Understanding Credit Spreads: The role of systematic variation in liquidity and expected loss

- Viral V. Acharya (London Business School and CEPR), joint with Yakov Amihud (NYU) and Sreedhar Bharath (U.Michigan)
Introduction

• Two burgeoning, and somewhat distinct, literatures in financial economics

• Effect of Liquidity and Liquidity Risk on Asset Prices

• (In)Ability of structural models of credit risk to explain levels of credit spreads
Our Proposal...

• Bridge the gap between these literatures
  – Use ideas from asset-pricing literature on how liquidity and liquidity risk should be priced
  – To understand how large, if any, is the liquidity premium contained in credit spreads
  – I will mainly focus on this aspect of the proposal

• Also re-examine some of the systematic risk factors driving credit spreads
  – In particular, the systematic risk of expected loss given the new evidence on recovery-rate risk
Liquidity and Asset Pricing

• Liquidity co-moves with market liquidity

• Liquidity comoves with returns (negatively), and predicts future returns

• Expected illiquidity is priced
  – Amihud and Mendelson (1986)

• Liquidity risk is also priced
Credit Spread Modeling

• Merton (1974)-based models seem unable to match the level of credit spreads
• CAN, however, match well the hedge ratios – Schaefer and Strebulaev (2003)
• Nevertheless, residual variability is high – Collin-Dufresne, Goldstein, Martin (2000)
  – Failure is highest for high-rated bonds
• CGM find that this residual variability is correlated across ALL bond types
• Some recent contributions (discussed later) suggest liquidity may be playing a role
Acharya-Pedersen model

- Expected Return =
  Expected (%) Trading-cost times Holding Period
  +
  Risk-premium times Net Beta

- Net Beta = Covariance \( (r^i - c^i, r^M - c^M) \)

- Risk-premium = Expected \( (r^M - c^M - r^f) \)
Estimation Approach

- NYSE/AMEX 1963-2000
  - Monthly average of $|R^i| / DV^i$ for stock $i$
  - Highly correlated with Kyle’s (1985) $\lambda$ (Hasbrouck, 2004)
  - ILLIQ is higher for illiquid stocks and in periods where the markets are illiquid
  - Shown by Amihud (2002) to affect stock prices in both cross-section and time-series analysis
- Average across stocks for market ILLIQ $c^M$ (see plot)
- Construct market beta and liquidity betas
- Test the asset-pricing model for liquidity-sorted portfolios

Acharya and Pedersen (2003)
Results

- \( E(r) = 0.04 \times \text{Expected } \% \text{Trading-cost} + 1.449 \times \text{Net Beta} \)

- \( 0.04 \) = Holding period of 25 months
- \( 1.5 \) = Net market risk-premium per month (a bit too high)
- Does not allow for separate liquidity premium

- \( E(r) = 0.04 \times \text{Expected } \% \text{Trading-cost} + 1.150 \times \text{Market Beta} + 4.334 \times \text{Liquidity Beta} \)
Why is this useful?

- Provides estimate of liquidity risk-premium from a simple yet well-founded economic model

- Researchers can compare liquidity and liquidity risk of alternative asset classes to those of stock portfolios

- Use estimated risk-premium to come up with preliminary (suggestive) estimates of how large might the effect of illiquidity be in credit spreads
# Application to Credit Spreads

(Bid-asks from Chen, Lesmond, Wei, WP 2004)

<table>
<thead>
<tr>
<th></th>
<th>AAA</th>
<th>BBB</th>
<th>BB</th>
<th>B</th>
<th>CCC</th>
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<td>Bid-Ask</td>
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<td>1767</td>
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<td>%cost</td>
<td>3.18</td>
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<td>4.28</td>
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<tr>
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<tr>
<td>Yield</td>
<td>850</td>
<td>954</td>
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<tr>
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<tr>
<td>Bid-Ask</td>
<td>56</td>
<td>52</td>
<td>64</td>
<td>82</td>
<td>100</td>
</tr>
<tr>
<td>Yield</td>
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<td>954</td>
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<td>1163</td>
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<tr>
<td>%cost</td>
<td>6.59</td>
<td>5.45</td>
<td>6.52</td>
<td>7.05</td>
<td>5.66</td>
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</table>

Spread over rf 76 178 322 486 970
Comparison to AP Portfolios

• Based on trading costs:
  Short-maturity bonds = Portfolio 23
  Medium-maturity bonds = Portfolio 24
  Long-maturity bonds = Portfolio 25

