THE JOURNAL OF FINANCE • VOL. LXII, NO. 5 • OCTOBER 2007

Liquidity or Credit Risk? The Determinants of Very Short-Term Corporate Yield Spreads

DAN COVITZ and CHRIS DOWNING*

ABSTRACT

Employing a comprehensive database on transactions of commercial paper issued by domestic U.S. nonfinancial corporations, we study the determinants of very short-term corporate yield spreads. We find that liquidity plays a role in the determination of spreads but, somewhat surprisingly, credit quality is the more important determinant of spreads, even at horizons of less than 1 month. These results are robust across a variety of proxies for liquidity and credit risk, and have important implications for the literature on the modeling of corporate bond prices.

THE SEMINAL PAPER BY MERTON (1974) PROVIDES a basic structural framework for valuing defaultable corporate debt. One of the principal strengths of the Merton approach is that it makes clear causal links between the price of a firm's debt and observables, thus providing specific testable predictions. However, the empirical evidence for the model and various of its extensions is mixed. For example, Sarig and Warga (1989) use a sample of long-term discount bonds to demonstrate that yield spreads vary with maturity in a manner that is roughly consistent with Merton's model, but Helwege and Turner (1999) argue that this result is an artifact of the method used to construct the corporate term structures.[1] Moreover, while direct tests of Merton-style models find that the models seriously underpredict the level of long-term corporate bond spreads (Jones, Mason, and Rosenfeld (1984), Ogden (1987), Collin-Dufresne, Goldstein, and Martin (2001), Elton et al. (2001), Delianedis and Geske (2001), Huang and Huang (2003), and others), Lyden and Saraniti (2000) and Eom, Helwege, and Huang (2004) find that some extensions of the Merton model (such as Leland and Toft (1996) and Collin-Dufresne and Goldstein (2001)) overpredict spreads for poorly capitalized firms, but continue to underpredict spreads for large, well-capitalized firms. It is also well known that structural models severely underpredict yield spreads for bonds maturing in less than 1 year.

*Covitz is at the Federal Reserve Board. Downing is at Barclays Global Investors. The authors are grateful for helpful comments from an anonymous referee, Mark Carey, Paul Harrison, Eric Heitfeld, and Calvin Schnure. Shannon Hart provided excellent research assistance. This paper represents the views of the authors and does not necessarily represent the views of the Federal Reserve System or members of its staff. Any errors are our own.

[1] We define the "yield spread" on a corporate bond as the difference between the yield-to-maturity on the corporate bond less the yield-to-maturity on a comparable-maturity default-free instrument such as a Treasury bond. "Long-term" bonds are defined as those with more than 1 year to maturity, and we take "credit risk" to include both the probability of default and the loss given default.

One potential explanation for why Merton-style models tend to underpredict yield spreads—the so-called "credit puzzle"—is that these models omit a liquidity factor. Indeed, an increasing amount of research effort seeks to understand the extent to which liquidity, that is, the ability to transact in large volumes quickly and with limited price impact, helps to explain the time-series and cross-sectional variation of yield spreads and bond returns. For example, Driessen (2005) provides evidence for a liquidity component in corporate bond spreads using the Duffie and Singleton (1999) reduced-form pricing approach, and Chordia, Sarkar, and Subrahmanyam (2003) provide evidence of a link between money flows and transactions liquidity. Chacko (2005) and Downing, Underwood, and Xing (2006) explore the role of liquidity in the corporate bond market and find that liquidity risk is a priced factor in bond returns. De Jong and Driessen (2004) show that fluctuations in Treasury bond and equity market liquidity affect corporate bond returns.

In this paper, we attempt to shed additional light on the credit puzzle and liquidity by studying yield spreads on commercial paper (CP) of less than 35 days to maturity. The credit puzzle takes an extreme form at these very short maturities: None of the aforementioned structural models produce a yield spread on instruments of less than 1 month to maturity. In part, this reflects the fact that these models typically associate credit risk with expected losses, and nearly all of the firms that issue CP are large, well-capitalized firms. Conventional wisdom therefore holds that liquidity is the principal determinant of commercial paper spreads, a view that is supported by the apparent lack of a secondary market for CP (see, for example, Krishnamurthy (2002)), though data limitations have prevented a careful study of very short-term corporate yield spreads at the transaction level. This study takes a step toward filling this void in the literature by bringing CP transactions data to bear on the question of the determinants of very short-term yield spreads.

The very short-term portion of the corporate term structure is interesting for at least two additional reasons. First, the market for CP is large, with over \$1 trillion of face value outstanding, and second, the CP market has its own set of institutional features. As we discuss at length below, a defining feature of the CP market is that at year-end, market liquidity often drops and yield spreads rise substantially. This feature of the market affords us the opportunity to examine how the relations between firm-level yields spreads, credit quality, and instrument liquidity change in the face of wide swings in market liquidity.[2]

Our analysis is based on a comprehensive data set of new issues, secondary market trades, and repurchase agreement transactions of commercial paper issued by U.S. firms from January 1, 1998 to October 31, 2003; this data set is new to the literature. We begin by examining transaction activity on the CP market with the aim of quantifying the liquidity of CP instruments. Consistent with the conventional wisdom, we find that, on average, secondary market

[2] We use the term "instrument liquidity" to refer to liquidity measurements taken at the individual security level. The term "market liquidity" is used to refer to liquidity measurements that are aggregated across all securities on a particular market.

transactions account for just a few percentage points of total daily transaction volumes, whether measured in terms of the number of trades or in terms of the par amount traded. It is also apparent from these data that the market for commercial paper repurchase agreements (CP-repo) is very thinly traded, with daily transactions on the CP-repo market accounting for only a small fraction of total CP market activity.[3] Furthermore, the commercial paper that is pledged in repo transactions is heavily discounted. Typically, the discounts that are applied to the CP in these transactions are an order of magnitude larger than the discounts applied to Treasury collateral in Treasury-repo transactions, indicating that it is relatively costly to liquify a CP position in the repo market.

Despite the fact that the CP secondary and repo markets are so thin, our analysis of CP market transaction activity suggests that most CP may be much more liquid than is commonly believed. The bulk of market transactions are in CP maturing in 4 days or less—paper that is, at least in certain respects, inherently liquid. For example, positions in overnight paper are liquidated the next day at zero price impact. In contrast to long-term corporate bonds, the firm effectively functions as the most important liquidity provider to holders of very short-dated CP, suggesting that the firm's credit quality might be an important determinant of the yield spread on its CP. On the other hand, the credit rating agencies require that all issuers of CP maintain backup lines of credit at money-center banks. Firms that are unable to roll over their CP or pay off their CP investors with cash can turn to these bank backup lines to avoid default.

In order to disentangle the contributions of liquidity and credit risk in the determination of CP yield spreads, we next conduct regressions of spreads on a variety of controls for firm-level credit risk and CP instrument liquidity.[4] Consistent with our observation that CP is liquid by virtue of its short maturity, we find that credit risk appears to be the more important determinant of CP spreads, a result that is robust to alternative proxies for both liquidity and credit risk, as well as to the cross-sectional correlation in our data. These results suggest that Merton-style structural debt pricing models omit one or more components of credit risk that are important to the very short end of the corporate yield curve. Moreover, given that credit risk may be more important for long-term bond spreads than for CP spreads, these findings suggest that structural models of long-term bond spreads, which have been shown to consistently underpredict spreads, may be omitting important components of credit risk as well.

[3] A repurchase agreement is essentially a collateralized loan. The party seeking to borrow money provides collateral, in this case, commercial paper, to the counterparty. At the conclusion of the contract period, the collateral is returned to the borrower if the loan is repaid in full with interest. In general, the collateral value is discounted from its market price at the initiation of the repo contract in order to protect the counterparty from declines in the value of the collateral over the course of the contract period.

[4] Similar regression approaches have been used to uncover the determinants of long-term bond spreads. For instance, Elton et al. (2001) estimate regressions of bond spreads (yield spread less expected loss component) on systematic risk factors, and Longstaff, Mithal, and Neis (2005) regress the nondefault components of long-term bond yields on measures of individual bond liquidity.

The remainder of this paper proceeds as follows. Section I describes the data and provides facts on daily transaction volumes and yield spreads in the commercial paper market. Section II discusses our regression results and robustness checks. The final section concludes.

I. Data

The data set that we employ in this study includes transactions (new issues, secondary market trades, and repurchase agreements) of commercial paper issued by domestic nonfinancial U.S. firms from January 1, 1998 to October 31, 2003, approximately two million transactions over 1,441 trading days. These data come from the Depository Trust Company (DTC), the agent that electronically clears and settles directly and dealer-placed commercial paper.[5] The issues in the sample are discount instruments paying face value at maturity; none of the issues contain embedded options or credit enhancements. The yields on primary market offerings are exclusive of the dealers' fees.[6] We observe the offer side of secondary market transactions. All of these transactions are for "bid backs" by the CP dealers as a service to their investors.[7]

The above data allow us to construct detailed accounts of daily trading activity on the CP market. We first partition the data into six maturity categories: 1 to 4 days; 5 to 10 days; 11 to 24 days; 25 to 44 days; 45 to 74 days; and greater than 74 days.[8] Within each of these maturity categories, we compute the average daily shares of the total par amount traded and of the total number of trades accounted for by primary (new issue), secondary, and repurchase agreement transactions.

