Idiosyncratic Volatility vs. Liquidity?
Evidence from the U.S. Corporate Bond Market

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Abstract

In this paper, we explore the relative contribution of equity volatility and bond liquidity in determining corporate bond spreads. Portfolio analysis and Fama-Macbeth regressions reveal that while both volatility and liquidity effects are significant, volatility has the primary impact, and liquidity (represented by bond characteristics and price impact measure) has the secondary impact on bond spreads. Conditional analysis, however, reveals that while distressed bonds and distress regimes are associated with overall higher impact of credit and liquidity shocks, the relative impact of these shocks do vary. Volatility effects are more prominent for distressed bonds and during distressed regimes; liquidity effects are stronger for less distressed bonds and during low distress regimes. Our findings indicate that, unlike equity markets, idiosyncratic risk does not subsume the information in liquidity in explaining corporate bond spreads. Our results also imply a regime-switching behavior of bond spreads with varying effects of volatility and liquidity across distress regimes.

Key Words: bond liquidity, equity volatility, illiquid markets, corporate bond spreads, Fama-Macbeth regressions

JEL Classification: G10, G14

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1. Introduction

Idiosyncratic volatility refers to the risk specific to a firm after controlling for industry and market risk factors. Liquidity reflects the ability to trade large quantities of a security quickly with minimal trading costs and little price impact. Several recent studies have independently documented the significance of *either* idiosyncratic volatility (hereafter, equity volatility) *or* bond liquidity in determination of corporate bond spreads, i.e., the excess of bond yields over equal maturity benchmark yields.

An increase in idiosyncratic volatility increases the ex-ante probability of firm default, thereby depressing corporate bond prices and causing higher bond spreads (Merton, 1974). Equivalently, a lower stock price causes higher volatility due to the leverage (Black, 1976) and volatility feedback (Bekaert and Wu, 2000) effects, and implies higher default intensity and bond spreads (Das and Sundaram, 2007). On the other hand, lack of liquidity imposes search costs, thereby inhibiting the frequency of trading and increasing the hedging risk for bond investors. As a result, investors demand higher ex-ante liquidity risk premium and higher bond spreads (Lo et al., 2004). Higher liquidity spreads also arise from higher adverse selection and/or inventory control costs that lead to higher bid-ask spreads and hence higher required rates of return (Brennan and Subrahmanyam, 1996). Liquidity can be also interpreted as a potential explanation for the “credit puzzle”, i.e., the underprediction of corporate bond spreads of Merton-type models (Covitz and Downing, 2007; Driessen, 2005).

Though previous work has examined the role of *either* equity volatility *or* bond liquidity on bond pricing, there can potentially be substantial *overlap* in the explanatory powers of idiosyncratic risk and bond liquidity on expected bond spreads. While higher equity volatility implies higher bond spreads, it is not obvious whether higher spreads are attributable to higher equity volatility, lower bond liquidity, or both. Negative firm-specific news events leading to high underlying equity volatility can result in higher bond spreads as well as lower bond liquidity over time.[1] Similarly, in cross-section, firms that experience higher volatility shocks can be associated with higher spreads and lower liquidity. Moreover, the relative significance of volatility and liquidity on bond spreads can be different, and their individual effects may vary depending on the underlying bond- and issuer-specific characteristics (such as ratings, industry, and the levels of equity volatility and bond liquidity), and overall market conditions (such as business cycle regimes, and aggregate market volatility and liquidity levels).

The objective of this paper is to systematically explore the interaction between equity volatility and bond liquidity in determining corporate bond spreads, and how such interactions are altered when underlying bond and firm characteristics vary, or when market conditions change. This paper contributes to literature by providing a better understanding of the *relative* importance of equity volatility and bond liquidity in pricing corporate debt, which comprise a significant proportion of capital structure of firms and yet are highly illiquid.[2]

In this paper, we examine whether idiosyncratic risk subsumes the information in liquidity in explaining corporate bond prices. We explore the roles of volatility and liquidity unconditionally, as well as conditional on several underlying distress features. High distress issues are construed as bonds with low ratings, low liquidity, or high underlying equity volatility. High distress periods refer to recessionary periods, and periods of high aggregate equity volatility, or low aggregate bond liquidity in the economy. Our study, therefore, strives to shed more light on the interaction and potential substitution effects between volatility and liquidity on pricing in the context of intrinsically illiquid securities such as corporate bonds.

Our paper also addresses several unexplored issues in bond markets. Is there any pecking order in how different variables such as equity volatility, bond liquidity,

[1] Chordia et al. (2005) study the common determinants of liquidity and volatility in stock and Treasury bond markets. Bao and Pan (2008a) show that bond liquidity variables are useful in explaining the cross-sectional variations in excess corporate bond market volatility over short-term horizons.

[2] For example, Hendersen et al. (2006) report that convertible and non-convertible debt together account for 83% (90%) of domestic (international) capital raised by firms during 1990-2001. Harris and Piwowar (2006) reveal that the median corporate bond on Trade Reporting and Compliance Engine (TRACE) system trades on only 48% of all days during 2003-2005 period.

and bond characteristics matter in the pricing of bonds? How do the interactions among volatility, liquidity, and spreads vary when underlying cross-sectional bond attributes or market conditions change?

We employ over 195,000 secondary trades of option-free corporate bonds issued by 818 firms over an 11-year period, 1994-2004. Following the norms of current literature, we measure equity volatility as the standard deviation of multifactor risk-adjusted residual returns, and quantify bond liquidity in terms of price impact of underlying trades as well as underlying bond characteristics.[3]

We document three principal findings. *First*, while both equity volatility and bond liquidity effects are important, equity volatility has the primary impact, and bond liquidity (represented by bond characteristics as well as bond price impact measures) has the secondary impact on bond spreads. Raw cross-correlations between equity volatility and bond liquidity variables are marginal and small, and portfolio analysis reveals monotonic variation in bond spreads along both volatility and liquidity, indicating that there is little overlap in their relative information content for bond spreads. Unconditional Fama-Macbeth regressions indicate equity volatility explains 32% to 35% of the yield spreads, whereas addition of liquidity measures (bond characteristics and bond price impact) further increases explanatory power between 4.03% and 7.63%. We also find that one standard deviation (henceforth, 1σ) positive shock to volatility results in widening of bond spreads by 77 to 111 basis points (henceforth, bps), whereas 1σ positive shock to all illiquidity measures together result in 34-55 bps higher spreads. All our results and conclusions about the pecking order remain unaltered when we (a) control for term-structure, default, market volatility (VIX), and aggregate liquidity factor betas, (b) control for equity liquidity, (c) adopt alternate measures of liquidity and volatility, (d) use bond portfolios, and (e) orthogonalize liquidity and volatility measures.

Second, conditional cross-sectional tests reveal that, in general, distressed bonds (bonds with low ratings, low liquidity, and high equity volatility) and distress regimes (recessionary years, and high equity volatility and low bond liquidity periods)

[3] Though bond volatility too can impact bond spreads, low liquidity in corporate bond trades precludes us from constructing a meaningful proxy for bond market volatility.

experience higher impacts of shocks to volatility as well as liquidity. Since idiosyncratic volatility shock corresponds to higher ex-ante credit risk and bond spreads, our finding implies that distressed bonds and distress regimes are associated with both higher credit and liquidity shocks.

Finally, conditional cross-sectional tests further reveal a segmentation of relative significance of volatility and liquidity effects conditional on underlying firm-specific or systematic distress. On a *relative basis*, idiosyncratic volatility effects are very prominent for (a) distressed bonds, (b) bonds issued by Industrial and Utilities, and during (c) high distress regimes. For example, 1σ volatility shock widens bond spreads by 177 (13) bps for low- (high-) rated bonds; similarly 1σ shock to volatility implies higher spreads of 203 (46) bps during recessionary (growth) periods. On the other hand, liquidity variables have comparatively higher information content and exert relatively greater impact on bond spreads of low distress bonds and during low distress regimes. For example, 1σ liquidity shock contributes to 24.20% (64.23%) of the total impact on bond spreads for low- (high-) rated issues, and 19.80% (42.29%) of the total effect during recessionary (growth) periods.

While our findings reconcile with those of Campbell and Taksler (2003) and Chen et al. (2007) with respect to impact of volatility or liquidity on corporate debts, we also provide additional insights into the role of volatility and liquidity conditional on several distress conditions. Specifically, we render decomposition of the relative importance of volatility and liquidity unconditionally as well as conditional on different portfolios and regimes. Our results attest that idiosyncratic risk has a first-order effect, but it does not subsume the information in liquidity in explaining bond prices, unlike the findings in equity market (Spiegel and Wang, 2005). Our results further imply a regime-switching behavior of bond spreads with varying effects of volatility and liquidity across distress regimes. Our findings therefore provide further guidelines to current bond pricing models on the relative significance of volatility and liquidity effects.

The rest of the paper is structured as follows. Section 2 discusses background literature. Section 3 describes the data and variables. Section 4 presents univariate and bivariate portfolio results. Sections 5 and 6 report the results from unconditional and conditional Fama-Macbeth regressions for bond spreads. Section 7 concludes.

2. Background and Related Literature

Our paper is related to the extant literature that explores the role of equity volatility and bond liquidity on corporate bond spreads. Equity volatility studies include Campbell and Taksler (2003), who find that idiosyncratic equity volatility has a significant role in explaining bond spreads; and Cremers et al. (2008a,b), who show the incremental information content of option-implied jump premiums and option-implied volatilities in predicting bond spreads. Bond liquidity studies include Houweling et al. (2005), who examine several liquidity proxies that impact bond spreads; Chen et al. (2007), who find a positive relation between bid-ask spreads and corporate yield spreads; Driessen (2005), who provides evidence for a liquidity component in corporate bond spreads; and Mahanti et al. (2008), who develop an aggregate bond liquidity measure based on the custodian bank's turnover.[4,5]

Our work also represents an extension to bond market of the recent work that has examined the relative information content of volatility and liquidity risks in equity returns. For example, Spiegel and Wang (2005) find that idiosyncratic risk contains and subsumes all the information about liquidity in explaining future stock returns. Bali et al. (2005) document that the relation between equity returns and idiosyncratic volatility is largely driven by small stocks (traded on NASDAQ), and hence is a liquidity issue. Boehme et al. (2006) document that idiosyncratic volatility is positively related to required rate of returns for stocks with short sale (and hence with liquidity) constraints.

Finally, our paper is broadly related to the existing literature on information spillovers between stocks and corporate bonds.

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[4] Other bond liquidity studies include Alexander et al. (2000b), Bao et. al. (2008b), Hong and Warga (2000), Kalimipalli and Warga (2002), Buraschia and Menini (2002), Chakravarty and Sarkar (2003), Bessembinder et al. (2006), Edwards et al. (2007), Gady et al. (2007), Das and Hanouna (2007), and Jankowitsch et al. (2008).

[5] Several papers also examine the relevance of equity volatility and liquidity in the cross-sectional pricing of equities. Malkiel and Xu (1997, 2006), Campbell et al. (2001), Goyal and Santa-Clara (2003), Ang et al. (2006), and Bali and Cakici (2008) highlight the significance of idiosyncratic risk. Amihud (2002), Pastor and Stambaugh (2003), Acharya and Pederson (2005), and Liu (2006) document liquidity effects.

. First, liquidity and volatility of stocks and corporate bonds are both influenced by macro-economic fundamentals that determine the business cycle phase at any given time. For example, business downturns or recessions relate to periods of low liquidity and high yield spreads for corporate bonds arising from flight-to-quality concerns. Such flights to quality and liquidity occur in periods of high uncertainty arising from financial, credit, oil, technology, or war-related shocks, when the underlying equities too experience high volatility regimes.

Second, according to microstructure theory, an increase in volatility of underlying security returns implies that market makers face higher inventory risk (on account of portfolio imbalances) and adverse selection risk (due to increased possibility of trading with informed traders). As a result, higher underlying volatility leads to wider bid-ask spreads. This in turn increases volatility because of higher bid-ask bounce, and lowers liquidity due to higher transaction costs (McInish and Wood, 1992; O'Hara, 2003). If unexpected firm-specific news shocks impact both stocks and bonds, then corresponding volatility and liquidity variables are likely to be strongly correlated.

Third, as bonds and stocks are joint claims on the underlying firm's assets, firm-specific information shocks affect the joint dynamics of their returns, volatility, and liquidity. Previous literature has examined the relative informational efficiency of stock and bond markets (Kwan, 1996; Hotchkiss and Ronnen, 2002; Downing et al. 2009) and associated momentum spillovers (Gebhardt et al. 2005b). Corporate news events such as announcements of risky projects, mergers, takeovers, issuances of new debt, or stock repurchases involving wealth transfer to equity holders induce linkages between bonds and underlying stocks (Alexander et al. 2000a; Maxwell and Stephens, 2003).

Fourth, when there is a high divergence of opinion about the true value of a financial asset, the speculative component of volume tends to be high and liquidity tends to be low, since large movements in security prices are needed to absorb changes in trading volume (Harris and Raviv, 1993; Kandel and Pearson, 1995; Bamber et al. 1999). For example, there is evidence of abnormal trading volume, high volatility, and low liquidity (increased bid-ask spreads) around earnings announcements (Bamber, 1986; Krinsky and Lee, 1996). Therefore, during firm-specific news or shock events, when there exists a large disagreement about the intrinsic value of a firm, idiosyncratic volatility goes up and liquidity drops, affecting the required rates of returns for both stocks and bonds.

Fifth, events that lead to high credit risk (and high idiosyncratic volatility) for a given firm also typically lead to high liquidity risk (Ericsson and Renault, 2006; Covitz and Downing, 2007; Beber et al., 2009[6]). When idiosyncratic volatility goes up, implicit concerns about the credit quality of the issuer and resulting flights-to-quality and liquidity can drive up the credit and liquidity spreads. Therefore, idiosyncratic volatility has bearings on both default and liquidity components of bond spreads.

