The Pricing of Liquidity Dimensions in Corporate Bonds

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Abstract

Kyle (1985) and Harris (2003) define three dimensions of liquidity – cost, depth, and time. This study is the first to examine the non-default component of corporate bond yield spreads in order to determine the importance of these three dimensions to investors. We find that while illiquidity premia in bonds varies with each individual dimension, the cost dimension is the biggest contributor to illiquidity premia, followed by the time dimension, and lastly, depth. We also examine whether market-wide or only bond-specific liquidity measures affect the value of corporate debt, and find that not only do market-wide liquidity measures affect the value of debt, but they are actually more important than bond-specific measures. Finally, we examine whether the non-default component of yield spreads is comprised solely of the state tax and illiquidity premia.

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1. Introduction

Corporate bond yield spreads over treasuries have been shown by Elton, Gruber, Agrawal, and Mann (2001) among others to be significantly larger than can be explained by default risk and state taxes. Chief among the factors shown to affect the non-default component of yield spreads is liquidity. However, as of yet, there has been no attempt to explore what specific aspects of liquidity are priced in corporate bond yields. In his seminal work in market microstructure Kyle (1985) defined three dimensions of liquidity – cost, depth, and time. These dimensions are also proposed by Harris (2003).

In this study, we examine whether these dimensions are priced in bond yields, the relative importance of each dimension to traders, whether bond-specific or market-wide dimensions are priced in the yields, and, finally, whether factors beyond state taxes and liquidity affect the valuation of bonds.

We contribute to the extant literature in several key ways. We develop a measure of resiliency (the time dimension of liquidity) for over-the counter markets. We are the first to examine whether the time dimension of liquidity is priced in corporate bonds. We are also the first to test whether the three dimensions of liquidity are priced *in conjunction*, opposed to separately. Moreover, we examine whether bond-specific or market-wide liquidity factors drive the variation of the non-default component of the yield spread. Finally, our sample allows us to separate the default and non-default components more cleanly than previous studies.

Because the liquidity risk of a security and the default risk of a firm are almost always endogenous, separating the two has previously involved measurement error. Intuitively, and according to the Ericcson and Renault (2006) model, variation in default risk leads to variation in liquidity risk. However, He and Xiong (2012) also show that variation in liquidity risk can lead to further variation in default risk. In this study, we use a sample of bonds in which liquidity risk and default risk are exogenous. In fact, there is no default risk above treasuries in our sample. This allows us to analyze the non-default component of the yield spread (hereafter the non-default spread) without measurement error induced by modeling the default spread, as is done in previous studies. The lack of measurement error allows us to determine the magnitude of the components of the non-default spread with much more confidence than in previous studies.

We find that all three dimensions of liquidity are priced factors in the non-default spread. The cost dimension, the transaction cost to buy or sell a specific bond, is the most important to investors; that is, the level of the non-default spread varies most with variation in this dimension. Following cost, the time dimension is the second most important liquidity dimension to investors. The time dimension of liquidity is also commonly referred to as resiliency. Resiliency can be thought of as how fast a trader can trade a quantity of a given bond without paying greater transaction costs. In order to measure resiliency in an over-the-counter market, we develop a measure of resiliency determined by the mean reversion of dealer inventory, based on the model put forth by Kyle (1985) and Mayston, Kempf, and Yadav (2007). Lastly, while the depth dimension is priced in the non-default spread, it is roughly only 20 percent as important as the cost dimension and 40 percent as important as the time dimension. In this study, we define the depth dimension as the price impact of large trades using Kyle's (1985) λ.

Commonality in liquidity has been examined in several studies [Chordia, Roll, and Subrahmanyam (2000a, 2000b); Pástor and Stambaugh (2003); Acharya and Pedersen (2005); Lin, Wang, Wu (2011); Boa, Pan, and Wang (JF 2011)]. These articles suggest, among other things, that market-wide liquidity factors may affect the non-default spread more than their idiosyncratic counterparts. Because of this, we create indices which measure the transaction cost, depth, and resiliency of the corporate bond market as a whole. We find that market-wide liquidity is quite important. More specifically, market-wide transaction costs matter most to traders. Market-wide resiliency is next, but only a tenth as important as the market-wide cost dimension.

We then turn our attention to whether or not we have accounted for all of the variation in the non-default spread. In other words, is the non-default spread comprised solely of a state tax premium and an illiquidity premium? We find mixed results when attempting to answer this question. We find that, when controlling for idiosyncratic liquidity variables and the state tax premium, there are at least 10 basis points unaccounted for in the non-default spreads of the sample bonds, suggesting that there are other factors constituting the non-default spread. However, when we include market-wide liquidity factors into the model, we find negative intercept terms, which, in addition to being difficult to interpret, suggest that our results concerning this question are inconclusive.