As Panel A of Table I shows, in terms of face amounts the bulk of primary issuance consists of paper with very short maturities of 4 days or less. However, there is some clustering of maturities in the 25 to 44 day range (the 30-day maturity is a significant mass point). Panel B shows that the pattern of issuance across maturities in terms of the number of issues is similar.

On average, secondary market offerings account for a very small share of total daily market activity—only about 8% of the total face amount traded, or about 16% of the total transaction volume—consistent with the conventional wisdom that CP is an illiquid buy-and-hold instrument. Secondary market transactions concentrate in the 25 to 44 day maturity range; secondary market trades in this maturity range account for 2.5% of total daily dollar volume, or 4.3% of the total number of trades.

[5] A tiny fraction of market participants still use physical clearance and settlement, but these account for less than 5% of market activity, according to DTC. For additional information on the CP market and its clearance and settlement systems, see Stigum (1986, 1990).

[6] A dealer's fee for acting as the placement agent for an issuer's commercial paper typically amounts to three to five basis points on the issuer's CP volume. These fees are paid as side payments by the issuers to the dealers and hence do not appear in our data.

[7] Because we only see the offer side, we cannot compute bid-ask spreads. Our regression results in the next section are unaffected if we drop the secondary market transactions from the analysis.

[8] These maturity ranges correspond roughly to those reported in the Federal Reserve's daily commercial paper release. The daily release is available at: http://www.federalreserve.gov/releases/cp.

Table I

Commercial Paper Market Trading Activity

This table reports average shares of total daily trade volumes for three CP submarkets. The "Primary" submarket includes new issues; the "Secondary" submarket is for paper traded after its issue date in the primary market; the "Repo" submarket includes CP pledged as collateral in repurchase agreements. The shares are expressed in percent; the shares do not sum to 100% in each panel because they are averages of daily shares. The figures below each average share are the standard deviations of the daily shares. Panel B displays average shares of the total number of trades each day; the column labeled "*N*" shows the average number of trades per day in each submarket, with the daily standard deviation below each average; the row labeled "*N*" shows the average daily number of trades in each maturity range. All of the shares are computed over the subperiod from January 1, 1998 through July 8, 1999; data on secondary market activity are unavailable for the rest of the sample period.

Panel A: Face Amount (% of Total)

	Days to Maturity						Row
	1 to 4	5 to 10	11 to 24	25 to 44	45 to 74	75+	Sum
Primary	57.30	6.37	5.23	9.96	4.65	6.20	89.71
	6.70	3.03	1.15	2.88	1.47	2.10	
Secondary	0.52	0.85	1.52	2.48	1.35	1.62	8.34
	0.56	0.39	0.53	0.89	0.50	0.61	
Repo	0.07	0.08	0.12	0.32	0.19	0.22	1.00
	0.06	0.07	0.10	0.26	0.15	0.16	

Panel B: Number of Trades (% of Total)

	Days to Maturity						
	1 to 4	5 to 10	11 to 24	25 to 44	45 to 74	75+	*N*
Primary	44.35	8.41	7.06	11.44	5.30	6.50	5,100
	5.47	2.63	1.25	2.49	1.45	1.54	661
Secondary	1.33	2.15	3.49	4.31	2.35	2.36	978
	0.96	0.76	0.83	1.08	0.58	0.57	183
Repo	0.04	0.04	0.06	0.14	0.08	0.09	24
	0.02	0.03	0.04	0.09	0.05	0.05	10
N	2,800	650	657	986	482	561	
	490	185	129	220	119	129	

Another potential source of liquidity for holders of CP is the repurchase agreement market. However, returning to Table I, we see that there is very little daily activity in the CP-repo market, whether measured in dollar terms or in terms of the number of trades. Nevertheless, over the course of our sample period we observe several thousand repo transactions, and the discounts (the so-called "haircuts") applied to the CP used to collateralize these agreements provide some additional information on how easily CP investors can convert their holdings to cash. In order to estimate the size of CP-repo haircuts, we employ an exact-match methodology. For each date and maturity range, we first compute the par value weighted average settlement price for each issuer's repo and nonrepo CP, denoted by P^r and P, respectively. Next we match the average repo and nonrepo prices by date, maturity, and issuer. The haircut at time t on commercial paper maturing at $t + m$ and originally issued by issuer i is computed as

$$H_{t,t+m,i} = 100\left(1 - \frac{P^r_{t,t+m,i}}{P_{t,t+m,i}}\right).$$

The sizes of these haircuts reflect all of the risks to which a CP holder is exposed, including credit, liquidity, and interest rate risks. Table II displays summary statistics for the haircuts, sorted by the issuer's average long-term credit rating and the maturity of the CP. With the exception of the CP-repo for AAA-rated firms, for which the sample sizes are quite small, the median haircut is roughly 100 basis points at all credit ratings and maturities. The distributions are clearly skewed toward higher haircuts, but it is apparent that for the bulk of CP a haircut of 100 basis points is applied. To put these results in perspective, the standard discount applied to the Treasury collateral in general collateral repurchase agreements is about an order of magnitude smaller (Stigum (1990)). These results indicate that it is relatively costly to liquify a CP position in the repo market.

It is clear from the foregoing discussion that the secondary and repo markets for CP are thinly traded. However, the bulk of activity on the primary market is in paper that matures in just a few days, which we argue is inherently liquid. Just how important is liquidity as a determinant of CP yield spreads? If the firm is the principal liquidity provider to CP holders, then what role, if any, does credit risk play in determining CP yield spreads? To begin to answer these questions, we compute yield spreads on CP as the annualized continuously compounded money market yield on CP less the yield on comparable-maturity general collateral (GC) repurchase agreements. Because GC repos are collateralized with Treasury securities, they are free of credit risk. Moreover, GC repo contracts are very actively traded in the maturity range we consider.[9]

As can be seen from Figure 1, yield spreads are sizable for commercial paper, even for CP issued by AAA- or AA-rated firms. The figure plots the par value weighted average yield spread by maturity for CP issued by firms with the indicated long-term credit rating. The data consist of 47,319 CP issues by firms with a AAA rating, 398,208 issues with a AA rating, 923,073 issues with an A rating, and 597,074 issues with a BBB rating. The figure shows that the average yield spread for the shortest maturity CP (1 to 4 days) ranges from 10 basis points for AAA issuers to 34 basis points for BBB issuers. The average yield spread for each rating class increases almost monotonically with maturity. At the longest maturity ($>$74 days), the yield spread is approximately 22 basis points for AAA issuers and 72 basis points for BBB issuers.

[9] Longstaff (2000) argues that GC repurchase rates are superior to Treasury bill yields as a proxy for short-term risk-free rates. The repurchase rate data are from Garban, Inc. The effective rate on federal funds is another important benchmark for the pricing of CP. However, the federal funds rate embeds credit risk and is thus not an appropriate benchmark for our analysis of CP risk spreads.

Table II

Discounts on Commercial Paper Pledged in Repurchase Agreements

The table displays the average discount ("haircut") applied to commercial paper pledged as collateral in repurchase agreements of different maturities. Also displayed are the standard deviations and number of observations in each maturity range. The haircut at time t on commercial paper maturing at $t+m$ and originally issued by issuer i is computed as

$$H_{t,t+m,i} = 100\left(1 - \frac{P^r_{t,t+m,i}}{P_{t,t+m,i}}\right),$$

where P^r is the market price for commercial paper pledged in a repo agreement, and P is the primary market price for paper with the same maturity date issued by the same firm but not pledged in a repo contract. The line labeled "N" shows the number of observations in the indicated maturity range. The sample period is January 1, 1998 to October 31, 2003. The discounts are expressed in basis points.

