15.415x Foundations of Modern Finance

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Lecture 17: Financing/Capital Structure I

Key concepts

- Financing decisions and capital structure
- Capital structure empirics
- Capital structure theory: Modigliani-Miller theorems
- WACC (weighted average cost of capital)
- Business risk vs. financial risk
- Insights from MM
- Corporate debt and default risk
- Default premium and risk premium
- Default risk empirics

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Corporate financial decisions

Questions answered so far: How financial markets value assets:

- Time value of money – market interest rates,
- Risk premium – APT, CAPM, Option pricing models,
- How to value real assets.

Questions to answer next: How corporations make financial decisions using market valuations and instruments.

- Real investments (capital budgeting): What projects to invest in?
- Financing: How to finance a project?
  - Selling financial assets/securities/claims (bank loans, public debt, stocks, convertibles, …)
- Payout: What to pay back to shareholders?
  - Paying dividends, buyback shares, …
- Risk management: What risk to take/to avoid and how?

Financing decisions

Given the investment decisions, how to meet funding needs?

- Take investment policy as given for now.
- What is the best source of funds?
  - Internal funds (i.e., cash)
  - Debt (i.e., borrowing)
  - Equity (i.e., issuing stock)
  - Warrants, convertibles, other securities, …
- Moreover, different kinds of funds:
  - Internal funds (e.g., cash reserves vs. cutting dividends)
  - Debt (e.g., bank loans vs. bonds)
  - Equity (e.g., VC vs. IPO, PE vs. SEO), preferreds, ...

A seasoned equity offering or secondary equity offering (SEO) or capital increase is a new equity issued by an already publicly traded company

Capital structure

- Capital structure describes how assets are financed. It represents the mix of financial claims against a firm's assets/cash flows.

  which is the liability side of the balance sheet

- Characteristics of financial claims:
  - Payoff structure (e.g., fixed promised versus discretionary payments)
  - Priority (debt paid before equity)
  - Maturity
  - Covenants
  - Voting rights and control rights
  - Options (convertibility, call provisions, etc.) ...

- We'll start with debt vs. equity (leverage).

  No leverage means no debt. And higher leverage means more debt relative to equity or total capital.

Capital structure

- Is there an “optimal” capital structure, i.e., an optimal mix between debt and equity or leverage?
- More generally, can we add value on the RHS (right hand side) of the balance sheet by following a good financing policy? add value to the firm
- If yes, does the optimal financing policy depend on the firm’s operations (real investments), and how?
- We mainly focus on leverage (debt vs. equity) and how it affects firm value.

