# Liquidity and Its Pricing in the US Corporate Bond Market

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# Motivations and Contributions

- How to measure illiquidity and what are its properties?
  - We propose illiquidity measures that are more robust than existing ones.
- What are the pricing implications of illiquidity? Can the credit spread puzzle be explained by illiquidity?
  - Credit spread puzzle, e.g., Huang and Huang (2003), and Elton, Gruber, Agrawal, and Mann (2001).
  - We identify that illiquidity level is priced in the corporate bond market.
  - Illiquidity risk effect is weaker and is driven by the crisis.

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# Main Results

- Three illiquidity measures robust to various specifications
  - Residual volatility $\sigma_u$, variance ratio $VR$, and signed price impact $\lambda^{VW,signed}$
- Bond yield spreads explained by illiquidity measures with 5% improvement in $R^2$ for 2002-2010 (8% improvement in $R^2$ for 2008-2010). On average,
  - 1 cross-sectional SD change in $\sigma_u$ associated with 16 bps in yield spreads.
  - 1 cross-sectional SD change in $VR$ associated with 6 bps in yield spreads.
  - 1 cross-sectional SD change in $\lambda^{VW,signed}$ associated with 6 bps in yield spreads (2008-2010).
  - Together, 1-SD changes of $\sigma_u$ and $VR$ explain 23bps in yield spreads (2002-2010).
  - Together, 1-SD changes of $\sigma_u$, $VR$, and $\lambda^{VW,signed}$ explain 44bps in yield spreads (2008-2010).

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# What is liquidity? What determines liquidity?

- Liquidity is how easy to trade without causing price movement.
- Illiquidity is caused by the following market imperfections, Vayanos and Wang (2012):
  - Asymmetric information
  - Imperfect competition
  - Transaction costs
  - Participation costs
- Two components of illiquidity:
  - Permanent component
  - Transitory component

# Outline

# Measures in Literature/ Proposed Measures (1/2)

There 4 broad classes of illiquidity measures:

1. **Heuristic measures**, e.g., age, maturity, issuance, turnover, trade size, number of trades, etc.
   - Longstaff, Mithal, and Neis (2005)
   - Chen, Lesmond, and Wei (2007)
   - Mahanti, Nashikkar, Subrahmanyam, Chacko, and Mallik (2008)
2. **Price reversal $\gamma$ and variants**
   - Bid-ask spread in Roll (1984), estimated transaction cost in Hasbrouck (2009)
   - Minus covariance $\gamma \equiv -Cov(r_t, r_{t-1})$ in Bao, Pan, and Wang (2011)
   - Price reversal conditional on volume $\gamma^{CGW}$ in Campbell, Grossman, and Wang (1993)

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# Measures in Literature/ Proposed Measures (2/2)

3 **Price impact $\lambda$ and variants**

- Amihud price impact $\lambda^A \equiv \frac{|p_t - p_{t-1}|}{Q_t}$, $Q_t$ is trade size, in Amihud (2002)
- Price impact normalized by issuance $\lambda^I$
- Coefficient of return regressed on signed volume $\lambda^{VW,signed}$ in Vayanos and Wang (2012) - theory, and this work - empirical

4 **Other measures**

- Residual volatility $\sigma_u$ from AR(p) fit of return
- Minus sum of mean reversion coefficients $\Phi$
- Variance ratio $VR$ in Lo and MacKinlay (1988)

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# Price Model

- Bond log price, $p_t \equiv ln(price)$
- $p_t$ has two components: $f_t$ is fundamental component (a random walk with shock $e_t$), and $x_t$ is transitory component.

$$p_t = f_t + x_t, \text{where} \tag{1}$$
$$f_t = f_{t-1} + e_t$$

- Bond log return

$$r_t \equiv \Delta p_t = p_t - p_{t-1}$$
$$q_t \equiv \Delta x_t$$

$$\boxed{r_t = q_t + e_t} \tag{2}$$

  - $q_t$ is the transitory component of return.

# Price Reversal $\gamma$

- Bao, Pan, and Wang (2011) defines price reversal $\gamma$

$$\boxed{\gamma \equiv -Cov(r_t, r_{t-1})} \tag{3}$$

- From Price Model,
  - Return

$$r_t = q_t + e_t \tag{4}$$

  - Transitory component $q_t$, consider $q_t$ modelled by AR(1) process.

$$q_t = \rho_1 q_{t-1} + \epsilon_t, \tag{5}$$

    with AR(1) coefficient $\rho_1$, and uncorrelated homoskedastic noise $\epsilon_t$.

