

---

Backus/March 26, 1998

## 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

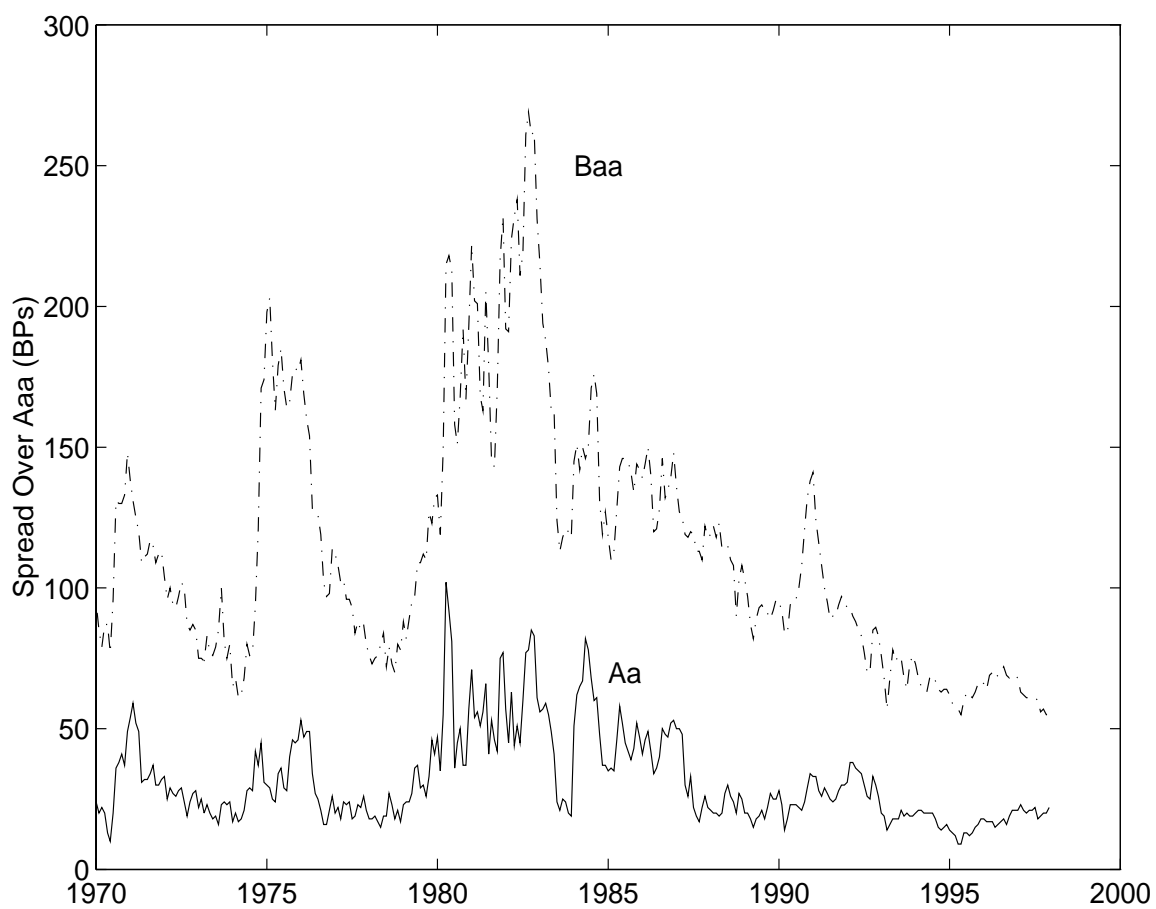
Amounts outstanding, billions of US dollars, 1996:

|                                  |        |
|----------------------------------|--------|
| 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):

| Rating | Mean | Std Dev |
|--------|------|---------|
| Aa     | 32   | 16      |
| A      | 64   | 35      |
| Baa    | 114  | 45      |

- Remarks:
  - Credit risk is the major factor
  - Liquidity plays a role, too
  - Spreads highly variable

### 3. Default and Recovery Rates

- Default rates (%), 1970-96:

| Rating | 1-Year | 5-year | 10-year |
|--------|--------|--------|---------|
| Aaa    | 0.00   | 0.13   | 0.74    |
| Aa     | 0.03   | 0.40   | 1.13    |
| A      | 0.01   | 0.57   | 1.73    |
| Baa    | 0.12   | 1.71   | 4.61    |
| Ba     | 1.36   | 11.57  | 20.94   |
| B      | 7.27   | 29.45  | 44.31   |

Source: Moody's.