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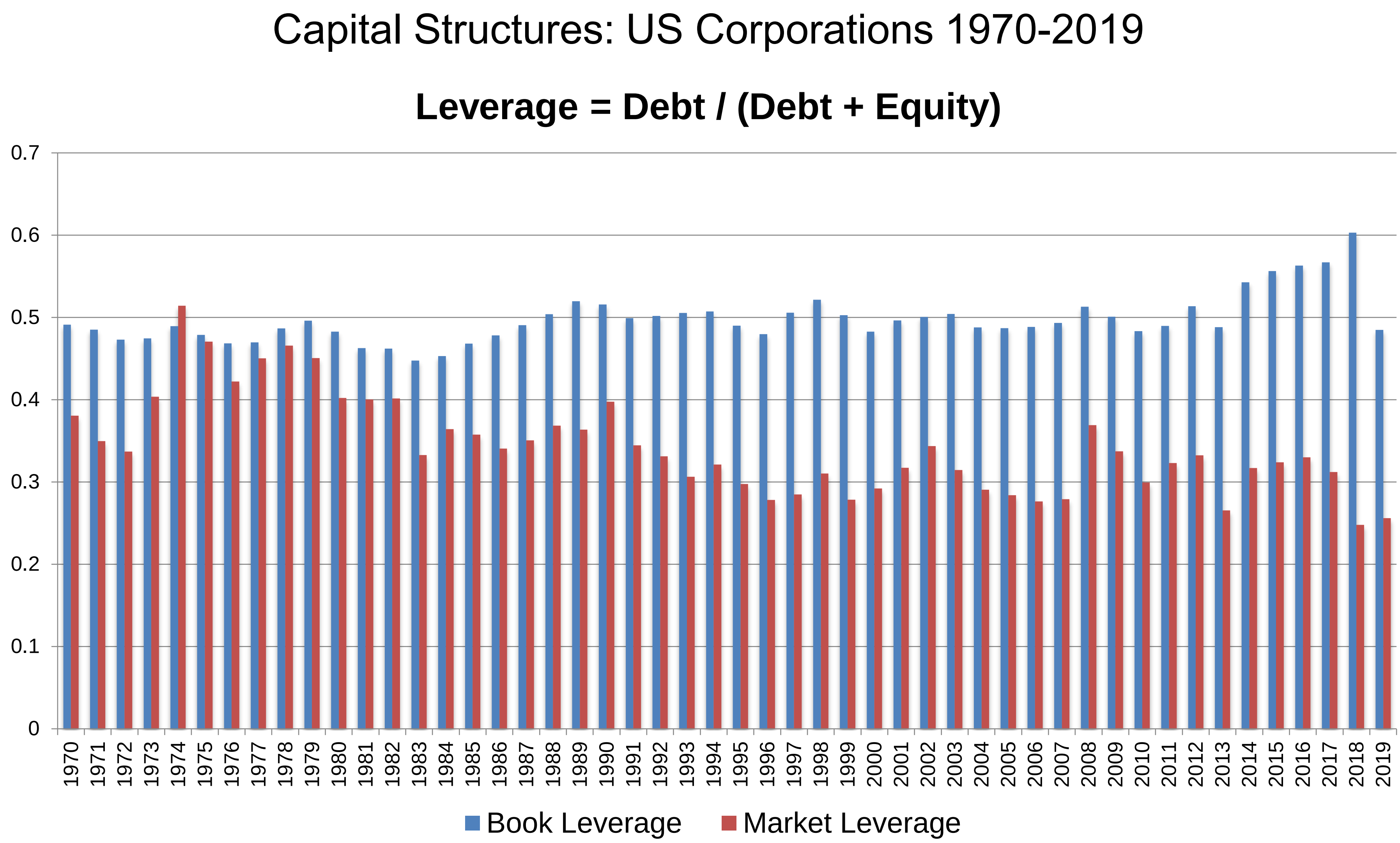
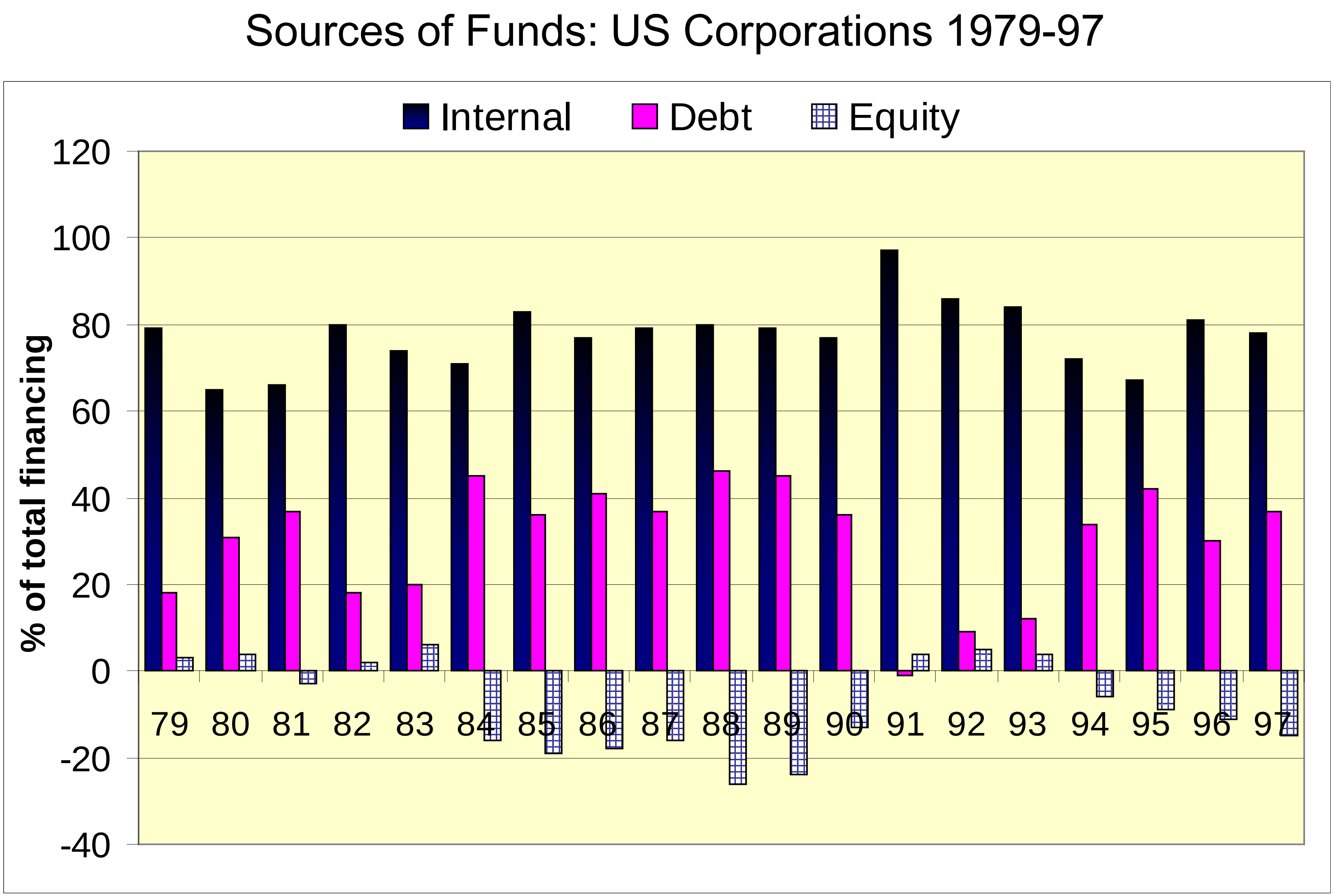
Capital structure empirics



Capital structure empirics

negative equity financing means that firms are buying back their shares, returning money to the shareholders



pecking order theory: Firms rely mostly on internal funds for investments.
When external funds are needed, they rely more on debt than equity.