- $\gamma$ combines effects of persistence and noise variance of the transitory component.

$$\gamma \equiv -Cov(r_t, r_{t-1})$$

$$\gamma = -\rho_1 \frac{\sigma_\epsilon^2}{1 - \rho_1^2}, \tag{6}$$

where $\sigma_\epsilon^2$ is the variance of $q_t$ shock.

# Variance Ratio *VR*

- Lo and MacKinlay (1988) proposes *VR* to test random walk hypothesis of stock prices.

$$\boxed{VR(\tau) \equiv \frac{Var[r_t(\tau)]}{\tau Var[r_t(1)]},} \tag{7}$$

where $\tau$ is the number of trading days, and $r_t(\tau)$ is the $\tau$-day return. $Var[r_t(\tau)]$ denotes the variance of the $\tau$-day return.

- As $\tau \to \infty$, $Cov(r_t, r_{t+\tau}) \approx 0$

$$VR(\tau) \to 1 - \frac{Var[q_t]}{Var[r_t]}, \tag{8}$$

Steady-state *VR* implies the relative size of the transitory component and fundamental component of returns.

# Mean-Reversion Coefficient $\Phi$ and Residual Volatility $\sigma_u$ (1/2)

- Ideally, the transitory component can be decomposed from the return using Kalman Filter.

$$r_t = q_t + e_t, \text{ observation equation} \tag{9}$$

$$q_t = \rho_1 q_{t-1} + \epsilon_t, \text{ state equation} \tag{10}$$

  - Monte Carlo simulations show that 5,000 or more observations (#transactions in a month for a bond) is needed to get accurate estimates.
  - In practice, there are considerably fewer observations in a month for a bond.
- The size of the transitory component is about 3 times larger than that of the fundamental component for corporate bonds, according to *VR*.
- $r_t$ can be approximately used to estimate volatility and mean-reversion coefficient of the transitory component.

# Mean-Reversion Coefficient Φ and Residual Volatility $\sigma_u$ (2/2)

- AR(p) model of return

$$r_t^d = \phi_1 r_{t-1}^d + \phi_2 r_{t-2} + \ldots + \phi_p r_{t-p}^d + v_t, \tag{11}$$

where $r_t^d$ is the demeaned return of transaction $t$, $\phi_s$ is the correlation coefficient of lag $s$, and $v_t$ is the model error.

$$r_t^d = \widehat{\phi}_1 r_{t-1}^d + \widehat{\phi}_2 r_{t-2}^d + \widehat{\phi}_3 r_{t-3}^d + \widehat{\phi}_4 r_{t-4}^d + \eta_t, \tag{12}$$

where $\widehat{\phi}_s$ is the estimated coefficient of lag $s$, and $\eta_t$ is the error from estimation.

- Minus sum of mean reversion coefficients Φ

$$\Phi \equiv -(\widehat{\phi_1} + \widehat{\phi_2} + \ldots + \widehat{\phi_p}) \tag{13}$$

- Residual volatility $\sigma_u$

# Price Impacts: $\lambda^{I}$ and $\lambda^{VW,signed}$

- Price impact normalized by issuance $\lambda^{I}$

$$\lambda_t^I \equiv \frac{|p_t - p_{t-1}|}{Q_t / I} \tag{14}$$

$Q_t$ is the trade size, and $I$ is the issuance size

- Coefficient of return regressed on signed volume $\lambda^{VW,signed}$

$$r_t = \alpha + \lambda^{VW,signed} \frac{V_t}{V} \tag{15}$$

$V_t$ is negative if the dealer sells bonds to the customer and $V_t$ is positive if the dealer buys bonds from the customer. Inter-dealer trades are excluded.

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# Data and Filters

- Corporate bond data (July 2002 to December 2010) from TRACE and Mergent FISD
- Apply filters to data to ensure enough observations for estimation. For example,
  - Investment-grade bonds
  - Traded at least 75% of trading days
- Sample: 907 bonds (about 10 million transaction-level observations)
- Use transaction-level observations to estimate monthly illiquidity measures.

