Capital structure management

Corporate Finance

Modigliani-Miller (MM)

- Does capital structure matter?
- Does the value of an asset depend on the mix of debt and equity that is used to finance its purchase?
- Absent taxes, transaction costs or limits, and other frictions, the answer is no
- Obvious in the world of CAPM: asset value depends on its payoffs alone

The question

- Consider two corporations with the same random $EBIT$ denoted X over $t = 1,2,3, \ldots$
- $Dep = I$ so that unlevered FCFF is $(1 - \tau)X$
- At first, $\tau = 0$, so that unlevered FCFF is X
- First corporation is financed with equity E and debt D, its value is:

$$V^L = E + D$$

- L for *levered* or *leverage*
- Second corporation is 100% equity financed, and has value V^U

The question

Can we have:

$$V^L > V^U$$

or

$$V^U > V^L?$$

MM theorem: *When markets are perfect,* $V^U = V^L$.

An arbitrage argument

- Assume, by way of contradiction, that $V^L > V^U$
- Portfolio 1: Buy fraction α of levered asset's equity, which costs αE
- Payoff: $\alpha(X - Dr^D)$
- Portfolio 2: Borrow αD and buy αV^U of equity in unlevered firm, which costs:

$$\alpha V^U - \alpha\, D \;=\; \alpha(V^U - D) \;<\; \alpha(V^L - D) \;=\; \alpha E$$

- Payoff: $\alpha X - \;\alpha\, Dr^D$
- Violation of the law of one price

Return on equity

- Unlevered case: $r^U = \frac{X}{V^U}$
- Levered case: $r^E = \frac{(X - r^D D)}{E}$
  $= r^U + (D/E)\,(r^U - r^D)$
- Leverage: more debt means more return on equity as long as $\mathrm{E}(r^U) > r^D$
- What's the catch? Risk goes up:
- $VAR(r^E) = Var(r^U)\left(1 + \frac{D}{E}\right)^2$

Levered betas

- How does the beta of the levered firm's equity compare to the beta of the unlevered firm?
- $$\begin{aligned} \beta^L &= \beta(r^E) \\ &= \beta(r^U + (D/E)(r^U - r^D)) \\ &= (1 + (D/E))\, \beta^U \end{aligned}$$
- It is higher, confirming that leverage implies risk
- Some stake-holders (debt-holders) assume "no" risk leaving equity holders to bear more risk

Weighted average cost of capital (WACC)

- $WACC = \frac{E}{E+D} E(r^E) + \frac{D}{E+D} r^D$

- MM proposition II: $WACC = E(r^U)$ regardless of D

- WACC fact: the asset's value is the expected present value of all future cash flows discounted at the WACC

- Loosely speaking, a positive NPV when discounted at WACC means that cash-flows, in expected terms, are sufficient to meet the expected returns of all stake-holders

MM: a WACC proof

Under MM assumptions:

1. Firm cash flows are independent of capital structure
2. Firm value is present value of cash flows at WACC
3. WACC is independent of capital structure

$\Rightarrow$ Firm value is independent of capital structure

What does MM tell us?

- Not so much that capital structure does not matter

- It says that if capital structure matters, it must be because of the frictions MM assume away:
  1. Taxes
  2. Costs associated with financial distress
  3. Agency problems (manager incentives vs. shareholder objectives)
  4. …

Taxes

- If asset's owner is a taxed corporation, they face taxes, but debt payments are tax deductible

- FCFF, in each period, is:

$$X - \tau(X - Dr^D) = (1-\tau)X + \tau Dr^D$$

- The last term is called the tax shield, it adds value to the asset

- One shows: $V^L = V^U + \tau D$

- General principle:
$APV = PV(unlevered\ corporation) + NPV(financing)$

Other MM results with taxes

- Unlevered case: $r^U = (1-\tau)X/V^U$
- Levered case:
  1. $r^E = r^U + \left(\frac{(1-\tau)D}{E}\right)(r^U - r^D)$
  2. $\beta^L = \left(1 + (1-\tau)\,\frac{D}{E}\right)\beta^U$
  3. $WACC = \frac{E}{E+D}E(r^E) + \frac{D}{E+D}(1-\tau)r^D$
- Discounting expected net-of-taxes cash flows at WACC continues to give the right answer