Capital structure empirics

Capital Structures for Different Industries (US, 2019)

market leverage level

Select Industries	Market debt to Capital Ratio (%)
Telecom Equipment	46
Coal & Related Energy	38
Chemicals (Basic)	37
Food Processing	31
Paper and Forest Products	31
General Retailers	19
Software (Internet)	17
Software (Entertainment)	1
Average over All Industries ex. Financials	38

excluding the financial industry due to its very high leverage level.

Capital structure empirics

Returns on Major US Asset Classes

(Source: Ibbotson Associates, Inc. Yearbook 2019)

Annual total returns from 1926 to 2018 (nominal)

Asset	Mean (%)	SD (%)
T-bills	3.4	3.1
Long term T-bonds	5.9	9.8
Long term corp. bonds	6.3	8.4
Large stocks	11.9	19.8
Small stocks	16.2	31.6
Inflation	3.0	4.1

When short-term interest rates become very low, a firm should use more short-term debt instead of long-term debt for financing because it lowers borrowing cost.

False. Trading in the financial market is a zero NPV activity. In the absence of arbitrage, all financial instruments are fairly priced in a way that trading them gives 0 NPV.

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Capital structure theory I

Outline of our discussion:

1. Modigliani-Miller Theorem:
   - Capital structure is irrelevant (under “ideal conditions”).
2. What’s missing from MM? incorporate different types of frictions
   - Taxes
   - Costs of debt (financial distress)
   - Other factors: transaction costs, asymmetric info, agency costs ...
   - Capital structure is not irrelevant when there are imperfections.
3. “Textbook” view of optimal capital structure:
   - Trade off between debt and equity.
   - Checklist.

We focus on 1 first and return to 2 and 3 later.

Modigliani – Miller

Assume:

- Complete financial market, a rich set of traded securities in a market
- Market efficiency and no asymmetric information, information-efficient market
- No taxes,
- No transaction and bankruptcy costs,
- Hold constant the firm's investments (assets).

Then, we have (under the above assumptions):

MM Irrelevance Theorem.

- Financing decisions are irrelevant for firm value.
- In particular, the choice of capital structure is irrelevant (MM I).

Modigliani – Miller

Let

V: Value of a firm's asset (or a project),

D: Value of debt,

E: Value of equity,

All values are in market values

r_A: Required rate of return on asset (project),

r_D: Required rate of return on debt,

r_E: Required rate of equity.

Modigliani – Miller

Proof of MM. Let

- CF_A be the total payoff from firm's assets,
- CF_D and CF_E be the payoff from firm's debt and equity, respectively.

Then,

Since the firm's asset is held constant, all its payoff must be paid out either to debt holders or to equity holders.

$$CF_D + CF_E = CF_A$$

By no arbitrage, we have:

$$PV(CF_D) + PV(CF_E) = PV(CF_A)$$

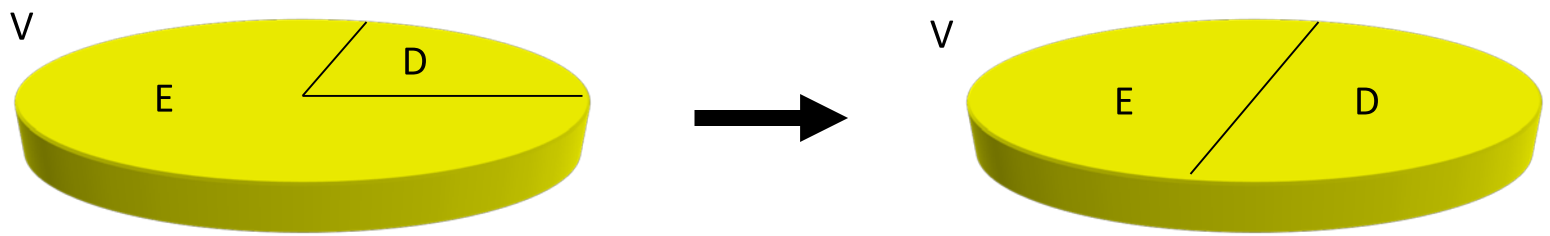
or

$$D + E = A$$

- A firm's value is determined by the total cash flow on its assets.
- Capital structure only determines how total cash flow is split between debt and equity holders.
- Given its assets, capital structure won't affect a firm's total value.

Modigliani – Miller

The “Pie Theory”



- How a pie (total asset) is sliced (into debt and equity) does not change the total size of the pie!
- What if it does? Then there will be an arbitrage.
- Slicing a pie is a zero NPV activity.

If a levered firm's debt and equity are trading at prices that sum to be lower than the value of its asset, we can then buy up the debt and equity and then form an unlevered firm, which is simply the firm's asset, and sell it for more than the cost. This is again an arbitrage.