# Data Summary Statistics

**Table 2.1: Summary Statistics of Bond Sample**

This table reports summary statistics of the sample of 907 bonds by period. Rating is a numerical translation with AAA=1 and D=22. Turnover is the percentage of issuance traded per month.

| | Pre-Crisis Jul 2002 - Nov 2007 | | | Crisis Dec 2007 - Jun 2009 | | | Post-Crisis Jul 2009 - Dec 2010 | | |
|---|---|---|---|---|---|---|---|---|---|
| | Median | Mean | Std. | Median | Mean | Std. | Median | Mean | Std. |
| #Bonds | | 442 | | | 461 | | | 504 | |
| Issuance ($10^6$\$) | 1,000 | 1,170 | 1,043 | 1,000 | 1,259 | 1,278 | 1,000 | 1,199 | 1,216 |
| Rating (AAA=1, D=22) | 5.15 | 5.30 | 1.94 | 6.00 | 6.19 | 1.93 | 6.17 | 6.93 | 1.93 |
| Age (yr) | 2.19 | 2.54 | 2.06 | 2.35 | 3.20 | 2.71 | 1.94 | 2.64 | 2.41 |
| Maturity (yr) | 5.13 | 7.33 | 6.84 | 6.17 | 8.62 | 8.13 | 5.93 | 8.44 | 7.93 |
| Coupon (%) | 5.50 | 5.49 | 1.28 | 5.55 | 5.63 | 0.99 | 5.65 | 5.70 | 1.45 |
| Years traded (yr) | 5.19 | 5.79 | 1.91 | 4.64 | 5.22 | 1.97 | 3.05 | 3.61 | 2.20 |
| Turnover (% of iss./month) | 8.22 | 10.43 | 7.16 | 6.07 | 7.38 | 4.80 | 6.87 | 9.15 | 7.57 |
| Trd Size ($10^3$\$, monthly) | 442 | 587 | 486 | 214 | 318 | 343 | 285 | 420 | 414 |
| #Trades (per month) | 159 | 198 | 108 | 274 | 371 | 304 | 199 | 281 | 233 |
| Price | 100.74 | 102.31 | 5.67 | 99.18 | 98.52 | 5.29 | 105.78 | 106.87 | 5.92 |

# Table 2.4: Cross-sectional Variation in Measures and Bond Characteristics

This table reports pooled regressions of measures on bond charactersitics. T-statistics in brackets account for cross-sectional and serial correlations. The data are from July 2002 to December 2010 except the signed measures whose period is from November 2008 to December 2010.

Panel A: Full Sample (July 2002 - December 2010)

| | $\gamma$ | | | $\gamma^{CGW}$ | | |
|---|---|---|---|---|---|---|
| Intercept | 0.52 | 0.61 | 0.19 | -0.97 | -1.01 | -0.83 |
| | [2.45] | [2.92] | [0.95] | [-5.71] | [-5.92] | [-4.46] |
| Age | **0.01** | 0.01 | **0.01** | -0.01 | -0.01 | -0.01 |
| | [2.62] | [1.08] | [2.16] | [-2.69] | [-1.96] | [-2.47] |
| Maturity | **0.05** | **0.05** | **0.05** | -0.01 | -0.01 | -0.01 |
| | [13.45] | [13.46] | [14.00] | [-3.83] | [-4.04] | [-3.97] |
| ln(Issuance) | -0.06 | -0.06 | -0.11 | 0.22 | 0.23 | 0.25 |
| | [-2.10] | [-2.36] | [-3.88] | [9.06] | [9.26] | [9.01] |
| Rating | 0.01 | 0.01 | 0.01 | -0.02 | -0.02 | -0.02 |
| | [1.42] | [1.86] | [0.81] | [-3.34] | [-3.70] | [-2.99] |
| Turnover | | **-0.01** | | | 0.00 | |
| | | [-3.41] | | | [1.85] | |
| ln(Num Trds) | | | **0.14** | | | -0.06 |
| | | | [8.33] | | | [-2.60] |
| Obs | 22,046 | 22,046 | 22,046 | 21,885 | 21,885 | 21,885 |
| $R^2$(%) | 22.82 | 23.35 | 24.35 | 4.28 | 4.33 | 4.50 |