	Days to Maturity					
	1–4	5–10	11–24	25–44	45–74	75+
Panel A: AAA-Rated Firms						
25th Pctl.	102.8	99.2	99.3	96.5	96.7	1.7
Median	256.7	99.4	101.7	100.2	99.7	10.8
75th Pctl.	378.7	224.1	208.7	197.7	101.6	97.7
Mean	246.1	121.2	178.1	131.8	123.3	36.7
SD	138.2	79.2	151.4	74.2	96.0	53
N	3	7	11	15	8	3
Panel B: AA-Rated Firms						
25th Pctl.	99.3	99.1	99.3	99.2	99.1	99.1
Median	100.0	100.2	100.1	100.1	100.1	99.9
75th Pctl.	195.9	196.3	196.2	197.1	197.1	198.2
Mean	137.7	141.8	144.5	147.4	142.7	144.9
SD	69.8	81.2	98	66.2	77.5	74.5
N	39	42	56	133	85	45
Panel C: A-Rated Firms						
25th Pctl.	99.2	99.2	99.3	99.2	99.3	99.1
Median	99.4	99.8	99.8	99.9	103.9	99.8
75th Pctl.	99.8	104.9	120.9	195	196.6	197.6
Mean	110.8	131.9	141.0	146.2	147.5	154.4
SD	58.4	95.3	110.6	147.1	98.0	121.4
N	496	243	403	366	142	66
Panel D: BBB-Rated Firms						
25th Pctl.	99.2	99.2	99.2	99.1	99.1	98.7
Median	99.4	99.5	99.5	99.4	99.6	99.4
75th Pctl.	99.9	100.5	99.9	100.1	218.0	99.9
Mean	109.9	111.0	111.6	114.3	173.3	104.3
SD	53.4	62.1	65.2	71.4	145.2	75.2
N	760	212	320	438	71	21

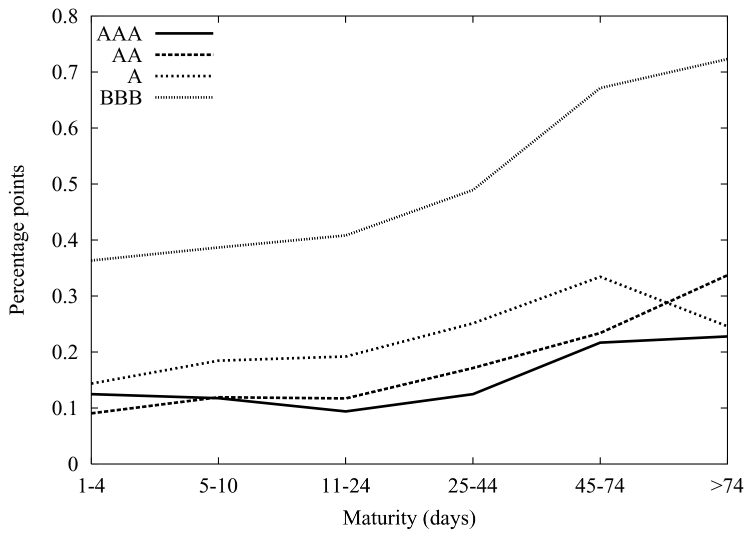

Figure 1. Yield spreads for commercial paper of different maturities and credit ratings. The figure plots the par value weighted average yield spread for commercial paper of different maturities issued by firms with the indicated long-term bond rating. The data are the offer side of all transactions in commercial paper issued by domestic U.S. nonfinancial firms from January 1, 1998 to October 31, 2003. Yield spreads are calculated as the annualized continuously compounded money market yield less the yield on comparable maturity general collateral repurchase agreements.

As Figure 1 illustrates, the rise in yield spreads along the credit quality dimension hints at an important role for credit risk. In the next section, we employ a regression modeling approach in order to better identify the contributions of credit risk and liquidity to commercial paper yield spreads.

II. Regression Analysis

A. Methodology

Our basic unit of analysis is the CP transaction; on each day we may observe multiple transactions in a given firm's CP at a given maturity. Yield spreads on the individual transactions are calculated as in the previous section. We omit repo transactions because, as we discuss above, their prices reflect sizable discounts. We also discard transactions of paper with over 35 days to maturity in order to focus our analysis on the portion of the yield curve over which the credit puzzle is at its most extreme.

To assess the roles of liquidity and credit risk in the pricing of commercial paper, we estimate panel regressions of CP yield spreads on proxies for liquidity and credit risk. Our basic specification is given by

$$(\textit{log-CP spread})_{ijt} = \beta_0 + \beta_1(\textit{log-Credit Risk})_{ijt} + \beta_2(\textit{log-Liquidity})_{ijt} + \epsilon_{ijt} \qquad (1)$$

for business days t from January 1, 1998 to October 31, 2003, firms $i = 1, 2, \ldots, N$, and CP issues $j = 1, 2, \ldots, J$. The term *log-Credit Risk* is a placeholder for what will be a set of proxies for the default risk of the firm. Similarly, the term *log-Liquidity* is a placeholder for a set of proxies for the liquidity of a firm's CP. We take logs of all of the variables to limit the impact of outliers.[10] The standard errors are clustered at the firm level since repeated observations on a given firm's CP are not necessarily independent.[11]

As a check on the robustness of our results, we also estimate (1) using daily cross-sectional regressions following Fama and MacBeth (1973). Under this approach, the results are robust to cross-sectional correlation in our panel of data. However, as Fama and French (2002) note, the time-series standard errors of the coefficient estimates can be biased downward by autocorrelation in the coefficient estimates. Fama and French (2002) show that the true standard error is the time-series standard error multiplied by $\sqrt{(1+\rho)/(1-\rho)}$, where ρ is the autocorrelation of the given regression coefficient. To be conservative, we multiply each raw time-series standard error by 10. This multiplicative factor implies $\rho \approx 0.9$, which is greater than the estimated autocorrelations of our regression coefficients. Our multiplicative factor of 10 is more than double that used by Fama and French (2002).

B. Liquidity and Credit Risk Proxies

Our first two proxies for liquidity are calculated daily at each maturity for which we observe one or more trades in a given firm's CP. The first two proxies are the log of the number of trades, *Trade Volume*, and the log of the total face value issued, *Dollar Volume*. These variables have been widely used in studies of equity market liquidity (for example, Brennan and Subrahmanyam (1995) and Chordia, Roll, and Subrahmanyam (2000)), and have been related to the ease with which market makers (in this case, the CP dealers) expect to turn around their inventories (Stoll (1978)). To the extent that higher *Trade Volume* or higher *Dollar Volume* indicates greater liquidity in an issuer's CP instruments, we expect these variables to be negatively related to yield spreads.

The third liquidity proxy, *Maturity*, is defined as the log of the days to maturity of the commercial paper in each CP transaction. As we argue at the outset, very short-maturity securities are de facto liquid in the sense that they are liquidated at maturity with zero price impact, and we observe the bulk of market activity in 1 to 4 day CP.[12] Moreover, as Longstaff, Mithal, and Neis (2005)

[10] None of our basic conclusions change if we estimate the regressions in levels, though the precision of some of the coefficient estimates declines.

[11] It is reasonable to question whether multiple observations on a given firm's CP at a particular maturity contribute any additional information over that contained in a single observation. We estimate all of our regressions using only the daily average yields at each maturity for each firm; the precision of our estimates declines but none of our conclusions change.

[12] In stark contrast, it is standard practice in studies of corporate bond price quotes to drop bonds of under 1 year remaining to maturity on the grounds that transactions in these bonds are so infrequent that the price quotes are unreliable (see Warga (1991)).

suggest, there might be maturity clienteles for corporate bonds; the clustering of CP transaction activity in the overnight and 30-day maturities that we document in the previous section suggests a similar phenomenon might be at work in the commercial paper market. On the other hand, shorter-maturity securities might also embody less credit risk, rendering the interpretation of this variable as a credit or liquidity proxy somewhat ambiguous. By treating the variable as a liquidity proxy, we are being conservative from the perspective of finding a role for credit risk. In any case, below we study the interaction of *Maturity* with all of our liquidity and credit proxies.

We consider three credit risk variables. The first is the log of the 1-year expected default frequency, *EDF*, constructed by Moody's KMV corporation for all publicly traded firms. The *EDF* is based on the Merton (1974) model and is estimated on firm-level equity price and balance sheet data. The second credit risk proxy is the log of the firm's average long-term credit rating, *Credit Rating*, coded as AAA = 1, AA+ = 2, and so forth.[13]

The variables *EDF* and *Credit Rating*, while widely used for research on corporate bonds, are constructed by third parties using methodologies that are not publicly available. As a transparent and simple alternative to these two measures of credit risk, we also employ the log of the issuer's equity return volatility over the previous 60 business days, *Equity Volatility*, computed using CRSP equity returns.[14] After our data filters and merges with the Moody's KMV, credit rating, and CRSP databases, we are left with 1,009,580 observations across 254 firms.

Table III presents summary statistics for the dependent and independent variables. For ease of interpretation, the variables are not expressed in logs in this section. The average of *Spread* is 0.202%, with a standard deviation of 0.226%. As can be seen from the quantiles, the distribution of spreads is skewed to the right, reflecting some very large spreads in the right tail of the distribution. The variable *Trade Volume* averages about 13 trades per day per issuer, with a long right tail resulting from a few issuers rolling over large amounts of overnight CP, and *Daily Dollar Volume* averages $196.591 million, again with a long right tail. The average maturity is about 9 days (and the median is even lower at 3 days), reflecting the high proportion of trades in overnight CP.

As we note earlier, firms that issue CP tend to be large, well-capitalized firms, and this is apparent in the relatively high credit ratings of the firms in our sample. The mean credit rating is about seven (between A and A−), well into the investment-grade portion of the credit quality scale, with a standard deviation of about two rating notches. There are a few firms at the very low end of the

[13] None of our results change in a material way if the credit ratings are coded using dummy variables. This likely owes to the preponderance of investment-grade firms in the data set. We opt for the numeric coding of ratings to keep the presentation of the results as compact as possible.

[14] We experiment with lag-lengths of 30 and 90 days as well. At a lag-length of 30 days, the estimated coefficients on equity volatility lose precision in certain specifications, but our basic conclusions are unchanged. There are no material differences in the results with a lag-length of 90 days.