2. Literature Review and Hypothesis Development

Merton (1974) proposes that corporate debt should be valued on three items: the risk-free rate of return, the security's provisions, and default risk. However, since the inception of the "credit spread puzzle" by Elton, et al. (2001), researchers have searched for other factors which affect the valuation of corporate debt. Collin-Dufresne, Goldstein, and Martin (2001) suggest that the illiquidity of corporate debt is a possible explanation of the excess yield. Since these studies, both state taxes and bond illiquidity have been shown to affect the value of corporate debt. The literature has since found that the three dimensions of liquidity affect the value of various financial securities.

Possibly the most explored aspect of liquidity in extant literature is the cost dimension, typically estimated by the bid-ask spread of a security. In the bond market, Longstaff, Mithal, and Neis (2005) split corporate yield spreads into default and non-default components and find that, among other factors, bid-ask spreads are indeed priced in the non-default component. Dick-Nielsen, Feldhutter, and Lando (2012) also find that bid-ask spreads – as well as the variation thereof – are priced in the non-default spreads of corporate bonds. We therefore base Hypothesis 1a on those studies.

H1a: *The cost dimension is priced in the non-default spread of corporate bonds.*

Research has also analyzed the pricing of the depth dimension of liquidity. While studying equity markets (in the limit-order-book setting) Brennan and Subrahmanyam (1996) document that along with transaction costs, Kyle's λ – or the depth dimension – is a priced risk factor in equities. In the bond market, Dick-Nielsen, et al. (2012) find that the Amihud (2002) measure – estimate of Kyle's λ – of a bond is priced in the non-default spread. These studies in particular motivate Hypothesis 1b.

H1b: *The depth dimension is priced in the non-default spread of corporate bonds.*

By far the least explored of the three dimensions, resiliency, or the time dimension of liquidity has not been shown in previous literature to be a priced factor in either stocks or bonds. Mayston, et al. (2007) first developed a measure of resiliency for limit-order-book markets, using Kyle (1985) as the basis for modeling resiliency as the mean reversion of order-flow. While univariate correlations looked promising, their sample size was too small for asset-pricing tests. Using this measure of resiliency, Obizaeva and Wang (2013) show that an optimal strategy of trading a given security depends largely on the resiliency of the security. Because of this, we postulate Hypothesis 1c, and are the first to explore this.

H1c: *The time dimension is priced in the non-default spread of corporate bonds.*

To date, no other study has looked at whether these dimensions are priced *in conjunction*, and not just separately. It is theoretically possible that these dimensions are largely collinear, in which case no single dimension would necessarily be more important than the others. Therefore we postulate the null in Hypothesis 2.

H2: *The importance of each dimension of liquidity is equal.*

However, in the case that these dimensions are largely orthogonal (as we demonstrate is the case in this sample), then traders will necessarily alter their valuation of a bond based on the level of the various dimensions of liquidity, and their preferences will be revealed by the covariation between the non-default spreads and the different liquidity variables. Therefore we can investigate Hypotheses 3a, 3b, and 3c.

H3a: *The cost dimension affects the non-default spread more than either other dimension.*

H3b: *The depth dimension affects the non-default spread more than either other dimension.*

H3c: *The time dimension affects the non-default spread more than either other dimension.*

Commonality in liquidity has been widely explored in the existing microstructure literature, beginning with Chordia, Roll, and Subrahmanyam (2000a; 2000b) who show that the bid-ask spreads of securities co-move with one another, and that the depths of securities also co-move with one another. In their seminal work, Pástor and Stambaugh (2003) show that a market-wide illiquidity measure is priced in stocks. While this illiquidity measure is not a clearly defined liquidity dimension, it measures volume-related return reversals, so it is closely related to resiliency and depth. Similarly, Acharya and Pedersen (2005) demonstrate that a stock's return depends on its relationships with market liquidity. In the bond markets, Lin, Wang, and Wu (2011) show that investors in corporate bonds are compensated for their exposure to general market illiquidity. Moreover, Boa, Pan, and Wang (2011) show that for high-rated bonds, market illiquidity actually explains more than credit risk. Taken in union, these findings lead us to Hypothesis 4.