| | $\lambda^I$ ($\times 10^3$) | | | $\Phi$ ($\times 10^{-2}$) | | |
|---|---|---|---|---|---|---|
| Intercept | -6.06 | -5.80 | -6.61 | 168.70 | 166.50 | 158.27 |
| | [-13.47] | [-13.54] | [-14.68] | [26.79] | [25.32] | [24.66] |
| Age | **0.06** | **0.04** | **0.05** | **-1.22** | **-1.05** | **-1.29** |
| | [5.74] | [3.95] | [5.42] | [-6.81] | [-5.49] | [-7.20] |
| Maturity | **0.04** | **0.04** | **0.04** | **-0.57** | **-0.58** | **-0.55** |
| | [7.31] | [7.67] | [7.63] | [-6.58] | [-6.64] | [-6.73] |
| ln(Issuance) | 0.93 | 0.91 | 0.83 | 1.43 | 1.57 | -0.36 |
| | [14.73] | [14.92] | [12.66] | [1.80] | [1.94] | [-0.42] |
| Rating | 0.03 | **0.04** | 0.02 | **-2.48** | **-2.56** | **-2.62** |
| | [1.95] | [2.65] | [1.39] | [-9.99] | [-10.35] | [-10.76] |
| Turnover | | **-0.02** | | | 0.15 | |
| | | [-7.25] | | | [2.94] | |
| ln(Num Trds) | | | **0.23** | | | 4.34 |
| | | | [5.71] | | | [4.53] |
| Obs | 22,046 | 22,046 | 22,046 | 22,046 | 22,046 | 22,046 |
| $R^2$(%) | 32.58 | 33.92 | 34.14 | 5.29 | 5.43 | 6.04 |

# Table 2.4: Cross-sectional Variation in Measures and Bond Characteristics (Continued)

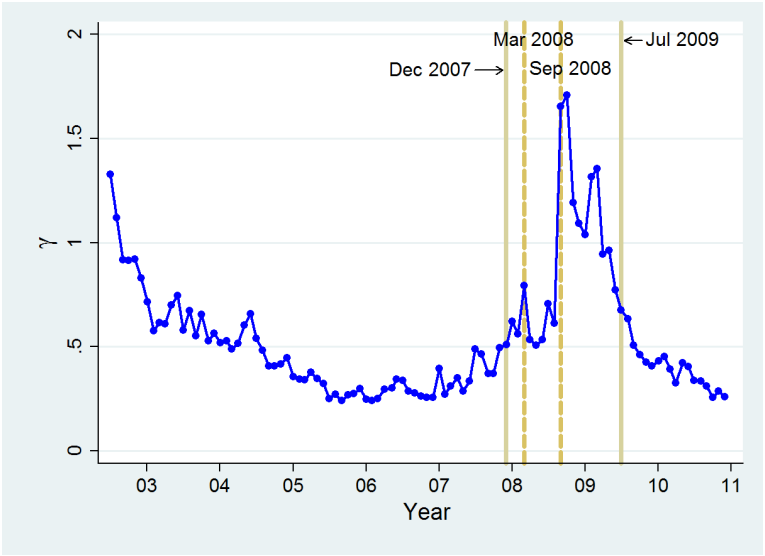
Panel A: Full Sample (July 2002 - December 2010) (Continued)

