Credit Risk and Liquidity Risk: 1 + 1 > 2

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MIT Sloan and NBER

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Based on Chen, Cui, He, Milbradt (2014): Quantifying Liquidity and Default Risks of Corporate Bonds over the Business Cycle
Outline

Introduction

A Theoretical Framework

Calibration

A New Decomposition

Conclusion
Credit Risk and Liquidity Risk

Credit spread = Corporate bond yield – Treasury yield

Example: 5/28/2015
- AT&T bond with 10-year maturity (BBB): 3.785%
- 10-year treasury: 2.128%
- Spread: 1.66% or 166 bps

Credit spread = Expected default loss + Default risk premium
+ Liquidity component
+ Tax component
+ Treasury convenience yield
Default risk only accounts for part of corporate bond spreads

- Longstaff, Mithal, Neis (2005): Aaa/Aa 50%; Baa 70%
- Empirical evidence linking liquidity to rating and maturity
- Structural credit models since Merton (1974) mostly target default component of credit spreads

This paper: an attempt to explain total credit spreads in a unified framework

- Demonstrate links between liquidity frictions and credit risk
- Default-liquidity spiral over the business cycle

A new structural decomposition of default and liquidity components in credit spreads
Why Should We Care?

- Investing: the CDS-Bond basis trade
- Accounting: when and how to recognize credit losses
- Policy: cost-benefit analysis for liquidity injection programs
No Liquidity Frictions

Firm:
\( dy = \mu dt + \sigma dZ \)

Default at \( y_b \):
\( D = \alpha v_b \)

Reissue

\( D: c \ dt \)

Maturity

\( m \)
Idiosyncratic Liquidity Shocks

\[ dy = \mu dt + \sigma dZ \]

- Reissue

- Maturity \( m \)

- Default at \( y_b \)

\[ D_H: c \ dt \]

\[ D_L: (c - hc) \ dt \]

\( \xi \) Shock
Secondary Market for Bond Trading

\[ dy = \mu^s dt + \sigma^s dZ \]

Firm:

Default at \( y_b^s \):
\[ D_H = \alpha_H^s y_b^s \]
\[ D_L = \alpha_L^s y_b^s \]

\[ D_H : c dt \]

\[ D_L : (c-hc^s) dt \]

Maturity

Reissue

Resale

Liq. Shock

\( \xi^s \)

\( A = D_H \)

\( B = D_L + \beta(D_H - D_L) \)

Interdealer Market

Intermediation
Micro-foundation of Holding Costs

What are liquidity shocks?

- Liquidity shock $\Rightarrow$ significant need for cash
- Uncollateralized financing: $r + \chi$
- Bond can be used as collateral to borrow at rate $r$
- Haircut: $h$ (depends on riskiness of asset)

Where do the holding costs come from?

- Marginal (flow) benefit of bond as collateral: $\chi [1 - h(y)] P(y)$
- Marginal (flow) benefit from immediate sale of bond: $\chi B(y)$
- Holding cost for illiquid bond: relative to cash
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One advantage of the structural model is that we can assess its quantitative effects through calibration.

1. Solve the model for endogenous default boundaries
   \[ \mathbf{y}_b = [y_b(G), y_b(B)]^\top. \]

2. Calculate prices of fixed maturity bonds numerically given \( \mathbf{y}_b \).

3. Within each rating class, map the observed distribution of market leverage into a distribution of initial cash-flow states \( \mathbf{y}_0 \) to address Jensen's inequality.

4. Compute conditional model implied aggregate moments.

5. Search for parameters that best fit key aggregate moments in the data (default rates, credit spreads, bid-ask)
Heterogeneity in the Data

- Rating class defined by the *empirical distribution* of market leverages as given by distribution for each quarter.
# Default probability & credit spreads (5-year)

<table>
<thead>
<tr>
<th></th>
<th>Aaa/Aa</th>
<th>A</th>
<th>Baa</th>
<th>Ba</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Panel A. Default probability (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>data</td>
<td>0.7</td>
<td>1.3</td>
<td>3.1</td>
<td>9.8</td>
</tr>
<tr>
<td>model</td>
<td>0.5</td>
<td>1.5</td>
<td>3.7</td>
<td>9.9</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th></th>
<th>G</th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Panel B. Credit spreads (bps)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State G</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>data</td>
<td>55.7</td>
<td>85.7</td>
<td>149</td>
<td>315</td>
</tr>
<tr>
<td>model</td>
<td>72.9</td>
<td>103</td>
<td>170</td>
<td>341</td>
</tr>
</tbody>
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<table>
<thead>
<tr>
<th></th>
<th>B</th>
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<td>State B</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>data</td>
<td>107</td>
<td>171</td>
<td>275</td>
<td>542</td>
</tr>
<tr>
<td>model</td>
<td>99</td>
<td>148</td>
<td>243</td>
<td>459</td>
</tr>
</tbody>
</table>
## Bid-Ask Spread (5 year bonds)

