spot Lending Fee Only

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Intercept	0.0003^{**}	0.0002^{***}	0.001^{***}	0.001^{***}	0.001^{***}	0.001^{***}	0.002^{***}	0.003^{***}
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0004)
SAF	0.973^{***}	0.989^{***}	0.959^{***}	0.936^{***}	0.906^{***}	0.886^{***}	0.854^{***}	0.813^{***}
	(0.014)	(0.005)	(0.023)	(0.022)	(0.030)	(0.032)	(0.045)	(0.051)
Obs.	294,182	415,854	749,903	1,144,243	389,076	1,133,789	1,074,024	1,141,807
Adj. R^2	0.961	0.971	0.931	0.894	0.831	0.783	0.727	0.649

Panel C: Implied and Spot Lending Fees

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Intercept	0.00004	−0.00002	−0.00005	0.0001	0.0004^{**}	0.001^{***}	0.001^{***}	0.002^{***}
	(0.00004)	(0.00004)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0003)	(0.0003)
Impl. Lending Fee	0.001^{**}	0.001^{***}	0.006^{***}	0.013^{***}	0.026^{***}	0.038^{***}	0.057^{***}	0.041^{***}
	(0.0002)	(0.0002)	(0.002)	(0.003)	(0.006)	(0.008)	(0.013)	(0.007)
SAF	0.971^{***}	0.985^{***}	0.940^{***}	0.902^{***}	0.855^{***}	0.824^{***}	0.775^{***}	0.766^{***}
	(0.015)	(0.005)	(0.029)	(0.027)	(0.037)	(0.037)	(0.049)	(0.054)
Obs.	294,182	415,854	749,903	1,144,243	389,076	1,133,789	1,074,024	1,141,807
Adj. R^2	0.961	0.971	0.933	0.897	0.837	0.791	0.739	0.657

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table XVII (cont.): Panel Regressions of the Realized over Lagged Implied Lending Fee and Other Controls

Panel D: Implied and Spot Lending Fees and Implied Volatility

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Intercept	-0.0004^{***}	-0.0004^{***}	-0.001^{***}	-0.001^{***}	-0.002^{***}	-0.002^{***}	-0.003^{***}	-0.006^{***}
	(0.0001)	(0.0001)	(0.0003)	(0.0004)	(0.001)	(0.001)	(0.001)	(0.001)
Impl. Lending Fee	0.0003^{*}	0.001^{***}	0.004^{**}	0.010^{***}	0.020^{***}	0.029^{***}	0.044^{***}	0.025^{***}
	(0.0001)	(0.0002)	(0.002)	(0.003)	(0.006)	(0.007)	(0.012)	(0.006)
SAF	0.969^{***}	0.983^{***}	0.937^{***}	0.899^{***}	0.851^{***}	0.821^{***}	0.770^{***}	0.745^{***}
	(0.016)	(0.005)	(0.029)	(0.027)	(0.037)	(0.037)	(0.049)	(0.053)
Impl. Vol.	0.001^{**}	0.001^{***}	0.004^{***}	0.005^{***}	0.007^{***}	0.008^{***}	0.011^{***}	0.020^{***}
	(0.001)	(0.0004)	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.004)
Obs.	294,182	415,854	749,903	1,144,243	389,076	1,133,789	1,074,024	1,141,807
Adj. R^2	0.961	0.971	0.933	0.897	0.838	0.793	0.742	0.667