H4: *The non-default spread varies with both market and idiosyncratic liquidity measures.*

Finally, we turn our attention to the unexplained portion of the non-default spread – or potential lack thereof. While the non-default spread has been explained empirically using variables like maturity, market uncertainty, and certain debt covenants, theoretically, these factors should only affect the value of the bond through one of these three liquidity dimensions. As there is no theoretical or empirical evidence that factors beyond illiquidity and state taxes affect the non-default spread, we propose Hypothesis 5.

H5: *The non-default spread is comprised only of the illiquidity and state-tax premia.*

3. Sample and Research Design

Debt Guarantee Program

In order to isolate the non-default spread, we must control for default risk. To do this, we use a special set of corporate bonds with the same default risk as the US treasury. This special set of bonds comes out of the financial crisis and Debt Guarantee Program (DGP), in which the FDIC insured bank debt against default with the full faith and credit of the United States government.

While numerous forms of debt – including overnight loans, commercial paper, and bonds – were insured by the FDIC under the DGP, the insured bonds provide a very clean setting in which to analyze the yield spreads of corporate debt. This is because the insured bonds should have default risk equal to that of treasuries and, therefore, no additional default premium. By comparing these insured bonds to treasury debt, we can observe the implied non-default component of the yield spread without relying on measurement-error-inducing models.

Sample

Transaction-level data for this study comes from the TRACE (Trade Reporting and Compliance Engine) Enhanced dataset. The sample collected from TRACE includes all transactions of DGP bonds with fixed or no coupons. The program began in October of 2008 and though it continued through December of 2012, the enhanced TRACE dataset only contains trades through December 2011. Bond-level data for the bonds in the sample was obtained from Mergent Fixed Investment Securities Database (FISD) and merged by CUSIP. To eliminate erroneous entries in the TRACE data, the transactions are filtered according to the methods outlined by Dick-Nielsen (2009). We also employ the agency filter from Dick-Nielsen (2009) to remove agency trades. The data are then processed further using a 10% median filter as described in Friewald, Jankowitsch, and Subrahmanyam (2012). Following Bessembinder, Kahle, Maxwell, and Xu (2009), daily yields are obtained by weighting individual trade prices by volume and finding the yield from the resulting price.

Daily treasury yields are obtained from the H-15 release data from the Federal Reserve and maturity-adjusted for each observation using simple linear interpolation. These treasury yields are then subtracted from the yields of the government-guaranteed bonds to generate a spread independent of the default risk of the firm, or a non-default spread. After later merging these non-default spreads with the different measures of liquidity, we're left with 9,062 observations from 60 different bonds.

Research Design

To test the aforementioned hypotheses, I calculate proxies for each of the three dimensions of liquidity. The TRACE Enhanced dataset makes this possible by providing non-truncated volumes and a buy/sell indicator.

As a proxy for the cost dimension, we follow Hong and Warga (2000) and approximate the daily bid-ask spread for each bond by taking the difference between the daily volume-weighted averages of the buy and sell prices. The effective half-spread is then scaled by the midpoint of the average buy and sell prices as follows:

$$Spread_i = \frac{\sum_{D=1} q_{it}p_{it} - \sum_{D=-1} q_{it}p_{it}}{\sum_{D=1} q_{it}p_{it} + \sum_{D=-1} q_{it}p_{it}}, \quad (1)$$

where q_{it} is the volume of trade *t* for bond i, p_{it} is the price of that trade, and D equals 1 for all public buys and -1 for all public sales.

Kyle's λ has been used in several previous studies as a proxy for price impact and the depth dimension of liquidity. Following those studies, we use the Glosten and Harris (1988) Kyle's λ as used by Brennan and Subrahmanyam (1996), which is given by the λ in the following regression:

$$\Delta p_t = \lambda D_t q_t + \psi(D_t - D_{t-1}) + \varepsilon. \quad (2)$$

In this equation, λ can be interpreted as the change in price for a given quantity traded, which is exactly what the theoretical model of Kyle (1985) suggests is a valid measure of depth.