Sixth, active capital structure arbitrage strategies implemented by hedge funds can reinforce the news spillovers between equity and debt markets, and imply long-term co-movements of underlying stocks and bonds (Duarte et al. 2005; Yu, 2006).

Finally, as Brunnermeier and Pedersen (2009) and Brunnermeier (2009) argue, liquidity and volatility shocks can arise on account of margin spiral stemming from funding illiquidity.

3. Data, Variables, and Descriptive Statistics

We use a sample of corporate bonds that covers an 11-year period from 1994 through 2004 and comes from two complementary sources: the Mergent Fixed Investment Securities Database (FISD) issuance data and the National Association of Insurance Commissioners (NAIC) pricing database.[7] As Campbell and Taksler (2003) report based on Flow of Funds Accounts published by the Federal Reserve, insurance companies hold about one third of all outstanding corporate bonds in their portfolios and hence account for a significant fraction of institutional corporate bond trades.

From the NAIC database, we collect transaction information (trade date, market value of transaction, par amount of traded bonds, accrued interest, etc.) on U.S. corporate bond trades between 1994 and 2004. The NAIC bond trades are merged with

[6] Extant work also explores issues of liquidity and credit risks embedded in credit default swap spreads (e.g., Longstaff et al. 2005; Tang and Yan, 2007; Das and Hanouna, 2009; and Ericsson et al. 2009).

[7] The FISD includes detailed issue- and issuer-related information on all U.S. debt securities maturing in 1990 or later. The NAIC database lists details of bond transactions by all insurance companies (life insurance companies, property and casualty insurance companies, and health maintenance organizations [HMOs]). Previous studies that have used the NAIC database include Chakravarty and Sarkar (1999), Schultz (2001), Hong and Warga (2000), Campbell and Taksler (2003) and Bessembinder et al. (2006).

various bond attributes (issuance date, maturity, coupon, and other issue- and issuer-specific variables) obtained from FISD. Based on 6-digit CUSIP numbers, we match the corporate bonds with the stock price data in the Center for Research in Security Prices (CRSP) database. Bond ratings (and amount outstanding) on transaction date of each bond trade are extracted from Ratings (Amount) History tables in FISD. For bond ratings, we use Standard & Poor's (S&P) rating value if it exists; otherwise we use Moody's rating data. On the transaction dates of bond trades, we compute yield-to-maturity and Macaulay duration based on reported buy or sell prices and other related variables. We obtain yield spreads for each bond transaction using matching maturity swap rates as benchmark (Houweling et al. 2005). Daily swap rates for 15 different maturities (ranging between 1 and 30 years) are obtained from DATASTREAM. Each bond trade is matched to a corresponding swap rate based on flat interpolation of yields for extreme maturities of the swap rate curve and linear interpolation of two closest neighboring maturity swap yields for interim maturities.

We use different screening criteria. From the NAIC database, we exclude bond trades characterized by any of the following: (a) there are erroneous trade dates and incorrect third-party vendor names; (b) underlying maturity is less than one year on transaction date; (c) missing transaction prices or transaction prices are extreme (transaction price is below \$100 or above \$10,000, where \$1,000 is the par value); (d) variables needed to compute yield-to-maturity are missing or are erroneous; (e) yield-to-maturity cannot be computed (non-convergence of pricing formula) or computed yield is greater than 100% or less than 1%; and (f) variables needed to compute Macaulay duration are missing or Macaulay duration cannot be computed.

Based on FISD variables, we exclude all the following bond issues: bonds with callable, redeemable, putable, exchangeable, convertible, sinking fund, enhancement, or asset-backed features; perpetual bonds; variable rate bonds; medium-term notes; Yankee, Canadian, and foreign currency issues; Rule 144a issues; TIPS, Treasuries, Munis, Treasury coupon- and principal-strips; and agency type bonds. We also drop bond issues that are unrated, or have either missing or extreme bond ratings (below C grade, or belonging to AAA or Aaa ratings[8]). Finally, we drop all bond trade

[8] Campbell and Taksler (2003) report pricing problems for high investment grade issues in NAIC data.

observations that (a) do not have any matching stock in the CRSP database, or (b) have insufficient stock returns data in the six months prior to the bond transaction date (and hence equity volatilities cannot be computed).

All computed bond measures (yield-to-maturity, yield spread, and duration) are winsorized at the 1% level. The final matched dataset consists of issuance- and transaction-related information on fixed rate, U.S. dollar denominated, domestic, straight corporate bond trades by all insurance companies for publicly traded equity firms. Our final sample consists of 196,085 bond transactions (both buy and sell) by insurance companies for 3,047 straight bonds issued by 818 publicly listed companies spanning 132 months over the 11-year period from 1994 through 2004.

[Insert Table 1 here]

Table 1 reports the number of bond trades and average yield spreads for different sub-samples based on industry, rating, maturity, and time period. A majority of the total of 196,085 transactions correspond to Industrial, short-term maturity (1-7 years) and A-rated bonds during the first half of the sample period (1994-1999). Industrial bonds have the highest average yield spreads, closely followed by Utilities; Financials have the lowest spreads. The second half of the sample (2000-2004), which corresponds to the slowdown phase subsequent to the high-tech expansion period, is characterized by fewer bond trades and significantly higher yield spreads. In unreported results, we find that the term-structure of yield spreads is upward sloping during the 1994-1999 period, but becomes U-shaped in the 2000-2004 period with medium-term bonds having smaller spreads than short- and long-term bonds. Industrials are mostly A or BBB rated, while Financials are largely A rated and Utilities BBB rated.

[Insert Figure 1 here]

Figure 1 plots the annual number of bond trades and average yield spreads. Bond trades gradually increase during the high-tech bubble period (1994-1999) reaching a peak in year 1999, and then decline substantially. We observe that A and BBB rated bonds and Industrial and Financial sector bonds account for the majority of the trades over the years; short-term maturity bonds dominate the second half of the sample. Bond spreads increase substantially after year 2000. Industrial bonds earn the highest spreads for most years, but Utilities have carried maximum spreads since year

2002. The yield spreads for non-investment grade bonds (BB and lower) seem to have increased significantly since year 2000. The U-shape in the term-structure of yield spreads is evident in the second half of the sample.

[Insert Table 2 here]

Based on exhaustive survey of the extant literature (summarized in Section 2), we employ five different volatility measures and 11 different liquidity measures. Table 2 defines the volatility and liquidity variables used in our study.

The five equity volatility measures include a daily total stock return volatility measure (reflecting both idiosyncratic and market news), and daily and monthly idiosyncratic volatility measures based on Fama-French 3- and 4-factor models. Specifically, we compute the total volatility, *V*, of a stock as the variance of equity returns over a 125-day period preceding a bond trade, adjusted for the autocorrelation in daily returns using the approach proposed by French et al. (1987) (and adopted by Goyal and Santa-Clara, 2003; Campbell and Taksler, 2003):

$$V_{i,t} = \sum_{d=1}^{125} r_{i,t-d} + 2\sum_{d=2}^{125} r_{i,t-d} r_{i,t-d+1} \qquad (1)$$

where t is the date of a specific bond trade and $r_{i,t}$ is the return of stock i on date t.

We compute the idiosyncratic volatility, *IV*, of any stock i as the variance of the residuals in the 3-factor or 4-factor Fama-French (1993) models applied to a 125-day or 6-month period preceding a bond trade:

$$IV_i = \text{variance}_{\text{180-day}}(\varepsilon_{i,t}) \text{ or variance}_{\text{6-month}}(\varepsilon_{i,t})$$

where $\forall\ i$ and t, $\varepsilon_{i,t}$ is obtained as residuals from either of the following models: (2)

3-factor model: $r_{i,t} - r_{f,t} = \alpha_i + \beta_{i,MKT}\left(r_{MKT,t} - r_{f,t}\right) + \beta_{i,SMB}\left(SMB_t\right) + \beta_{i,HML}\left(HML_t\right) + \varepsilon_{i,t}$

4-factor model: $r_{i,t} - r_{f,t} = \alpha_i + \beta_{i,MKT}\left(r_{MKT,t} - r_{f,t}\right) + \beta_{i,SMB}\left(SMB_t\right) + \beta_{i,HML}\left(HML_t\right) + \beta_{i,MOM}\left(MOM_t\right) + \varepsilon_{i,t}$

where t is the date of a bond trade, $r_{i,t}$ is the return of stock i on date t, $r_{MKT,t}$ and $r_{f,t}$ are the market (CRSP value-weighted index) and risk-free (30-day Treasury Bill) returns on date t, SMB_t, HML_t and MOM_t are the returns on small minus big capitalization factor, high minus low book-to-market equity value factor and momentum factor respectively on date t, ε is the regression residual and variance denotes the 125-day or

6-month variance.[9] Daily (monthly) return volatility variables are annualized by scaling with 252 (12). All volatility variables are winsorized at the 1% level.

Based on available data from NAIC and FISD, we employ ten different bond liquidity variables.[10] They consist of six bond- and issuer-specific characteristics (offer amount, amount outstanding, age of the issue, time to maturity, coupon rate, and dummy for financial issues); two trade-based variables (trade size and annual trading frequency); and two bond price impact variables. All liquidity variables are winsorized at the 1% level.

Trade size is computed as the actual dollar cost incurred (amount received) for buy (sell) trades; the dollar amounts exclude accrued interest (and hence reflect clean prices), but include commissions and fees. Trading frequency is the number of transactions in the year prior to a specific bond trade. The bond price impact variables measure the daily price impact of order flow on current returns, and are computed as the impact of total trading volume on the standard deviation as well as range of bond prices, where trading volume is obtained as the total dollar value of trades in the year prior to a bond transaction.

We also employ an equity liquidity variable based on Amihud (2002), which is computed as the absolute percentage price change per dollar of trading volume, where trading volume is obtained as the dollar value of all equity trades over 125 days prior to the bond transaction date. We employ the inverse of the Amihud measure to minimize the variability in this variable, and obtain a stable measure of the price impact.[11]

Previous literature documents the relation of different liquidity proxies with bond liquidity and yield spreads. Higher bond liquidity (and hence lower bond spread) is associated with higher issue amount or amount outstanding, lower age, longer maturity, larger trade size, higher trading frequency, and smaller bond price impact

[9] Wharton Research Data Services (WRDS) is the source of daily and monthly equity factors data.

[10] All liquidity measures employed are based on previous bond liquidity studies cited in Section 2.

[11] To illustrate, for our full sample of 196,085 bond trades, the original Amihud measure has a mean of 132 and standard deviation of 10,914 (*t*-statistic = 5.35). On the other hand, the inverse of this measure has a mean of 0.41 and standard deviation of 0.63 (*t*-statistic = 291.65). This stark difference arises because the denominator (dollar trading volume) in the original Amihud measure is significantly more variable than the numerator (absolute returns). There is, however, no material impact on our results or conclusions if we use the original Amihud measure instead of its inverse.

variables. Financials have higher liquidity and lower bond spreads compared to Industrials and Utilities. Higher coupon normally implies a higher price or a lower yield. However, higher coupon also implies a larger tax burden and hence a higher required yield. Finally, higher equity liquidity is expected to have a positive impact on bond liquidity, and hence result in lower spreads.

[Insert Table 3 here]

Table 3 presents the summary statistics (Panels A and B) and correlations (Panels C, D and E) of all volatility and liquidity variables. Panel A shows that idiosyncratic equity volatilities are smaller than total return variance, and idiosyncratic volatility is higher when measured at daily (compared to monthly) frequency. The median values indicate that all volatility measures are positively skewed.

Panel B reveals that the dollar amount outstanding is, on average, 99% of the issued amount; the two variables are not substantially different since our sample excludes all callable and sinking fund bonds. However, large standard deviations indicate wide dispersion of the two variables across issues: for some observations, the amount outstanding is as low as 19% of the issued amount. On average, on bond transaction dates, our sample of corporate bonds are about 3 years and 7 months old, have a term-to-maturity of about 8 years and 4 months, and carry a 7.3% coupon. About 37% of all bonds traded are issued by Financials. On average, each bond trades about 32 times per year (or once every eight trading days) and has a trade size of $2.77 million. We observe that all liquidity variables too are positively skewed.

Panel C shows that all equity volatility variables are highly correlated. Daily idiosyncratic volatilities are more strongly correlated to total volatility. For a given frequency, 3- and 4-factor idiosyncratic volatilities are almost perfectly correlated. Bond spreads bear large positive correlations with all equity volatilities.

Panel D indicates that, as expected, issued amount and amount outstanding are highly correlated. Older bonds tend to pay larger coupons. Large-sized issues and younger bonds trade more often. Equity liquidity is higher for large bond issues and for more frequently traded bonds. Both bond price impact variables are highly correlated. Correlations between bond spreads and many liquidity variables have the expected signs: bond spreads are lower for bigger issues, younger bonds, Financials, larger trades, and more frequently traded bonds. Bonds with higher price impact (lower liquidity) carry higher spreads. Coupons and spreads are positively correlated, suggesting the possibility of tax effect of higher coupons. Bonds with higher underlying equity liquidity have lower spreads. Overall, we find that bond spreads and bond liquidity are negatively related.

Panel E reveals that the cross-correlations between equity volatility and many liquidity variables are negligible. Bonds as well as stocks with lower liquidity tend to have higher underlying equity volatility, but the correlations are, however, very low. This is highly relevant in light of later results highlighting orthogonality of volatility and liquidity in explaining bond spreads.