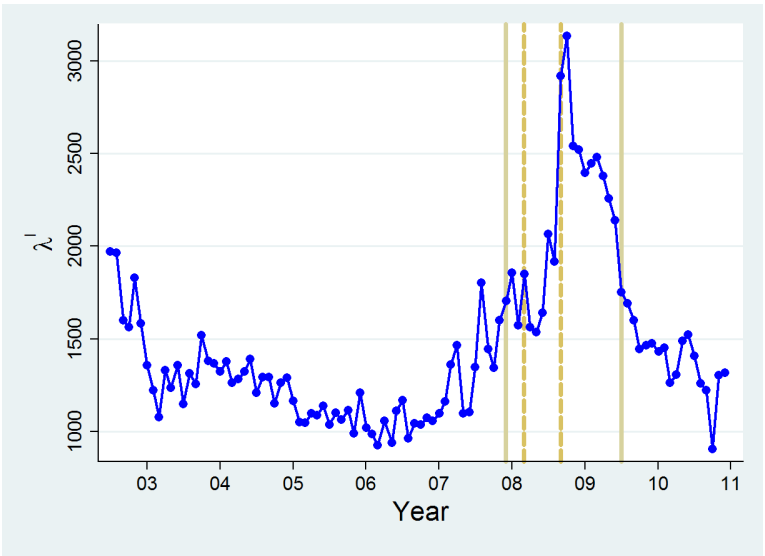
| | $\sigma_u$ | | | $VR$ ($\times 10^{-2}$) | | |
|---|---|---|---|---|---|---|
| Intercept | 0.69 | 0.78 | 0.41 | -14.89 | -16.19 | -17.51 |
| | [5.19] | [6.09] | [3.13] | [-5.88] | [-6.30] | [-6.99] |
| Age | **0.02** | **0.01** | **0.01** | -0.39 | -0.30 | -0.41 |
| | [3.96] | [2.46] | [3.55] | [-4.30] | [-3.28] | [-4.60] |
| Maturity | **0.04** | **0.04** | **0.04** | 0.27 | 0.26 | 0.27 |
| | [17.51] | [17.67] | [18.29] | [6.70] | [6.72] | [6.65] |
| ln(Issuance) | -0.04 | -0.05 | -0.09 | 2.44 | 2.51 | 1.97 |
| | [-2.34] | [-2.80] | [4.64] | [7.38] | [7.64] | [5.27] |
| Rating | **0.03** | **0.03** | **0.02** | 1.05 | 0.98 | 1.02 |
| | [4.30] | [4.64] | [3.77] | [8.70] | [8.45] | [8.56] |
| Turnover | | **-0.01** | | | 0.14 | |
| | | [-4.17] | | | [4.46] | |
| ln(Num Trds) | | | **0.12** | | | 1.13 |
| | | | [8.05] | | | [3.88] |
| Obs | 22,046 | 22,046 | 22,046 | 18,412 | 18,412 | 18,412 |
| $R^2$(%) | 26.47 | 27.29 | 41.78 | 24.79 | 26.29 | 25.81 |

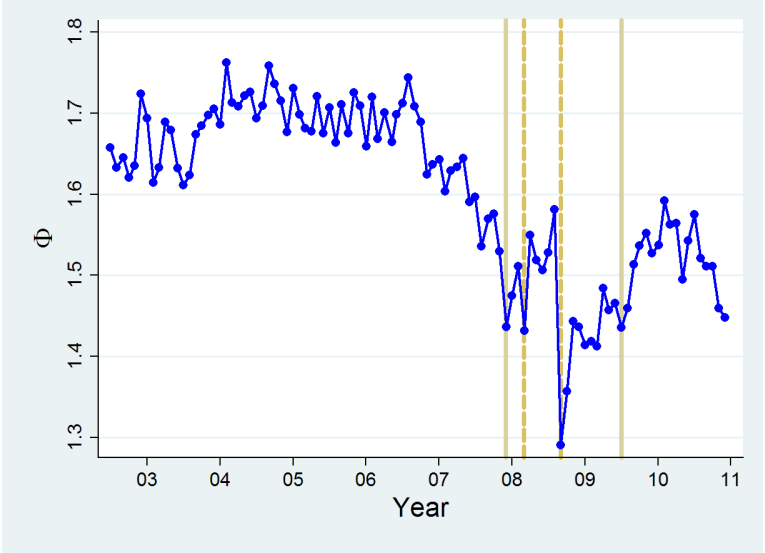
Panel B: Signed Volume Data Available (November 2008 - December 2010)