Panel E: All Controls

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Intercept	0.001	-0.002^{***}	-0.005^{***}	-0.006^{**}	-0.007^{**}	-0.003	0.003	0.015
	(0.002)	(0.001)	(0.002)	(0.003)	(0.003)	(0.004)	(0.006)	(0.010)
Impl. Lending Fee	0.0002^{*}	0.0005^{***}	0.004^{**}	0.008^{***}	0.017^{***}	0.024^{***}	0.036^{***}	0.016^{***}
	(0.0001)	(0.0001)	(0.002)	(0.003)	(0.006)	(0.007)	(0.012)	(0.006)
SAF	0.956^{***}	0.981^{***}	0.922^{***}	0.880^{***}	0.829^{***}	0.807^{***}	0.752^{***}	0.713^{***}
	(0.023)	(0.006)	(0.037)	(0.035)	(0.046)	(0.044)	(0.055)	(0.056)
Impl. Vol.	0.001^{***}	0.001^{***}	0.004^{***}	0.005^{***}	0.007^{***}	0.008^{***}	0.010^{***}	0.017^{***}
	(0.0004)	(0.0003)	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.004)
RV (20 days)	-0.001	-0.002^{**}	-0.004^{***}	-0.006^{***}	-0.008^{***}	-0.010^{***}	-0.014^{***}	-0.016^{***}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)
Utilization	0.00004^{**}	0.00003^{***}	0.0001^{***}	0.0001^{***}	0.0001^{***}	0.0002^{***}	0.0002^{***}	0.0002^{***}
	(0.00002)	(0.00001)	(0.00003)	(0.00002)	(0.00003)	(0.00003)	(0.00003)	(0.00004)
Available Ratio	-0.002^{*}	-0.0002	-0.002	-0.002	-0.003	-0.004^{*}	-0.007^{**}	-0.013^{***}
	(0.001)	(0.0003)	(0.001)	(0.001)	(0.002)	(0.002)	(0.003)	(0.005)
Log(Var(SAF))	0.00003	-0.00002	0.00003	0.0001	0.0001	0.0001^{**}	0.0001	0.0003^{***}
	(0.00004)	(0.00002)	(0.00005)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Log(Var(Util.))	-0.0002^{**}	-0.0001^{***}	-0.0004^{***}	-0.0005^{***}	-0.001^{***}	-0.001^{***}	-0.001^{***}	-0.001^{***}
	(0.0001)	(0.00002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0003)
Avg. Tenure	0.00000	-0.000	0.00000	0.00000	-0.00000^{*}	-0.00000	-0.00000	-0.00000
	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Inv. Concentr.	0.001	0.0001	0.0003	0.002	0.002	0.005	0.007	0.008
	(0.001)	(0.001)	(0.001)	(0.002)	(0.003)	(0.004)	(0.006)	(0.007)
Loan Concentr.	-0.0001	0.0002^{**}	0.0001	0.00000	-0.0002	-0.001	-0.001	-0.003^{***}
	(0.0002)	(0.0001)	(0.0002)	(0.0003)	(0.0004)	(0.001)	(0.001)	(0.001)
Demand Concentr.	-0.0002	-0.0001	-0.0002	-0.0002	-0.0002	-0.0001	-0.001	0.00004
	(0.0001)	(0.0001)	(0.0003)	(0.0003)	(0.0005)	(0.001)	(0.001)	(0.001)
Log(Mkt. Cap.)	-0.00001	0.0001^{***}	0.0002^{***}	0.0003^{***}	0.0003^{***}	0.0002	-0.00003	-0.0004
	(0.00004)	(0.00003)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0003)
Obs.	284,019	400,785	722,637	1,102,771	375,062	1,093,947	1,036,976	1,108,921
Adj. R^2	0.960	0.973	0.936	0.903	0.848	0.808	0.760	0.691

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table XVIII: Panel Regressions of the Lending Fee Risk Premia over Lagged Implied Lending Fee and Other Controls

This table shows the panel regressions of the lending fee risk premia to the lagged estimated implied lending rate and other lagged variables. Columns (1) through (8) show the regression for rates with maturities of less than 7 days, 8 to 15 days, 16 to 30 days, 31 to 60 days, 61 to 90 days, 91 to 180 days, 181 to 360 days, and more than 361 days. Panel A shows the regression on the implied lending fee only. Panel B show the regression on the spot lending fee only (SAF from Markit). Panel C combined the implied and spot lending fees. Panel D adds the estimated implied implied volatility. Panel E adds a variety of controls. Results with fixed effects are not shown. Standard errors are clustered by time (year-month) and firm.