In summary, we find that bond spreads are positively (negatively) related to equity volatility (bond liquidity) measures. Cross-correlations between equity volatility and bond liquidity variables tend to be marginal, indicating that they are unlikely to subsume each other in bond pricing.

4. Univariate and Bivariate Portfolio Trends

We commence by exploring the unconditional relation between bond yield spreads and various liquidity and volatility variables. To this end, we form portfolios based on one-way and two-way sorts on different liquidity and volatility variables, and explore the impact of these variables on the bond spreads.

4.1 Univariate sorts

We first construct univariate liquidity and volatility quintiles by sorting all bond trade observations based on values of different liquidity and volatility variables on bond transaction dates. We compute averages of bond spreads, bond characteristics, and liquidity and volatility measures along these portfolios. This exercise enables us to examine the unconditional relation between bond spreads and different liquidity and volatility variables. Table 4 reports the trends along univariate portfolios formed based on one liquidity and one volatility measure.

[Insert Table 4 here]

When portfolios are formed on bond liquidity index 1 (Panel A), low liquidity (or high index value) portfolios have higher bond spreads and equity volatilities, but lower ratings and equity liquidity. We thus find a strong correspondence between higher bond spreads, higher volatility, and lower liquidity. The trends appear largely monotonic. Panel B indicates that high equity volatility portfolios have higher bond spreads, lower ratings, and lower values of some bond liquidity variables, namely, trade size, coupon, and percentage of Financials. Though bond liquidity (measured as price impact) is the lowest for the most volatile portfolio, there is no distinct monotonic trend indicating a large degree of orthogonality between bond liquidity and equity volatility.

All one-way ANOVA *F*-statistics reported in both panels are highly significant, thereby implying the rejection of the null hypothesis of equality of each variable across the portfolios. Bond portfolios based on any given criterion of liquidity or volatility are uniquely different from each other.

In results not tabulated, we find similar relations between bond spreads and other liquidity and volatility variables. For example, when we form portfolios on ranked values of dollar amount outstanding, we find that lower dollar amount portfolios (indicating lower liquidity) are accompanied by higher bond spreads and higher volatility. Furthermore, low-rated bonds have higher bond spreads and underlying equity volatility, and lower bond and equity liquidity. For duration sorted portfolios, however, lower duration bonds are characterized by higher spreads and larger equity volatilities, but not necessarily by lower liquidity.

To summarize, univariate portfolio analysis indicates that both equity volatility and bond liquidity have unconditional impact on bond spreads. Bond spreads appear to be positively related to equity volatility and negatively related to bond liquidity.

4.2 Bivariate sorts

Next we construct two-way sorted portfolios based on different liquidity and volatility variables; this enables us to simultaneously control for the effects of liquidity and volatility while examining their joint impact on bond spreads. We form quintiles of bond transactions based on ranked values of each liquidity variable, and then independently form five more portfolios based on sorted values of volatility measures.

Allocation of observations to the two sets of independent quintiles yields 25 liquidity-volatility portfolios. We compute average yield spread for each portfolio. Table 5 presents the trend of bond spreads along bivariate portfolios corresponding to nine liquidity variables and the idiosyncratic volatility from 3-factor daily returns model.[12]

[Insert Table 5 here]

Panel A reveals that bond spreads are the smallest for newly issued bonds and increase with issue age. Bond spreads also increase monotonically with volatility within each issue age portfolio. Thus, both issue age and idiosyncratic volatility are important in explaining bond spreads.

Similarly, Panels B, C, and D show that, after controlling for volatility, bond spreads are monotonically negatively correlated with trade size and trading frequency; and spreads increase monotonically with higher coupons. Panels E and F indicate rather weak negative (positive) relation between bond spreads and amount outstanding (time to maturity). On the other hand, there is always a strong monotonic positive correlation between yield spreads and volatility after controlling for these five liquidity variables.

Panels G and H reveal that, for a given volatility level, bond spreads are lower for higher liquidity (smaller bond liquidity index) portfolios and the trends appear monotonic. Panel I shows that bond spreads and equity liquidity are negatively correlated. In all three panels, yield spreads and equity volatility are strongly positively correlated. These trends imply that both bond and stock price impact variables along with equity volatility are important in explaining bond spreads.

All two-way ANOVA *F*-statistics in Table 5 for tests of null hypothesis of equality of bond spreads along (a) all liquidity portfolios for a given level of volatility and (b) all volatility portfolios for a given level of liquidity are highly significant, rejecting the null of equality of bond spreads. All model *F*-statistics are also strongly significant indicating that both liquidity and volatility variables impact bond spreads.

In summary, bivariate portfolio analysis implies that both liquidity and volatility measures are critical to bond spreads, and idiosyncratic risk may not subsume the explanatory power of underlying liquidity.

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[12] Though we report results corresponding to 3-factor daily idiosyncratic volatility in this table and all subsequent tests, all our findings are robust to other idiosyncratic volatility measures.

5. Unconditional Fama-MacBeth Cross-Sectional Regressions

We perform cross-sectional regressions using Fama-MacBeth (1973) procedures with an objective to explore the relative impact of bond liquidity and equity volatility measures on bond spreads after conditioning for control variables. We term these standard Fama-MacBeth tests as unconditional regressions since these are conducted using the full sample of all bond trades over the entire sample period. We follow Gebhardt et al. (2005a), who employ Fama-MacBeth tests to study bond returns.

5.1 Fama-MacBeth regressions

We implement Fama-MacBeth regressions based on the standard two-stage test approach. First, each month, we conduct regressions of bond yield spreads on corresponding bond characteristics, price impact measures, and volatility variables, in addition to ratings and duration as controls. We repeat such cross-sectional regressions for all 132 months in the sample. We report the time-series averages of slopes (coefficient values), associated *t*-statistics (ratio of average slope to time-series standard error with Newey-West adjustment for serial correlation) and adjusted R^2 values.

[Insert Table 6 here]

Table 6, Panel A reports the results of Fama-MacBeth regressions for different combinations of variables. Regression 1 uses bond liquidity index 1 and 3-factor daily idiosyncratic volatility as sole explanatory variables. Regression 2 augments regression 1 with rating and duration. Regressions 3, 4, and 5 employ different combinations of bond characteristics along with bond liquidity index and volatility; all bond characteristics are not considered simultaneously because of multicollinearity issues.

All five sets of regressions reveal that equity volatility and bond liquidity are always significant. In particular, the coefficients and *t*-statistics associated with volatility and liquidity index remain largely unchanged whether considered standalone, jointly or along with bond characteristics. Bond liquidity and equity volatility have their own individual impact on bond spreads. Many bond characteristics, used as proxies for liquidity, remain significant. We further observe that ratings and duration, used as control variables, are also significant.

Regressions 1a and 1b highlight that volatility has greater explanatory power than liquidity index (adjusted R^2 of 33% versus 4.42%). When conditioned for rating and duration, adjusted R^2 increases from 33% to 49% in regression 2b compared to 1b. However, adding liquidity characteristics to volatility variable (going from regression 2b to 3d) increases adjusted R^2 by just 3.07% (from 48.96% to 52.03%). Finally, adding liquidity index 1 to the above variables (going from regression 3d to 3c) increases adjusted R^2 further by 1.67% (from 52.03% to 53.70%). Thus, volatility has the maximum impact on R^2, followed by bond characteristics and liquidity index. These results imply that, in terms of overall explanatory power, equity volatility has the first-order impact, and liquidity (measured by bond characteristics and bond price impact) has the second-order effect on bond spreads.

Similar results obtain when we compare regression 2 to regressions 4 and 5 involving other combinations of bond characteristics. For example, in regression 4, adding bond characteristics to volatility (going from regression 2b to 4d) increases adjusted R^2 by 2.32%. Adding liquidity index 1 as well (going from regression 4d to 4c) increases adjusted R^2 further by 1.71%.

Analogous conclusions bear out from shock analysis conducted using the regression coefficients and the standard deviations of variables (from Panels A and B in Table 3). We find that one 1σ positive shock to volatility results in widening of bond spreads by about 77 bps. However, 1σ shock to liquidity index (resulting in lower liquidity) causes bond spreads to go up by 23 bps. Similar 1σ shocks to issue age, coupon, and maturity result in higher spreads of about 2, 8, and 24 bps respectively.

In summary, volatility and liquidity index retain largely unchanged coefficients and significant *t*-statistics across different regressions. Both volatility and liquidity matter in determining corporate bond spreads; idiosyncratic risk does not subsume the information in underlying liquidity. Based on explanatory power and shock analysis, *equity volatility* has the *first-order* impact, and *liquidity* has the *second-order* effect on bond spreads. We next examine the robustness of our results under various controls.

5.2 Robustness tests using bond market factors

We repeat our tests with bond market factor betas, namely, term-structure and default factor betas (e.g., Gebhardt et al. 2005a; Houweling et al. 2005) replacing ratings and duration. The term-structure variable (TERM) is obtained as the difference between 10-year and 2-year swap rates, and default factor (DEF) is computed as the difference between Moody's BAA yield and 10-year swap rate (all data obtained from DATASTREAM). Starting January 1995, using 18 bond portfolios (formed each month based on classification of bonds into 3 industries, 2 ratings and 3 duration categories), we obtain the bond factor betas on a rolling basis each month by regressing 24 months (12 months in case of 1995) of past portfolio spreads on corresponding TERM and DEF factors. Portfolio betas are assigned to individual bonds constituting the portfolio in a given month. We repeat Fama-MacBeth regressions augmented with these factor betas.

[Insert Table 7 here]

Table 7 indicates that default factor betas are always highly significant, but term factor betas are significant in only certain combinations. However, all earlier conclusions remain robust to the inclusion of term and default factor betas. Specifically, volatility and liquidity index have unchanged significance; equity volatility has the first-order impact on bond spreads (34.99% from regression 1b), and liquidity has the second-order effect on bond spreads (bond characteristics account for 6.03% from regression 3d vs. 2b, and price impact accounts for 1.60% from regression 3c vs. 3d). Further, regressions 3c, 4c, and 5c reveal that 1σ positive shocks to volatility cause higher bond spreads ranging between 108 and 111 bps. Similar shocks to liquidity index imply 25 to 27 bps wider spreads, while those to amount outstanding, coupon, and maturity widen spreads by just 6, 16, and 8 bps respectively.

5.3 Robustness tests using equity liquidity

We next examine whether conditioning for equity liquidity modifies our results and conclusions. There are two motivating reasons for including equity liquidity: (a) Spiegel and Wang (2005) document significant overlap in the explanatory powers of equity volatility and equity liquidity on expected stock returns; and (b) there is also a possibility of overlap in the explanatory powers of equity liquidity and bond liquidity. We conduct Fama-MacBeth tests including equity liquidity, measured as the inverse of

Amihud (2002) price impact variable (results not tabulated for brevity). We find that equity liquidity has incremental explanatory power (i.e., is significant and increases adjusted R^2), but does not subsume the impact of either equity volatility or bond liquidity on bond spreads. Both equity volatility and bond liquidity continue to matter significantly. 1σ positive shock to equity liquidity (resulting in higher liquidity) lowers bond spreads by 13 bps, compared to 108 (25) bps higher spreads for 1σ volatility (bond liquidity index) shocks. Equity volatility has the first-order impact, bond characteristics and price impact have the second-order effect, and equity liquidity has the third-order effect on bond spreads.

5.4 Robustness tests using aggregate stock market volatility and bond market liquidity

We use monthly VIX as a proxy for aggregate equity market volatility factor and compute the aggregate bond market liquidity factor as an equally-weighted average of bond liquidity index 1 values of all bonds each month. We estimate the risk premium betas associated with TERM, DEF, volatility and liquidity factors in a multivariate rolling regression setup involving portfolios (as outlined in Section 4.2). We repeat the regressions of Table 7, augmented with volatility and liquidity risk premium betas. The two additional factor betas remain largely insignificant in most regressions, all our earlier results continue to hold and conclusions remain unaltered (results not reported).

5.5 Robustness tests using bond portfolios

Each month, we form 18 bond portfolios by classifying all individual bond observations into three industries (Industrials, Financials, and Utilities), two ratings (high and low) and three duration (high, medium, and low) categories. We obtain portfolio values of spreads, bond liquidity, equity volatility, and other attributes by averaging the values of component individual bonds. Each month, we conduct Fama-MacBeth cross-sectional regressions of yield spreads across 18 portfolios on corresponding bond characteristics, price impact measures, and volatility variables; and aggregate the results of 132 monthly regressions.

Based on both explanatory power and shock analysis (results not reported), we again find that both equity volatility and bond liquidity matter; volatility has the first-order impact, and liquidity (measured using bond characteristics and bond price impact) has the second-order effect on bond spreads.

5.6 Further robustness tests

Bond liquidity and equity volatility can potentially be correlated because of information spillovers between the underlying markets. To control for possible endogeneity effects, we regress bond liquidity index on associated equity volatility and the two dynamic bond liquidity characteristics (trade size and trading frequency), and compute an *orthogonalized liquidity index* as the sum of regression intercept and residuals (analogous to the approach of Fama and French, 1993). We use this orthogonalized liquidity variable in lieu of liquidity index in all the Fama-Macbeth regressions reported in Table 6. We again find all earlier results and conclusions to be robust and unaltered (results not presented).

In further untabulated results, we replicate Fama-Macbeth regressions for individual bonds as well as portfolios using liquidity index 2 in lieu of liquidity index 1, and substituting 3-factor daily idiosyncratic volatility with other volatility measures. Our results remain robust.