| | $\gamma^{CGW,signed}$ | | | $\lambda^{VW,signed}$ ($\times 10^{-3}$) | | |
|---|---|---|---|---|---|---|
| Intercept | -0.38 | -0.36 | -0.54 | 8.94 | 12.49 | -0.89 |
| | [-1.83] | [-1.87] | [-2.49] | [1.96] | [2.70] | [-0.20] |
| Age | -0.00 | -0.01 | -0.01 | **0.76** | **0.56** | **0.65** |
| | [-0.66] | [-0.86] | [-0.89] | [6.29] | [4.77] | [5.52] |
| Maturity | 0.00 | 0.00 | 0.00 | **0.21** | **0.23** | **0.27** |
| | [1.26] | [1.29] | [1.67] | [4.77] | [5.37] | [6.23] |
| ln(Issuance) | 0.04 | 0.04 | 0.01 | -0.63 | -0.92 | -2.32 |
| | [2.21] | [2.26] | [0.51] | [-1.00] | [-1.47] | [-3.51] |
| Rating | 0.01 | 0.01 | 0.01 | -0.19 | -0.02 | -0.30 |
| | [1.02] | [1.03] | [0.88] | [-1.15] | [-0.13] | [-2.01] |
| Turnover | | 0.00 | | | **-0.28** | |
| | | [-0.51] | | | [-6.22] | |
| ln(Num Trds) | | | 0.06 | | | **3.93** |
| | | | [2.61] | | | [8.44] |
| Obs | 8,609 | 8,609 | 8,609 | 8,317 | 8,317 | 8,317 |
| $R^2$(%) | 0.07 | 0.07 | 0.14 | 1.91 | 3.44 | 4.59 |

**Figure 2.1: Monthly Time-Series of Aggregate Illiquidity Level Measures (issuance-weighted average)**

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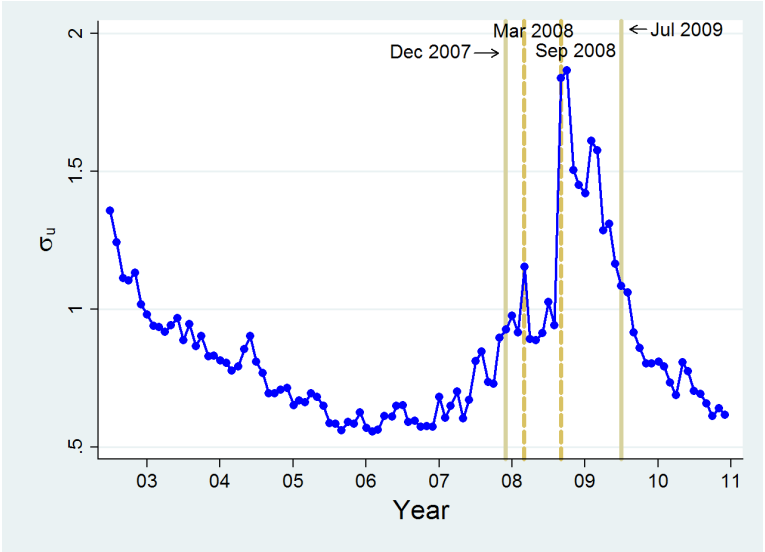
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# Outline

# Table 3.1: Bond Yield Spread and Illiquidity Level Measures

Monthly Fama-MacBeth cross-sectional regression of bond yield spreads on illiquidity measures and control variables. The t-statistics in brackets account for serial correlation with Newey-West correction. Top and bottom 0.5% of illiquidity level estimates are winsorized. Top and bottom 1% of yield spreads are trimmed.

Panel A: Full Sample (July 2002 - December 2010)