The time dimension poses the most significant challenge. Because the only previous measures of resiliency were constructed from limit order book markets, we construct a new measure of resiliency for over-the-counter markets based on the principles outlined by Mayston, et al. (2007). Resiliency addresses the question, when large uninformed trades change market prices and lead to temporary pricing errors how fast are these pricing errors eliminated through the competitive market? To answer this question, we investigate the relationship between the level of dealer inventory and the change in dealer inventory. This relationship addresses the above question by showing how dealers behave when they have large inventory levels. Intuitively, dealers should prefer lower inventory levels, and will give enticing prices to buyers and unappealing priced to sellers when they have relatively high inventory levels, and vice versa when their inventory levels are relatively low. So the stronger the negated relationship between the level of dealer inventory and the change in dealer inventory, the higher the resiliency. Therefore, the daily ϕ measure from the following regression is used as the resiliency measure in further analysis:

$$\Delta Inv_t = \alpha - \phi Inv_{t-1} + \varepsilon. \quad (3)$$

We assume that aggregate dealer inventory is zero at the beginning of the sample. Ultimately, ϕ measures the mean reversion of dealers' inventory. This number should theoretically be between 0 and 1, with 0 indicating that dealer inventory is a random walk with no mean reversion, and 1 indicating perfect resiliency, meaning that dealers keep no inventory from trade to trade – every bond they take on in one trade, they sell with the next trade, which eliminates pressure on prices to deviate from their intrinsic value. Therefore, the higher the value of ϕ, the greater the price resiliency – and the more liquid a bond is in the time dimension.

Following Elton, et al. (2001) we use a bond's coupon rate to control for the state tax premium. Because of the U.S. Constitution, the state and federal governments cannot tax income from one another. This is usually illuminated in municipal bonds, wherein the income is exempt from federal taxation. However, the roles are reversed for treasury bonds. States cannot tax the income from treasuries. They can, however, tax the income (coupon payments) from corporate bonds, therefore corporate bonds, even those of equal default and liquidity risk, will have a slight yield spread over treasuries.

Later, to estimate the relative importance of each dimension to the valuation of bonds, we calculate the Z-score of each observation by demeaning the three liquidity variables for each bond, and scaling them by the standard deviation of each bond. The non-default spread, effective half-spread, and Kyle's λ are all increasing in illiquidity, however ϕ (or *Resil*) is decreasing in illiquidity. Therefore, for ease of interpretation, the sign of *Resil Z* is negated.

Descriptive statistics for these measures are located in Panel A of Table 1. In Panel B of Table 1, are the correlations of all of these variables. This table shows that the three dimensions are largely orthogonal. The cost dimension (*Spread*) only has a 0.006 correlation with the depth dimension (*Kyle's* λ) and a -0.065 correlation with the time dimension (*Resil*). The depth and time dimension only have a -0.018 correlation.

4. Empirical Results

Pricing of Liquidity Dimensions

We begin by testing hypotheses 1a through 1c in the cross-section. We do so two ways. First, we use the between estimator to examine the variation between bonds only. This is done by averaging the non-default spread and liquidity measures for each bond and using the 60 means in the following cross-sectional regression:

$$\overline{NDS}_i = \alpha + \beta_1 \overline{Spread}_i + \beta_2 \overline{Kyle's\ \lambda}_i + \beta_3 \overline{Resil}_i + \beta_4 Coupon_i + \varepsilon. \quad (4)$$

Note that $Coupon_i$ does not need to be demeaned, as it is time-invariant.

The results of this regression are reported in Model 1 of Table 2. These results offer preliminary evidence in support of Hypothesis 1a, that the cost dimension is priced in the non-default spread. We find that variation in the effective half-spread is associated with variation in the non-default spread at the 1 percent level. Surprising, we do not find evidence that either the depth or time dimensions are priced using this model. Consistent with Elton, et al. (2001) we find that state taxes are roughly priced at 4.33 percent.

We then use Fama and MacBeth (1973) panel regressions as another method to analyze cross-sectional pricing. This is accomplished by running cross-sectional regressions using the available observations for each day, and then averaging the regression coefficients over the time sample. In total, we had the observations available to run 632 cross-sectional regressions. As documented in Model 2 of Table 2, the results are much weaker using this methodology. The cost dimension is only significant at the 10 percent level and most of the variation is unexplained, inflating our intercept term.

Next, we explore the time-series pricing of these liquidity dimensions and find support for Hypotheses 1a, 1b, and 1c. While portfolio formation – *a la* Fama and French (1993) – would be a superior method to examine time-series pricing, we are unable to observe the non-default spread out of sample, and therefore we are unable to test time series pricing in this manner. Therefore to address time-series pricing, we employ bond-level fixed effects as shown in the following equation:

$$NDS_{it} = \alpha_i + \beta_1 Spread_{it} + \beta_2 Kyle's\ \lambda_{it} + \beta_3 Resil_{it} + \varepsilon. \quad (5)$$