### Bid-ask spreads

<table>
<thead>
<tr>
<th></th>
<th>State G</th>
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<tbody>
<tr>
<td></td>
<td>Superior</td>
<td>Investment</td>
<td>Junk</td>
<td>Superior</td>
</tr>
<tr>
<td>data</td>
<td>40</td>
<td>50</td>
<td>70</td>
<td>77</td>
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<tr>
<td>model</td>
<td>38</td>
<td>50</td>
<td>91</td>
<td>104</td>
</tr>
<tr>
<td>(hc^s = cst^s)</td>
<td>46</td>
<td>50</td>
<td>54</td>
<td>117</td>
</tr>
</tbody>
</table>

### Haircut for collateralized financing

<table>
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<th>Aaa/Aa</th>
<th>Baa</th>
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</tr>
</thead>
<tbody>
<tr>
<td>data (BIS)</td>
<td>6.7%</td>
<td>12%</td>
<td>23%</td>
</tr>
<tr>
<td>model</td>
<td>9.0%</td>
<td>12%</td>
<td>18%</td>
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</tbody>
</table>
## Comparative statics: Perfect liquidity

<table>
<thead>
<tr>
<th>Maturity = 5 years</th>
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<tr>
<td>$hc = 0$</td>
<td>0.4</td>
<td>1.0</td>
<td>2.8</td>
<td>8.2</td>
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<tr>
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<tr>
<td>$hc = 0$</td>
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<td>26.5</td>
<td>68.8</td>
<td>194</td>
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<td>$hc = 0$</td>
<td>12.9</td>
<td>33.8</td>
<td>84.0</td>
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### Comparative statics: Constant holding costs

**Maturity = 5 years**

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<td>$hc_s = cst_s$</td>
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<td>150</td>
<td>196</td>
<td>328</td>
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<td>243</td>
<td>459</td>
</tr>
<tr>
<td>$hc_s = cst_s$</td>
<td>187</td>
<td>216</td>
<td>277</td>
<td>433</td>
</tr>
</tbody>
</table>
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Structural Decomposition

Traditional View:
- CDS spread measures “Default component”
- Bond-CDS spread = Credit spread - CDS spread measures “Non-default component”

Our view:
- Default component
  (i) pure default: from a liquidity-free model
  (ii) residual of liquidity-driven default
- Liquidity component:
  (iii) pure liquidity for risk-free bond with same liquidity frictions
  (iv) residual default-driven liquidity
State $G$

Aaa/Aa 72.9 bps
A 103 bps
Baa 170 bps
Ba 341 bps

Pure
Pure Liq
Liq–driven Default
Default–driven Liq
$G \rightarrow B$
Structural decomposition in time series

Panel A. Baa-rating

Panel B. Baa-rating

Panel C. B-rating

Panel D. B-rating
**Assumption:** Injecting liquidity means improving dealer contact intensity $\lambda^s$ and reducing the un-collateralized borrowing premium, lowering holding costs $hc^s$
Liquidity Provision

- **Policy evaluation:** What are the effects of “injecting liquidity” on lowering “borrowing cost” (setting state $B$ liquidity parameters same as in $G$)?

  Caveat: ignoring GE effects

- Pure liquidity channel is dominant for higher rated bonds; liquidity-driven default channel is dominant for lower rated bonds.

<table>
<thead>
<tr>
<th>Credit Spread Contributions to Change (%)</th>
<th>w/o policy</th>
<th>w policy</th>
<th>LIQ→DEF</th>
<th>pure LIQ</th>
<th>DEF→LIQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aaa/Aa $G$</td>
<td>72.9</td>
<td>54.7</td>
<td>30</td>
<td>56</td>
<td>14</td>
</tr>
<tr>
<td>Aaa/Aa $B$</td>
<td>99.1</td>
<td>59.2</td>
<td>30</td>
<td>64</td>
<td>6</td>
</tr>
<tr>
<td>Ba $G$</td>
<td>341</td>
<td>295</td>
<td>62</td>
<td>22</td>
<td>16</td>
</tr>
<tr>
<td>Ba $B$</td>
<td>459</td>
<td>347</td>
<td>67</td>
<td>23</td>
<td>11</td>
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Conclusion

- A tractable quantitative framework to capture the interactions between default risk and liquidity risk

- Ability to explain total credit spread, i.e., credit risk premium and liquidity premium, cross-sectionally (across rating classes) and over the business cycle (across aggregate states)

- Towards a micro-foundation for the “mysterious” holding costs

- Counterfactual analysis reveals sizable benefits of injecting liquidity in bad times through default-liquidity interactions