6. Conditional Fama-MacBeth Cross-Sectional Regressions

Next, we carry out Fama-Macbeth cross-sectional regressions over sub-samples by conditioning for (a) underlying bond- and issuer-specific characteristics such as rating, equity volatility, bond liquidity, and industry classification, and (b) overall market conditions such as time-period (for regime effects), aggregate equity market volatility and aggregate bond market liquidity. The objective is to discern how the interaction between equity volatility and bond liquidity is altered while explaining bond spreads when underlying issue and firm characteristics, or market conditions change. Tables 8, 10, 11, and 12 present specific sub-sample results, while Table 9 summarizes the results of all conditional regressions.

6.1 High and low rating categories

[Insert Tables 8 & 9 here]

We first examine how the impact of volatility and liquidity differs between high-rated (rated AA or A) and low-rated (rated BBB or below) bond issues. Equity volatility alone explains 38.45% (4.50%) of the variation in spreads for high- (low-) rated bonds, as revealed in regression 1b of Panel A (Panel B) in Table 8. After controlling for default and term-structure factor betas in regression 2b, adjusted R^2 due to equity volatility is 40.43% for low-rated bonds (Panel A) and a mere 7.22% for high-rated bonds (Panel B). On the other hand, liquidity variables (bond characteristics and price impact index) together account for 9.21% of bond spreads for low-rated bonds (comparing regressions 2b and 3c in Panel A), and 12.94% for high-rated bonds (comparing regressions 2b and 3c in Panel B). Thus, volatility has higher significance for distressed bonds, while the impact of liquidity is stronger for high credit issues.

Table 9 summarizes above results. It shows that, based on the total adjusted R^2 in regression 3c, volatility accounts for 77.46% of the total explanatory power for low-rated portfolios, and only 22.32% for high-rated bonds. In contrast, liquidity accounts for 64.19% of total adjusted R^2 for high-rated bonds vs. just 18.55% for low-rated bonds. Similar findings emerge from shock analysis; 1σ positive shocks to volatility and liquidity in regression 3c increase bond spreads by 171 and 54 bps for low-rated bonds, and 13 and 20 bps for high-rated bonds. In absolute terms, both volatility and liquidity shocks are more prominent for low-rated compared to high-rated bonds (columns 6 and 7), implying that the impact of shocks to volatility and liquidity on bond spreads is much higher for low-rated bonds.

However, on a relative basis (columns 8 and 9), volatility shocks account for 75.80% of the total effect on spreads for low-rated bonds, and only 39.77% for high-rated bonds. The relative effect of liquidity shock is however 60.23% for high-rated bonds, compared to 24.20% for low-rated bonds. In short, while low-rated bonds have higher absolute shock impacts, the relative impact of equity volatility is far more pronounced for low-rated issues, and liquidity variables have substantially greater marginal impact on high-rated bonds.

6.2 High and low idiosyncratic volatility portfolios

Next, we partition our sample into low and high volatility bond portfolios based on annual median values of underlying 3-factor daily idiosyncratic volatility. We conduct cross-sectional regressions for each volatility sub-sample.

[Insert Tables 9 and 10 here]

In Table 10, coefficients and *t*-statistics corresponding to both volatility and liquidity are higher for high-volatility bonds indicating that these issues are more sensitive to changes in volatility and liquidity (further confirmed by shock analysis in Table 9). However, analysis of explanatory power reveals a segmentation in the relative importance of the two variables. Adjusted R^2 in regression 1b due to equity volatility is significantly higher for high-volatility bonds (36.35% vs. 1.76% for high- vs. low-volatility bonds). On the other hand, regressions 2b and 3c indicate that liquidity variables explain more for low-volatility issues (12.63% and 8.87% for low- and high-volatility issues respectively).

Table 9 shows that the contribution of equity volatility to total explanatory power is substantially higher for high-volatility bonds compared to low-volatility issues (71.39% vs. 7.62%). In contrast, contribution of liquidity to total explanatory power is substantially higher for low- rather than high-volatility issues (54.70% vs. 17.42%). While in absolute terms both volatility and liquidity shocks are more prominent for high-volatility bonds (columns 6 and 7), on a relative basis volatility (liquidity) shocks account for 69.19% (71.20%) of the total effect on spreads for high-(low-)volatility issues. In summary, while high-volatility bonds have higher absolute impacts of shocks to volatility and liquidity, relatively volatility matters substantially more for high-volatility portfolio and liquidity impact is strongly evident for low-volatility portfolio.

6.3 High and low bond liquidity portfolios

We also examine the relative impact of volatility and liquidity separately for high and low bond liquidity issues, where liquidity is measured in terms of bond liquidity index 1. Using annual median values of bond liquidity index 1, we classify individual bonds into low- and high-liquidity index portfolios. As bond liquidity index is inversely related to bond liquidity, low-(high-) bond liquidity index portfolio corresponds to bonds with high (low) underlying bond liquidity.

[Insert Table 9 here]

We find that while low-liquidity issues have higher absolute effects of shocks, the relative impact of equity volatility is more material for low-liquidity issues, and liquidity variables are more relevant for high-liquidity bonds (regression results not reported for brevity). Contributions are summarized in Table 9. Volatility (liquidity) accounts for 79.13% (12.09%) of the total explanatory power for low-liquidity issues and 36.30% (36.04%) for high-liquidity issues. Shock analysis reveal that volatility (liquidity) shocks marginally account for 73.75% (26.25%) of the total effect on spreads for low-liquidity bonds and 60.67% (39.33%) for high-liquidity issues.

6.4 Financials versus Industrials and Utilities

We also examine the relative impact of volatility and liquidity by industry classification. Financial issues possess better credit ratings and higher liquidity than other issues. In contrast, Industrials and Utilities are relatively high-yield issues.

[Insert Table 9 here]

We find that volatility is prominent for Industrial and Utility bonds; liquidity variables have greater impact on Financial bonds. Table 9 indicates that volatility accounts for 71.51% of the total explanatory power for Industrials and Utilities, and just 44.47% for Financials; liquidity accounts for 25.78% (18.04%) of the total explanatory power for Financials (non-Financials). Volatility and liquidity shocks have stronger overall impact on bond spreads for non-financial firms. Based on relative shock analysis, volatility shocks account for 72.93% (51.72%) of the total effect on spreads for Industrials and Utilities (Financials); liquidity shocks account for 48.28% (just 27.07%) of the total effect of Financials (non-Financials).

To summarize, analysis in preceding Sections 6.1 through 6.4 reveal that *high distress bonds* (bonds with low ratings, high equity volatility, and low bond liquidity) and Industrials and Utilities have higher *absolute* impact levels of shocks to both volatility and liquidity, compared to *low distress bonds* (bonds with high ratings, low volatility, and high liquidity) and Financials. Since idiosyncratic volatility shock implies higher ex-ante credit risk, our findings imply that distressed bonds are characterized by higher magnitudes of credit and liquidity shocks. However, *relatively,* volatility effects are more pronounced for high distress bonds, while liquidity variables have higher information content for low distress bonds. Our results, therefore, indicate that the relative effect of volatility shocks on spreads can be severely magnified in all high distress portfolios; similarly relative liquidity effects can be substantially higher for low distress portfolios.

6.5 Different sample periods

[Insert Figure 2 here]

We next examine the impact of different variables on bond spreads over sub-periods. Figure 2 plots the trends of bond spreads and explanatory variables by year. In the second half of our sample (corresponding to the post high-tech bubble recessionary period), equity volatility goes up, bond liquidity drops (index rises), and equity liquidity increases, while bond spreads go up. These trends are significantly more pronounced for low-rated bonds (right panel in the figure).

[Insert Tables 9 & 11 here]

We repeat Fama-MacBeth regressions separately for 1995-1999 and 2000-2004 sub-periods. Table 11 shows that adjusted R^2s are much higher for all regressions in the second sub-period largely due to higher marginal effect of equity volatility. Table 9 indicates a substantial contribution of volatility during the recessionary period (adjusted R^2 of 85.49% and 58.85% respectively in the second and first sub-period). However, liquidity variables play a greater role during the growth period (adjusted R^2 of 28.52% and 7.76% respectively during 1995-99 and 2000-04). The 2000-2004 recessionary period has higher volatility and liquidity shock impact on spreads (columns 6 and 7). However, relative shock analysis shows that the effect of 1σ volatility shock is significantly higher in the recessionary period (80.20%), while 1σ liquidity shock has a stronger effect in the growth period (42.29%).

6.6 High and low market volatility periods

To explore the conditioning effects of aggregate market volatility, we partition the 1995-2004 period into 60 months each of high and low market volatility (VIX) regimes based on the 10-year median value of VIX, and repeat Fama-MacBeth tests.

[Insert Tables 9 & 12 here]

Table 12 (regression 2b) reveals that volatility is more significant during high-VIX periods (adjusted R^2 of 43.78% vs. 34.79%). Table 9 shows that liquidity variables have higher incremental power during low-VIX regimes (relative contribution to adjusted R^2 of 20.48% vs. 12.56%). Shock analysis reveal that 1σ positive shock to volatility has a higher relative impact of 75.38% during high-VIX periods; similar shock to liquidity elicits a stronger relative impact of 35.53% during low-VIX regimes.

6.7 High and low bond market liquidity periods

Finally, we examine the differential impact of volatility and liquidity during high and low (bond) market liquidity periods, where market liquidity is the equally-weighted average of bond liquidity index 1 values of all bonds each month (as in Section 5.4). We define 60 months each of high and low market liquidity regimes depending on whether aggregate bond price impact values are above or below the full-sample median value.

[Insert Table 9 here]

We find that volatility is more significant during low market liquidity regimes (Table 9 shows relative contribution to adjusted R^2 of 82.63% (64.29%) in low- (high-) liquidity periods); but liquidity variables have higher incremental explanatory power during high-liquidity regimes (relative contribution to adjusted R^2 of 10.93% (23.07%) in low- (high-) liquidity periods). Shock analysis confirm these results. While low market liquidity regimes have higher absolute shock impacts, relatively volatility (liquidity) matters substantially during low (high) market liquidity period.

In summary, analysis in Sections 6.5 through 6.7 imply that *high distress regimes* (recessionary years, and high equity volatility or low bond liquidity periods), in general, experience higher *absolute* impacts of shocks to both volatility and liquidity. Distress regimes, therefore, witness higher credit and liquidity shocks. However, *relatively*, equity volatility effects are substantially higher during *high distress regimes*, whereas the effects of bond liquidity variables are more pronounced during *low distress regimes* (high growth years, and low equity volatility or high bond liquidity periods).

Our findings imply that *relative* effects of volatility (liquidity) shocks on spreads can be severely magnified during high (low) distress periods.

7. Conclusions

The primary objective of this paper is to explore the relative importance of bond liquidity and equity volatility in jointly explaining corporate bond spreads. We specifically investigate whether idiosyncratic risk subsumes information contained in bond illiquidity while predicting bond yield spreads.

Cross-correlations between equity volatility and bond liquidity variables are low, implying that they are unlikely to subsume each other in bond pricing. Portfolio analysis (univariate and bivariate) indicate that bond spreads co-vary with liquidity as well as volatility measures. Unconditional Fama-Macbeth regressions reveal that both volatility and liquidity are significant in explaining bond spreads; equity volatility, however, has the first-order impact, and bond liquidity (represented by bond characteristics and bond price impact measures) has the second-order effect on bond spreads. These results and conclusions remain unaltered when we (a) control for term-structure, default, market volatility and aggregate liquidity factor betas, (b) control for equity liquidity, (c) adopt alternate measures of liquidity and volatility, (d) use bond portfolios, and (e) orthogonalize liquidity and volatility measures.

Conditional cross-sectional regressions after partitioning the bond sample based on relative distress characteristics of the securities, and subdividing the time-period based on comparative distress reveal the *absolute* and *relative* significance of the two effects for different portfolios and under different regimes. On an *absolute* basis, we find that distressed bonds (bonds with low ratings, low liquidity, and high equity volatility) and distress regimes (recessionary years, and high equity volatility and low bond liquidity periods) experience higher impact of shocks to both volatility and liquidity. Since idiosyncratic volatility shock translates to higher ex-ante credit risk, distressed bonds and distress regimes in corporate bonds are thus characterized by higher credit and liquidity shocks. However, *relatively*, idiosyncratic volatility effects are considerably more prominent for distressed bonds and Industrials and Utilities, and during high distress regimes. On the other hand, liquidity variables have comparatively higher information content, and exert *relatively* greater impact on bond spreads of low distress bonds and Financials, and during low distress regimes.

Our results imply that bond pricing models can deliver improved pricing and hedging performance by incorporating the relative significance of equity volatility and bond liquidity effects for different distress portfolios and regimes. Our results also indicate a need for regime-switching models for bond spreads that can better incorporate the varying effects of volatility and liquidity across distress regimes (for e.g., Watanabe and Watanabe (2008) and Acharya et al.(2008) explore the presence of liquidity regimes in equity and corporate debt markets respectively).

Further, our findings imply that idiosyncratic risk does not subsume the information content in bond liquidity in explaining corporate bond spreads, unlike the results documented by Spiegel and Wang (2005) for equity markets. Corporate bond markets are inherently more illiquid compared to the equity markets, thereby rendering it much harder to diversify liquidity. This perhaps can explain why no significant overlap exists in the explanatory powers of idiosyncratic risk and bond liquidity on bond spreads.

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Table 1
Summary statistics

The table reports the number of observations (bond trades) and average yield spreads in percentage (first and second rows respectively) for different sub-samples of bonds based on industry, rating, maturity, and time period. FIN, IND, and UTL refer to Financial, Industrial, and Utility firms. ≤BB indicates bonds with BB or lower ratings.