Note that we are unable to include a control for the state tax premium in this form of estimation, as the variable $Coupon_i$ is time invariant, and is subsumed by the intercept term. In order to account for both bond-specific and day-specific common shocks, the standard errors are clustered by bond and by day, as demonstrated by Pedersen (2009). As shown in Model 1 of Table 3, in the time series, we find support for Hypotheses 1a through 1c, all at the 1 percent level. For the cost dimension, we find that a 1 percent deviation from the mean in the effective half-spread results in a 0.02 basis point increase in the non-default spread. The minute scale of Kyle's λ makes interpretation of the depth dimension more difficult, however a 1 percent deviation from the mean of Kyle's λ yields a 0.0001 basis point change in the non-default spread. Finally, keeping in mind that resiliency is *decreasing* in illiquidity, we find that a 1 percent deviation from the mean in the time dimension of liquidity leads to an increase of 0.03 basis points. This lends preliminary support to Hypothesis 3c, however we will explore this further later in the paper.

Next, we test the combined cross-sectional and time-series pricing of the liquidity dimensions by running a pooled panel regression. It is important to note that the unbalanced nature of this panel gives more weight to the more liquid bonds in both the fixed-effect and pooled model. Using the following equation along with two-way clustered standard errors allows us to test the time-series and cross-sectional pricing, while still controlling for the state tax premium as well as bond- and day- specific effects:

$$NDS_{it} = \alpha + \beta_1 Spread_{it} + \beta_2 Kyle's\ \lambda_{it} + \beta_3 Resil_{it} + \beta_4 Coupon_i + \varepsilon. \quad (6)$$

The results of the above regression are displayed in Model 2 of Table 3. We find results extremely similar to the fixed-effect model, with all three dimensions of liquidity being significantly priced and with the hypothesized sign. This clearly suggests that the pricing of the three different liquidity dimensions is driven by time time-series, and not cross-sectional pricing. Also of note, this model estimates marginal state taxes to be 4.02 percent.

As we documented earlier, the liquidity dimensions are largely orthogonal, not collinear, which refutes Hypothesis 2. We therefore move to tests of Hypotheses 3a through 3c, to see which dimension of liquidity is more consequence to traders. To do this, we standardize the three liquidity variables over each bond using the following equation:

$$Z_{it} = \frac{L_{it} - \bar{L}_i}{\sigma_{L,i}}, \quad (7)$$

where L_{it} is the observed liquidity measure, $\bar{L}_i$ is the bond-specific mean so the variable, $\sigma_{L,i}$ is the bond-specific standard deviation of the variable, and Z_{it} is the Z-score of the observation. The resiliency Z-score is then negated to reflect its inverse relationship to illiquidity. We then run the pooled model shown in equation 6 using these standardized variables. These results are shown in Model 1 of Table 4. In this specification, all of the variables remain significant at the 1 percent level, and marginal state taxes are estimated to be 4.58 percent. More importantly, now that the three dimensions are measured in the same units (standard deviations from the mean), we can study how variation in each dimension affects the non-default spread. We find that a one standard deviation change in the cost dimension affects the non-default more than a one standard deviation change in either of the other dimensions. A one standard deviation increase in the effective half-spread increases the non-default spread 4.92 basis points. Next, a one standard deviation decrease in resiliency increases the non-default spread 2.60 basis points. Finally, a one standard deviation increase in Kyle's λ changes the non-default spread 0.98 basis points. This offers strong evidence in support of Hypothesis 3a, that the cost dimension matters most to investors. An intriguing finding is that the time dimension, which is been relatively uncharted in extant literature, is the second most consequential dimension of liquidity, notable more impactful than the depth dimension.

Bond-specific and Market-wide Factors

As discussed previously, common market liquidity has been well documented in the literature, because of this we propose Hypothesis 4, that the non-default spread varies with both market and idiosyncratic liquidity measures. In order to test this, we create market-wide liquidity measures and include them in the pooled model.

For the market-wide liquidity measures, we first calculated the effective half-spread, Kyle's λ, and resiliency for every bond-day in the TRACE database. We then take an equally-weighted average of the bonds' liquidity measures for each day. Finally, for tests specific to Hypothesis 4, we also find the Z-scores for these market-wide variables, using the method illustrated by equation 7.

As documented in Model 2 of Table 4, we include these variables in the previous pooled model. These results show that variation in the market-wide cost dimension is the chief component of the illiquidity premium. A one standard deviation increase in market-wide bid-ask spreads lead to a 17.84 basis point increase in a bond's non-default spread. Following market-wide cost in importance is market-wide time. As market resiliency decreases by one standard deviation, the non-default spread increases by 1.78 basis points, ten times less consequential than the cost dimension. The idiosyncratic depth and time dimensions are only priced at the 5 percent significance level, while the idiosyncratic cost and market-wide depth dimensions don't seem to be priced. This suggests the upmost importance of commonality in liquidity, as it is more important than idiosyncratic liquidity measures in bond valuation.