WACC issues

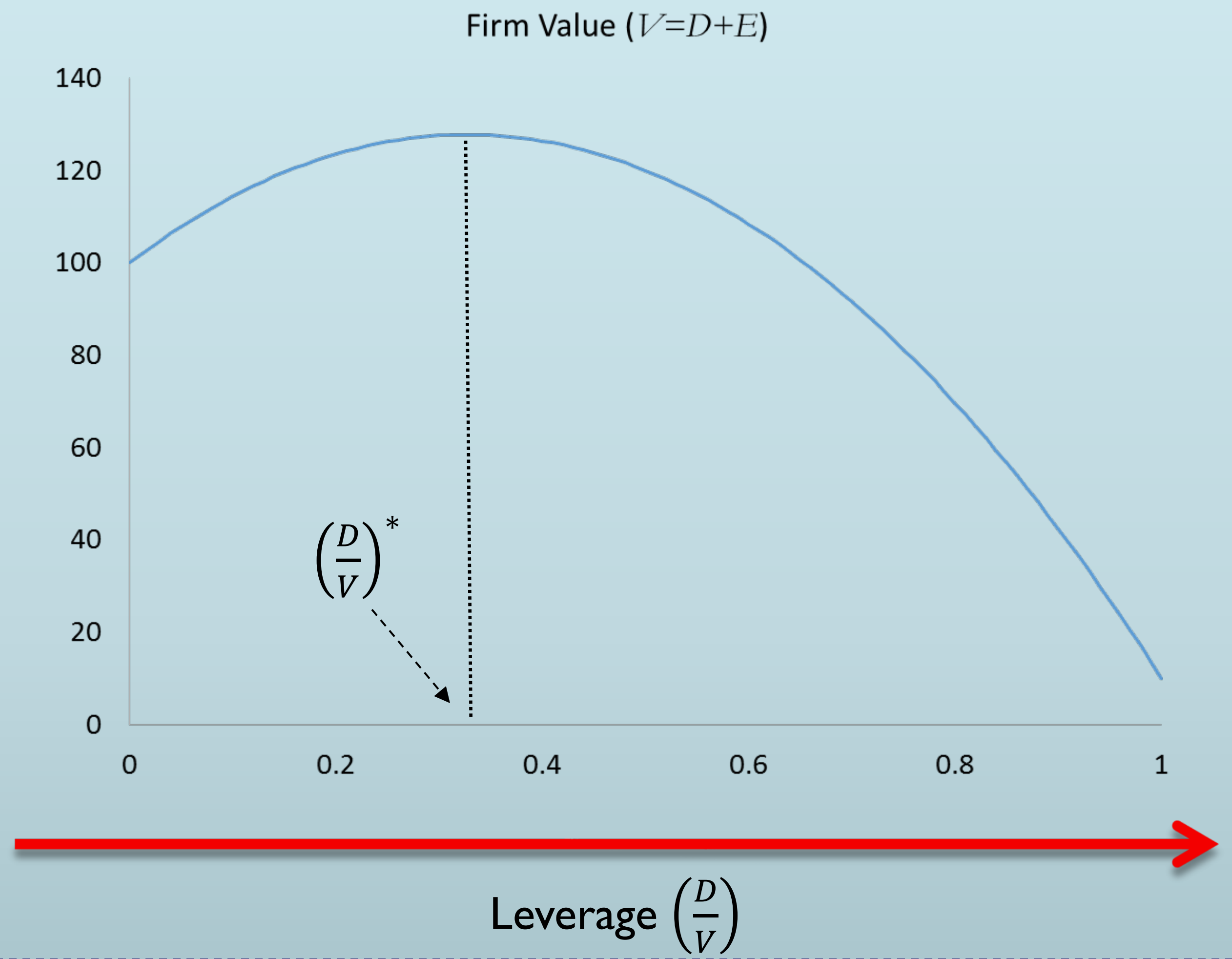
- WACC has at least two virtues:
  1. One can write a model (MM) where it is the right discount rate
  2. It has intuitive appeal