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WACC

liabilities are really claims on its asset,

From the "portfolio view" of the firm (its liabilities/claims), we have:

$$A = D + E$$

The general equation also holds for the required rates of return on asset, debt, and equity

$$r_A = \frac{D}{D+E} r_D + \frac{E}{D+E} r_E$$

- A firm's cost of capital is the required rate of return on its assets r_A.
- It equals the weighted average of:
  - Required rate of return on the firm's debt r_D, cost of debt
  - Required rate of return on the firm's equity r_E. cost of equity

When a firm is financed by both debt and equity, its cost of capital (r_A) equals the weighted average of its costs of debt (r_D) and equity (r_E) (WACC):

$$\text{WACC} = \frac{D}{D+E} r_D + \frac{E}{D+E} r_E = w_D r_D + w_E r_E$$

Cheap debt fallacy

"Debt is better because debt is cheaper than equity":

- Because (for essentially all firms) debt is safer than equity, investors demand a lower return for holding debt than for holding equity, i.e., $r_D \leq r_E$. (True)
- The difference is significant: 6% vs. 12% in expected return!
- So, companies should always finance with debt because they have to give away less returns to investors, i.e., debt is cheaper.

Is this argument correct?

Cheap debt fallacy

This reasoning ignores the “hidden” cost of debt:

- Raising more debt makes existing equity more risky!
  - Given investments (assets), r_A is fixed,
  - Increasing w_D tends to increase r_E, leverage
  - This is unrelated to default risk, i.e., true even if debt is risk-free.

Example. Assume CAPM holds. Suppose $\beta_D = 0$. We have:

$$\beta_A = w_D\beta_D + (1 - w_D)\beta_E = (1 - w_D)\beta_E \quad \text{or} \quad \beta_E = \frac{1}{1-w_D}\beta_A$$

- Given β_A, increasing w_D will increase β_E and consequently r_E.
- Don’t confuse the two meanings of “cheap”:
  - Low cost,
  - Good deal.

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Leverage and financial risk

Since

$$r_A = \frac{D}{D+E} r_D + \frac{E}{D+E} r_E$$

we have the following result:

MM II. The cost of equity for a levered firm is:

$$r_E = r_A + \frac{D}{E}(r_A - r_D)$$

- r_A is independent of D/E;
- r_E increases with D/E (assuming riskless debt);
- Equity becomes riskier as financial leverage increases; and hence demand higher expected rate of return
- r_D may also increase as debt becomes risky. with leverage

The risk associated with a firm's asset is referred to as its business risk, which arises from the firm's real business activities.

Business vs. financial risks

When the firm's asset is kept constant, its business risk is also fixed.

Comparing two firms, U and L:

fixed business risk, whether the firm's asset is constant or not, lead to fixed WACC (return on asset)

- They have the same assets,
- U is 100% equity financed (unlevered),
- L is financed by equity and debt (levered).

From MM II, we have:

- L's required rate of return on equity differs from U's,
- Required rate of return on equity of U compensates for business risk,
- In addition to business risk, L's equity involves an additional financial risk, which arises from leverage,
- The difference between the required rate of return on L and U compensates for the financial risk of L's equity.

Business vs. financial risks

If CAPM holds, we have:

$$\beta_A = w_D\beta_D + (1 - w_D)\beta_E = (1 - w_D)\beta_E \quad \text{or} \quad \beta_E = \frac{1}{1 - w_D}\beta_A$$

- β_A captures asset's business risk, independent of financing.
- $\beta_E - \beta_A \neq 0$, depending on financing, captures the financial risk of equity.
- If $D = 0$, $\beta_E = \beta_A$ and equity has no financial risk.
- Typically, β_D is small and $\beta_A > 0$. Thus, $\beta_E > \beta_A$.
- If $\beta_D = 0$ (debt is riskless), then:

$$\beta_E = \left(1 + \frac{D}{E}\right)\beta_A$$

  which increases with D/E.

Firms with similar businesses can have very different equity betas if they have different capital structures.

Uncover asset beta

In absence of taxes, only the required rate of return on the asset (project) is needed in capital budgeting (investment decisions).

- We need to find traded firms with comparable asset (business).
- Their equity return equals asset return if 100% equity financed.

However, we may not always be so lucky.

- Traded firms may not be 100% equity financed.
- Cannot naively use the return on equity when there is leverage.
- Need to un-lever it to obtain the asset return.

Uncover asset beta

Example. To obtain cost of capital to value a software business. There are two publicly traded software stocks with similar business risks but financed differently:

	β_E	β_D	D/E
Firm 1	1.42	0.24	0.5
Firm 2	1.56	0.57	1.2

We have:

$$1.42 = \beta_A^1 + (0.5)(\beta_A^1 - 0.24)$$
$$1.56 = \beta_A^2 + (1.2)(\beta_A^2 - 0.57)$$

which imply $\beta_A^1 = 1.03$, $\beta_A^2 = 1.02$ and an average β_A of 1.03.

The cost of capital: $4\% + (1.03)(8\%) = 12.24\%$.

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Modigliani – Miller insights

- MM Theorem was initially meant for capital structure.
- But it applies to all aspects of financial policy:

  in the absence of frictions we have the following MM irrelevance
  - Capital structure is irrelevant
  - Long-term vs. short-term debt is irrelevant
  - Payout policy is irrelevant
  - Risk management is irrelevant …

  holding the asset side fixed, financial transactions involving the liability side
- MM implies that all of the above are properly priced. Indeed, the proof applies to all financial transactions because they are zero NPV activities.