Table III

Univariate Statistics for Regression Variables

The table displays pooled summary statistics for the variables that we use in our regression analysis. For purposes of these calculations, the variables are not expressed in logs. The variable "Spread" is the difference between the CP rate and the rate on comparable maturity general collateral repurchase contracts; "Trade Volume" measures the number of trades at the maturity of the Spread observation; "Dollar Volume" is the total face amount on these trades in millions of dollars; "Maturity" is the days to maturity of the paper; "EDF" is the Moody's-KMV expected default frequency, "Credit Rating" is the firm's long-term bond rating, coded so that AAA = 1; and "Equity Volatility" is the volatility of the firm's equity returns realized over the previous 60 days. The sample period is January 1, 1998 to October 31, 2003; the sample includes 1,009,580 transaction observations.

			Quantiles				
Variable	Mean	*SD*	Min	25	50	75	Max
Spread	0.202	0.226	0.0003	0.060	0.130	0.261	6.795
Trade volume	13.142	17.413	1	3	7	16	212
Dollar volume	196.591	335.120	0.01	20	67	207	3,578
Maturity	8.549	10.222	1	1	3	14	35
EDF	0.343	0.631	0.02	0.06	0.17	0.39	20
Credit rating	7.124	2.192	1	6	7	9	15
Equity volatility	0.023	0.009	0.0052	0.017	0.022	0.028	0.122

credit quality scale. The weakest rating is coded as 15 (B+), and the maximum EDF is 20 (the maximum reported by Moody's KMV). However, these few observations have a negligible impact on our regression results because these firms tend to issue CP very infrequently, and the log–log regression specification further ameliorates the influence of extreme observations. Finally, *Equity Volatility* averages a little over 2% per month, with a standard deviation of about 1%.

Table IV displays the pairwise correlation coefficients for the unlogged variables. As expected, *Dollar Volume* and *Trade Volume* are highly correlated, with a correlation coefficient of about 0.87. These liquidity measures are both negatively correlated with *Maturity*, consistent with the small shares of transaction activity observed at longer maturities. The credit risk variables are positively correlated with one another: *EDF* is relatively highly correlated with the other two credit risk measures, while *Equity Volatility* and *Credit Rating* exhibit a weaker pairwise correlation. Notably, *Equity Volatility* is only weakly positively correlated with *Trade Volume* and *Dollar Volume*, and is weakly negatively correlated with *Maturity*.[15] The variable *EDF* exhibits weak negative correlations

[15] The literature on the volume-volatility relation posits a positive link between transaction volumes and return volatility (for example, Kim and Verrecchia (1991) and Kyle (1985)), a prediction that has been verified empirically in the equity market (see Karpoff (1987) for a review of early empirical work; more recent work includes Jones, Kaul, and Lipson (1994) and Daigler and Wiley (1999)). The fact that we find no correlation between a firm's recent equity volatility and its current CP transaction activity suggests that the transaction volumes of a firm's equity and CP are unrelated, though further work to examine this issue is outside the scope of this article.

Table IV

Pairwise Correlations between Independent Variables

This table displays the pairwise correlation coefficients for the variables used in our regression analysis. For purposes of these calculations, the variables are not expressed in logs. The variable "Trade Volume" measures the number of trades at the maturity of the paper transacting in the observation; "Dollar Volume" is the total face amount on these trades in millions of dollars; "Maturity" is the days to maturity of the paper; "EDF" is the Moody's-KMV expected default frequency, "Credit Rating" is the firm's long-term bond rating, coded so that "AAA" = 1; and "Equity Volatility" is the volatility of the firm's equity returns realized over the previous 60 days. The sample period is January 1, 1998 to October 31, 2003; the sample includes 1,009,580 transaction observations.

	Trade Volume	Dollar Volume	Maturity	EDF	Credit Rating
Dollar volume	0.8743				
Maturity	−0.3115	−0.3151			
EDF	−0.0949	−0.0626	−0.0067		
Credit rating	−0.1948	−0.1967	−0.0734	0.2856	
Equity volatility	0.0750	0.0821	−0.0204	0.3640	0.1300

with our liquidity proxies, while the *Credit Rating* variable is negatively correlated with the liquidity proxies.

C. Regression Results

The regression results for the entire sample are summarized in Table V. The table displays the results for nine specifications that rotate through the liquidity and credit proxies in order to reveal the incremental importance of each variable. The first four models include all three credit risk proxies; Model 1 omits all of the liquidity proxies, and Models 2 to 4 enter each of the liquidity proxies in turn. Model 5 omits all of the credit risk proxies, and Models 6 to 8 rotate through each of the three credit risk proxies in turn. Model 9 includes all of the variables.

As can be seen from Table V, the coefficients on *Trade Volume* have the expected signs and are significant at the 95% level in all of the specifications. The coefficient on *Dollar Volume* has the expected negative sign and is significantly different from zero when it is the only liquidity proxy in the specification (Model 3), but the sign reverses in the specifications that also include *Trade Volume*. Thus, controlling for the number of trades, higher yields must be offered in order to move larger blocks of commercial paper, perhaps indicating a downward-sloping demand curve for CP. The coefficient on *Maturity* has the expected sign and is statistically significant in four of the six specifications in which it appears.

The liquidity variables explain only a small share of the total variation in CP yield spreads. The adjusted-R^2 is only 3.4% for the regression that includes the three liquidity proxies but no credit risk proxies (Model 5). Nevertheless, as the last column shows, the Wald statistic of 42 indicates a clear rejection of the null hypothesis that the liquidity proxies are jointly equal to zero.

Table V

The Determinants of Commercial Paper Yield Spreads

The table displays regression results for the full sample of 1,009,580 commercial paper transactions from January 1, 1998 to October 31, 2003. The dependent variable is the log of the difference between the yield on the commercial paper and the yield on a comparable-maturity general collateral repurchase agreement. The independent variables, all expressed in logs, are: "Trade Volume," the number of trades at the maturity of the spread observation; "Dollar Volume," the total face amount on these trades in millions of dollars; "Maturity," the days-to-maturity of the paper; "EDF," the Moody's-KMV expected default frequency; "Credit Rating," the firm's long-term bond rating, coded so that AAA = 1 and so forth; and "Equity Volatility," the volatility of the firm's equity returns realized over the previous 60 days. The line labeled "*F*" shows the *F*-statistic for the joint hypothesis that all of the slope coefficients are equal to zero. The line labeled "Wald" shows the Wald test statistic for the joint hypothesis that the coefficients on the indicated set of variables are all equal to zero. Robust standard errors, clustered at the firm level, are shown in parentheses below each coefficient estimate. There are 254 firms in the sample. Coefficients marked with an asterisk are significant to at least the 95% level.

	Model								
	1	2	3	4	5	6	7	8	9
	1	2	3	4	5	6	7	8	9
Constant	−2.774*	−2.156*	−2.273*	−3.004*	−2.030*	−1.656*	−4.832*	0.595	−2.732*
	(0.483)	(0.497)	(0.491)	(0.483)	(0.101)	(0.106)	(0.357)	(0.471)	(0.499)
Trade volume		−0.145*			−0.289*	−0.209*	−0.161*	−0.296*	−0.160*
		(0.020)			(0.026)	(0.024)	(0.030)	(0.025)	(0.028)
Dollar volume			−0.071*		0.080*	0.058*	0.076*	0.071*	0.065*
			(0.017)		(0.021)	(0.019)	(0.018)	(0.021)	(0.017)
Maturity				0.140*	0.028	0.057*	0.118*	0.024	0.113*
				(0.021)	(0.025)	(0.021)	(0.020)	(0.023)	(0.019)
EDF	0.081*	0.064	0.075*	0.079*		0.256*			0.066
	(0.036)	(0.038)	(0.038)	(0.037)		(0.034)			(0.038)
Credit rating	1.144*	1.081*	1.110*	1.190*			1.292*		1.143*
	(0.173)	(0.170)	(0.176)	(0.182)			(0.179)		(0.174)
Equity volatility	0.380*	0.447*	0.421*	0.394*				0.669*	0.428*
	(0.115)	(0.120)	(0.119)	(0.114)				(0.120)	(0.118)
Adj.-R^2	0.148	0.163	0.156	0.165	0.034	0.086	0.152	0.065	0.171
F	26.524	34.157	22.840	27.260	46.711	67.270	60.215	38.884	45.742
Wald test: Trade volume = Dollar volume = Maturity = 0									42
Wald test: EDF = Credit rating = Equity volatility = 0									28

As Table V suggests, credit risk appears to be the most important determinant of commercial paper spreads. The coefficients on the credit risk proxies have the expected signs and are significantly different from zero in nearly all of the specifications, with the notable exception of the coefficients on *EDF* in Models 2 and 9. In addition, the adjusted-R^2 is 14.8% for the specification that includes all three credit risk proxies but no liquidity proxies (Model 1). As with the liquidity proxies, the null hypothesis that the credit proxies are jointly equal to zero is clearly rejected with a Wald statistic of 28.