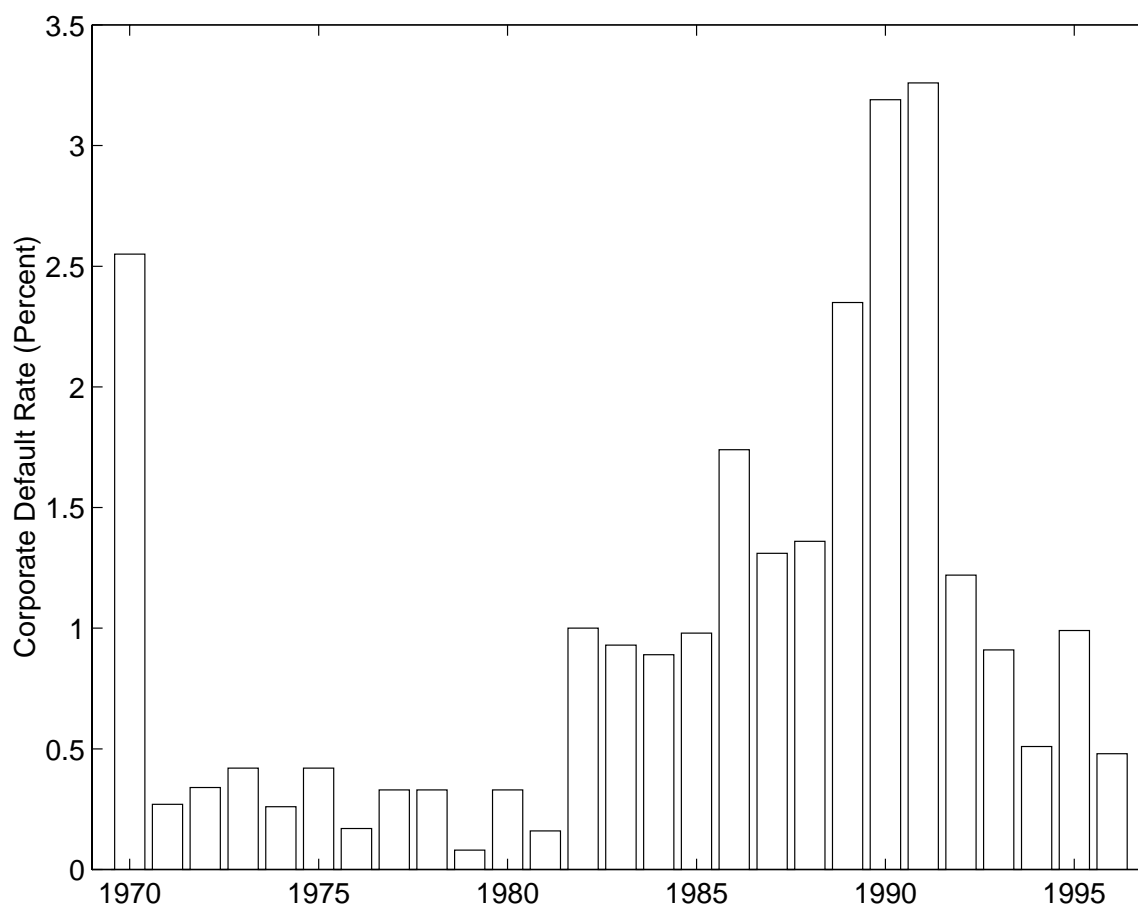
- Recovery rates (%), 1989-96:

| Security                 | Average Recovery |
|--------------------------|------------------|
| Senior Secured Debt      | 63               |
| Senior Unsecured Debt    | 48               |
| Senior Subordinated Debt | 38               |
| Subordinated Debt        | 28               |
| All Public Debt          | 41               |