Panel A: Implied Lending Fee Only

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Intercept	0.210^{***}	0.060^{***}	0.023^{***}	0.011^{***}	0.004^{***}	0.002^{**}	0.0005	0.001^{*}
	(0.011)	(0.004)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Impl. Lending Fee	0.932^{***}	0.842^{***}	0.796^{***}	0.750^{***}	0.733^{***}	0.699^{***}	0.642^{***}	0.682^{***}
	(0.011)	(0.010)	(0.010)	(0.010)	(0.017)	(0.020)	(0.025)	(0.018)
Obs.	234,960	394,086	725,612	1,128,208	389,384	1,160,558	1,116,311	1,183,012
Adj. R^2	0.564	0.612	0.669	0.687	0.692	0.665	0.604	0.548

Panel B: Spot Lending Fee Only

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Intercept	0.582^{***}	0.213^{***}	0.099^{***}	0.052^{***}	0.027^{***}	0.019^{***}	0.012^{***}	0.019^{***}
	(0.030)	(0.011)	(0.006)	(0.003)	(0.002)	(0.002)	(0.001)	(0.001)
SAF	3.864^{***}	3.152^{***}	2.400^{***}	1.763^{***}	1.080^{***}	0.749^{***}	0.519^{***}	0.330^{***}
	(0.406)	(0.291)	(0.223)	(0.159)	(0.130)	(0.115)	(0.100)	(0.091)
Obs.	232,060	384,360	700,364	1,068,202	362,745	1,054,386	1,001,625	1,068,064
Adj. R^2	0.038	0.090	0.140	0.157	0.124	0.095	0.075	0.021

Panel C: Implied and Spot Lending Fees

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Intercept	0.211^{***}	0.060^{***}	0.023^{***}	0.011^{***}	0.005^{***}	0.003^{***}	0.001^{***}	0.002^{***}
	(0.011)	(0.004)	(0.001)	(0.001)	(0.001)	(0.0005)	(0.0005)	(0.0004)
Impl. Lending Fee	0.940^{***}	0.853^{***}	0.818^{***}	0.789^{***}	0.803^{***}	0.804^{***}	0.771^{***}	0.787^{***}
	(0.011)	(0.011)	(0.011)	(0.011)	(0.014)	(0.017)	(0.020)	(0.014)
SAF	-0.469^{***}	-0.285^{***}	-0.290^{***}	-0.372^{***}	-0.501^{***}	-0.564^{***}	-0.542^{***}	-0.578^{***}
	(0.096)	(0.071)	(0.058)	(0.043)	(0.041)	(0.043)	(0.051)	(0.052)
Obs.	232,060	384,360	700,364	1,068,202	362,745	1,054,386	1,001,625	1,068,064
Adj. R^2	0.565	0.613	0.671	0.692	0.702	0.694	0.654	0.590

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$

Table XVIII (cont.): Panel Regressions of the Lending Fee Risk Premia over Lagged Implied Lending Fee and Other Controls

Panel D: Implied and Spot Lending Fees and Implied Volatility

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Intercept	0.104^{***}	-0.010^{**}	-0.015^{***}	-0.013^{***}	-0.011^{***}	-0.007^{***}	-0.004^{***}	0.0003
	(0.012)	(0.004)	(0.003)	(0.002)	(0.002)	(0.001)	(0.001)	(0.002)
Impl. Lending Fee	0.870^{***}	0.789^{***}	0.771^{***}	0.749^{***}	0.763^{***}	0.776^{***}	0.752^{***}	0.783^{***}
	(0.011)	(0.013)	(0.012)	(0.012)	(0.016)	(0.021)	(0.024)	(0.015)
SAF	-0.896^{***}	-0.515^{***}	-0.380^{***}	-0.412^{***}	-0.518^{***}	-0.573^{***}	-0.548^{***}	-0.583^{***}
	(0.083)	(0.067)	(0.056)	(0.041)	(0.042)	(0.043)	(0.051)	(0.051)
Impl. Vol.	0.358^{***}	0.226^{***}	0.119^{***}	0.071^{***}	0.044^{***}	0.026^{***}	0.016^{***}	0.005
	(0.028)	(0.017)	(0.011)	(0.007)	(0.005)	(0.005)	(0.005)	(0.005)
Obs.	232,060	384,360	700,364	1,068,202	362,745	1,054,386	1,001,625	1,068,064
Adj. R^2	0.576	0.626	0.680	0.699	0.708	0.697	0.656	0.590