Remaining factors in the non-default spread

Knowing the effects of the three dimensions of liquidity, we can now control for illiquidity as well as state taxes and test whether the non-default spread is comprised of components outside those two. To control for state taxes, we once again include the coupon as a control variable. Controlling for liquidity is more difficult. To do this we must extrapolate and examine a hypothetical "perfectly liquid bond." A bond which is perfectly liquid in each dimension would have a bid-ask spread of zero, a price impact (Kyle's λ) of zero, and a resiliency measure of 1. Therefore, by subtracting 1 from the observed resiliency measure and regressing the non-default spread on these three variables and coupon, we are able to test whether the intercept is significantly different from zero. If the intercept is greater than zero, then there are factors outside of state taxes and these three dimensions of liquidity which affect the value of bonds, however if the intercept is statistically indifferent from zero, then we cannot reject Hypothesis 5 that only that state tax and illiquidity premia comprise the non-default spread.

As is shown in Table 5, we find mixed and inconclusive results. When only including idiosyncratic liquidity factors, we find a 10 basis point intercept, suggest that more than just illiquidity and state taxes affect the non-default spread of a bond. However, as we discovered previously, market-wide liquidity factors play an important role in the valuation of the non-default spread. We therefore include these factors in Model 2 of Table 5, and use only these measures for Model 3. When using these specifications, we actually find a *negative* intercept. This means that a perfectly liquid bond would be more liquid than treasury bonds to such an extent that the spread over treasuries would actually be negative. While this suggests that there may not be factors outside of state taxes and illiquidity which affect the non-default spread, these results are inconclusive. Without the aid of Fama and French (1993) style portfolio analysis, we cannot determine whether the intercept is truly different from zero.

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5. Concluding Remarks

Although Kyle (1985) and Harris (2003) identify three dimensions of liquidity, this is the first study to determine whether all three of these measures are priced in debt markets. In this study, we examine whether these dimensions are priced in bond yields, as well as the relative importance of each dimension to traders. We then investigate whether bond-specific or market-wide dimensions are priced in the yields. Finally, we determine whether the non-default components of yield spreads are larger than state taxes and these three dimensions of liquidity would suggest.

This paper contributes to the current literature numerous ways. First, we develop a measure of resiliency for over-the counter markets. This is therefore the first research to examine whether the time dimension of liquidity is priced in corporate bonds. We find that it is indeed priced. We are also the first to test whether the three dimensions of liquidity are priced *in conjunction*, opposed to separately, as has been done in previous literature. Additionally, we find that when using bond-specific liquidity measures, all of the dimensions are factors affecting the valuation of bonds. Finally, we examine whether bond-specific or market-wide liquidity factors drive the variation of the non-default component of the yield spread. We find that while both covary with the non-default spread, market-wide factors are of more importance than bond-specific liquidity factors. Specifically, the cost dimension of common market liquidity is the most important factor in determining the illiquidity premium in bonds, while the market time dimension is the second most important.

References

Acharya, V.V., Pedersen, L. H., 2005. Asset pricing with liquidity risk. Journal of Financial Economics 77, 375-410.

Amihud, Y., 2002. Illiquidity and Stock Returns: Cross-section and Time-series Effects. Journal of Financial Markets 5, 31-56.

Bao, J., Pan, J., Wang, J., 2011. The Illiquidity of Corporate Bonds. Journal of Finance 66, 911-946.

Bessembinder, H., Kahle, K., Maxwell, W., Xu, D., 2009. Measuring Abnormal Bond Performance. Review of Financial Studies 22, 4219-4258.

Brennan, M. J., Subrahmanyam, A., 1996. Market microstructure and asset pricing: On the Compensation for Illiquidity in Stock Returns. Journal of Financial Economics, 41, 441-464.

Chordia, T., Roll, R., Subrahmanyam, A. 2000. Co-Movements in Bid-Ask Spreads and Market Depth. Financial Analysts Journal 56, 23-27.

Chordia, T., Roll, R., Subrahmanyam, A.,2000. Commonality in Liquidity. Journal of Financial Economics 56, 3-28.

Collin-Dufresne, P., Goldstien, R.S., Martin, J., 2001. The determinants of credit spread changes. Journal of Finance 62, 119-149.

Dick-Nielsen, J., 2009. Liquidity Biases in TRACE. Journal of Fixed Income 19, 43-55.