The credit risk and liquidity proxies appear to be picking up different information. In the specification that includes all of the liquidity and credit risk proxies (Model 9), with the exception of *EDF*, all of the estimated coefficients are significantly different from zero at better than the 95% confidence level. While it retains the expected sign, the coefficient on *EDF* is borderline insignificant with a t-statistic of 1.73; it appears that the *EDF* provides little explanatory power for CP spreads over that provided by *Credit Rating* and *Equity Volatility*. The adjusted-R^2 of the specification with all of the credit risk and liquidity proxies is 17.1%. For this and all of the other specifications, the standard F-test of the hypothesis that the slope coefficients are jointly zero is overwhelmingly rejected.[16]

D. Maturity Interactions

As we note earlier, *Maturity* might be viewed as either a liquidity or a credit risk proxy. In the discussion of the results above, we group *Maturity* with the liquidity proxies in order to be conservative from the perspective of finding a role for credit risk in CP spreads. In Table VI, we explore the role of *Maturity* in more detail by interacting each liquidity and credit risk proxy with the maturity variable. In Table VI, Model 1 includes the liquidity proxies, Model 2 includes the credit proxies, and Model 3 includes both sets of proxies.

As can be seen, the interaction terms add little to the quality of the fit (Model 3): The adjusted-R^2 rises by just 0.04% with the addition of the interaction terms; this likely reflects the fact that the bulk of the observations are in the 1 to 4 day maturity range. Moreover, by comparing the models we

[16] It is worth noting that we also estimate specifications including an indicator variable for the issuer's regulatory "credit tier" designation. Rule 2a-7 of the Investment Company Act of 1940 limits the credit risk that money market mutual funds may bear by restricting their investments to "eligible" securities. An eligible security must carry one of the two highest ratings ("1" or "2") for short-term obligations from at least two of the nationally recognized statistical ratings agencies. A Tier-1 security is an eligible security rated "1" by at least two of the rating agencies; a Tier-2 security is an eligible security that is not a Tier-1 security. Money funds may hold no more than 5% of their assets in the Tier-1 securities of any individual issuer and no more than 1% of their assets in the Tier-2 securities of any individual issuer; moreover, a money fund's holdings of Tier-2 securities may constitute no more than 5% of the fund's total assets. According to the Federal Reserve's Flow of Funds accounts, money funds hold approximately 40% of the CP issued in the United States. The indicator variable for credit tier is statistically insignificant in all specifications, indicating that the credit tier designation has no marginal explanatory power over and above the liquidity and credit risk variables shown in Table V.

Table VI

Maturity Interactions

The table displays regression results for specifications that include interactions of "Maturity," the log of the days to maturity of the CP, with each of the liquidity and credit proxies. The dependent variable is the log of the difference between the yield on the commercial paper and the yield on a comparable-maturity general collateral repurchase agreement. The other independent variables, all expressed in logs, are: "Trade Volume," the number of trades at the maturity of the spread observation; "Dollar Volume," the total face amount on these trades in millions of dollars; "EDF," the Moody's-KMV expected default frequency; "Credit Rating," the firm's long-term bond rating, coded so that AAA = 1 and so forth; and "Equity Volatility," the volatility of the firm's equity returns realized over the previous 60 days. The line labeled "F" shows the F-statistic for the joint hypothesis that all of the slope coefficients are equal to zero. The time period is January 1, 1998 to October 31, 2003. The sample size is 1,009,580 CP transactions in paper issued by 254 firms. Robust standard errors, clustered at the firm level, are shown in parentheses below each coefficient estimate.

	Model		
	1	2	3
Constant	−2.261*	−2.839*	−2.707*
	(0.165)	(0.479)	(0.682)
Trade Volume	−0.390*		−0.265*
	(0.051)		(0.050)
Trade Volume × Maturity	0.048*		0.056*
	(0.019)		(0.017)
Dollar Volume	0.182*		0.147*
	(0.051)		(0.037)
Dollar Volume × Maturity	−0.054*		−0.042*
	(0.018)		(0.012)
Maturity	0.058		−0.077
	(0.087)		(0.202)
Maturity × Maturity	0.032*		0.039*
	(0.015)		(0.010)
EDF		0.049	0.028
		(0.043)	(0.043)
EDF × Maturity		0.024	0.029*
		(0.014)	(0.014)
Credit Rating		1.316*	1.261*
		(0.243)	(0.235)
Credit Rating × Maturity		−0.089	−0.083
		(0.059)	(0.062)
Equity Volatility		0.514*	0.545*
		(0.138)	(0.159)
Equity Volatility × Maturity		−0.091*	−0.092*
		(0.036)	(0.045)
Adj.-R^2	0.038	0.167	0.175
F	39.599	21.807	29.749

see that our basic conclusion concerning the relative importance of the credit and liquidity proxies is unchanged. The credit proxies and their interactions (Model 2) explain 16.7% of the variation in yield spreads while the liquidity proxies and their interactions (Model 1) explain just 3.8% of the variation in spreads.

Nevertheless, an examination of the individual coefficient estimates sheds some additional light on how yield spreads are related to credit risk and liquidity. The coefficient on *Trade Volume* is negative and statistically significant and the coefficient on its interaction with *Maturity* is positive and significant in both of the specifications in which they appear (Models 1 and 3). From the full model (Model 3), the marginal effect of *Trade Volume* on *Spread* is given by

$$\frac{\partial(\mathit{Spread})}{\partial(\mathit{Trade\ Volume})} = -0.265 + 0.056 \times \mathit{Maturity}. \tag{2}$$

Equation (2) shows that, ceteris paribus, higher daily *Trade Volume* depresses spreads, but at longer maturities the marginal effect reverses and higher daily *Trade Volume* boosts spreads. For example, bearing in mind that all of the variables are in logs, at the 35-day maturity the marginal effect is 0.464, compared to −0.265 at the overnight maturity.

Also from Model 3, the marginal effect of *Dollar Volume* on *Spread* is given by

$$\frac{\partial(\mathit{Spread})}{\partial(\mathit{Dollar\ Volume})} = 0.147 - 0.042 \times \mathit{Maturity}. \tag{3}$$

Equation (3) shows that *Dollar Volume* has its biggest marginal effect in the overnight maturity. Indeed, by the 35-day point the marginal effect of *Dollar Volume* is nearly zero.

Based on equations (2) and (3), we conclude that the positive relation between spread and average trade size is driven principally by the transactions at the shortest maturities. At longer maturities, spreads decline with average trade size, suggesting that a downward-sloping demand curve alone is not sufficient to explain the relation between average trade sizes and CP yield spreads. As we note earlier, Longstaff, Mithal, and Neis (2005) suggest that clienteles may exist for corporate bonds; the results here are consistent with the existence of maturity clienteles, with the different clienteles exhibiting different elasticities of demand for CP.

Turning to the other coefficient estimates, we note that the coefficient on the squared *Maturity* term is positive and statistically significant, indicating a quadratic component to the effect of an increase in *Maturity* on spreads. The interaction of *Maturity* with *Credit Rating* is statistically insignificant, but the interaction of *Maturity* with *EDF* is positive and statistically significant in Model 3. Interestingly, this interaction term, in conjunction with the other interactions, appears to knock out the level of the *EDF*. This could reflect the fact that the *EDF* is designed to measure the expected default frequency over a 1-year horizon. Thus, it seems natural to expect that the *EDF* would have greater explanatory power for yield spreads as the maturity horizon lengthens, as indicated by the significance of the interaction term coefficient.

The coefficient on *Equity Volatility* is positive and highly statistically significant in Models 2 and 3, and the coefficient on its interaction with *Maturity* is negative and significant. Model 3 gives the marginal effect of *Equity Volatility* on *Spread* as

$$\frac{\partial(\mathit{Spread})}{\partial(\mathit{Equity\ Volatility})} = 0.545 - 0.092 \times \mathit{Maturity}. \tag{4}$$

The marginal effect of *Equity Volatility* falls with *Maturity*, perhaps owing to the greater importance of the *EDF* at longer maturities.

E. Yields Spreads at Year-End

Commercial paper yield spreads around year-end often differ substantially from those observed over the rest of the year. Figure 2 illustrates this point for paper of approximately 30 days to maturity; the other maturities exhibit qualitatively similar year-end dynamics and hence are omitted for the sake of brevity. Panel A of Figure 2 shows the par value weighted average yield spread for 25- to 35-day CP issued by firms with AA long-term ratings.[17] Panel B displays the similarly constructed series for CP issued by BBB-rated firms.[18]

As Figure 2 illustrates, yield spreads tend to jump as year-end approaches, with the largest increases for BBB-rated issuers. The yield spread then typically declines as year-end passes. The size of the spike varies substantially from year to year, with the largest year-end yield spreads occurring at the end of 1999, when investors were concerned that computer failures could cause major disruptions in financial markets.

To date, the literature offers at least three explanations for these year-end effects. First, some of the largest investors in commercial paper appear to engage in "window dressing" at year-end. According to the Federal Reserve's Flow of Funds accounts, approximately one-half of all commercial paper is held by mutual funds, insurance companies, and pension funds. Most of these entities report on their portfolio holdings at year-end, and Musto (1997, 1999) presents evidence that around year-end these investors tend to temporarily substitute higher quality investments for their usual holdings. Second, Griffiths and Winters (1997, 2005) argue that some firms and individuals have an increased demand for cash holdings in late December, which would reduce their desire to hold CP and other money market instruments that have limited liquidity. Third, Downing and Oliner (2006) suggest that commercial paper issuers may wish to lock-in term funding over year-end, a period when overnight interest rates tend to be relatively more volatile. The wider yield spreads at year-end could reflect a premium that issuers are willing to pay to insure against this heightened interest rate risk.