• Three most illiquid stock portfolios
  – Smallest market cap (20-40 mln USD)
  – Most volatile (40-60% annualized)
  – Most liquidity-risky (0.75-1.5% vol of trading costs)
  – Highest average returns (13.2% annualized)
Calibrating Liquidity Effects

<table>
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<tr>
<th>Effect of expected liquidity:</th>
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<th>BB</th>
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<th>CCC</th>
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<tr>
<td>Short</td>
<td>0.1271</td>
<td>0.1006</td>
<td>0.1713</td>
<td>0.1857</td>
<td>0.1856</td>
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<tr>
<td>Medium</td>
<td>0.2353</td>
<td>0.1593</td>
<td>0.1998</td>
<td>0.2098</td>
<td>0.1358</td>
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<tr>
<td>Long</td>
<td>0.2635</td>
<td>0.2180</td>
<td>0.2610</td>
<td>0.2820</td>
<td>0.2264</td>
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<tr>
<td>$\text{cov}(r,\text{ILLIQ})$</td>
<td>-0.0008</td>
<td>-0.0012</td>
<td>-0.0021</td>
<td>-0.0021</td>
<td>-0.0040</td>
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</table>

<table>
<thead>
<tr>
<th>Effect of liquidity risk:</th>
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<tr>
<td>Low risk-premium</td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>$\lambda=1.5$</td>
<td>0.1203</td>
<td>0.1757</td>
<td>0.3110</td>
<td>0.3140</td>
<td>0.6029</td>
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<tr>
<td>High risk-premium</td>
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<tr>
<td>$\lambda=4.5$</td>
<td>0.361</td>
<td>0.527</td>
<td>0.9329</td>
<td>0.9419</td>
<td>1.8086</td>
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Calibration (Cont’d)

<table>
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<th>CCC</th>
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</thead>
<tbody>
<tr>
<td><strong>Low RP</strong></td>
<td>0.36</td>
<td>0.33</td>
<td>0.51</td>
<td>0.52</td>
<td>0.74</td>
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<tr>
<td>% of Yield</td>
<td>4.18</td>
<td>3.51</td>
<td>5.21</td>
<td>4.50</td>
<td>4.18</td>
</tr>
<tr>
<td>% of Spread</td>
<td>46.79</td>
<td>18.82</td>
<td>15.86</td>
<td>10.78</td>
<td>7.62</td>
</tr>
<tr>
<td><strong>High RP</strong></td>
<td>0.6</td>
<td>0.69</td>
<td>1.13</td>
<td>1.15</td>
<td>1.94</td>
</tr>
<tr>
<td>% of Yield</td>
<td>7.06</td>
<td>7.23</td>
<td>11.52</td>
<td>9.89</td>
<td>10.98</td>
</tr>
<tr>
<td>% of Spread</td>
<td>78.95</td>
<td>38.76</td>
<td>35.09</td>
<td>23.66</td>
<td>20.00</td>
</tr>
</tbody>
</table>

- Based on reasonable risk-premium estimates, the effect of expected illiquidity and liquidity risk on bonds can be 20-50% of yield spreads
Supporting Findings

• Existing literature has found the SMB (small minus big size) portfolio to explain
  – The part of credit spreads not related to expected loss
    • Elton, Gruber, Agrawal and Mann (2001)
  – The part of credit spreads not related to Merton-model predicted variation
    • Schaefer and Strebulaev (2003)

• AP find that liquidity and liquidity risk explain SMB effect completely
  – A well-accepted fact in literature by now
Obvious Caveats…

• Our aggregate liquidity measure does not include bond-market liquidity
  – The liquidity-risk effect may in fact be greater
  – There may be liquidity risk “local” to bond markets

• Need to check that liquidity, liquidity-risk are actually priced in the cross-section of bonds

• Need to appropriately eliminate credit-risk determinants before studying any liquidity effects in cross-section as well as time-series
Some Recent Contributions

• Since our proposal, we have discovered some useful, interesting papers
• Chen, Lesmond, Wei (2004)
  – Use % of zero returns (and implied) measures of bond illiquidity based on daily data
  – Show illiquidity is priced in the cross-section
  – Also provide some time-series evidence
• Goyenko (2005)
  – Uses similar measure to show that both stock and bond market illiquidities are priced
Recent Contributions (Cont’d)

- Houweling, Mentink, Vorst (2005)
  - Study bonds denominated in Euros
  - Show that nine different measures of liquidity are related, almost all are priced (individually)
  - Overall effect of liquidity of 13-23 bps