The key insight is that a firm's value is primarily determined by its assets by its real investments. Holding the asset constant, financial transactions such as the choice of financing do not change the firm's value.

Modigliani – Miller insights

- MM is true under its assumptions, which leave out important things.
- But it is the starting point for modern (corporate) finance.
- MM helps in exposing fallacies.
- It leads us to ask the right questions: Look for reasons why capital structure may matter.
- In particular, how might financing change the size of the pie?

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Default risk

Corporate debt has promised payoffs of fixed amount at fixed times. Unlike (some) government debt, corporate debt has the risk of failing to pay as promised.

definition of default is any failure in delivering promised payments on time, independent of how much in amount and in time.

- Default risk (credit risk) refers to the risk that a debt issuer fails to make the promised payments (interest or principal).
- Bond ratings by rating agencies (e.g., Moody's and S&P) provide indications of the likelihood of default by each issuer.

Description	Moody's	S&P
Gilt-edge	Aaa	AAA
Very high grade	Aa	AA
Upper medium grade	A	A
Lower medium grade	Baa	BBB
Low grade	Ba	BB

  - Investment grade: Aaa — Baa by Moody's or AAA — BBB by S&P.
  - Speculative (junk): Ba and below by Moody's or BB and below by S&P.

these ratings aim at capturing the chance of default, not its magnitude

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same promised payoff, but trading at a lower price simply reflects that it has substantial default risk.

Default premium and risk premium

Example. Suppose all bonds have a par value of $1,000 and:

- 10-year Treasury STRIPS is selling at $463.19, yielding 8%, risk free rate
- 10-year zero coupon bond issued by XYZ Inc. is selling at $321.97,
- Expected payoff from XYZ's 10-year zero coupon bond is $762.22.

For the XYZ bond, we have: risk free: 8% for both the promised yield and the expected yield.

$$\text{Promised YTM} = \left(\frac{1{,}000.00}{321.97}\right)^{1/10} - 1 = 12\%$$

$$\text{Expected YTM} = \left(\frac{762.22}{321.97}\right)^{1/10} - 1 = 9\%$$

and

Default Premium reflects the actual yield the bond has to promise to compensate its default risk.

$$\text{Default Premium} = \text{Promised YTM} - \text{Expected YTM} = 12\% - 9\% = 3\%$$

risk premium is expected excess return

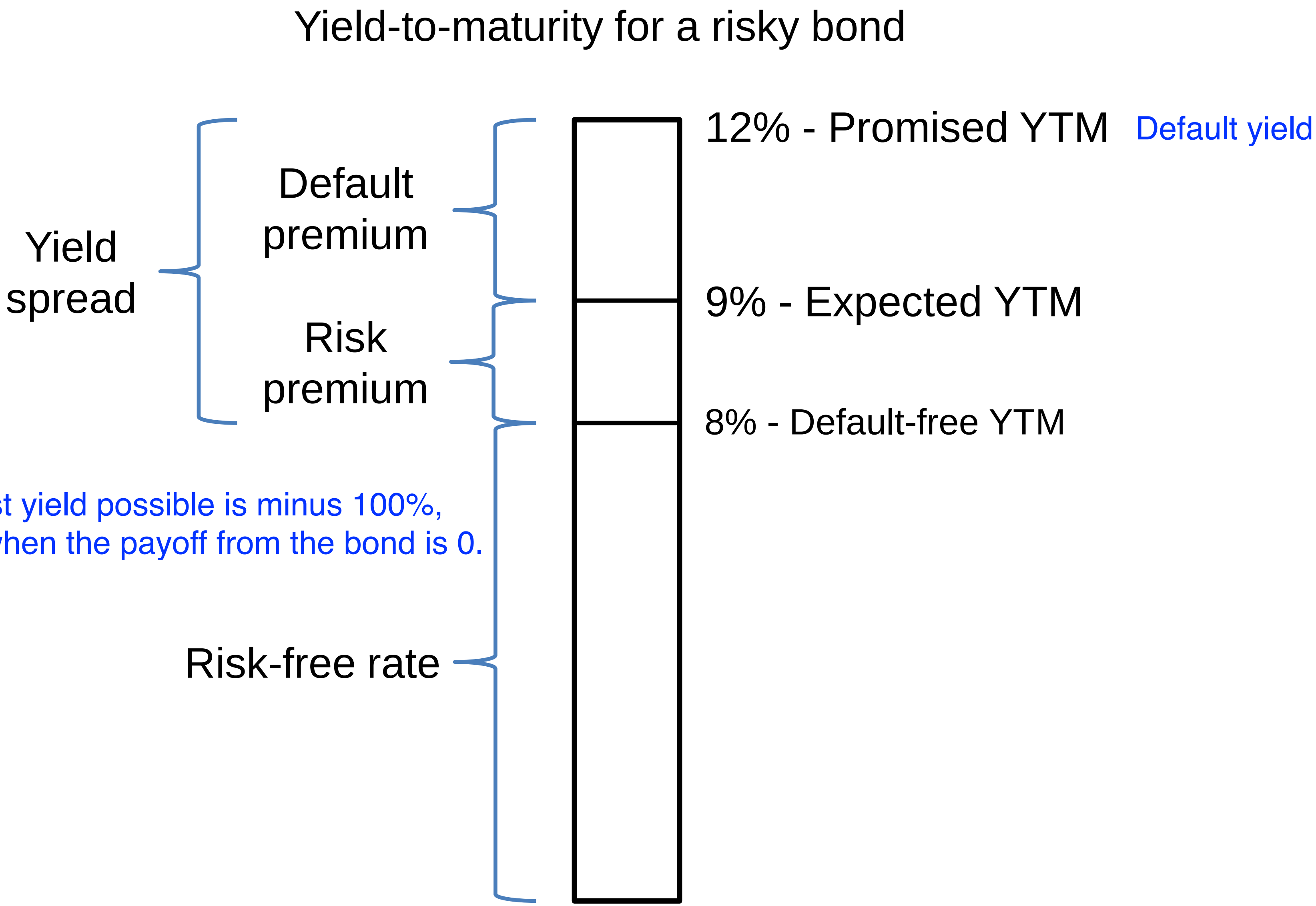
$$\text{Risk Premium} = \cancel{\text{Expected YTM} - \text{Default} - \text{free YTM}} = 9\% - 8\% = 1\%$$