Dick-Nielsen, J., Feldhütter, P., Lando, D., 2012. Corporate Bond Liquidity Before and After the Onset of the Subprime Crisis. Journal of Financial Economics 103, 471-492.

Elton, E., Gruber, M., Agrawal, D., Mann, C., 2001. Explaining the Rate Spread on Corporate Bonds. Journal of Finance 56, 247-277.

Ericcson, J., Renault, O., 2006. Liquidity and Credit Risk. Journal of Finance 61, 2219-2250.

Fama, E. F., French, K. R.,1993. Common Risk Factors in the Returns on Stocks and Bonds. Journal of Financial Economics 33, 3-56.

Fama, E. F., MacBeth, J. D., 1973. Risk, Return, and Equilibrium: Empirical Tests. The Journal of Political Economy 81, 607-636.

Friewald, N., Jankowitsch, R., Subrahmanyam, M., 2012. Illiquidity or credit deterioration: A Study of Liquidity in the US Corporate Bond Market during Financial Crises. Journal of Financial Economics 105, 18-36.

Harris, L., 2003. Trading & Exchanges: Market Microstructure for Practitioners. Oxford University Press.

He, Z., Xiong, W., 2012. Rollover Risk and Credit Risk. The Journal of Finance, 67, 391-430.

Hong, G., Warga, A., 2000. An Empirical Study of Bond Market Transactions. Financial Analysts Journal 56, 32-46.

Kyle, A, 1985. Continuous Auctions and Insider Trading. Econometrica 6, 1315-1335.

Lin, H., Wang, J., Wu, C., 2011.Liquidity risk and expected corporate bond returns. Journal of Financial Economics 99, 628-650.

Longstaff, F., Mithal, S., Neis, E., 2005. Corporate Yield Spreads: Default Risk or Liquidity? New Evidence from the Credit Default Swap Market. Journal of Finance 50, 2213-2253.

Mayston, D., Kempf, A., Yadav, P., 2007. Resiliency, a Dynamic View of Liquidity: Empirical Evidence from a Limit Order Book Market. Working Paper.

Merton, R.C., 1974. On the Pricing of Corporate Debt: The Risk Structure of Interest Rates. Journal of Finance 29, 449-470.

Obizhaeva, A., and Wang, J., 2012. Optimal trading strategy and supply/demand dynamics. Journal of Financial Markets 16, 1-32.

Pástor, L., Stambaugh, R. F., 2003. Liquidity Risk and Expected Stock Returns. Journal of Political Economy 111, 642-685.

Pedersen, M., 2009. Estimating Standard Errors in Finance Panel Data Sets: Comparing Approaches. Review of Financial Studies 22, 435-480.

Roll, R., 1984. A Simple Implicit Measure of the Effective Bid-Ask Spread in an Efficient Market. Journal of Finance 4, 1127-1139.

Table 1: Variable Description

Panel A: Descriptive Statistics

Variable	Obs.	Mean	St. Dev.	Min.	Med.	Max.
NDS	9062	0.2778	0.2581	-0.7537	0.2011	2.3056
Spread	9062	0.0013	0.0020	-0.0132	0.0008	0.0213
Kyle's λ ($\times 10^9$)	9062	-1.5494	71.320	-2261.46	-0.0691	3127.75
Resil	9062	0.3971	0.2979	-0.9949	0.3615	1.0000
Coupon	9062	2.5339	0.5546	1.2500	2.6250	3.2500
Market Spread	9062	0.0144	0.0037	0.0088	0.0136	0.0286
Market Kyle's λ($\times 10^9$)	9062	6.1545	94.246	-1139.22	4.7624	1404.31
Market Resil	9062	0.2926	0.0480	0.1062	0.2922	0.5294

Panel B: Correlation Matrix

	Spread	*Kyle's λ*	*Resil*	*Coupon*	*Market Spread*	*Market Kyle's λ*	*Market Resil*
NDS	0.166	0.015	-0.103	0.097	0.796	-0.027	-0.069
Spread		0.006	-0.065	0.023	0.228	-0.020	0.016
Kyle's λ			-0.018	-0.008	0.016	0.003	0.020
Resil				-0.081	-0.108	0.007	0.014
Coupon					0.021	-0.013	-0.026
Market Spread						-0.023	-0.002
Market Kyle's λ							-0.048

Table 2: Cross-Sectional Analysis

Model 1 reports results from the between estimator for the unbalanced panel of observations, in which variables are averaged across each bond and then ran in the regression. Model 2 reports results from Fama and MacBeth (1973) panel regressions, in which cross-sectional regressions are ran for each day and then averaged over the time-series. Both estimate cross-sectional pricing.