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:

| Current Rating | Future Rating |      |      |      |       |
|----------------|---------------|------|------|------|-------|
|                | Aaa           | Aa   | A    | Baa  | Other |
| Aaa            | 89.6          | 7.2  | 0.7  | 0.1  | 0.1   |
| Aa             | 1.1           | 88.8 | 6.9  | 0.3  | 0.2   |
| A              | 0.1           | 2.5  | 89.0 | 5.2  | 0.8   |
| Baa            | 0.0           | 0.2  | 5.2  | 85.3 | 6.4   |

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

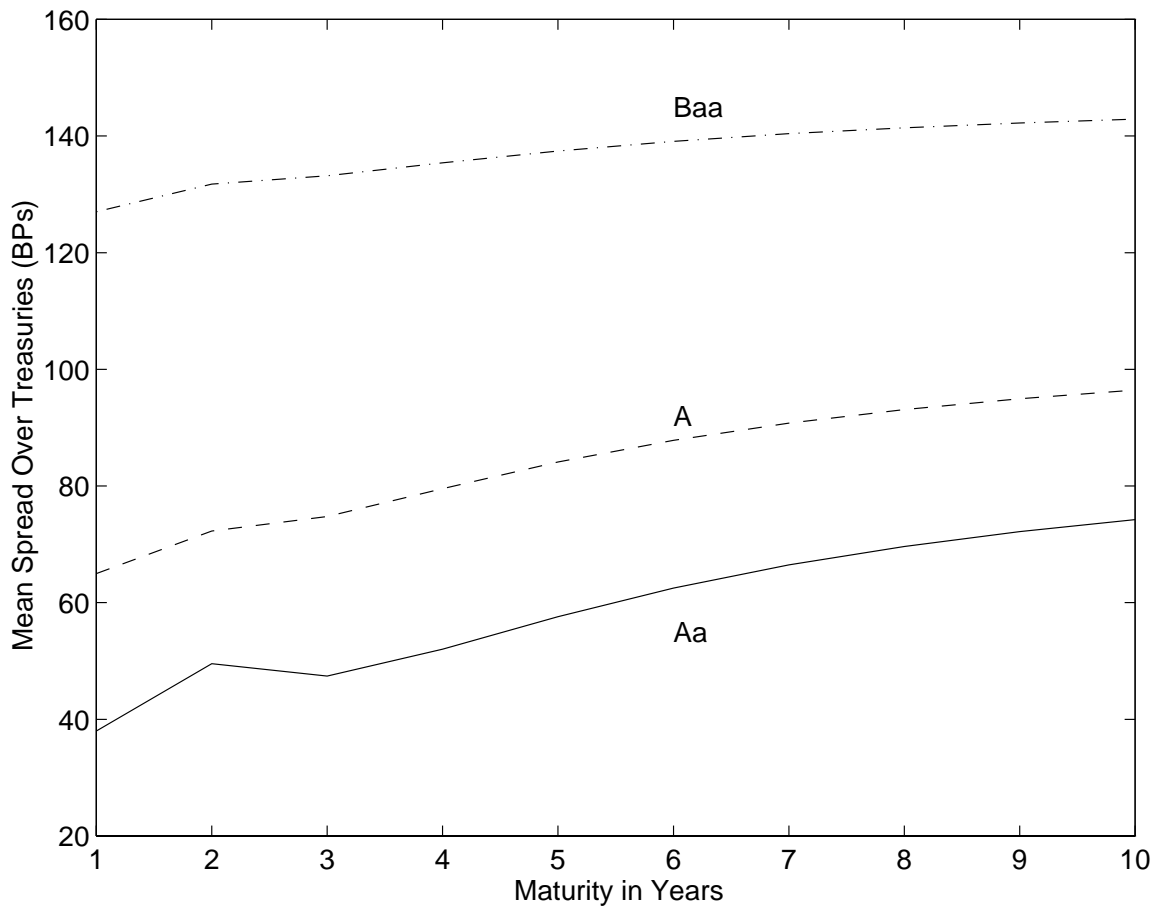
| Current Rating | Future Rating |      |      |      |       |
|----------------|---------------|------|------|------|-------|
|                | Aaa           | Aa   | A    | Baa  | Other |
| Aaa            | 62.5          | 21.8 | 4.9  | 0.5  | 1.2   |
| Aa             | 5.5           | 52.9 | 22.3 | 3.9  | 2.7   |
| A              | 0.3           | 9.9  | 59.6 | 15.0 | 5.8   |
| Baa            | 0.2           | 1.9  | 18.8 | 49.7 | 17.8  |