Expected YTM - free YTM

Default premium and risk premium

- Promised YTM: the yield if default does not occur.
- Expected YTM: the probability-weighted average of all possible yields.
- Default premium: the difference between promised yield and expected yield.
- Risk premium: the difference between the expected yield on a risky bond and the yield on a risk-free bond of similar maturity and coupon rate.

Default premium and risk premium



The lowest yield possible is minus 100%,
which is when the payoff from the bond is 0.

Default premium and risk premium

Factors affecting default premium:

- Probability of default,
- Financial loss in the event of default.

Default premium and risk premium

Example. A firm plans to issue a 1-year coupon bond of par \$1,000. It has a probability of $p = 6\%$ to default, in which case only $(1 - \lambda) = 90\%$ of the promised payment (coupon plus principal) is paid (loss rate $\lambda = 10\%$). Suppose the market expects a yield of $\bar{y} = 10\%$ for bonds of similar risk. The firm wants to sell the bond at par. At what coupon rate must the firm issue this bond?

"recovery rate"

Since the bond is selling at par, the promised yield is the promised coupon rate. Let it be y. Then,

$$1 + \bar{y} = (1 - p) \times (1 + y) + p \times [(1 - \lambda)(1 + y)]$$

Thus,

$$y = \frac{\bar{y} + p\,\lambda}{1 - p\,\lambda} = \frac{0.1 + (0.06)(0.1)}{1 - (0.06)(0.1)} = 10.66\%$$

default premium: 0.66%
reason: not only the default probability is not very high--nearly
6% plus the recovery rate of 90%, which is quite high

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Determinants of default risk premiums

Example. Cambridge International Technologies (CIT) is a tech services company. Its asset's market value is \$10 billion now (year 0), and will be \$15 billion or \$5 billion next year (year 1), with probability 2/3 and 1/3, respectively. It has a 1-year, zero-coupon bond outstanding with a par value of \$6 billion. The current risk-free rate is 5%.

- What is the payoff of CIT's bond next year?
- What is the current price of CIT's bond?
- What is the current price of CIT's stock?
- What is the promised yield on CIT's bond?
- What is the probability of default? What is the loss rate when default?
- What is the expected yield on CIT's bond?
- What is the default premium on the bond?
- What is the risk premium on the bond?

Determinants of default risk premiums

Example (cont'd).

- Bond payoff next year:

	Payoff ($ billion)	
	Good state (up)	Bad state (down)
Asset	15	5
Bond	6	5
Stock	9	0

- In order to price the bond and the stock, we need the state prices (ϕ_u, ϕ_d). From the prices of CIT's asset and the risk-free asset:

asset's market value now is 10

$$\left.\begin{aligned} 10 &= 15\,\phi_u + 5\,\phi_d \\ 1/(1+0.05) &= \phi_u + \phi_d \end{aligned}\right\}$$

this is how the risk-neutral probability equation is derived: by using one-price theory (no arbitrage)

Thus, the state prices are $(\phi_u, \phi_d) = (11/21,\ 9/21)$.

Determinants of default risk premiums

Example (cont'd).

- The current prices of bond (D) and stock (E):

$$D = (6)\left(\frac{11}{21}\right) + (5)\left(\frac{9}{21}\right) = \frac{111}{21} = 5.286, \qquad E = (9)\left(\frac{11}{21}\right) + (0)\left(\frac{9}{21}\right) = \frac{99}{21} = 4.714$$

  Total value of asset: $A = D + E = \$10$ billion.

- Promised yield on the bond (i.e., yield when no default):

$$y = \frac{6}{D} - 1 = \frac{6}{5.286} - 1 = 13.5\%$$

- The probability of default: $1/3$. The loss rate: $\lambda = (6-5)/6 = 16.7\%$.