Number of observations and average bond spreads by industry, rating, maturity and time period

	By Industry			By Rating				
	FIN	IND	UTL	AA	A	BBB	≤BB	Total
By Maturity								
Long-Term	5,039	21,406	1,720	2,901	13,778	9,616	1,870	28,165
> 15 years	0.97	1.28	1.37	0.58	0.81	1.49	4.03	1.23
Medium-Term	23,062	29,624	5,497	7,514	30,295	16,642	3,732	58,183
7-15 years	0.57	0.79	0.67	0.24	0.46	0.88	2.68	0.69
Short-Term	44,607	53,603	11,527	12,056	56,422	32,338	8,921	109,737
1-7 years	0.64	1.31	1.19	0.27	0.49	1.17	4.86	1.02
By Time Period								
1994-1999	42,091	61,503	12,336	14,414	58,585	36,203	6,728	115,930
	0.49	0.64	0.46	0.22	0.38	0.73	2.09	0.57
2000-2004	30,617	43,130	6,408	8,057	41,910	22,393	7,795	80,155
	0.85	1.89	2.19	0.45	0.73	1.81	6.00	1.52
Total	72,708	104,633	18,744	22,471	100,495	58,596	14,523	196,085
	0.64	1.16	1.05	0.30	0.53	1.14	4.19	0.96

Table 2
Variable definitions

The table defines the volatility and liquidity measures and bond market factors used in the paper.

Volatility measures (Sources: CRSP, WRDS)

1. Total 6-month return variance: Daily total stock return variance with autocorrelation adjustment (French et al.,1987) in the six months prior to the transaction date.
2. Id. Volatility (3-factor, monthly): Idiosyncratic volatility computed as the variance of residuals from the application of Fama-French 3-factor model on 6 months of monthly stock returns prior to the transaction date.
3. Id. Volatility (4-factor, monthly): Idiosyncratic volatility computed as the variance of residuals from the application of Fama-French 4-factor model on 6 months of monthly stock returns prior to the transaction date.
4. Id. Volatility (3-factor, daily): Idiosyncratic volatility computed as the variance of residuals from the application of Fama-French 3-factor model on 125 days of daily stock returns prior to the transaction date.
5. Id. Volatility (4-factor, daily): Idiosyncratic volatility computed as the variance of residuals from the application of Fama-French 4-factor model on 125 days of daily stock returns prior to the transaction date.

All the volatility measures are reported on an annualized basis, i.e. scaled by 12 (252) for monthly (daily) data.

Liquidity measures (Sources: FISD, NAIC, CRSP)

1. Issue or offer amount (in 000's of dollars).
2. Amount outstanding (in 000's of dollars).
3. Age of the issue (in years).
4. Time to maturity (in years).
5. Coupon rate (in %).
6. Dummy for financial issue (1 if the issuer is a financial firm, 0 otherwise).
7. Trade size (in 000's of dollars): based on NAIC variable "actual_cost" if it is a buy trade, and NAIC variable "consideration" if it is a sell trade.
8. Annual trading frequency: number of transactions in one year prior to the transaction date.
9. Bond liquidity index 1: bond price impact variable calculated based on the transaction prices of all trades in one year prior to the transaction date as: $10^8 \times (\sigma_{\text{prices}}) / \text{total volume}$, where σ_{prices} is the standard deviation of transaction prices of all trades and total volume is the dollar volume of all trades in the one year prior to the transaction date. Higher price impact values imply lower liquidity.
10. Bond liquidity index 2: bond price impact variable calculated based on the transaction prices of all trades in one year prior to the transaction date as: $10^8 \times \left(\frac{\text{maximum price} - \text{minimum price}}{\text{average price}} \right) \Big/ \text{total volume}$, where total volume is defined as in variable 9 above. Higher price impact values imply lower liquidity.
11. Equity liquidity: Inverse of Amihud (2002) equity impact measure computed over a 125-day window as inverse of $\sum_{k=1}^{125} 10^8 \times \left(|\text{returns}_{t-k}| / \text{\$ trading volume}_{t-k} \right) / 125$ (excluding days of zero trading volume). It measures the inverse of the cumulative price impact of order flow. Higher price impact values imply higher liquidity.

Bond market factors (Source: DATASTREAM)

1. Term-structure factor (TERM): 10-year swap rate minus 2-year swap rate.
2. Default factor (DEF): Moody's BAA yield minus 10-year swap rate.
3. Liquidity factor: equally-weighted average of bond liquidity index 1 values of all bonds each month
4. Volatility factor: VIX index

Table 3
Summary statistics and correlations
The table presents summary statistics and correlations for all volatility and liquidity measures used in the paper.

Panel A: Summary statistics of all equity volatility measures

	Obs	Mean	Median	Std. Dev.	Min	Max
Total 6-month return variance	163,304	0.15	0.10	0.18	0.01	2.53
Id. Volatility (3- factor, monthly)	162,278	0.06	0.04	0.09	0.00	1.37
Id. Volatility (4-factor, monthly)	162,278	0.06	0.03	0.09	0.00	1.19
Id. Volatility (3-factor, daily)	162,815	0.10	0.07	0.13	0.01	1.81
Id. Volatility (4-factor, daily)	162,815	0.10	0.07	0.13	0.01	1.79

Panel B: Summary statistics of all bond and equity liquidity measures

	Obs	Mean	Median	Std. Dev.	Min	Max
Issued amount	196,085	388,616	250,000	401,132	25,000	2,750,000
Amount outstanding	195,689	385,936	250,000	402,305	4,826	2,750,000
Issue age	196,085	3.80	3.31	3.15	0.00	67.56
Time to maturity	196,085	8.67	6.27	8.53	1.01	98.60
Coupon amount	196,085	7.29	7.12	1.11	0.00	15.00
Dummy for financials	196,085	0.37	0.00	0.48	0.00	1
Trade size	196,063	2,772	1,130	3,934	1	35,585
Annual trading frequency	196,063	32.46	18.00	42.41	1.00	381.00
Bond liquidity index 1	194,034	15.72	4.00	66.71	0.00	1,246.36
Bond liquidity index 2	196,063	0.40	0.12	1.57	0.00	31.77
Equity liqudity	163,304	0.41	0.18	0.61	0.00	5.76

Panel C: Correlations of all equity volatility measures

	Total 6-month return variance	Id. Volatility (3-factor, monthly)	Id. Volatility (4-factor, monthly)	Id. Volatility (3-factor, daily)	Id. Volatility (4-factor, daily)	Yield Spread
Total 6-month return variance	1.00					
Id. Volatility (3-factor, monthly)	0.66	1.00				
Id. Volatility (4-factor, monthly)	0.62	0.91	1.00			
Id. Volatility (3-factor, daily)	0.94	0.69	0.65	1.00		
Id. Volatility (4-factor, daily)	0.93	0.69	0.65	1.00	1.00	
Yield Spread	0.59	0.50	0.46	0.63	0.63	1.00

Panel D: Correlations of all bond and equity liquidity measures

	Issued amount	Amount outstanding	Issue age	Time to maturity	Coupon amount	Dummy for financials	Trade size	Annual trading frequency	Bond liquidity index 1	Bond liquidity index 2	Equity liquidity	Yield spread
Issued amount	1.00											
Amount outstanding	1.00	1.00										
Issue age	-0.23	-0.24	1.00									
Time to maturity	-0.05	-0.05	-0.08	1.00								
Coupon amount	-0.19	-0.20	0.40	0.10	1.00							
Dummy for financials	0.23	0.23	-0.16	-0.13	-0.16	1.00						
Trade size	-0.01	-0.01	-0.04	0.13	0.05	-0.04	1.00					
Annual trading frequency	0.80	0.80	-0.37	-0.03	-0.25	0.22	0.00	1.00				
Bond liquidity index 1	-0.07	-0.08	0.09	0.00	0.04	-0.01	-0.07	-0.08	1.00			
Bond liquidity index 2	-0.07	-0.07	0.09	0.00	0.02	-0.01	-0.08	-0.07	0.96	1.00		
Equity liquidity	0.35	0.35	0.12	0.01	-0.14	0.16	-0.02	0.21	-0.04	-0.04	1.00	
Yield spread	-0.04	-0.04	0.11	0.01	0.13	-0.10	-0.05	-0.05	0.16	0.25	-0.12	1.00

Panel E: Cross-correlations between all liquidity and volatility measures

	Total 6-month return variance	Id. Volatility (3-factor, monthly)	Id. Volatility (4-factor, monthly)	Id. Volatility (3-factor, daily)	Id. Volatility (4-factor, daily)
Issued amount	0.12	0.00	0.01	0.04	0.04
Amount outstanding	0.12	0.00	0.01	0.04	0.04
Issue age	0.01	0.05	0.04	0.02	0.02
Time to maturity	-0.04	-0.03	-0.03	-0.03	-0.03
Coupon amount	0.00	0.03	0.02	0.04	0.04
Dummy for financials	0.03	-0.10	-0.09	-0.09	-0.08
Trade size	-0.04	-0.04	-0.04	-0.04	-0.04
Annual trading frequency	0.12	0.03	0.04	0.05	0.05
Bond liquidity index 1	0.10	0.10	0.08	0.11	0.11
Bond liquidity index 2	0.19	0.19	0.16	0.20	0.20
Equity liquidity	-0.04	-0.10	-0.09	-0.10	-0.11

Table 4
Univariate portfolio results

The table presents average values of bond yield spreads, liquidity and volatility variables and other bond characteristics along univariate portfolios formed based on bond liquidity index 1 and 3-factor daily idiosyncratic volatility. For each variable, quintiles are formed based on the sorted values of the measure, and observations are allocated to five portfolios depending on the value of the measure on the bond transaction date. Reported *F*-statistics correspond to one-way ANOVA tests for null hypothesis of equality of variable under consideration across portfolios.

Panel A:

Average bond characteristics and volatility measures for portfolios based on bond liquidity index 1

Bond liquidity index 1	Rating value	Time to maturity	Duration	Yield	Yield spread	Total 6-month return variance	Id. Volatility (3-factor, monthly)	Id. Volatility (4-factor, monthly)	Id. Volatility (3-factor, daily)	Id. Volatility (4-factor, daily)
Low	6.59	7.64	5.31	6.45	0.55	0.17	0.06	0.06	0.10	0.10
2	6.94	8.53	5.52	6.46	0.63	0.13	0.05	0.05	0.09	0.09
3	7.00	8.83	5.62	6.53	0.76	0.13	0.05	0.05	0.09	0.09
4	7.05	9.17	5.71	6.69	0.93	0.13	0.06	0.05	0.09	0.09
High	7.72	9.13	5.62	7.60	1.91	0.18	0.09	0.08	0.13	0.13
Total	7.06	8.66	5.55	6.74	0.95	0.15	0.06	0.06	0.10	0.10
F-stat	*1,116.44*	*211.10*	*106.44*	*2,134.42*	*3,226.00*	*570.02*	*824.35*	*665.20*	*631.71*	*635.92*

Average liquidity measures for portfolios based on bond liquidity index 1

Bond liquidity index 1	Issued amount	Amount outstanding	Issue age	Coupon amount	Dummy for financials	Trade size (exact)	Annual trading frequency	Bond liquidity index 1	Bond liquidity index 2	Equity liquidity
Low	736,597	735,977	1.72	6.86	0.46	3,387	81.35	0.67	0.03	0.49
2	428,618	427,518	3.08	7.18	0.38	3,204	34.89	1.96	0.07	0.45
3	323,976	321,909	4.15	7.33	0.36	3,006	21.99	4.08	0.13	0.43
4	254,894	251,801	4.74	7.45	0.36	2,557	15.35	8.77	0.26	0.38
High	211,225	206,330	5.24	7.59	0.30	1,703	10.33	63.13	1.55	0.29
Total	391,115	388,490	3.79	7.28	0.37	2,771	32.79	15.72	0.41	0.41
F-stat	*13,506.48*	*13,582.37*	*9,346.18*	*2,612.17*	*559.26*	*1,161.33*	*27,786.11*	*7,119.43*	*7,442.28*	*508.97*

Panel B:

Average bond characteristics and volatility measures for portfolios based on 3-factor daily idiosyncratic volatility

Id. Volatility (3-factor, daily)	Rating value	Time to maturity	Duration	Yield	Yield spread	Total 6-month return variance	Id. Volatility (3-factor, monthly)	Id. Volatility (4-factor, monthly)	Id. Volatility (3-factor, daily)	Id. Volatility (4-factor, daily)
Low	6.39	8.68	5.82	6.18	0.43	0.04	0.02	0.02	0.02	0.02
2	6.65	9.25	5.92	6.48	0.55	0.07	0.03	0.03	0.04	0.04
3	6.88	9.12	5.75	6.53	0.65	0.10	0.04	0.04	0.07	0.07
4	7.20	9.22	5.76	6.78	0.83	0.16	0.07	0.07	0.11	0.11
High	8.16	8.22	5.22	7.94	2.07	0.36	0.15	0.14	0.26	0.26
Total	7.05	8.90	5.69	6.78	0.90	0.15	0.06	0.06	0.10	0.10
F-stat	*2,732.62*	*89.36*	*285.17*	*3,939.66*	*4,569.55*	*26,634.61*	*14,586.84*	*14,097.81*	*28,998.52*	*29,100.10*

Average liquidity measures for portfolios based on 3-factor daily idiosyncratic volatility

Id. Volatility (3-factor, daily)	Issued amount	Amount outstanding	Issue age	Coupon amount	Dummy for financials	Trade size	Annual trading frequency	Bond liquidity index 1	Bond liquidity index 2	Equity liquidity
Low	356,964	353,695	3.69	7.18	0.45	2,730	28.32	17.12	0.40	0.55
2	355,815	354,034	3.45	7.34	0.39	2,898	30.83	13.52	0.32	0.40
3	384,022	380,800	3.48	7.30	0.35	2,883	32.09	12.60	0.30	0.40
4	436,700	434,237	3.59	7.30	0.30	2,858	37.61	11.52	0.30	0.39
High	470,652	469,292	3.50	7.29	0.31	2,554	44.32	18.80	0.58	0.31
Total	400,828	398,449	3.54	7.28	0.36	2,785	34.63	14.71	0.38	0.41
F-stat	*495.62*	*501.80*	*33.09*	*94.98*	*547.21*	*44.13*	*677.56*	*80.29*	*218.71*	*677.35*

Table 5
Bivariate portfolio results

The table presents average yield spreads along bivariate portfolios formed based on nine liquidity variables and the 3-factor daily idiosyncratic volatility. Independent univariate quintiles are formed based on the sorted values of the liquidity and volatility variables and observations are allocated to 25 liquidity-volatility bivariate portfolios. The three two-way ANOVA *F*-statistics report the significance of the test of equality of spreads across univariate liquidity portfolios, univariate volatility portfolios, and bivariate liquidity-volatility portfolios respectively.