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Intercept | 0.93 | -0.91 | -0.85 | -0.90 | -0.83 | -0.87 | -1.05 | -0.96 | -0.78 | -1.09 | -0.96 | -0.87 |
| | [8.50] | [-4.54] | [-4.73] | [-4.50] | [-4.25] | [-4.33] | [-5.25] | [-4.93] | [-4.07] | [-4.95] | [-4.84] | [-4.53] |
| $\gamma$ | | | **0.19** | | | | | | | -0.13 | | |
| | | | [5.19] | | | | | | | [-5.69] | | |
| $\gamma^{CGW}$ | | | | -0.01 | | | | | | | | |
| | | | | [-1.22] | | | | | | | | |
| $\lambda^I$ | | | | | **0.03** | | | | | -0.03 | | |
| ($\times 10^3$) | | | | | [4.47] | | | | | [-3.17] | | |
| $\Phi$ | | | | | | **-0.04** | | | | | | |
| | | | | | | [-2.21] | | | | | | |
| $\sigma_u$ | | | | | | | **0.40** | | | 0.60 | **0.42** | |
| | | | | | | | [6.30] | | | [8.34] | [7.28] | |
| $\sigma_u - E[\sigma_u \mid Eq.Volatility]$ | | | | | | | | 0.33 | | | | 0.33 |
| | | | | | | | | [6.00] | | | | [5.73] |
| $VR$ | | | | | | | | | **0.76** | 0.92 | **0.93** | 0.73 |
| | | | | | | | | | [5.01] | [6.22] | [6.32] | [5.00] |
| $\gamma - E[\gamma \mid \sigma_u, VR]$ | | | | | | | | | | | -0.01 | -0.01 |
| | | | | | | | | | | | [-0.77] | [-0.57] |
| $\lambda^I - E[\lambda^I \mid \sigma_u, VR]$ | | | | | | | | | | | -0.02 | -0.01 |
| ($\times 10^3$) | | | | | | | | | | | [-1.92] | [-1.13] |
| Age | | 0.02 | 0.02 | 0.02 | 0.02 | 0.02 | 0.01 | 0.03 | 0.02 | 0.01 | 0.01 | 0.02 |
| | | [3.55] | [3.44] | [3.35] | [3.47] | [3.42] | [2.73] | [4.49] | [3.50] | [2.71] | [2.71] | [5.12] |
| Maturity | | 0.03 | 0.02 | 0.03 | 0.03 | 0.03 | 0.01 | 0.03 | 0.03 | 0.01 | 0.01 | 0.03 |
| | | [14.94] | [5.13] | [14.54] | [12.45] | [14.74] | [2.97] | [13.80] | [12.94] | [2.23] | [2.00] | [11.87] |
| ln(Num Trds) | | 0.20 | 0.20 | 0.20 | 0.19 | 0.21 | 0.21 | 0.21 | 0.18 | 0.20 | 0.19 | 0.19 |
| | | [7.01] | [7.29] | [6.93] | [6.55] | [7.03] | [7.20] | [7.29] | [6.08] | [5.83] | [6.22] | [6.43] |
| Eq. Volatility | | 0.02 | 0.01 | 0.02 | 0.01 | 0.02 | 0.01 | 0.02 | 0.01 | 0.01 | 0.01 | 0.02 |
| | | [5.79] | [5.73] | [5.91] | [5.77] | [5.82] | [5.78] | [5.89] | [5.28] | [5.26] | [5.28] | [5.40] |
| A Dummy | 0.36 | 0.31 | 0.29 | 0.31 | 0.31 | 0.31 | 0.27 | 0.30 | 0.28 | 0.23 | 0.24 | 0.28 |
| | [4.60] | [5.68] | [5.98] | [5.66] | [5.73] | [5.63] | [6.05] | [5.71] | [5.14] | [5.46] | [5.38] | [5.15] |
| BAA dummy | 1.07 | 0.95 | 0.91 | 0.95 | 0.95 | 0.95 | 0.86 | 0.94 | 0.83 | 0.71 | 0.73 | 0.81 |
| | [10.61] | [9.16] | [9.97] | [9.12] | [9.10] | [9.20] | [10.28] | [9.24] | [8.00] | [8.88] | [8.63] | [7.91] |
| Avg. # bonds/month | 216 | 216 | 216 | 215 | 216 | 216 | 216 | 214 | 192 | 192 | 192 | 190 |
| $R^2$(%) | 26.90 | 58.32 | 60.17 | 58.23 | 58.65 | 58.49 | 61.40 | 59.93 | 59.19 | 63.59 | **63.38** | 61.66 |

# Table 3.8: Bond Yield Spread and Illiquidity Level and Risk
(Subperiod when signed volume data is available)

Monthly Fama-MacBeth cross-sectional regression of bond yield spreads on illiquidity measures and control variables. The t-statistics in brackets account for serial correlation with Newey-West correction. Top and bottom 0.5% of illiquidity level estimates are winsorized. Top and bottom 1% of illiquidity risk estimates are winsorized. Top and bottom 1% of yield spreads are trimmed.