- But it relies on heroic assumptions:
  1. Capital structure is fixed
  2. Discount rates have no term structure
  3. …

If debt's so great, why use equity at all?

- MM abstract from issues associated with financial distress
- Distress is costly both for obvious reasons and more subtle ones
- As a result, optimal debt-to-value ratio is less than 100%
- Trade-off theory: optimal capital structure balances the costs and benefits of leverage

Trade-off theory



Trade-off theory, WACC version

- Consider a corporation with only debt and equity so that:

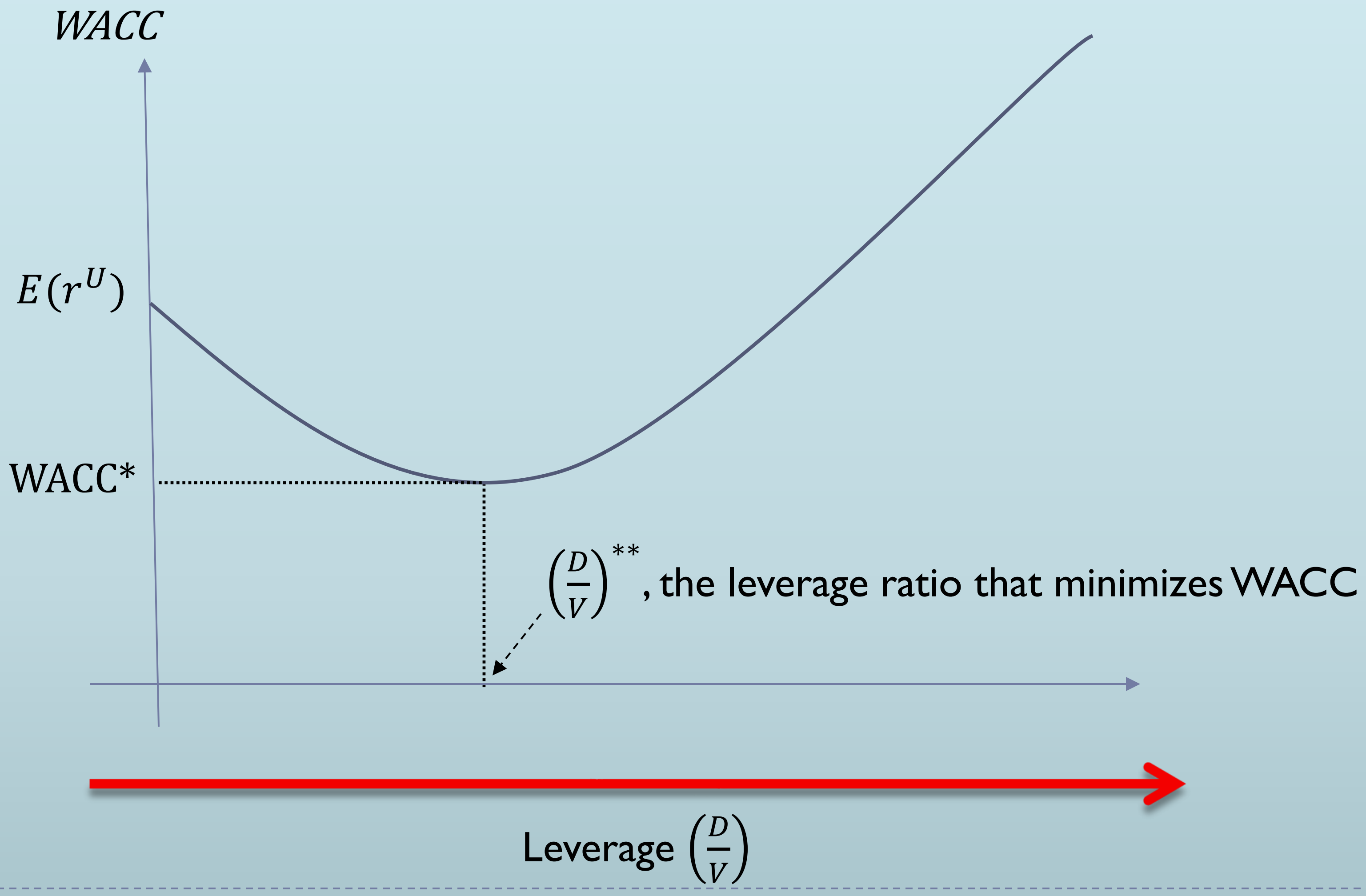
$$WACC = \frac{E}{D+E} r^E + \frac{D}{D+E} r^D (1 - \mathrm{t})$$