[17] AA-rated firms are used to represent the top of the credit quality scale because, as noted earlier, there are very few AAA-rated issuers. We include firms rated AA+, AA, and AA- in these calculations in order to boost the sample size; we include CP in the 25- to 35-day maturity range for the same reason.

[18] As with the AA-rated firms, we include BBB+, BBB, and BBB- firms in the BBB subsample in order to boost the sample size.

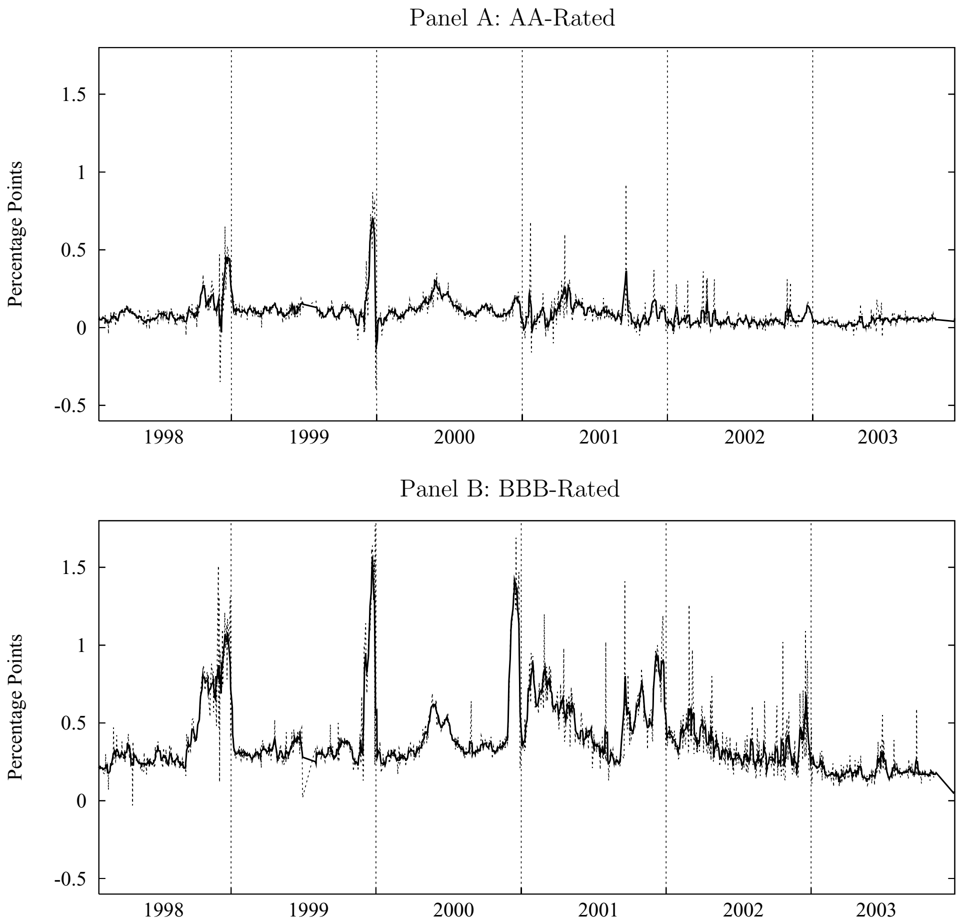

Figure 2. Yields spreads for 25- to 35-day commercial paper. The figure plots the par-value weighted average yield spread for 25- to 35-day commercial paper issued by firms with the indicated long-term bond rating. The data are the offer side of all transactions in commercial paper issued by domestic U.S. nonfinancial firms from January 1, 1998 to October 31, 2003. Yield spreads are calculated as the annualized continuously compounded money market yield less the yield on comparable maturity general collateral repurchase agreements. The solid line displays the 5-day moving average of the raw yield spreads shown by the dotted line. Firms with AA+, AA, and AA- long-term ratings are included in the set of AA firms for Panel A; firms with BBB+, BBB, and BBB- long-term ratings are included in the set of BBB firms for Panel B. The dashed vertical lines identify January 1 of each year.

Based on an aggregate analysis of the maturity structure of outstanding commercial paper, yield spreads, and CP term premia, Downing and Oliner (2006) present evidence supporting all three potential explanations for the year-end effects in the CP market. From the firm-level perspective of this paper, these potential explanations are interesting to the extent that they bear on the relations between a firm's CP yield spreads, its credit risk, and the liquidity of its CP instruments. The window dressing explanation is directly tied to credit quality. Investors that window dress temporarily replace their holdings of higher-risk commercial paper with safer securities. Assuming other investors do not step in to take the place of the investors engaged in window dressing, yield spreads on CP, particularly relatively risky CP, must rise in order to clear the market. The preference for cash explanation directly relates to liquidity: At year-end some investors move their funds to a preferred habitat in zero-maturity, perfectly liquid cash. Of the three explanations, only the third—that the rise in yield spreads reflects greater short-term interest rate volatility—is not directly related to CP credit quality or liquidity.

Figure 3 presents new evidence that, indeed, sizable shifts in CP market liquidity are observed at year-end. Panel A displays the log of the 5-day moving average of total dollar volume, and Panel B shows the log of the 5-day moving average of the total number of transactions on the market.[19] The data in the two panels exhibit a similar pattern: In late December there are sizable declines in both the total dollar amount transacted and in the number of transactions on the CP market, and these declines are reversed in early January. The biggest swings in market liquidity are observed at the end of 1999, owing to the concerns about computer failures noted above, and in 2001, following the 9/11 terrorist attacks.

Table VII displays the estimation results for specifications in which we interact all of the variables with a dummy variable, *YR*, that takes the value one when the maturity of the issue crosses year-end, and zero otherwise. In this specification, the coefficient on *YR* captures the shift in the intercept at year-end, and the interaction terms capture the changes in the marginal effects of the liquidity and credit risk proxies at year-end. As in Table VI, Model 1 includes the liquidity proxies, Model 2 includes the credit proxies, and Model 3 includes both sets of proxies.

As can be seen from Table VII, the coefficient on the year-end dummy variable, *YR*, is significant in Model 1, where only the liquidity proxies are included. However, in Models 2 and 3, where we include the credit proxies, the coefficient on *YR* loses its significance, indicating that the credit proxies can account for the average difference between CP yield spreads at year-end and the rest of the year. These results are consistent with the extant evidence in support of the window dressing explanation for year-end effects, where investors are unwilling to hold relatively low credit–quality instruments over year-end.

An examination of the interaction terms indicates that we cannot rule out the preference for cash explanation for year-end effects. Only the interactions of *Trade* and *Dollar Volume* with *YR* are statistically significant. Model 3 gives the marginal effect of *Trade Volume* on *Spread* as

$$\frac{\partial(\mathit{Spread})}{\partial(\mathit{Trade\ Volume})} = -0.168 + 0.209 \times \mathit{YR}. \tag{5}$$

[19] We apply the 5-day moving averages in order to smooth the series. We note that the year-end effects in the moving average series are less pronounced than in the underlying data.

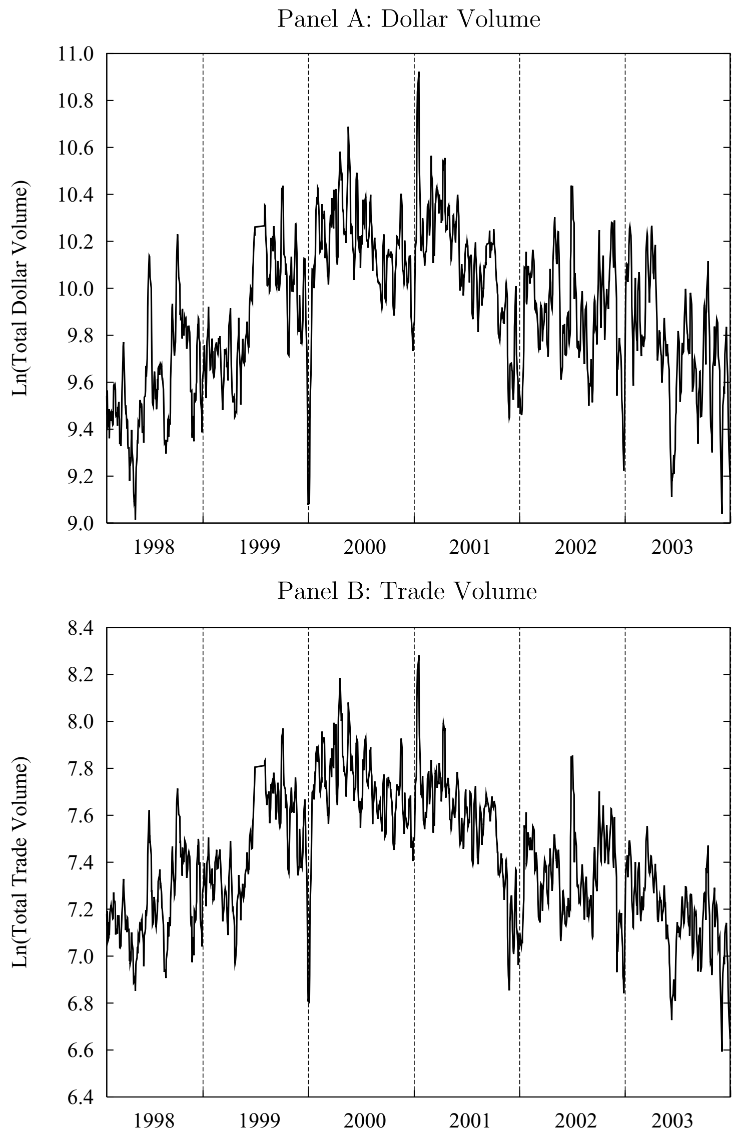

Figure 3. Market liquidity at year-end. Panel A of the figure shows the log of the 5-day moving average of the total dollar amount transacted each day. Panel B shows the log of the 5-day moving average of the total number of trades each day. The data are the offer side of all transactions in commercial paper issued by domestic U.S. nonfinancial firms from January 1, 1998 to October 31, 2003. The dashed vertical lines identify January 1 of each year.