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):

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

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:

$$\begin{aligned} E(r_i) &= r_f + \beta_i [E(r_m) - r_f] \\ &= r_f + \pi_i \end{aligned}$$

(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:

$$\begin{aligned}\alpha &= \text{Prob}(\text{Solvency}) \\ &= 1 - \text{Prob}(\text{Default}) \\ \beta &= \text{Recovery Rate}\end{aligned}$$

- Expected cash flow from one dollar face value:

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

- Valuation:

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

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:

$$\alpha = 0.99$$

$$\beta = 0.50$$

$$\pi = 0$$

$$y = 6\%$$

- Calculations:

$$E(\text{Cash Flow}) = 0.995$$

$$\text{Treas Disc Factor} = 0.9709$$

$$\text{Corp Disc Factor} = 0.9660$$

$$s = 1.035\%$$

**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:

$$\frac{1}{1 + y/2} \times \alpha = \frac{1}{1 + (y + s)/2}$$

- Compute  $\alpha$  from ratio of discount factors:

$$\begin{aligned}\alpha &= \frac{\text{Corp Disc Factor}}{\text{Treas Disc Factor}} \\ &= 0.9660/0.9706 = 0.995,\end{aligned}$$

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:

$$\frac{1}{(1 + y/2)^n} \times \alpha = \frac{1}{(1 + (y + s)/2)^n}$$
$$\Rightarrow \alpha = \frac{\text{Corp Disc Factor}}{\text{Treas Disc Factor}}$$

**9. Corporate Bond Analytics 2 (continued)**

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

| Maturity (Yrs) | Treas Spot Rate | Baa Spread |
|----------------|-----------------|------------|
| 1              | 6.11            | 1.27       |
| 2              | 6.46            | 1.32       |
| 3              | 6.74            | 1.33       |
| 4              | 6.94            | 1.35       |
| 5              | 7.08            | 1.37       |
| 6              | 7.19            | 1.39       |
| 7              | 7.27            | 1.40       |
| 8              | 7.33            | 1.41       |
| 9              | 7.38            | 1.42       |
| 10             | 7.42            | 1.43       |

**9. Corporate Bond Analytics 2 (continued)**

- Implied default rates:

| Time Horizon (Yrs) | Treas DF | Baa DF | Def Rate (%) |
|--------------------|----------|--------|--------------|
| 1                  | 0.9416   | 0.9301 | 1.22         |
| 2                  | 0.8806   | 0.8585 | 2.51         |
| 3                  | 0.8198   | 0.7888 | 3.78         |
| 4                  | 0.7612   | 0.7225 | 5.08         |
| 5                  | 0.7060   | 0.6608 | 6.40         |
| 6                  | 0.6545   | 0.6040 | 7.72         |
| 7                  | 0.6065   | 0.5518 | 9.02         |
| 8                  | 0.5620   | 0.5041 | 10.31        |
| 9                  | 0.5208   | 0.4605 | 11.57        |
| 10                 | 0.4825   | 0.4207 | 12.83        |

**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