- A treasurer wants to ask weather increasing D will lower their cost of capital

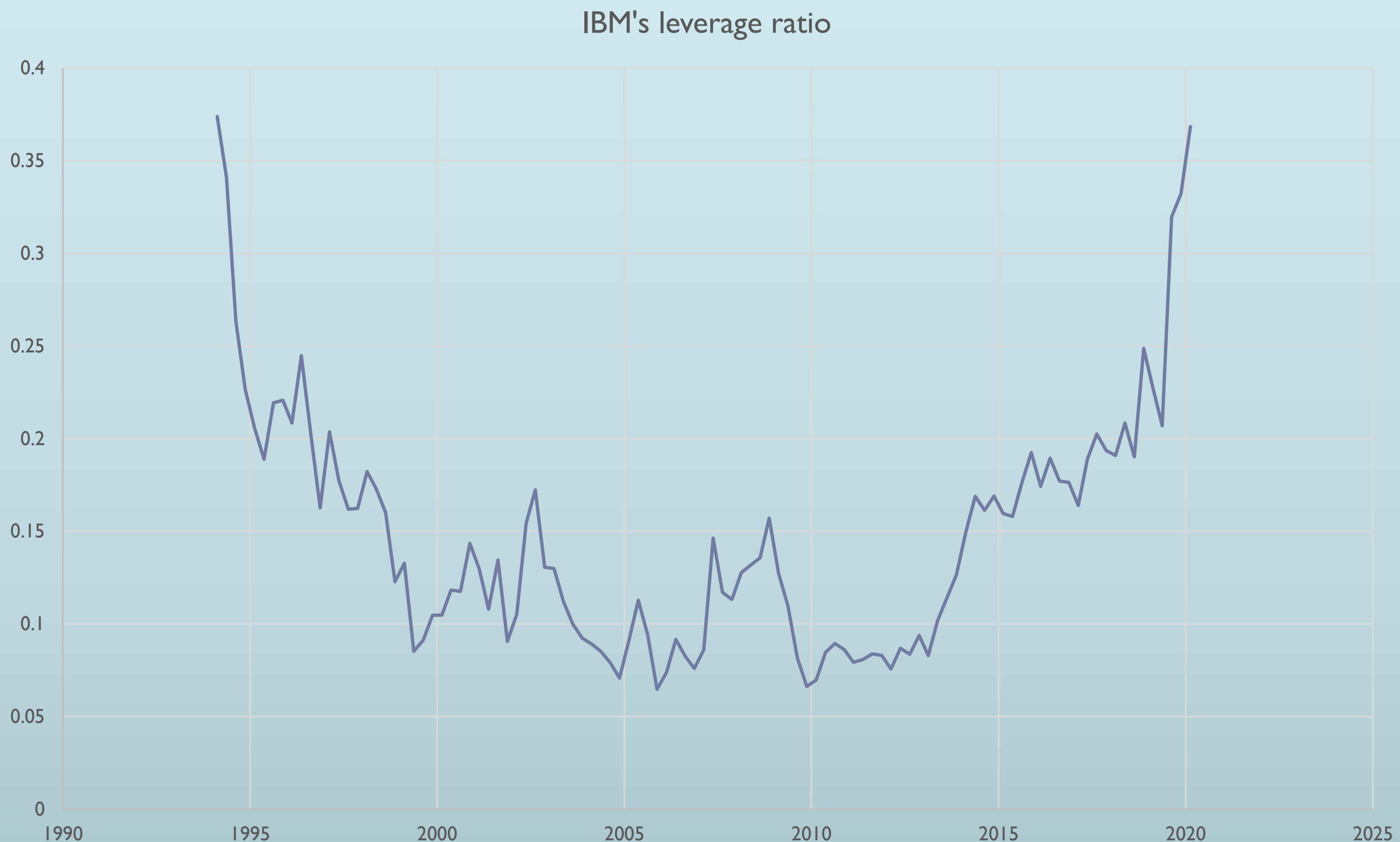
- Three main effects:
  1. Weight on debt increases (-)
  2. r^E goes up (+)
  3. r^D goes up if debt is risky (+)