Panel A: Issue age

	Id. Volatility (3-factor, daily)					
	Low	2	3	4	High	All
Low	0.40	0.44	0.51	0.63	1.01	0.59
2	0.36	0.46	0.59	0.77	1.68	0.80
3	0.39	0.51	0.63	0.90	2.59	0.99
4	0.43	0.56	0.71	0.89	2.44	0.97
High	0.60	0.85	0.85	0.98	2.88	1.26
All	0.43	0.55	0.65	0.83	2.07	0.90

F-stat (liquidity)	*F-stat (volatility)*	*F-stat (model)*
615.48	*4,617.70*	*2,627.01*

Panel B: Coupon amount

	Id. Volatility (3-factor, daily)					
	Low	2	3	4	High	All
Low	0.32	0.38	0.45	0.54	1.22	0.58
2	0.38	0.53	0.55	0.72	1.64	0.74
3	0.46	0.56	0.70	0.84	2.35	1.00
4	0.46	0.64	0.79	1.05	2.03	1.04
High	0.57	0.63	0.77	0.98	3.29	1.20
All	0.43	0.55	0.65	0.83	2.07	0.90

F-stat (liquidity)	*F-stat (volatility)*	*F-stat (model)*
638.36	*4,628.26*	*2,639.73*

Panel C: Trade size

	Id. Volatility (3-factor, daily)					
	Low	2	3	4	High	All
Low	0.43	0.56	0.66	0.94	2.92	1.14
2	0.40	0.53	0.66	0.87	2.52	1.04
3	0.40	0.52	0.62	0.79	1.87	0.82
4	0.45	0.55	0.66	0.81	1.61	0.81
High	0.47	0.57	0.65	0.74	1.16	0.71
All	0.43	0.55	0.65	0.83	2.07	0.90

F-stat (liquidity)	*F-stat (volatility)*	*F-stat (model)*
245.91	*4,502.83*	*2,420.24*

Panel D: Annual trading frequency

	Id. Volatility (3-factor, daily)					
	Low	2	3	4	High	All
Low	0.45	0.62	0.75	1.00	2.41	0.93
2	0.45	0.55	0.72	0.93	2.28	0.93
3	0.44	0.54	0.65	0.82	2.57	0.97
4	0.40	0.53	0.59	0.84	2.54	0.99
High	0.38	0.47	0.53	0.64	1.18	0.71
All	0.43	0.55	0.65	0.83	2.07	0.90

F-stat (liquidity)	*F-stat (volatility)*	*F-stat (model)*
413.69	*4,881.08*	*2,513.54*

Panel E: Amount outstanding

	Id. Volatility (3-factor, daily)					
	Low	2	3	4	High	All
Low	0.42	0.60	0.74	0.93	2.32	0.93
2	0.45	0.51	0.64	0.86	2.64	1.00
3	0.40	0.52	0.65	0.93	2.07	0.86
4	0.46	0.53	0.62	0.79	2.35	1.01
High	0.39	0.49	0.50	0.62	1.24	0.72
All	0.42	0.54	0.64	0.83	2.07	0.90

F-stat (liquidity)	*F-stat (volatility)*	*F-stat (model)*
283.33	*4,793.16*	*2,461.18*

Panel F: Time to maturity

	Id. Volatility (3-factor, daily)					
	Low	2	3	4	High	All
Low	0.39	0.53	0.65	0.78	2.84	1.14
2	0.38	0.48	0.55	0.79	1.86	0.88
3	0.36	0.49	0.59	0.83	2.33	0.91
4	0.37	0.47	0.56	0.73	1.07	0.61
High	0.64	0.76	0.87	0.99	2.09	1.03
All	0.43	0.55	0.65	0.83	2.07	0.90

F-stat (liquidity)	*F-stat (volatility)*	*F-stat (model)*
316.43	*4,490.23*	*2,460.70*

Panel G: Bond liquidity index 1

	Id. Volatility (3-factor, daily)					
	Low	2	3	4	High	All
Low	0.40	0.50	0.46	0.58	0.72	0.55
2	0.37	0.44	0.59	0.70	0.95	0.61
3	0.41	0.52	0.67	0.82	1.35	0.72
4	0.48	0.57	0.70	0.93	2.08	0.90
High	0.46	0.70	0.86	1.32	5.24	1.80
All	0.43	0.55	0.65	0.83	2.06	0.90

F-stat (liquidity)	*F-stat (volatility)*	*F-stat (model)*
2,876.10	*4,922.14*	*3,855.54*

Panel H: Bond liquidity index 2

	Id. Volatility (3-factor, daily)					
	Low	2	3	4	High	All
Low	0.39	0.45	0.48	0.59	0.73	0.55
2	0.39	0.49	0.58	0.67	0.95	0.61
3	0.41	0.51	0.67	0.80	1.24	0.70
4	0.46	0.59	0.69	0.96	1.76	0.84
High	0.47	0.69	0.88	1.34	5.27	1.89
All	0.43	0.55	0.65	0.83	2.07	0.90

F-stat (liquidity)	*F-stat (volatility)*	*F-stat (model)*
3,223.97	*4,836.23*	*4,076.36*

Panel I: Equidity liquidity

	Id. Volatility (3-factor, daily)					
	Low	2	3	4	High	All
Low	0.54	0.76	0.92	1.30	3.79	1.68
2	0.40	0.54	0.67	0.82	2.20	0.93
3	0.40	0.52	0.60	0.80	1.55	0.77
4	0.40	0.45	0.58	0.72	1.17	0.65
High	0.42	0.51	0.49	0.51	0.62	0.51
All	0.43	0.55	0.65	0.83	2.07	0.90

F-stat (liquidity)	*F-stat (volatility)*	*F-stat (model)*
1,670.25	*4,184.62*	*3,213.10*

Table 6

Fama-MacBeth regressions

The table presents the results of two-stage Fama-MacBeth regressions for individual bonds over the sample period 1994-2004. Each month, cross-sectional regressions of bond yield spreads are carried out on issue-specific bond characteristics (char) and liquidity and volatility values. For each regression, the first row reports the coefficients as the time-series average of 132 monthly regression slopes and the second row presents *t*-statistics computed as the ratio of time-series average slope to the time-series standard error of monthly slopes with Newey-West adjustment for serial correlation. The liquidity index (liq indx) and volatility measure (vol meas) refer to bond liquidity index 1 and 3-factor daily idiosyncratic volatility respectively.

	Bond Characteristics								Liquidity & Volatility measures		
Regression variables	Rating	Duration	Amount outstanding ($x 10^{-6}$)	Issue Age	Maturity	Coupon	Trade size ($x 10^{-6}$)	Trade frequency ($x 10^{-2}$)	Liquidity index	Volatility measure	Adjusted R^2
1 a) Liq Indx									0.007		4.42%
									8.16		
b) Vol Meas										9.16	32.99%
										18.52	
c) Liq Indx + Vol Meas									0.004	8.92	35.18%
									7.12	*18.33*	
2 a) Liq Indx	0.34	0.01							0.005		37.71%
	16.40	*1.74*							*7.75*		
b) Vol Meas	0.22	0.02								6.12	48.96%
	19.65	*4.79*								*17.07*	
c) Liq Indx + Vol Meas	0.21	0.02							0.004	5.93	50.97%
	19.89	*4.66*							*7.36*	*17.16*	
3 a) Char	0.34	-0.07	0.10		0.03	0.07	-0.02				37.67%
	15.83	*-6.79*	*5.05*		*10.41*	*8.20*	*-9.51*				
b) Char + Liq Indx	0.33	-0.06	0.15		0.03	0.06	-0.01		0.005		40.37%
	15.94	*-6.72*	*7.51*		*10.77*	*7.05*	*-8.09*		*7.55*		
c) Char + Liq Indx + Vol Meas	0.20	-0.05	0.03		0.03	0.07	-0.01		0.003	5.80	53.70%
	18.50	*-4.10*	*1.38*		*5.58*	*8.93*	*-4.81*		*7.30*	*17.35*	
d) Char + Vol Meas	0.21	-0.05	-0.02		0.03	0.08	-0.01			5.99	52.03%
	18.21	*-3.95*	*-0.88*		*5.13*	*10.04*	*-6.31*			*17.45*	
4 a) Char	0.35	-0.07	0.10	0.01	0.03		-0.02				36.93%
	16.28	*-7.15*	*4.59*	*2.87*	*11.13*		*-9.35*				
b) Char + Liq Indx	0.34	-0.07	0.14	0.00	0.03		-0.01		0.005		39.71%
	16.33	*-7.25*	*6.55*	*0.38*	*11.51*		*-7.98*		*7.54*		
c) Char + Liq Indx + Vol Meas	0.21	-0.05	0.02	0.01	0.03		-0.01		0.003	5.83	52.99%
	19.41	*-4.19*	*0.78*	*2.09*	*5.98*		*-4.50*		*7.28*	*17.44*	
d) Char + Vol Meas	0.22	-0.05	-0.02	0.01	0.03		-0.01			6.03	51.28%
	19.25	*-3.84*	*-0.88*	*4.28*	*5.36*		*-5.92*			*17.57*	
5 a) Char	0.34	-0.07			0.03	0.07	-0.02	0.08			37.60%
	15.92	*-6.77*			*10.16*	*8.35*	*-9.41*	*3.29*			
b) Char + Liq Indx	0.33	-0.07			0.03	0.07	-0.01	0.15	0.005		40.26%
	16.03	*-6.85*			*10.53*	*7.32*	*-7.93*	*5.91*	*7.43*		
c) Char + Liq Indx + Vol Meas	0.20	-0.05			0.03	0.08	-0.01	0.03	0.003	5.84	53.44%
	18.67	*-4.21*			*5.48*	*9.38*	*-4.69*	*1.23*	*7.20*	*17.05*	
d) Char + Vol Meas	0.20	-0.05			0.03	0.09	-0.01	-0.02		6.02	51.81%
	18.34	*-3.92*			*4.94*	*10.50*	*-6.21*	*-0.97*		*17.16*	

Table 7

Fama-MacBeth regressions augmented with bond market factor betas

The table presents the results of two-stage Fama-MacBeth regressions augmented with bond market factor betas for individual bonds over the sample period 1995-2004. The bond market factor betas are computed each month as slopes in the regression of past 12-24 monthly spreads of 18 bond portfolios on term and default factors. Each month, cross-sectional regressions of bond spreads are carried out on issue-specific bond characteristics (char) and liquidity and volatility values. For each regression, the first row reports the coefficients as the time-series average of 120 monthly regression slopes and the second row presents *t*-statistics computed as the ratio of time-series average slope to the time-series standard error of monthly slopes with Newey-West adjustment for serial correlation. The liquidity index (liq indx) and volatility measure (vol meas) refer to bond liquidity Index 1 and 3-factor daily idiosyncratic volatility respectively.

	Bond Characteristics						Liquidity & Volatility measures		Bond factors		
Regression variables	Amount outstanding (x 10^{-6})	Issue Age	Maturity	Coupon	Trade size (x 10^{-6})	Trade frequency (x 10^{-2})	Liquidity index	Volatility measure	Default beta	Term beta	Adjusted R^2
1 a) Liq Indx							0.007				4.85%
							8.40				
b) Vol Meas								9.46			34.99%
								17.72			
c) Liq Indx + Vol Meas							0.005	9.19			37.12%
							7.28	*17.44*			
2 a) Liq Indx							0.007		0.71	0.41	16.43%
							8.66		*7.36*	*3.44*	
b) Vol Meas								8.68	0.37	0.08	39.28%
								17.33	*6.76*	*1.23*	
c) Liq Indx + Vol Meas							0.004	8.42	0.37	0.10	41.31%
							7.57	*17.10*	*6.61*	*1.53*	
3 a) Char	-0.12		0.02	0.22	-0.03				0.69	0.34	19.25%
	-6.46		*12.53*	*12.56*	*-9.25*				*6.89*	*2.76*	
b) Char + Liq Indx	-0.05		0.02	0.20	-0.02		0.006		0.68	0.36	22.88%
	-2.24		*11.96*	*11.67*	*-8.39*		*8.15*		*6.93*	*2.94*	
c) Char + Liq Indx + Vol Meas	-0.12		0.01	0.14	-0.01		0.004	8.18	0.34	0.05	46.91%
	-6.31		*7.31*	*13.72*	*-5.29*		*7.12*	*17.36*	*6.34*	*0.80*	
d) Char + Vol Meas	-0.17		0.01	0.15	-0.01			8.42	0.34	0.04	45.31%
	-8.31		*7.62*	*14.93*	*-6.60*			*17.53*	*6.61*	*0.56*	
4 a) Char	-0.23	0.00	0.02		-0.03				0.75	0.38	16.31%
	-10.60	*-0.83*	*14.48*		*-9.08*				*7.34*	*3.01*	
b) Char + Liq Indx	-0.17	-0.01	0.02		-0.02		0.007		0.74	0.39	20.31%
	-7.67	*-3.26*	*13.96*		*-8.06*		*8.35*		*7.38*	*3.21*	
c) Char + Liq Indx + Vol Meas	-0.18	0.00	0.01		-0.01		0.004	8.39	0.37	0.07	45.13%
	-9.01	*-0.24*	*9.20*		*-4.44*		*7.35*	*17.47*	*6.75*	*1.09*	
d) Char + Vol Meas	-0.22	0.01	0.01		-0.01			8.66	0.38	0.06	43.36%
	-10.65	*1.79*	*9.70*		*-5.86*			*17.69*	*7.02*	*0.80*	
5 a) Char			0.02	0.22	-0.03	-0.10			0.69	0.34	19.34%
			12.36	*12.94*	*-9.27*	*-4.30*			*6.91*	*2.73*	
b) Char + Liq Indx			0.01	0.21	-0.02	0.00	0.006		0.68	0.35	22.98%
			11.91	*12.07*	*-8.32*	*0.18*	*8.19*		*6.97*	*2.91*	
c) Char + Liq Indx + Vol Meas			0.01	0.15	-0.01	-0.09	0.004	8.17	0.34	0.05	46.66%
			7.07	*13.91*	*-5.28*	*-3.66*	*7.18*	*17.21*	*6.31*	*0.83*	
d) Char + Vol Meas			0.01	0.16	-0.01	-0.15		8.41	0.35	0.04	45.07%
			7.35	*14.96*	*-6.64*	*-6.04*		*17.38*	*6.56*	*0.58*	