- Gebhardt, Hvidkjaer, Swaminathan (2005)
  - Use Term Spread and Default Spread as systematic variables based on Fama and French (1993)
  - Find significant explanatory power in the cross-section of bond returns (by rating categories)
Our Proposed Methodology

• Study cross-section as well as time-series of individual corporate bond returns
  – Effect of expected illiquidity
  – Effect of liquidity risk [NEW] (a la Acharya-Pedersen)

• In light of recent progress, it seems important to
  – Study the time-series of credit spreads in particular
    • Is liquidity an important determinant of variations in
      – Default Spread?
      – Term Spread?
  – Study both equity and bond-market liquidity
    • The latter implies significant data-collection effort
Proposal (Cont’d)

• As an illustration of time-series analysis, we have done some preliminary tests

• Relate the time-series variation in Default Spread and Term Spread to
  – Stock-market Illiquidity
  – Stock-market return
    • For both, focus on smallest portfolios given earlier discussion
  – Other determinants often insignificant: for example, broad market return and market volatility
Hypotheses for Default Spread

• Decreasing in stock-market returns
  – Market-return: value-weighted or equal-weighted?
  – Small stock-portfolio return?

• Increasing in stock-market illiquidity
  – Commonality in liquidity
    • Chordia, Sarkar and Subrahmanyam (2003)
    • Brunnermeier and Pedersen (2005)
  – Bonds like small-stock portfolios

• Increase in stock-market volatility
  – Value-weighted or equal-weighted?
Preliminary Results (Cont’d)

- Monthly data are over 40 years, 1963-2002
- Default spread in month t:
  \[ DEF_t = BAA_t - AAA_t \]
  \[ DDEF_t = DEF_t - DEF_{t-1} \]
  or \[ DEF_t / DEF_{t-1} \]
  or \[ \log(DEF_t / DEF_{t-1}) \]
- \[ DILLIQ_t = \log(IILLIQ_t/IILLIQ_{t-1}) \]
- The small stocks’ portfolios are where the liquidity effects are particularly pronounced.
- \[ DILLQSML = \text{average DILLIQ for size portfolios 2, 3 & 4} \]
- \[ RSML = \text{average returns for size portfolios 2, 3 & 4} \]
Dependent Variable: $DDEF_t$

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>$t$-statistic</th>
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<tbody>
<tr>
<td>$DILLIQSML_{t-1}$</td>
<td>0.013</td>
<td>0.77</td>
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<tr>
<td>$DILLIQSML_{t-2}$</td>
<td>0.038</td>
<td>2.70***</td>
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<tr>
<td>$RSML_{t-1}$</td>
<td>-0.263</td>
<td>-3.44***</td>
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<tr>
<td>$RSML_{t-2}$</td>
<td>-0.020</td>
<td>-0.02</td>
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<tr>
<td>$DDEF_{t-1}$</td>
<td>0.189</td>
<td>3.08***</td>
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<tr>
<td>$DDEF_{t-2}$</td>
<td>-0.106</td>
<td>-1.98***</td>
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</table>

$R^2 = 0.108$, $DW = 2.03$
### Dependent Variable: $DDEF_t$

<table>
<thead>
<tr>
<th>Variable</th>
<th>Sub-period I</th>
<th></th>
<th>Sub-period II</th>
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<td>Coefficient</td>
<td>$t$-statistic</td>
<td>Coefficient</td>
<td>$t$-statistic</td>
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<tr>
<td>$DILLIQSML_{t-1}$</td>
<td>0.046</td>
<td>1.25</td>
<td>-0.002</td>
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<td>$DILLIQSML_{t-2}$</td>
<td>0.056</td>
<td>1.85*</td>
<td>0.032</td>
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<tr>
<td>$RSML_{t-1}$</td>
<td>-0.199</td>
<td>-1.86*</td>
<td>-0.315</td>
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<td>$RSML_{t-2}$</td>
<td>-0.043</td>
<td>-0.34</td>
<td>0.057</td>
<td>0.040</td>
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<tr>
<td>$DDEF_{t-1}$</td>
<td>0.128</td>
<td>1.58</td>
<td>0.264</td>
<td>4.42***</td>
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<tr>
<td>$DDEF_{t-2}$</td>
<td>-0.140</td>
<td>-1.68*</td>
<td>-0.141</td>
<td>2.17**</td>
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</table>

$R^2 = 0.111$, $DW = 2.01$  
$R^2 = 0.130$, $DW = 2.04$
Hypotheses for Term Spread