- The expected yield on the bond:

$$\bar{y} = \frac{\left(\frac{2}{3}\right)(6) + \left(\frac{1}{3}\right)(5)}{5.286} - 1 = \frac{\frac{17}{3}}{5.286} - 1 = 7.2\%$$

- The default premium and the risk premium on the bond:

$$\text{Default premium} = 13.5 - 7.2 = 6.3\%, \qquad \text{Risk premium} = 7.2 - 5.0 = 2.2\%$$

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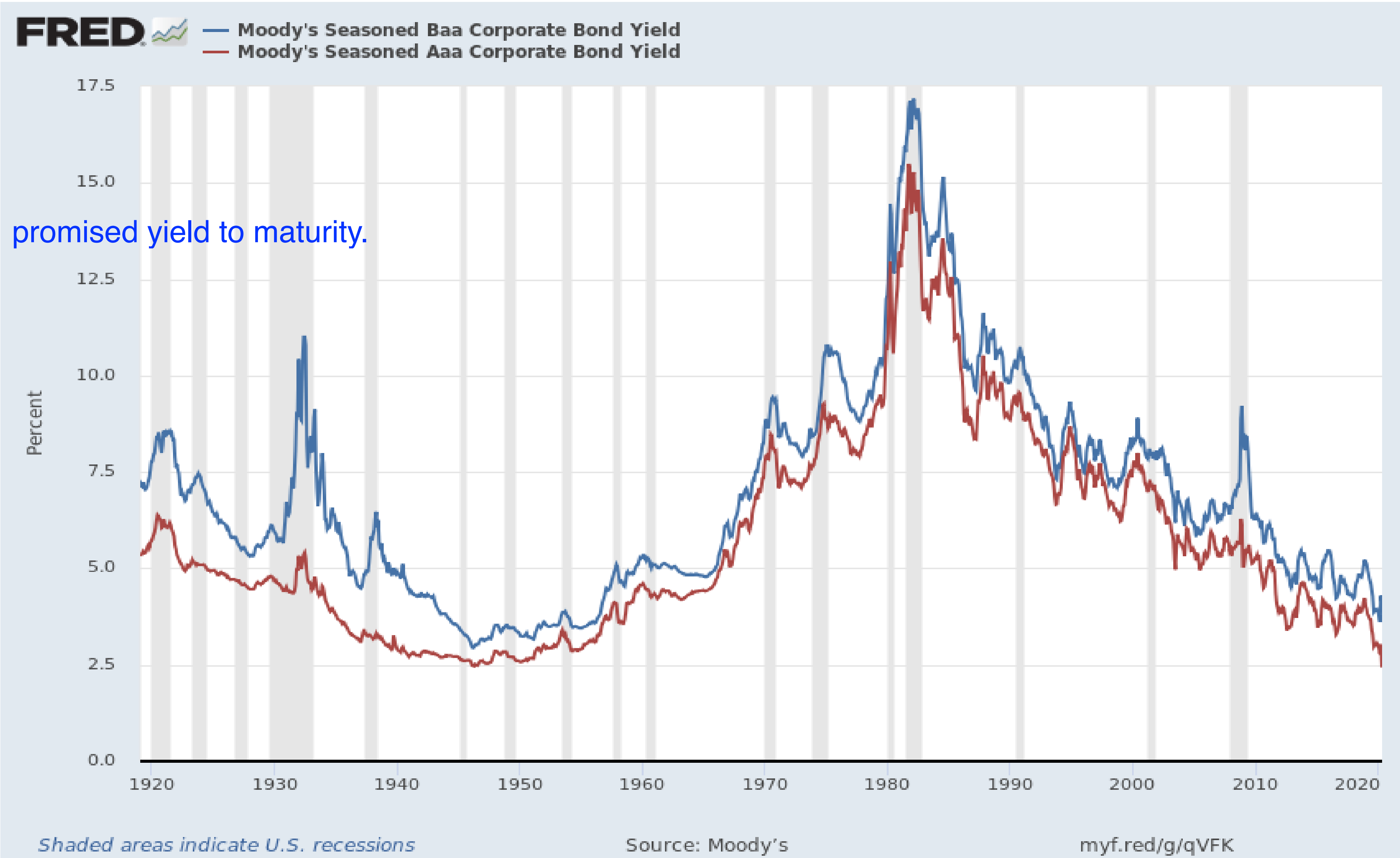
Corporate bond yield spreads

The overall time trend for the two yields are mostly driven by the changes in interest rates,

