Credit Risk on Corporate Debt

0. Overview

- Global Debt Markets
- Yield Spreads
- Default and Recovery Rates
- Pricing
- Bond Ratings
- Credit Derivatives
- Interest Sensitivity Revisited
1. Global Debt Markets

Amounts outstanding, billions of US dollars, 1996:

Public Domestic Issues
- US: 7.102
- Japan: 3.299
- Germany: 0.854
- Total: 16.205

Private Domestic Issues
- US: 4.513
- Japan: 1.469
- Germany: 1.024
- Total: 9.625

International Issues
- US: 0.403
- Japan: 0.357
- Germany: 0.342
- Emerging Markets: 0.276
- Total: 3.226

International Issues by Currency
- Dollars: 1.246
- Yen: 0.518
- Deutschemarks: 0.347
- Pounds: 0.237
- Swiss Francs: 0.166

Source: IMF.
2. Yield Spreads for US Corporates

Aa and Baa spreads over Aaa, 1970-1997:
2. Yield Spreads for US Corporates (continued)

- Yield spreads over Aaa (BPs):

<table>
<thead>
<tr>
<th>Rating</th>
<th>Mean</th>
<th>Std Dev</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aa</td>
<td>32</td>
<td>16</td>
</tr>
<tr>
<td>A</td>
<td>64</td>
<td>35</td>
</tr>
<tr>
<td>Baa</td>
<td>114</td>
<td>45</td>
</tr>
</tbody>
</table>

- Remarks:
  - Credit risk is the major factor
  - Liquidity plays a role, too
  - Spreads highly variable
3. Default and Recovery Rates

- Default rates (%), 1970-96:

<table>
<thead>
<tr>
<th>Rating</th>
<th>1-Year</th>
<th>5-year</th>
<th>10-year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aaa</td>
<td>0.00</td>
<td>0.13</td>
<td>0.74</td>
</tr>
<tr>
<td>Aa</td>
<td>0.03</td>
<td>0.40</td>
<td>1.13</td>
</tr>
<tr>
<td>A</td>
<td>0.01</td>
<td>0.57</td>
<td>1.73</td>
</tr>
<tr>
<td>Baa</td>
<td>0.12</td>
<td>1.71</td>
<td>4.61</td>
</tr>
<tr>
<td>Ba</td>
<td>1.36</td>
<td>11.57</td>
<td>20.94</td>
</tr>
<tr>
<td>B</td>
<td>7.27</td>
<td>29.45</td>
<td>44.31</td>
</tr>
</tbody>
</table>

Source: Moody’s.

- Recovery rates (%), 1989-96:

<table>
<thead>
<tr>
<th>Security</th>
<th>Average Recovery</th>
</tr>
</thead>
<tbody>
<tr>
<td>Senior Secured Debt</td>
<td>63</td>
</tr>
<tr>
<td>Senior Unsecured Debt</td>
<td>48</td>
</tr>
<tr>
<td>Senior Subordinated Debt</td>
<td>38</td>
</tr>
<tr>
<td>Subordinated Debt</td>
<td>28</td>
</tr>
<tr>
<td>All Public Debt</td>
<td>41</td>
</tr>
</tbody>
</table>

Source: Moody’s.
3. Default and Recovery Rates (continued)

Annual US corporate default rates:
4. Rating Drift

- Ratings typically drift down

- 1-year rating changes (%), 1970-93:

<table>
<thead>
<tr>
<th>Current Rating</th>
<th>Future Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aaa</td>
</tr>
<tr>
<td>Aaa</td>
<td>89.6</td>
</tr>
<tr>
<td>Aa</td>
<td>1.1</td>
</tr>
<tr>
<td>A</td>
<td>0.1</td>
</tr>
<tr>
<td>Baa</td>
<td>0.0</td>
</tr>
</tbody>
</table>

- 5-year rating changes (%), 1970-93:

<table>
<thead>
<tr>
<th>Current Rating</th>
<th>Future Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Aaa</td>
</tr>
<tr>
<td>Aaa</td>
<td>62.5</td>
</tr>
<tr>
<td>Aa</td>
<td>5.5</td>
</tr>
<tr>
<td>A</td>
<td>0.3</td>
</tr>
<tr>
<td>Baa</td>
<td>0.2</td>
</tr>
</tbody>
</table>

Source: Altman.