Hence, the sign on the marginal effect reverses at year-end. Likewise, the sign on the marginal effect of *Dollar Volume* reverses at year-end

$$\frac{\partial(\mathit{Spread})}{\partial(\mathit{Dollar\ Volume})} = 0.070 - 0.117 \times \mathit{YR}. \tag{6}$$

Table VII

Year-End Interactions

The table displays regression results for specifications that include interactions of "YR," a dummy variable that takes the value one when the maturity of the issue crosses year-end, with each of the liquidity and credit proxies. The dependent variable is the log of the difference between the yield on the commercial paper and the yield on a comparable-maturity general collateral repurchase agreement. The other independent variables, all expressed in logs, are: "Trade Volume," the number of trades at the maturity of the spread observation; "Dollar Volume," the total face amount on these trades in millions of dollars; "Maturity," the days to maturity of the paper; "EDF," the Moody's-KMV expected default frequency; "Credit Rating," the firm's long-term bond rating, coded so that AAA = 1 and so forth; and "Equity Volatility," the volatility of the firm's equity returns realized over the previous 60 days. The line labeled "F" shows the F-statistic for the joint hypothesis that all of the slope coefficients are equal to zero. The time period is January 1, 1998 to October 31, 2003. The sample size is 1,009,580 CP transactions in paper issued by 254 firms. Robust standard errors, clustered at the firm level, are shown in parentheses below each coefficient estimate.

	Model		
	1	2	3
Constant	−2.033*	−2.832*	−2.756*
	(0.101)	(0.486)	(0.502)
YR	0.844*	0.947	0.494
	(0.217)	(0.71)	(0.74)
Trade Volume	−0.299*		−0.168*
	(0.025)		(0.028)
Trade Volume × YR	0.281*		0.209*
	(0.065)		(0.052)
Dollar Volume	0.087*		0.07*
	(0.021)		(0.017)
Dollar Volume × YR	−0.16*		−0.117*
	(0.031)		(0.022)
Maturity	0.013		0.099*
	(0.024)		(0.019)
Maturity × YR	0.108		0.067
	(0.064)		(0.051)
EDF		0.082*	0.067
		(0.036)	(0.037)
EDF × YR		−0.108*	−0.086
		(0.054)	(0.054)
Credit Rating		1.145*	1.138*
		(0.176)	(0.176)
Credit Rating × YR		0.193	0.183
		(0.18)	(0.188)
Equity Volatility		0.37*	0.419*
		(0.116)	(0.119)
Equity Volatility × YR		0.096	0.037
		(0.181)	(0.179)
Adj.-R^2	0.043	0.159	0.179
F	95.261	71.075	98.349

Based on these estimates, we conclude that controlling for credit quality, an issuer placing relatively large blocks of CP across year-end achieves a lower yield spread relative to a strategy of many smaller placements. Thus, it is possible that some firms may be able to issue to a familiar clientele and therefore

Table VIII

Repeated Cross-Sectional Regression Results

This table reports the results of daily cross-sectional regressions for the same nine specifications shown in Table V. The average of the daily coefficient estimates are displayed; the numbers in parentheses are Fama–MacBeth t-statistics, computed as the average coefficient estimate divided by the standard deviation of the coefficient estimates (Fama and MacBeth (1973)). We multiply the standard deviations by 10 to take into account any potential serial correlation in the estimates. The row labeled "Adj.-R^2" shows the average adjusted-R^2 across the daily regressions. The sample period is January 1, 1998 to October 31, 2003, producing a total of 1,441 daily cross-sectional regressions with an average sample size of 723 transactions. Coefficients marked with an asterisk are significant to at least the 95% level.

	Model								
Variable	1	2	3	4	5	6	7	8	9
Constant	−5.028*	−4.267*	−4.393*	−5.494*	−2.061*	−1.553*	−5.299*	−0.508	−5.079*
	(0.746)	(0.675)	(0.717)	(0.775)	(0.236)	(0.224)	(0.588)	(0.646)	(0.741)
Trade Volume		−0.221*			−0.411*	−0.325*	−0.252*	−0.405*	−0.231*
		(0.064)			(0.078)	(0.072)	(0.064)	(0.077)	(0.061)
Dollar Volume			−0.105*		0.101*	0.080*	0.090*	0.095*	0.081*
			(0.039)		(0.037)	(0.037)	(0.035)	(0.037)	(0.034)
Maturity				0.209*	0.034	0.084	0.147*	0.036	0.157*
				(0.081)	(0.072)	(0.075)	(0.077)	(0.072)	(0.078)
EDF	0.200*	0.190*	0.197*	0.210*		0.361*			0.199*
	(0.054)	(0.053)	(0.053)	(0.053)		(0.050)			(0.052)
Credit Rating	1.230*	1.141*	1.199*	1.325*			1.479*		1.248*
	(0.245)	(0.229)	(0.238)	(0.244)			(0.237)		(0.229)
Equity Volatility	−0.185	−0.122	−0.138	−0.178				0.402*	−0.142
	(0.139)	(0.133)	(0.135)	(0.132)				(0.162)	(0.132)
Adj.-R^2	0.271	0.333	0.321	0.374	0.166	0.288	0.360	0.187	0.400

issue large blocks at relatively low yield spreads compared to firms that issue in smaller blocks because their usual clienteles reduce their holdings of CP at year-end. The loss of a familiar clientele could arise if some investors look to hold cash at year-end. However, the coefficient on the interaction of *Maturity* with *YR* is not significant, which one might expect if some investors were looking to hold "cash-like" instruments at year-end.

Finally, the results show that our basic conclusion that credit risk is the more important determinant of CP spreads is robust to the inclusion of the year-end interaction terms. The specification that includes only the liquidity proxies and their interactions, Model 1, accounts for just 4.3% of the total variation in spreads. The specification that includes only the credit risk proxies, Model 2, accounts for 15.9% of the variation in spreads.

F. Repeated Cross-Sectional Regression Results

We conclude our study of CP yield spreads with an investigation of a standard robustness issue that arises in panel data. In this section, we test whether correlations across the firms in our panel might be influencing the results. Table VIII presents the results from a repeated cross-sectional regression analysis. The table, which presents results for the same nine models in Table V, shows average coefficient values (averaged across the 1,441 daily regressions), adjusted time-series standard errors of the average coefficient values, average numbers of observations, and average adjusted-R^2 values.

The results confirm that credit risk is the more important determinant of commercial paper spreads. The average coefficients on *EDF* and *Credit Rating* have the expected sign and are statistically significant in all of the specifications. The average coefficient on *Equity Volatility* has the expected sign and is statistically significant when it is the only credit proxy in the specification (Model 7), but its sign reverses and its statistical significance declines when it is included with the other two credit risk proxies. These results suggest that multicollinearity might be an issue when estimating this coefficient on the relatively small daily cross-sections (the average sample size for the daily regressions is 723 transactions compared to over one million in the pooled sample). The average adjusted-R^2 is 27.1% for the daily regressions that include all three credit risk proxies but no liquidity proxies (Model 1), compared to only 16.6% for the specification that includes the three liquidity proxies but no credit proxies (Model 5). Hence, our main result, that credit risk appears to be the most important component of very short-term risk spreads, is robust to the cross-sectional correlation in our sample.

III. Conclusion

In this paper, we employ a comprehensive data set of all transactions in commercial paper issued by U.S. firms from January 1, 1998 to October 31, 2003 to examine transaction activity on the CP market and conduct regressions of CP yield spreads on controls for credit risk and liquidity. We find that, on average, secondary market transactions account for a small share of total daily transaction volumes, whether measured in terms of the number of trades or the par amount traded. CP-repo transactions account for only a small share of daily activity, as well, and we find that the CP used to collateralize repurchase agreements is heavily discounted. However, it is also clear from the results that the majority of CP transactions are primary issues in the 1 to 4 day maturity range, instruments that are de facto liquid by virtue of their very short maturities.