Table 8

Fama-MacBeth regressions based on rating groups

The table presents the results of Fama-MacBeth regressions for individual bonds sorted into two ratings portfolios over the period 1995-2004. High (low) ratings refer to ratings AA or A (BBB or below). Each month, cross-sectional regressions of bond spreads are carried out on bond characteristics (char) and liquidity and volatility values. For each regression, the first row reports the coefficients as the time-series average of 120 monthly regression slopes and the second row presents *t*-statistics computed as the ratio of time-series average slope to the standard error of monthly slopes with Newey-West correction. Bond liquidity index 1 is liq indx and 3-factor daily idiosyncratic volatility is vol meas.

Panel A: Low-rated (BBB and BB) bonds

	Bond Characteristics				Liquidity & Volatility measures		Bond factors		
Regression variables	Amount outstanding (x 10^{-6})	Maturity	Coupon	Trade size (x 10^{-6})	Liquidity index	Volatility measure	Default beta	Term beta	Adjusted R^2
1 a) Liq Indx					0.015				10.48%
					9.10				
b) Vol Meas						9.60			38.45%
						11.98			
c) Liq Indx + Vol Meas					0.009	8.98			42.45%
					6.92	*11.67*			
2 a) Liq Indx					0.015		0.27	0.30	14.41%
					9.67		*1.81*	*1.76*	
b) Vol Meas						9.57	0.09	0.12	40.43%
						12.15	*1.15*	*1.29*	
c) Liq Indx + Vol Meas					0.009	8.96	0.08	0.14	44.30%
					7.06	*11.85*	*0.99*	*1.50*	
3 a) Char	-0.24	0.01	0.33	-0.07			0.41	0.33	12.35%
	-2.44	*4.13*	*7.41*	*-6.43*			*2.35*	*1.60*	
b) Char + Liq Indx	0.19	0.01	0.28	-0.05	0.014		0.38	0.36	20.52%
	2.13	*2.23*	*6.45*	*-5.91*	*9.17*		*2.20*	*1.83*	
c) Char + Liq Indx + Vol Meas	-0.35	0.00	0.22	-0.03	0.008	8.81	0.12	0.15	49.64%
	-2.95	*0.58*	*9.19*	*-4.88*	*6.27*	*11.93*	*1.54*	*1.45*	
d) Char + Vol Meas	-0.57	0.01	0.24	-0.04		9.34	0.14	0.14	46.76%
	-4.04	*1.07*	*10.03*	*-5.43*		*12.04*	*1.80*	*1.40*	

Panel B: High-rated (AA and A) bonds

	Bond Characteristics				Liquidity & Volatility measures		Bond factors		
Regression variables	Amount outstanding (x 10^{-6})	Maturity	Coupon	Trade size (x 10^{-6})	Liquidity index	Volatility measure	Default beta	Term beta	Adjusted R^2
1 a) Liq Indx					0.001				1.06%
					5.31				
b) Vol Meas						2.02			4.50%
						6.57			
c) Liq Indx + Vol Meas					0.001	2.03			5.85%
					4.32	*6.64*			
2 a) Liq Indx					0.001		0.05	-0.05	3.71%
					5.32		*0.62*	*-0.72*	
b) Vol Meas						2.05	0.09	-0.14	7.22%
						6.56	*0.97*	*-1.99*	
c) Liq Indx + Vol Meas					0.001	2.04	0.09	-0.15	8.57%
					4.34	*6.58*	*0.93*	*-2.02*	
3 a) Char	-0.06	0.01	0.07	0.00			0.07	-0.08	13.41%
	-4.42	*12.88*	*10.02*	*-1.35*			*0.97*	*-1.19*	
b) Char + Liq Indx	-0.05	0.01	0.07	0.00	0.001		0.06	-0.09	14.36%
	-3.58	*12.84*	*9.67*	*-0.76*	*4.98*		*0.86*	*-1.19*	
c) Char + Liq Indx + Vol Meas	-0.06	0.01	0.06	0.00	0.001	1.96	0.08	-0.19	20.16%
	-4.19	*12.22*	*9.47*	*1.46*	*4.07*	*6.50*	*0.91*	*-2.45*	
d) Char + Vol Meas	-0.07	0.01	0.06	0.00		1.97	0.09	-0.19	18.95%
	-5.05	*12.23*	*9.87*	*0.77*		*6.57*	*0.96*	*-2.49*	

Table 9

Summary of Fama-MacBeth regressions

The table presents the summary of Fama-MacBeth regressions corresponding to different portfolios based on cross-sectional attributes and market conditions over the period 1995-2004. Columns 1 and 2 below refer to the incremental contribution of volatility (based on regression 1b) and liquidity variables (based on regressions 3c vs. 2b) in Tables 7, 8, 10, 11, and 12 (and other unreported tables). Column 3 refers to the corresponding total adjusted R^2 of regression 3c. Columns 4 and 5 capture the contribution of volatility and liquidity as a proportion of total adjusted R^2, and are obtained as (column 1)/(column 3) and (column 2)/(column 3) values. Columns 6 and 7 refer to the effect of 1σ shock to volatility and liquidity on bond spreads, in basis points, in regression 3c. Finally, columns 8 and 9 measure the effect of 1σ shocks to volatility and liquidity as a proportion of the total effect on bond spreads, and are obtained as (column 6)/(column 6 + column 7) and (column 7)/(column 6 + column 7) values. Overall, we consider four (three) sub-samples based on portfolio characteristics (market conditions). High (low) ratings refer to bonds with ratings AA or A (BBB or below). Low (high) idiosyncratic volatility issues refer to bonds whose underlying stock volatility values are below (above) the corresponding annual median values. Low (high) bond liquidity issues refer to bonds whose liquidity index 1 values are above (below) the corresponding annual median values. Low (high) VIX regime refers to months when VIX values are below (above) the full-period median. Low (high) market liquidity regime refers to months when aggregate liquidity (obtained as equally-weighted average of liquidity index 1 measure for all bonds) is above (below) the full-sample median. In columns 4, 5, 8 and 9 below, we further high-light that sub-sample where a given variable has the maximum contribution.

	Absolute contribution to adjusted R^2			Relative contribution to adjusted R^2		Absoute impact on spread (in bps) due to 1σ shock		Relative impact on spread due to 1σ shock	
	Volatility	Liquidity	Total	Volatility	Liquidity	Volatility	Liquidity	Volatility	Liquidity
	1	2	3	4	5	6	7	8	9
				(1)/(3)	(2)/(3)			(6)/(6+7)	(7)/(6+7)
From Table 7									
All bonds	34.99%	7.63%	46.91%	74.59%	16.27%	109	42	72.01%	27.99%
Sub-Samples Based on Cross-sectional Attributes									
From Table 8									
Low-rated	38.45%	9.21%	49.64%	77.46%	18.55%	171	54	75.80%	24.20%
High-rated	4.50%	12.94%	20.16%	22.32%	64.19%	13	20	39.77%	60.23%
From Table 10									
High idiosyncratic volatility	36.35%	8.87%	50.92%	71.39%	17.42%	144	64	69.19%	30.81%
Low idiosyncratic volatility	1.76%	12.63%	23.09%	7.62%	54.70%	10	26	28.80%	71.20%
Unreported Table									
Low bond liquidity	40.96%	6.26%	51.76%	79.13%	12.09%	150	53	73.75%	26.25%
High bond liquidity	11.18%	11.10%	30.80%	36.30%	36.04%	32	21	60.67%	39.33%
Unreported Table									
Industrials and Utilities	34.53%	8.71%	48.29%	71.51%	18.04%	124	46	72.93%	27.07%
Financials	18.18%	10.54%	40.88%	44.47%	25.78%	46	43	51.72%	48.28%
Sub-Samples Based on Market Conditions									
From Table 11									
Recessionary period (2000-2004)	47.38%	4.30%	55.42%	85.49%	7.76%	203	50	80.20%	19.80%
High growth period (1995-1999)	22.60%	10.95%	38.40%	58.85%	28.52%	46	34	57.71%	42.29%
From Table 12									
High VIX	39.24%	6.29%	50.07%	78.37%	12.56%	120	39	75.38%	24.62%
Low VIX	30.74%	8.96%	43.75%	70.26%	20.48%	76	42	64.47%	35.53%
Unreported Table									
Low bond market liquidity	43.53%	5.76%	52.68%	82.63%	10.93%	181	43	80.85%	19.15%
High bond market liquidity	26.45%	9.49%	41.14%	64.29%	23.07%	59	33	63.83%	36.17%

Table 10
Fama-MacBeth regressions based on underlying idiosyncratic volatility

The table presents the results of Fama-MacBeth regressions for individual bonds sorted into two equity volatility portfolios over the period 1995-2004. Low (high) idiosyncratic volatility issues refer to bonds whose underlying stock volatility values are below (above) the corresponding annual median values. Each month, cross-sectional regressions of bond spreads are carried out on bond characteristics (char) and liquidity and volatility values. For each regression, the first row reports the coefficients as the time-series average of 120 monthly regression slopes and the second row presents *t*-statistics computed as the ratio of time-series average slope to the standard error of monthly slopes with Newey-West correction. Bond liquidity index 1 is liq indx and 3-factor daily idiosyncratic volatility is vol meas.

Panel A: Low Idiosyncratic Volatility (Below Median) Issues

					Liquidity & Volatility measures		Bond factors		
Regression variables	Amount outstanding (x 10^{-6})	Maturity	Coupon	Trade size (x 10^{-6})	Liquidity index	Volatility measure	Default beta	Term beta	Adjusted R^2
1 a) Liq Indx					0.002				2.18%
					5.05				
b) Vol Meas						5.81			1.76%
						4.77			
c) Liq Indx + Vol Meas					0.002	5.89			3.97%
					5.07	*4.87*			
2 a) Liq Indx					0.002		0.26	0.03	10.96%
					5.16		*5.36*	*0.41*	
b) Vol Meas						5.17	0.26	0.01	10.46%
						4.59	*5.25*	*0.18*	
c) Liq Indx + Vol Meas					0.002	5.29	0.26	0.02	12.53%
					5.19	*4.69*	*5.09*	*0.32*	
3 a) Char	-0.10	0.02	0.08	0.00			0.26	0.00	20.32%
	-6.79	*17.09*	*10.61*	*-0.52*			*5.36*	*0.00*	
b) Char + Liq Indx	-0.08	0.02	0.07	0.00	0.002		0.26	0.01	22.19%
	-5.00	*16.15*	*9.88*	*0.25*	*4.70*		*5.17*	*0.14*	
c) Char + Liq Indx + Vol	-0.08	0.02	0.07	0.00	0.002	3.43	0.25	0.00	23.09%
Meas	*-5.26*	*15.88*	*9.00*	*0.30*	*4.68*	*3.69*	*5.00*	*0.04*	
d) Char + Vol Meas	-0.11	0.02	0.07	0.00		3.38	0.25	-0.01	21.21%
	-6.90	*16.64*	*9.70*	*-0.48*		*3.60*	*5.18*	*-0.09*	

Panel B: High Idiosyncratic Volatility (Above Median) Issues

					Liquidity & Volatility measures		Bond factors		
Regression variables	Amount outstanding (x 10^{-6})	Maturity	Coupon	Trade size (x 10^{-6})	Liquidity index	Volatility measure	Default beta	Term beta	Adjusted R^2
1 a) Liq Indx					0.013				8.61%
					7.13				
b) Vol Meas						10.00			36.35%
						11.99			
c) Liq Indx + Vol Meas					0.007	9.51			39.51%
					5.95	*11.68*			
2 a) Liq Indx					0.012		0.85	0.40	21.10%
					7.57		*4.67*	*2.00*	
b) Vol Meas						9.12	0.50	0.16	42.05%
						12.25	*4.31*	*1.31*	
c) Liq Indx + Vol Meas					0.007	8.65	0.49	0.20	44.98%
					6.32	*12.00*	*4.28*	*1.69*	
3 a) Char	-0.15	0.01	0.36	-0.05			0.80	0.27	22.86%
	-2.18	*4.34*	*7.12*	*-6.10*			*4.28*	*1.26*	
b) Char + Liq Indx	-0.01	0.01	0.32	-0.04	0.011		0.79	0.34	28.46%
	-0.20	*3.18*	*6.33*	*-5.67*	*7.00*		*4.40*	*1.66*	
c) Char + Liq Indx + Vol	-0.09	0.01	0.24	-0.02	0.006	8.48	0.45	0.14	50.92%
Meas	*-1.87*	*2.13*	*8.64*	*-5.15*	*5.77*	*12.14*	*4.02*	*1.24*	
d) Char + Vol Meas	-0.16	0.01	0.26	-0.02		8.90	0.46	0.12	48.76%
	-3.35	*2.53*	*9.79*	*-5.95*		*12.23*	*4.14*	*1.02*	

Table 11
Fama-MacBeth regressions based on time-period

The table presents the results of Fama-MacBeth regressions for individual bonds over two sub-periods: 1995-1999 and 2000-2004. Each month, cross-sectional regressions of bond yield spreads are carried out on issue-specific bond characteristics (char) and liquidity and volatility values. For each regression, the first row reports the coefficients as the time-series average of 60 monthly regression slopes and the second row presents *t*-statistics computed as the ratio of time-series average slope to the standard error of monthly slopes with Newey-West correction. Bond liquidity index 1 is liq indx and 3-factor daily idiosyncratic volatility is vol meas.