| Panel A: Signed Volume Data Available (November 2008 - December 2010) | | | |
|---|---|---|---|
| Intercept | 1.27 | -2.02 | -2.18 |
| | [4.82] | [-7.34] | [-11.08] |
| $\sigma_u$ | | | **0.86** |
| | | | [12.80] |
| *VR* | | | **1.17** |
| | | | [4.20] |
| $\lambda^{VW,signed}$ | | | **2.03** |
| | | | [2.47] |
| $\beta^{\sigma_u}$ | | | 0.00 |
| | | | [1.55] |
| Age | | 0.00 | -0.01 |
| | | [-0.88] | [-1.29] |
| Maturity | | 0.03 | -0.01 |
| | | [15.36] | [-2.57] |
| ln(Num Trds) | | 0.36 | 0.35 |
| | | [9.54] | [8.97] |
| Eq. Volatility | | 0.03 | 0.03 |
| | | [10.74] | [9.42] |
| A Dummy | 0.90 | 0.67 | 0.48 |
| | [6.55] | [6.63] | [5.02] |
| BAA dummy | 1.69 | 1.53 | 1.11 |
| | [9.71] | [6.57] | [5.16] |
| Avg. # bonds/month | 323 | 323 | 279 |
| $R^2$(%) | 20.60 | 58.89 | **66.98** |

## Table 3.5: Aggregate Yield Spreads and Aggregate Illiquidity

This table reports regressions of the monthly changes in the aggregate yield spread on changes in aggregate illiquidity measures and market variables. Newey and West (1987) t-statistics are reported in brackets. The sample period is specified in each panel.

Panel A: Full Sample (July 2002 - December 2010)

| | | | $\gamma$ | | $\gamma^{CGW}$ | | $VR$ | |
|---|---|---|---|---|---|---|---|---|
| Intercept | 0.009 | 0.007 | 0.010 | 0.010 | 0.000 | 0.007 | 0.004 | 0.008 |
| | [0.66] | [0.47] | [0.46] | [0.73] | [-0.00] | [0.44] | [0.13] | [0.48] |
| ΔMeasure | | | **1.272** | **0.565** | -1.005 | -0.423 | 2.934 | 2.734 |
| | | | [5.31] | [2.93] | [-1.93] | [-2.16] | [0.49] | [1.26] |
| ΔVIX | 0.028 | 0.037 | | 0.031 | | 0.036 | | 0.038 |
| | [5.93] | [8.49] | | [7.45] | | [8.64] | | [9.04] |
| ΔBond Index Return Volatility | 0.177 [0.93] | | | | | | | |
| ΔCDS Index | 0.062 [1.36] | | | | | | | |
| ΔTerm Spread | -0.033 [-0.32] | | | | | | | |
| Lagged Stock Mkt Return | -0.006 [-1.20] | | | | | | | |
| Lagged Bond Mkt Return | -0.013 [-0.86] | | | | | | | |
| $AdjR^2$ (%) | 69.25 | 59.49 | 32.54 | **64.12** | 6.72 | 60.39 | -0.62 | 60.06 |

## Table 3.5: Aggregate Yield Spreads and Aggregate Illiquidity (Cont.)

Panel A: Full Sample (July 2002 - December 2010)

| | | $\lambda^I(\times 10^3)$ | | $\Phi$ | | $\sigma_u$ | |
|---|---|---|---|---|---|---|---|
| Intercept | 0.007 | 0.007 | 0.010 | -0.001 | 0.007 | 0.008 | 0.009 |
| | [0.47] | [0.32] | [0.70] | [-0.02] | [0.47] | [0.40] | [0.67] |
| ΔMeasure | | **1.102** | **0.574** | **-0.770** | -0.062 | **1.219** | **0.500** |
| | | [4.72] | [5.01] | [-2.29] | [-0.22] | [7.17] | [3.67] |
| ΔVIX | 0.037 | | 0.032 | | 0.037 | | 0.032 |
| | [8.49] | | [8.00] | | [8.65] | | [6.59] |
| $AdjR^2(\%)$ | 59.49 | 26.47 | **65.57** | 2.03 | 59.10 | 30.08 | **63.07** |

# Conclusions

- Proposed measures $\sigma_u$, $VR$, and $\lambda^{VW,signed}$ are more robust and more economically significant than those in literature.
- Using various illiquidity measures, we test pricing implications of illiquidity level and illiquidity risk.
  - Illiquidity level carries risk premium.
  - Illiquidity risk is priced only during crisis, not normal time.

# Conclusions

- Proposed measures $\sigma_u$, $VR$, and $\lambda^{VW,signed}$ are more robust and more economically significant than those in literature.
- Using various illiquidity measures, we test pricing implications of illiquidity level and illiquidity risk.
  - Illiquidity level carries risk premium.
  - Illiquidity risk is priced only during crisis, not normal time.

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