• Trickier…
• Flight to quality and liquidity (short-end treasuries)
  • Holmstrom and Tirole’s LAPM (2001)
  • Longstaff (2002)
• Decreasing in stock-market returns
• Increasing in stock-market illiquidity
• Decreasing in inflation growth
Preliminary Results (Cont’d)

- Term Spread ($TS_t$) = 
  \[ \log \left( \frac{10\text{-yr Tsy Yield}_t}{3\text{-mo TBill Yield}_t} \right) \]
- $DTS_t = TS_t - TS_{t-1}$

- $INF_t = \log(CPI_t/CPI_{t-1})$
  - $CPI_t$ is seasonally adjusted, all items
- $DINF_t = INF_t - INF_{t-1}$

- Market illiquidity and return appear to be more important than small stock portfolio measures
## Dependent Variable: $DTS_t$

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<th>Variable</th>
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<td>$DILLIQ_t$</td>
<td>0.0080</td>
<td>2.87***</td>
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<td>$DILLIQ_{t-1}$</td>
<td>0.0061</td>
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<tr>
<td>$RM_{t-3}$</td>
<td>-0.315</td>
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<tr>
<td>$RM^2_{t-3}$</td>
<td>3.465</td>
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<td>$DINF_{t-1}$</td>
<td>-2.851</td>
<td>-2.45**</td>
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<td>$DTS_{t-1}$</td>
<td>0.313</td>
<td>5.45***</td>
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$R^2 = 0.140$  $DW = 1.93$
## Dependent Variable: DTS\textsubscript{t}

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<td>2.09**</td>
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<td>DILLIQ\textsubscript{t-1}</td>
<td>0.0080</td>
<td>2.85***</td>
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<td>RM\textsubscript{t-3}</td>
<td>-0.266</td>
<td>-2.24**</td>
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<td>RM\textsuperscript{2}\textsubscript{t-3}</td>
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<td>2.47**</td>
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<td>DI\textsubscript{t-1}</td>
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<td>-2.38**</td>
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<td>0.304</td>
<td>5.29***</td>
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<td>DDEF\textsubscript{t-1}</td>
<td>0.729</td>
<td>2.13</td>
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\[ R^2 = 0.161 \quad DW = 1.94 \]
Systematic Expected Losses

• Recent evidence shows that not just default likelihood (PD), but loss given default (LGD) is also systematic
  – Altman, Brady, Resti, Sironi (2003)
    • “Bad things happen in pairs”
    • PD and LGD are correlated
  – Acharya, Bharath, Srinivasan (2004)
    • Recovery is lower for “asset-specific” industries
    • Effect is at industry level, not just macro level
Expected Losses (Cont’d)

• Why is this “recovery risk” important?
  – Expected losses contain a “multiplier” systematic effect

• Traditional way of thinking about systematic risk of expected losses
  – Cov (PD * Avg LGD, Rm)

• But Cov (PD, LGD) > 0 …

• Correct way
  – Cov (PD * LGD, Rm)
Expected Losses (Cont’d)

• Calibration (again!)…
• Cov (PD, Rm) = -0.040%
• Statistically, LGD is well-described by
  \[ \text{LGD} = 0.4572 + 0.075 \times \text{PD} \]
• Cov (PD * LGD, Rm)
  \[ = 0.46 \text{Cov}(PD,Rm) + 0.075 \text{Cov} (PD^2,Rm) \]
  \[ = -0.056\% \]
• True systematic risk is about 40% greater
Expected Losses (Cont’d)

- Recent efforts at explaining rating-AAA spreads have focused on
  - Asset-pricing models with time-varying risk-premium (Habit models)
      - Risk-premium is higher in “bad” times
- Thus, there may be triple multiplier at work
  - PD, LGD, Risk-premium all go up at the same time
- Credit spreads may be of their size partly due to this multiplier effect
  - Not yet modeled in the literature
  - We hope to quantify the effect
Summary

• Liquidity, liquidity risk and recovery risk appear to be promising dimensions to pursue to explain
  – Level of credit spreads
  – Dynamics of credit spreads

• Preliminary results on liquidity risk suggest
  – Equity-market based measures of liquidity may themselves succeed in this endeavour
  – But bond-market liquidity measures may be necessary to obtain conclusive evidence
  – We plan to pursue both, subject to data constraints
Proposed Timeline and Budget

• Data acquisition/cleaning: end of Summer 2005
• Pilots: Fall 2005
• Empirical investigation: Summer 2006
• Paper(s) for circulation: Fall 2006

• Research assistants: €15,000
• Computing equipment: €4,000
• Travel expenses: €4,500
• Overheads: €1,500
• Data: €5,000