Standard errors are reported in the parentheses underneath the coefficient estimates Standard errors are consistent with White's robust standard errors in Model 1. In Model 2, the standard errors are the standard deviations of the cross-sectional coefficient estimates. ***, **, and * stand for statistical significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)
	Between	Fama-MacBeth
Variable	NDS	NDS
Constant	0.1272***	0.2435***
	(0.0336)	(0.0137)
Spread	0.1089***	0.0043*
	(0.0305)	(0.0026)
Kyle's λ	-0.0304	-0.1727
	(0.0766)	(0.3371)
Resil	-0.0408	0.0018
	(0.0392)	(0.0015)
Coupon	0.0433***	0.0096***
	(0.0140)	(0.0025)
Obs.	60 (Bonds)	632 (Days)
Adj. R^2	0.3193	

Table 3: Time-Series Analysis

Model 1 reports results from the fixed-effect estimator for the unbalanced panel of observations, in which a different constant term is fitted for each bond. This examines the variation *within* each bond over time. Model 2 reports results from the pooled unbalanced panel regression, in which only one constant term is fitted. This model examines both cross-sectional and time-series variation.

Standard errors are reported in the parentheses underneath the coefficient estimates. In both models, the standard errors are clustered two ways – by bond and by day. ***, **, and * stand for statistical significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)
	Bond FE	Pooled
Variable	NDS	NDS
Constant	Varies by	0.1783***
	Bond	(0.0407)
Spread	20.184***	20.623***
	(4.330)	(5.008)
Kyle's λ	56566***	46174**
	(18938)	(23141)
Resil	-0.0808***	-0.0738***
	(0.0166)	(0.0167)
Coupon		0.0402***
		(0.0154)
N	60	60
T	649	649
Obs.	9,062	9,062
Adj. R^2	0.1166	0.0432

Table 4: Dimension Analysis

Models 1 and 2 reports results from pooled unbalanced panel regressions. In Model 1, only bond-specific liquidity measures are included in the regression. In Model 2, both bond-specific and market-wide liquidity variables are included in the regression.

Standard errors are reported in the parentheses underneath the coefficient estimates. In both models, the standard errors are clustered two ways – by bond and by day. ***, **, and * stand for statistical significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)
Variable	Idiosyncratic NDS	Market NDS
Constant	0.1616***	0.1405***
	(0.0385)	(0.0310)
Spread Z	0.0492***	-0.0008
	(0.0080)	(0.0032)
Kyle's λ Z	0.0098***	0.0059**
	(0.0034)	(0.0027)
Resil Z	0.0260***	0.0055**
	(0.0055)	(0.0025)
Market Spread Z		0.1784***
		(0.0082)
Market Kyle's λ Z		-0.0027
		(0.0055)
Market Resil Z		0.0178***
		(0.0040)
Coupon	0.0458***	0.0368***
	(0.0146)	(0.0112)
N	60	60
T	649	649
Obs.	9,062	9,062
Adj. R^2	0.0522	0.6450

Table 5: Test of Hypothesis 5

Models 1 through 3 reports results from pooled unbalanced panel regressions. In Model 1, only bond-specific liquidity measures are included in the regression. In Model 2, both bond-specific and market-wide liquidity variables are included in the regression. In Model 3, only market-wide liquidity variables are used.

Standard errors are reported in the parentheses underneath the coefficient estimates. In both models, the standard errors are clustered two ways – by bond and by day. ***, **, and * stand for statistical significance at the 1%, 5% and 10% levels, respectively.

	(1)	(2)	(3)
	Idiosyncratic	Full	Market
Variable	NDS	NDS	NDS
Constant	0.1045***	-0.8621***	-0.6843***
	(0.0195)	(0.0694)	(0.0581)
Spread	20.623***	-2.233*	
	2.280	1.242	
Kyle's λ	46174**	12983	
	18923	15511	
(Resil - 1)	-0.0738***	-0.0093	
	(0.0117)	(0.0062)	
Market Spread		55.104***	44.926***
		1.776	1.598
Market Kyle's λ		-29611	12390
		61261	41057
(Market Resil - 1)		-0.3534***	-0.3519***
		(0.0757)	(0.0745)
Coupon	0.0402***	0.0363***	0.0246***
	(0.0075)	(0.0051)	(0.0059)
N	60	60	60
T	649	649	649
Obs	9062	9062	9062
Adj. R^2	0.0432	0.6448	0.1061