Panel A: Sub-period 1995-1999

	Bond Characteristics				Liquidity & Volatility measures		Bond factors		
Regression variables	Amount outstanding (x 10^{-6})	Maturity	Coupon	Trade size (x 10^{-6})	Liquidity index	Volatility measure	Default beta	Term beta	Adjusted R^2
1 a) Liq Indx					0.005				4.04%
					3.09				
b) Vol Meas						5.60			22.60%
						13.23			
c) Liq Indx + Vol Meas					0.004	5.42			24.74%
					3.37	*12.85*			
2 a) Liq Indx					0.005		0.51	0.18	12.59%
					3.39		*10.71*	*1.85*	
b) Vol Meas						5.07	0.35	0.04	27.45%
						12.99	*10.89*	*0.53*	
c) Liq Indx + Vol Meas					0.004	4.90	0.35	0.06	29.53%
					3.63	*12.65*	*10.72*	*0.97*	
3 a) Char	-0.13	0.02	0.13	-0.01			0.43	0.04	18.27%
	-5.79	*12.22*	*9.23*	*-4.40*			*10.03*	*0.38*	
b) Char + Liq Indx	-0.07	0.02	0.11	0.00	0.004		0.44	0.07	21.40%
	-3.13	*12.18*	*8.51*	*-2.69*	*3.00*		*9.66*	*0.63*	
c) Char + Liq Indx + Vol Meas	-0.11	0.01	0.11	0.00	0.003	4.74	0.28	-0.05	38.40%
	-4.59	*13.98*	*10.23*	*-1.06*	*3.29*	*13.03*	*8.54*	*-0.55*	
d) Char + Vol Meas	-0.15	0.01	0.12	0.00		4.89	0.27	-0.07	36.84%
	-6.14	*14.00*	*10.72*	*-2.51*		*13.32*	*8.97*	*-0.82*	

Panel A: Sub-period 2000-2004

	Bond Characteristics				Liquidity & Volatility measures		Bond factors		
Regression variables	Amount outstanding (x 10^{-6})	Maturity	Coupon	Trade size (x 10^{-6})	Liquidity index	Volatility measure	Default beta	Term beta	Adjusted R^2
1 a) Liq Indx					0.010				5.66%
					6.50				
b) Vol Meas						13.32			47.38%
						12.96			
c) Liq Indx + Vol Meas					0.005	12.95			49.51%
					4.46	*12.57*			
2 a) Liq Indx					0.008		0.91	0.64	20.28%
					6.55		*3.11*	*1.82*	
b) Vol Meas						12.30	0.39	0.13	51.12%
						12.92	*2.77*	*0.77*	
c) Liq Indx + Vol Meas					0.005	11.94	0.38	0.14	53.08%
					4.57	*12.61*	*2.60*	*0.84*	
3 a) Char	-0.12	0.02	0.31	-0.05			0.95	0.65	20.23%
	-2.78	*6.05*	*8.18*	*-8.34*			*3.16*	*1.79*	
b) Char + Liq Indx	-0.02	0.01	0.29	-0.04	0.008		0.92	0.65	24.37%
	-0.34	*5.21*	*7.58*	*-7.75*	*6.53*		*3.14*	*1.84*	
c) Char + Liq Indx + Vol Meas	-0.12	0.01	0.18	-0.02	0.004	11.61	0.40	0.15	55.42%
	-2.98	*1.47*	*7.83*	*-4.93*	*4.56*	*13.17*	*2.88*	*0.96*	
d) Char + Vol Meas	-0.18	0.01	0.19	-0.02		11.95	0.41	0.14	53.78%
	-3.87	*1.71*	*8.56*	*-5.64*		*13.45*	*3.20*	*0.88*	

Table 12

Fama-MacBeth regressions based on aggregate market volatility

The table presents the results of Fama-MacBeth regressions for individual bonds sorted into two aggregate market volatility (VIX) portfolios over the period 1995-2004. Low (high) VIX regime refers to months when VIX values are below (above) the full-period median. In each month of a specific regime, cross-sectional regressions of bond spreads are carried out on bond characteristics (char) and liquidity and volatility values. For each regression, the first row reports the coefficients as the time-series average of 60 monthly regression slopes and the second row presents *t*-statistics computed as the ratio of time-series average slope to the standard error of monthly slopes with Newey-West correction. Bond liquidity index 1 is liq indx and 3-factor daily idiosyncratic volatility is vol meas.

Panel A: Low VIX (Below Median) Regime

					Liquidity & Volatility measures		Bond factors		
Regression variables	Amount outstanding (x 10^{-6})	Maturity	Coupon	Trade size (x 10^{-6})	Liquidity index	Volatility measure	Default beta	Term beta	Adjusted R^2
1 a) Liq Indx					0.004				3.55%
					3.94				
b) Vol Meas						10.17			30.74%
						7.86			
c) Liq Indx + Vol Meas					0.003	9.93			32.48%
					3.39	*7.77*			
2 a) Liq Indx					0.004		0.62	0.27	13.77%
					4.03		*5.06*	*1.58*	
b) Vol Meas						9.33	0.33	0.05	34.79%
						7.67	*5.38*	*0.56*	
c) Liq Indx + Vol Meas					0.003	9.09	0.33	0.04	36.52%
					3.48	*7.61*	*5.71*	*0.51*	
3 a) Char	-0.10	0.02	0.20	-0.01			0.55	0.17	19.18%
	-3.31	*10.77*	*9.39*	*-4.22*			*4.21*	*0.88*	
b) Char + Liq Indx	-0.04	0.02	0.19	-0.01	0.004		0.55	0.15	22.02%
	-1.25	*11.37*	*8.99*	*-3.44*	*3.75*		*4.37*	*0.80*	
c) Char + Liq Indx + Vol	-0.04	0.02	0.13	0.00	0.003	8.70	0.29	-0.08	43.75%
Meas	*-1.43*	*8.32*	*9.87*	*-1.42*	*3.22*	*7.61*	*5.18*	*-0.80*	
d) Char + Vol Meas	-0.08	0.02	0.13	0.00		8.92	0.29	-0.07	42.34%
	-2.87	*8.20*	*11.12*	*-2.42*		*7.64*	*5.11*	*-0.74*	

Panel A: High VIX (Above Median) Regime

					Liquidity & Volatility measures		Bond factors		
Regression variables	Amount outstanding (x 10^{-6})	Maturity	Coupon	Trade size (x 10^{-6})	Liquidity index	Volatility measure	Default beta	Term beta	Adjusted R^2
1 a) Liq Indx					0.011				6.14%
					5.94				
b) Vol Meas						8.75			39.24%
						9.24			
c) Liq Indx + Vol Meas					0.006	8.45			41.77%
					5.06	*9.10*			
2 a) Liq Indx					0.009		0.81	0.54	19.09%
					6.24		*3.00*	*1.75*	
b) Vol Meas						8.04	0.41	0.12	43.78%
						9.20	*3.27*	*0.76*	
c) Liq Indx + Vol Meas					0.006	7.75	0.40	0.16	46.09%
					5.34	*9.07*	*3.01*	*1.05*	
3 a) Char	-0.14	0.01	0.24	-0.04			0.84	0.52	19.32%
	-3.90	*6.19*	*5.49*	*-5.52*			*3.07*	*1.65*	
b) Char + Liq Indx	-0.05	0.01	0.22	-0.03	0.009		0.81	0.56	23.75%
	-1.20	*5.18*	*4.98*	*-5.10*	*5.86*		*3.01*	*1.85*	
c) Char + Liq Indx + Vol	-0.19	0.00	0.16	-0.01	0.005	7.65	0.39	0.19	50.07%
Meas	*-6.30*	*1.09*	*6.90*	*-4.44*	*5.14*	*9.22*	*3.12*	*1.33*	
d) Char + Vol Meas	-0.25	0.00	0.17	-0.02		7.92	0.40	0.15	48.28%
	-6.79	*1.47*	*7.65*	*-5.09*		*9.31*	*3.46*	*1.04*	

Figure 1
Summary statistics by year

The figure plots the number of trades (left panel) and average yield spreads in percentage (right panel) by year for different industry groups, rating categories, and maturities for the sample period 1994-2004. Long-term bonds have maturities greater than 15 years, medium-term bonds have maturities between 7 and 15 years and short-term bonds have maturities less than or equal to 7 years.

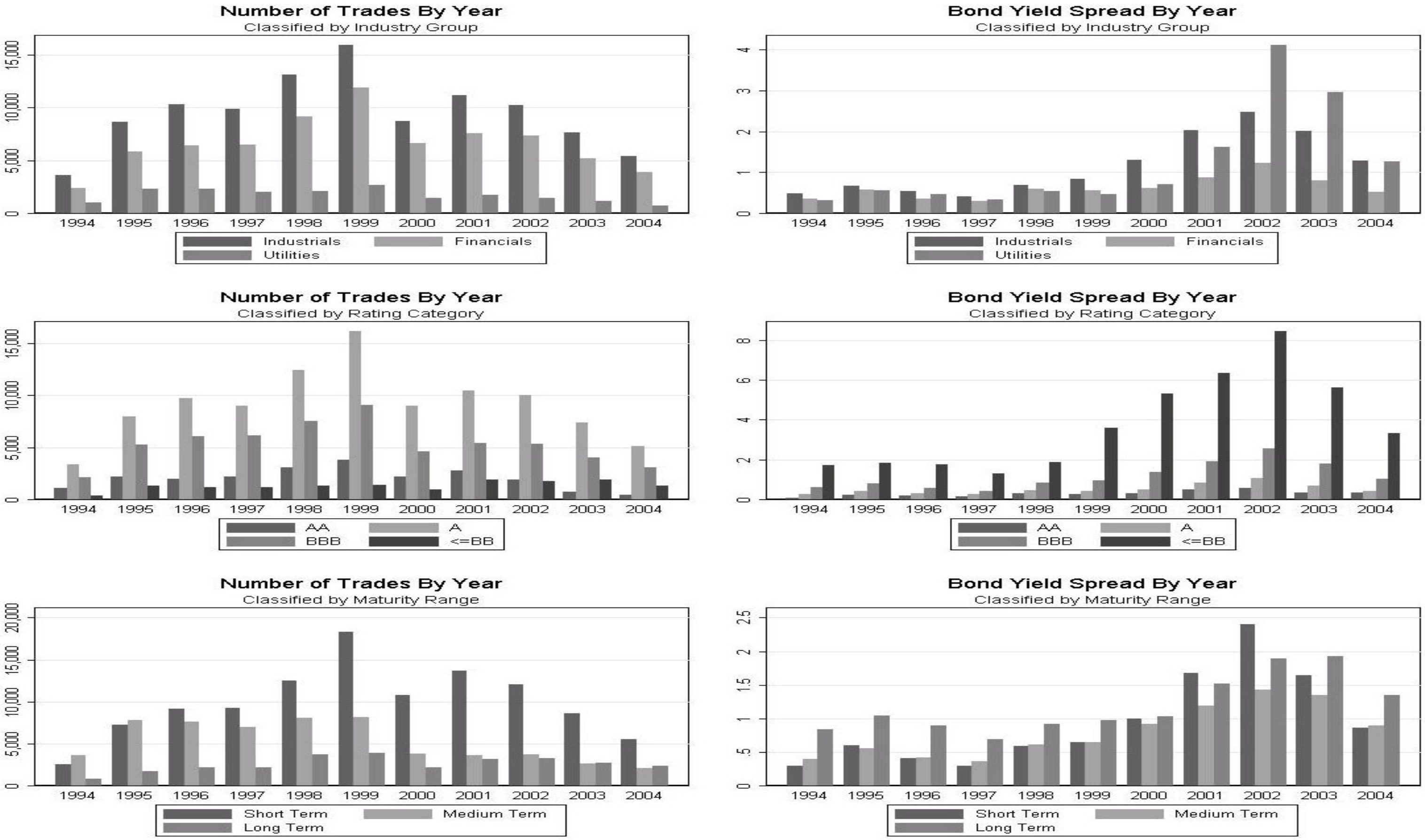

Figure 2

Time series trends of bond spreads, bond and equity liquidity, and equity volatility

The figure plots average yearly bond spreads, bond liquidity (bond liquidity index 1), equity volatility (based on Fama-French 3-factor model applied to daily data) and equity liquidity (inverse of Amihud (2002) measure) over the sample period 1994-2004. Left panel corresponds to high-rated bonds (rated AA or A); right panel presents low-rated bonds (rated BBB or below). Classification into high- and low-duration portfolios is based the median duration value of 8 years.