NB: Totals don’t sum to one (some ratings are withdrawn).
5. Spot Rate Spreads

- Reminder: yields depend on maturity and coupon

- Spreads for spot rates (1986-97):
5. Spot Rate Spreads (continued)

Spreads over treasuries (1986-97, BPs):

<table>
<thead>
<tr>
<th>Maturity (Yrs)</th>
<th>Aa</th>
<th>A</th>
<th>Baa</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>38</td>
<td>65</td>
<td>127</td>
</tr>
<tr>
<td>2</td>
<td>50</td>
<td>72</td>
<td>132</td>
</tr>
<tr>
<td>3</td>
<td>47</td>
<td>75</td>
<td>133</td>
</tr>
<tr>
<td>4</td>
<td>52</td>
<td>80</td>
<td>135</td>
</tr>
<tr>
<td>5</td>
<td>58</td>
<td>84</td>
<td>137</td>
</tr>
<tr>
<td>6</td>
<td>62</td>
<td>88</td>
<td>139</td>
</tr>
<tr>
<td>7</td>
<td>66</td>
<td>91</td>
<td>140</td>
</tr>
<tr>
<td>8</td>
<td>70</td>
<td>93</td>
<td>141</td>
</tr>
<tr>
<td>9</td>
<td>72</td>
<td>95</td>
<td>142</td>
</tr>
<tr>
<td>10</td>
<td>74</td>
<td>96</td>
<td>143</td>
</tr>
</tbody>
</table>

Source: Elton, Gruber, and Mann (preliminary!)
6. Evidence Wrap-up

- Observations:
  - Spreads large and variable
  - Spreads increase with maturity
  - Ratings drift down
  - Defaults bunched in time

- Conjecture: spreads reflect
  - Default probabilities
  - Risk premiums
7. CAPM Review

- Returns: \( r_f \) is the riskfree return, \( r_m \) the return on the market, and \( r_i \) the return on an arbitrary asset

- Expected returns:

\[
E(r_i) = r_f + \beta_i [E(r_m) - r_f] = r_f + \pi_i
\]

(think of \( \pi_i \) as the risk premium on asset \( i \))

- Valuation of asset \( i \):

\[
\text{Price} = \frac{\text{Expected Cash Flow}}{1 + r_f + \pi_i}
\]

(one-period example, but you get the idea)

- Summary: value based on expected cash flow, but the discount rate is adjusted for risk (\( \pi_i \))

- Remark: similar result applies in more general settings (ie, beyond the CAPM)
8. Corporate Bond Analytics 1

- One period bonds (practice)
- Objective: infer default rates from spot rates
- Notation:

\[ \alpha = \text{Prob(Solvency)} \]
\[ = 1 - \text{Prob(Default)} \]
\[ \beta = \text{Recovery Rate} \]

- Expected cash flow from one dollar face value:

\[ E(\text{Cash Flow}) = 1 \times [\alpha + (1 - \alpha)\beta] \]

- Valuation:

\[ \text{Corp Disc Factor} = \frac{1}{1 + (y + \pi)/2} \times [\alpha + (1 - \alpha)\beta] \]
\[ = \frac{1}{1 + (y + s)/2} \]

where \( y \) is the riskfree (treasury) spot rate, \( s \) is the appropriate corporate spread, and \( \pi \) the risk premium

- Remark: the spread \( s \) captures the effects of default on expected cash flow (\( \alpha \) and \( \beta \)) and risk premium (\( \pi \))
8. Corporate Bond Analytics 1 (continued)

- Example:

\[
\begin{align*}
\alpha &= 0.99 \\
\beta &= 0.50 \\
\pi &= 0 \\
y &= 6\%
\end{align*}
\]

- Calculations:

\[
\begin{align*}
E(\text{Cash Flow}) &= 0.995 \\
\text{Treas Disc Factor} &= 0.9709 \\
\text{Corp Disc Factor} &= 0.9660 \\
s &= 1.035\% 
\end{align*}
\]
8. Corporate Bond Analytics 1 (continued)

- Inferring default rates from spread
- Ignore recovery ($\beta = 0$) and risk premium ($\pi = 0$)  
  (Interpretation: default probability “soaks up” both)
- Thus:
  $$\frac{1}{1 + \frac{y}{2}} \times \alpha = \frac{1}{1 + (y + s)/2}$$
- Compute $\alpha$ from ratio of discount factors:
  $$\alpha = \frac{\text{Corp Disc Factor}}{\text{Treas Disc Factor}}$$
  $$= \frac{0.9660}{0.9706} = 0.995,$$
  making the default probability 0.005 or 0.5%.
- Remarks:
  - Smaller than the true default probability (1%):  
    we ignored recovery
  - In practice, the risk premium also plays a role
  - Despite this, calculation gives a concrete interpretation of the spread
9. Corporate Bond Analytics 2

- Multi-period bonds

- Continue to ignore recovery and risk premium

- Relation between discount factors still holds:

\[
\frac{1}{(1 + y/2)^n} \times \alpha = \frac{1}{(1 + (y + s)/2)^n}
\]

\[
\Rightarrow \quad \alpha = \frac{\text{Corp Disc Factor}}{\text{Treas Disc Factor}}
\]
9. Corporate Bond Analytics 2 (continued)

- Application to spot rates (average, 1986-97):