Panel E: All Controls

Days to Maturity	≤ 7 (1)	8-15 (2)	16-30 (3)	31-60 (4)	61-90 (5)	91-180 (6)	181-360 (7)	≥ 361 (8)
Intercept	2.089^{***}	0.921^{***}	0.316^{***}	0.153^{***}	0.081^{***}	0.045^{***}	0.023^{**}	0.032^{**}
	(0.155)	(0.072)	(0.033)	(0.020)	(0.014)	(0.011)	(0.011)	(0.014)
Impl. Lending Fee	0.805^{***}	0.748^{***}	0.747^{***}	0.731^{***}	0.751^{***}	0.769^{***}	0.749^{***}	0.787^{***}
	(0.013)	(0.014)	(0.013)	(0.013)	(0.017)	(0.023)	(0.026)	(0.016)
SAF	-1.036^{***}	-0.569^{***}	-0.400^{***}	-0.396^{***}	-0.487^{***}	-0.558^{***}	-0.530^{***}	-0.562^{***}
	(0.117)	(0.071)	(0.061)	(0.046)	(0.048)	(0.049)	(0.055)	(0.052)
Impl. Vol.	0.212^{***}	0.150^{***}	0.108^{***}	0.072^{***}	0.047^{***}	0.028^{***}	0.019^{***}	0.004
	(0.028)	(0.018)	(0.011)	(0.008)	(0.006)	(0.006)	(0.006)	(0.006)
RV (20 days)	0.152^{*}	0.048^{*}	-0.033^{***}	-0.024^{***}	-0.012^{**}	-0.003	0.004	0.015^{***}
	(0.078)	(0.026)	(0.010)	(0.008)	(0.005)	(0.004)	(0.004)	(0.003)
Utilization	-0.0001	-0.0001	-0.0001	-0.0002^{***}	-0.0002^{***}	-0.0002^{***}	-0.0002^{***}	-0.0002^{***}
	(0.0003)	(0.0001)	(0.0001)	(0.00004)	(0.00004)	(0.00003)	(0.00003)	(0.00004)
Available Ratio	-0.046	-0.101^{***}	-0.066^{***}	-0.033^{***}	-0.016^{**}	-0.007	0.001	-0.001
	(0.075)	(0.038)	(0.018)	(0.010)	(0.007)	(0.005)	(0.004)	(0.005)
Log(Var(SAF))	-0.005^{***}	-0.001	-0.0003	-0.0002	-0.0003^{**}	-0.0002^{***}	-0.0002^{***}	-0.0004^{***}
	(0.001)	(0.001)	(0.0004)	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Log(Var(Util.))	-0.012^{***}	-0.009^{***}	-0.004^{***}	-0.002^{***}	-0.001^{***}	-0.0002	0.0004	0.001^{**}
	(0.002)	(0.001)	(0.001)	(0.0004)	(0.0003)	(0.0002)	(0.0002)	(0.0003)
Avg. Tenure	0.0003^{***}	0.0001^{***}	0.0001^{***}	0.00003^{***}	0.00002^{***}	0.00001^{***}	0.00001^{*}	0.00001^{**}
	(0.0001)	(0.00003)	(0.00002)	(0.00001)	(0.00000)	(0.00000)	(0.00000)	(0.00000)
Inv. Concentr.	0.224^{**}	0.098^{**}	0.070^{***}	0.049^{***}	0.023^{***}	0.011^{*}	0.006	0.004
	(0.102)	(0.049)	(0.022)	(0.014)	(0.007)	(0.006)	(0.007)	(0.008)
Loan Concentr.	0.028	0.002	0.001	-0.001	-0.0002	0.0003	0.001	0.002
	(0.021)	(0.009)	(0.004)	(0.003)	(0.002)	(0.001)	(0.001)	(0.001)
Demand Concentr.	-0.006	-0.001	-0.004	-0.003	-0.002	-0.0004	-0.0004	-0.001
	(0.020)	(0.009)	(0.005)	(0.003)	(0.002)	(0.001)	(0.001)	(0.001)
Log(Mkt. Cap.)	-0.086^{***}	-0.038^{***}	-0.013^{***}	-0.007^{***}	-0.004^{***}	-0.002^{***}	-0.001^{***}	-0.002^{***}
	(0.006)	(0.003)	(0.001)	(0.001)	(0.001)	(0.0005)	(0.0004)	(0.0005)
Obs.	224,171	370,754	675,323	1,030,188	349,831	1,018,025	967,368	1,037,432
Adj. R^2	0.592	0.635	0.682	0.697	0.709	0.696	0.655	0.592

$^{*}p < 0.1$; $^{**}p < 0.05$; $^{***}p < 0.01$