Our regression results indicate that liquidity is an important determinant of commercial paper spreads. However, consistent with the observation that the bulk of CP is issued in the 1 to 4 day maturity range, we find that credit risk is the dominant determinant of CP spreads. This result is robust to alternative proxies for liquidity and credit risk, controls for maturity interactions, and the cross-sectional correlation in our data.

We also examine the relations among firm-level yield spreads, credit risk and instrument liquidity at year-end, when CP market liquidity drops. The results suggest that to the extent a firm can issue to a familiar clientele that is willing to hold its CP across year-end, it achieves lower risk spreads relative to a firm whose normal clienteles reduce their CP holdings at year-end, perhaps forcing the firm to issue in smaller blocks to unfamiliar buyers. These results are consistent with the extant evidence in support of the window dressing explanation for year-end effects in the CP market.

Taken together, the results suggest that most structural debt pricing models omit one or more important components of credit risk at the short end of the yield curve. Moreover, given that credit risk might be expected to be relatively more important for long-term bond spreads than for CP spreads, our findings suggest that structural models of long-term bond spreads, which have been shown to consistently underpredict spreads, may be omitting important components of credit risk as well. Finally, the results suggest that interpreting CP yield spreads as purely reflective of liquidity could be misleading.

A number of recent papers offer possible explanations for why models of long-term corporate bond prices that are based on characterizations of credit risk might fail to produce realistic yield spreads. For example, Duffie and Lando (2001) argue that asymmetric information between issuers and investors regarding credit risk boosts long-term yield spreads, and Giesecke (2003) suggests that uncertainty about model parameters might also play a role. Delianedis and Geske (2001) and Huang and Huang (2003) show that structural models incorporating jump components can produce larger yield spreads under certain parameterizations, though they require the assumption of large jump sizes or default risk premia. However, work by Liu, Longstaff, and Mandell (2002), Pan (2002), and Collin-Dufresne, Goldstein, and Helwege (2003) suggests that the price of jump risk could be large in certain markets. Based on the results in this paper, further work on the characterization of credit risk could prove fruitful in improving our understanding of the corporate term structure.

REFERENCES

Brennan, Michael J., and Avanidhar Subrahmanyam, 1995, Investment analysis and price formation in securities markets, *Journal of Financial Economics* 38, 361–381.

Chacko, George, 2005, Liquidity risk in the corporate bond markets, Working paper, Harvard Business School.

Chordia, Tarun, Richard W. Roll, and Avanidhar Subrahmanyam, 2000, Commonality in liquidity, *Journal of Financial Economics* 56, 3–28.

Chordia, Tarun, Asani Sarkar, and Avanidhar Subrahmanyam, 2003, An empirical analysis of stock and bond market liquidity, Working paper, Emory University, Federal Reserve Bank of New York, and UCLA.

Collin-Dufresne, Pierre, and Robert S. Goldstein, 2001, Do credit spreads reflect stationary leverage ratios? *Journal of Finance* 56, 1929–1957.

Collin-Dufresne, Pierre, and Jean Helwege, 2003, Is credit event risk priced? Modeling contagion via the updating of beliefs, Working paper, Carnegie Mellon University.

Collin-Dufresne, Pierre, Robert S. Goldstein, and J. Spencer Martin, 2001, The determinants of credit spread changes, *Journal of Finance* 56, 2177–2208.

Daigler, Robert, and Marilyn Wiley, 1999, The impact of trader type on the futures volatility-volume relation, *Journal of Finance* 54, 2297–2316.

De Jong, Frank, and Joost Driessen, 2004, Liquidity risk premia in corporate bond and equity markets, Working paper, University of Amsterdam.

Delianedis, G., and R. Geske, 2001, The components of corporate credit spreads: Default, recovery, tax, jumps, liquidity, and market factors, Working paper, UCLA.

Downing, Chris, and Stephen Oliner, 2007, The term structure of commercial paper rates, *Journal of Financial Economics* 83, 59–86.

Downing, Chris, Shane Underwood, and Yuhang Xing, 2005, Is liquidity risk priced in the corporate bond market? Working paper, Rice University.

Driessen, Joost, 2005, Is default event risk priced in corporate bonds? *Review of Financial Studies* 18, 165–195.

Duffie, Darrell, and David Lando, 2001, Term structures of credit spreads with incomplete accounting information, *Econometrica* 69, 633–664.

Duffie, Darrell, and Kenneth J. Singleton, 1999, Modeling term structures of defaultable bonds, *Review of Financial Studies* 12, 687–720.

Elton, E. J., M. J. Gruber, D. Agrawal, and C. Mann, 2001, Explaining the rate spread on corporate bonds, *Journal of Finance* 56, 247–277.

Eom, Young Ho, Jean Helwege, and Jingzhi Huang, 2004, Structural models of corporate bond pricing: An empirical analysis, *Review of Financial Studies* 17, 499–544.

Fama, Eugene F., and Kenneth R. French, 2002, Testing trade-off and pecking order predictions about dividends and debt, *Review of Financial Studies* 15, 1–33.

Fama, Eugene F., and James D. MacBeth, 1973, Risk, return, and equilibrium: Empirical tests, *Journal of Political Economy* 81, 607–636.

Giesecke, Kay, 2003, Default and information, Working paper, Cornell University.

Griffiths, Mark D., and Drew B. Winters, 1997, On a preferred habitat for liquidity at the turn-of-the-year: Evidence from the term repo market, *Journal of Financial Services Research* 12, 21–38.

Griffiths, Mark D., and Drew B. Winters, 2005, The turn of the year in money markets: Tests of the risk-shifting window dressing and preferred habitat hypotheses, *Journal of Business* 78, 1337–1364.

Helwege, Jean, and Chris Turner, 1999, The slope of the credit yield curve for speculative-grade issuers, *Journal of Finance* 54, 1869–1885.

Huang, J., and M. Huang, 2003, How much of the corporate treasury yield spread is due to credit risk? Working paper, Penn State University.

Jones, Charles M., Gautam Kaul, and Marc L. Lipson, 1994, Transactions, volume, and volatility, *Review of Financial Studies* 7, 631–651.

Jones, E. Philip, Scott P. Mason, and Eric Rosenfeld, 1984, Contingent claims analysis of corporate capital structures: An empirical investigation, *Journal of Finance* 39, 611–625.

Karpoff, Jonathan M., 1987, The relationship between price changes and trading volume: A survey, *Journal of Financial and Quantitative Analysis* 22, 109–126.

Kim, Oliver, and Robert E. Verrecchia, 1991, Market reaction to anticipated announcements, *Journal of Financial Economics* 30, 273–309.

Krishnamurthy, Arvind, 2002, The bond/old-bond spread, *Journal of Financial Economics* 66, 463–506.

Kyle, Albert, 1985, Continuous auctions and insider trading, *Econometrica* 53, 1315–1335.

Leland, Hayne E., and Klaus Bjerre Toft, 1996, Optimal capital structure, endogenous bankruptcy, and the term structure of credit spreads, *Journal of Finance* 3, 987–1019.

Liu, Jun, Francis A. Longstaff, and Ravit E. Mandell, 2002, The market price of credit risk: An empirical analysis of interest rate swap spreads, Working paper, UCLA.

Longstaff, Francis A., 2000, The term structure of very short-term rates: New evidence for the expectations hypothesis, *Journal of Financial Economics* 58, 397–415.

Longstaff, Francis A., Sanjay Mithal, and Eric Neis, 2005, Corporate yield spreads: Default risk or liquidity? New evidence from the credit default swap market, *Journal of Finance* 60, 2213–2253.

Lyden, S., and D. Saraniti, 2000, An empirical examination of the classical theory of corporate security valuation, Barclays Global Investors.

Merton, Robert C., 1974, On the pricing of corporate debt: The risk structure of interest rates, *Journal of Finance* 29, 449–470.

Musto, David K., 1997, Portfolio disclosures and year-end price shifts, *Journal of Finance* 52, 1563–1588.

Musto, David K., 1999, Investment decisions depend on portfolio disclosures, *Journal of Finance* 54, 935–952.

Ogden, Joseph P., 1987, Determinants of the ratings changes and yields on corporate bonds: Tests of the contingent claims model, *Journal of Financial Research* 10, 329–339.

Pan, Jun, 2002, The jump-risk premia implicit in options: Evidence from an integrated time-series study, *Journal of Financial Economics* 63, 3–50.

Sarig, Oded, and Arthur Warga, 1989, Some empirical estimates of the risk structure of interest rates, *Journal of Finance* 44, 1351–1360.

Stigum, Marcia L., 1986, *After the Trade: Dealer and Clearing-Bank Operations in Government and Money Market Securities* (The McGraw-Hill Companies New York).

Stigum, Marcia L., 1990, *The Money Market* (Dow Jones-Irwin New York).

Stoll, Hans R., 1978, The supply of dealer services in securities markets, *Journal of Finance* 33, 1133–1151.

Warga, Arthur, 1991, Corporate bond price discrepancies in the dealer and exchange markets, *Journal of Fixed Income* 1, 7–16.