<table>
<thead>
<tr>
<th>Maturity (Yrs)</th>
<th>Treas Spot Rate</th>
<th>Baa Spread</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>6.11</td>
<td>1.27</td>
</tr>
<tr>
<td>2</td>
<td>6.46</td>
<td>1.32</td>
</tr>
<tr>
<td>3</td>
<td>6.74</td>
<td>1.33</td>
</tr>
<tr>
<td>4</td>
<td>6.94</td>
<td>1.35</td>
</tr>
<tr>
<td>5</td>
<td>7.08</td>
<td>1.37</td>
</tr>
<tr>
<td>6</td>
<td>7.19</td>
<td>1.39</td>
</tr>
<tr>
<td>7</td>
<td>7.27</td>
<td>1.40</td>
</tr>
<tr>
<td>8</td>
<td>7.33</td>
<td>1.41</td>
</tr>
<tr>
<td>9</td>
<td>7.38</td>
<td>1.42</td>
</tr>
<tr>
<td>10</td>
<td>7.42</td>
<td>1.43</td>
</tr>
</tbody>
</table>
9. Corporate Bond Analytics 2 (continued)

* Implied default rates:

<table>
<thead>
<tr>
<th>Time Horizon (Yrs)</th>
<th>Treas DF</th>
<th>Baa DF</th>
<th>Def Rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0.9416</td>
<td>0.9301</td>
<td>1.22</td>
</tr>
<tr>
<td>2</td>
<td>0.8806</td>
<td>0.8585</td>
<td>2.51</td>
</tr>
<tr>
<td>3</td>
<td>0.8198</td>
<td>0.7888</td>
<td>3.78</td>
</tr>
<tr>
<td>4</td>
<td>0.7612</td>
<td>0.7225</td>
<td>5.08</td>
</tr>
<tr>
<td>5</td>
<td>0.7060</td>
<td>0.6608</td>
<td>6.40</td>
</tr>
<tr>
<td>6</td>
<td>0.6545</td>
<td>0.6040</td>
<td>7.72</td>
</tr>
<tr>
<td>7</td>
<td>0.6065</td>
<td>0.5518</td>
<td>9.02</td>
</tr>
<tr>
<td>8</td>
<td>0.5620</td>
<td>0.5041</td>
<td>10.31</td>
</tr>
<tr>
<td>9</td>
<td>0.5208</td>
<td>0.4605</td>
<td>11.57</td>
</tr>
<tr>
<td>10</td>
<td>0.4825</td>
<td>0.4207</td>
<td>12.83</td>
</tr>
</tbody>
</table>
10. Bond Ratings

- Rating agencies: Moody’s, Standard and Poors, Fitch, Duff and Phelps

- Ratings based on
  - Industry: how risky?
  - Firm’s status in industry
  - Financial situation
  - Management and accounting quality
  - Legal status: senior or subordinated, covenants

- Statistical approaches
  - Compute ratings from ratios of:
    * pretax earnings to interest payments (coverage)
    * working capital to total assets
    * retained earnings to total assets
    * operating income to total assets
    * book value of equity to total assets (leverage)
  - Estimation by a variety of statistical methods
  - Modifications dictated by data availability (eg, private firms and emerging markets)
11. Interest Sensitivity

- Duration computed the usual way

- Presumption: yields on treasuries and corporates change the same amount (spread doesn’t change)

- In fact, spread varies on its own and with treasuries (monthly changes, 1986-97)

  Std dev of 5-year treas spot 0.33%
  Std dev of 5-year corp spread 0.19%
  Correlation -0.31

Source: Elton, Gruber, and Mann

- Statistical approaches (eg, CreditMetrics)
  - Model both treasuries and the spread
  - Allow for downgrades, too
12. Credit Derivatives

- Market forces:
  - Banks (esp) want to diversify credit exposure, reduce capital requirements
  - Investors want easy access to credit risk
  - Problem: underlying assets hard to trade
  - Solution: credit derivatives

- Loan pools: collections of loans often “pooled” and issued as security (passthrough) or collateralized loan obligation (loans act as collateral for debt issues)

- Alternative: use derivative to sell the credit risk in the pool

- Total return swap: exchange fixed or floating rate for total return (interest plus change in price) of a loan pool or other asset

- Default swap or put: pay the difference between par and market price if default occurs
12. Credit Derivatives (continued)

- Outstanding issues:
  - Documentation: no ISDA standard agreement yet
  - Standardization and liquidity
  - Verification of credit events
  - Regulatory treatment: when is a hedge counted?
  - International differences in default/bankruptcy law
13. SEC Registration Basics

- Public issues in the US must be registered with the SEC under the 1933 Act:
  - Clear registration statement with SEC
  - File and distribute prospectus

- Failure to register when called for gives the buyer a put

- Shelf registration: Rule 415 allows a firm to register a security once, then issue or reissue within two years at its convenience

- Exemptions from registration:
  - Reg 144A: sales to Qualified Institutional Buyers (QIBs)
  - Reg S: ditto off-shore sales to non-US buyers
  - Private placements: some debt is placed directly
  - Issues with maturities under 180 days (paper)

- Disclosure applies to all: even when registration isn’t required, fraud laws and investor due diligence generally require borrowers to disclose relevant information
Summary

- Corporate debt trades at higher yields than treasuries

- Standard interpretation: credit risk

- Default rates can be observed and inferred from yield spreads

- Ratings are professional assessments of credit risk

- Credit risk is an extra ingredient in fixed income portfolios

- Credit derivatives: an increasingly popular tool for managing credit risk