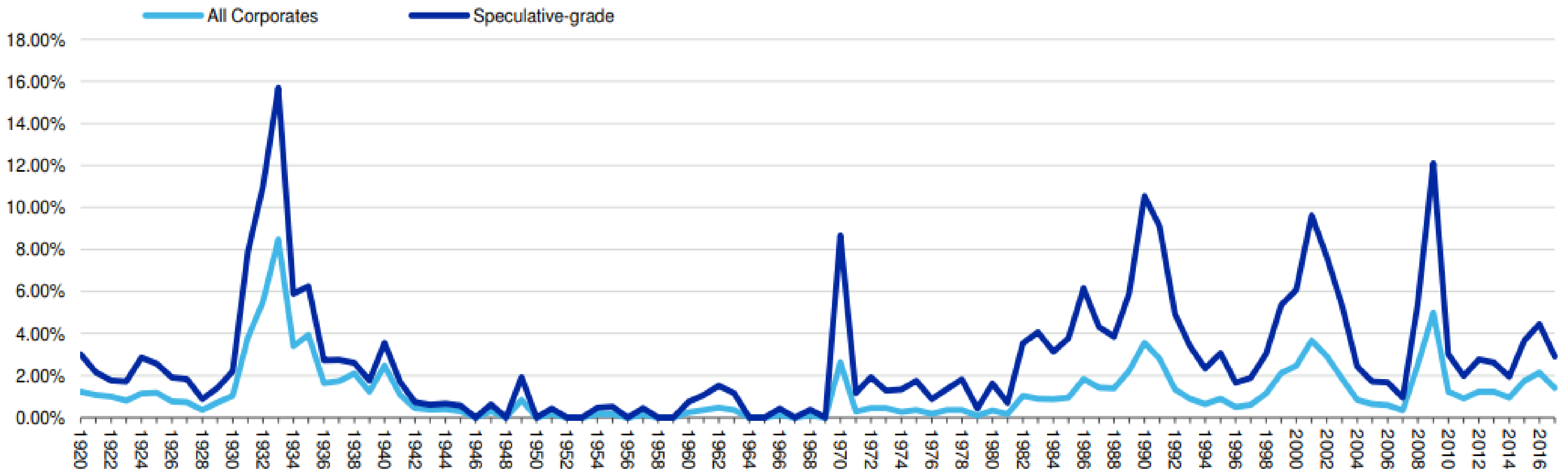
promised yield to maturity.



Default rates

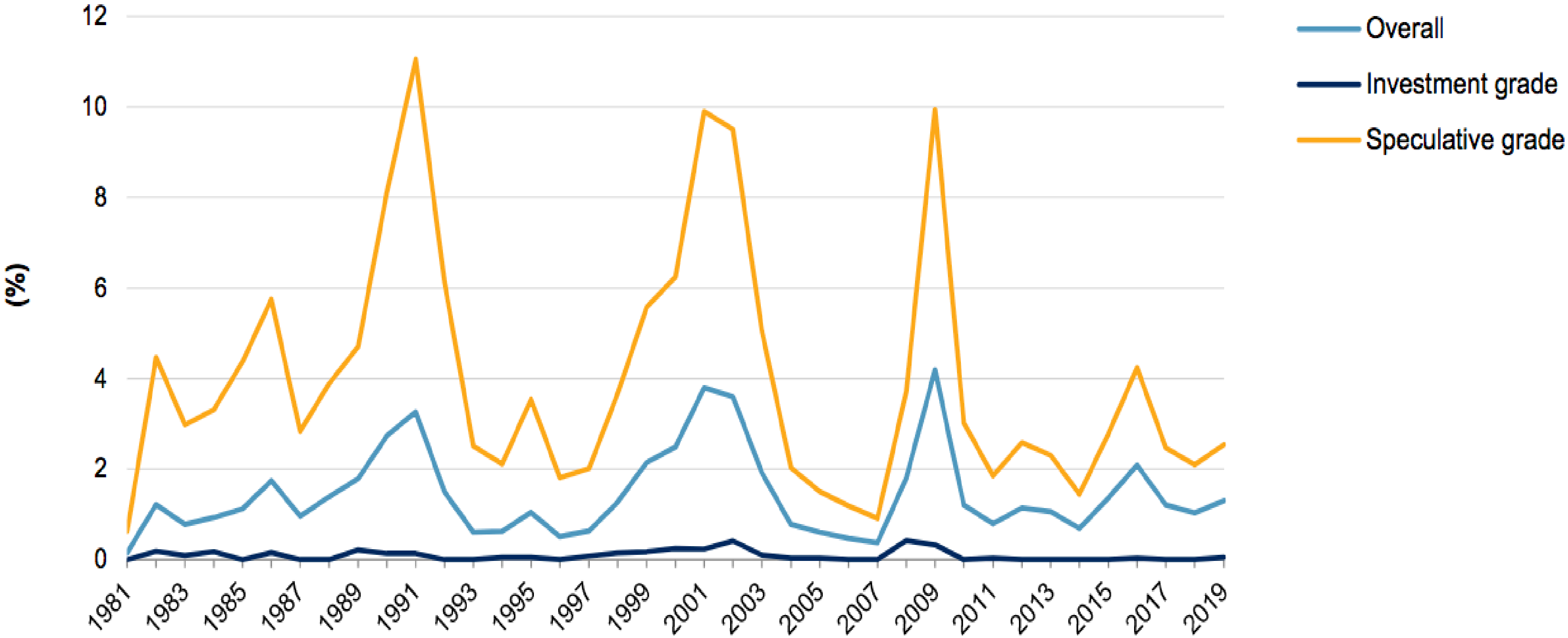
Global speculative-grade default rates from 1920-2017

percentage of bonds defaulted in each year.



Default rates

Global Default Rates: Investment Grade Versus Speculative Grade



Sources: S&P Global Ratings Research and S&P Global Market Intelligence's CreditPro®

Factors affecting default risk

Factors affecting default risk:

- Most of the default risk, as measured by default probability, is idiosyncratic.
- But a substantial part of the default risk is systematic (correlated).
- The systematic part of the default risk may exhibit fat tails.
- How about recovery rates (or loss rate)? exhibit similar properties as the default rates.

The systematic part of the default risk is also related, at least partially to economic cycles.

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