- Under perfect markets and no taxes, the first two effects exactly cancel one another (**Modigliani-Miller proposition II**)
- With taxes, effect 1 is stronger than effect 2
- With default risk, effect 3 becomes stronger and stronger as D goes up (it is *convex*, that is)

Trade-off theory, WACC version



Do firms have leverage targets?



A test

- Consider the following model:

$$\left(\frac{D}{V}\right)_{t+1} = \gamma\left(\frac{D}{V}\right)^{*} + (1-\gamma)\left(\frac{D}{V}\right)_{t} + \epsilon_{t+1}$$

where ϵ is noise and γ is the speed of adjustment

- If firms have a target then γ should estimate to a number between 0 and 1
- The closer to 1 the faster the speed of adjustment
- IBM's γ estimates to around 0.08 but is not statistically significant at all conventional levels
- If one truncates the data at 2017, γ does become statistically significant
- See Python notebook

A more reasonable test

- $\left(\frac{D}{V}\right)^*$ probably varies over time as IBM's and market fundamentals do

- Hovakimian, Opler, and Titman (2001) and Strebulaev (2004), among many others, find evidence in favor of this view

- Dynamic trade-off theory

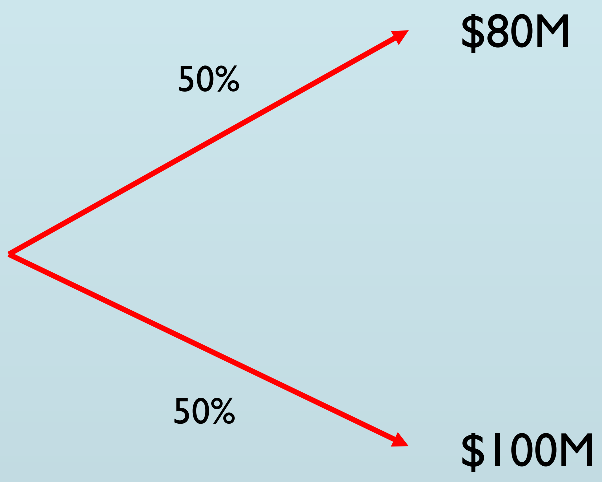
Leverage and distress

- *Debt overhang*: if new projects must be financed with new equity or junior debt, projects are passed up when their NPV falls short of the wealth transfer to senior debt holders (Myers, 1977)

- *Gambling for resurrection*: Limited liability caps shareholder losses, who cares about the downside? (Equivalently, equity is a call option on the firm's assets, the more volatility the better when default is a possibility)

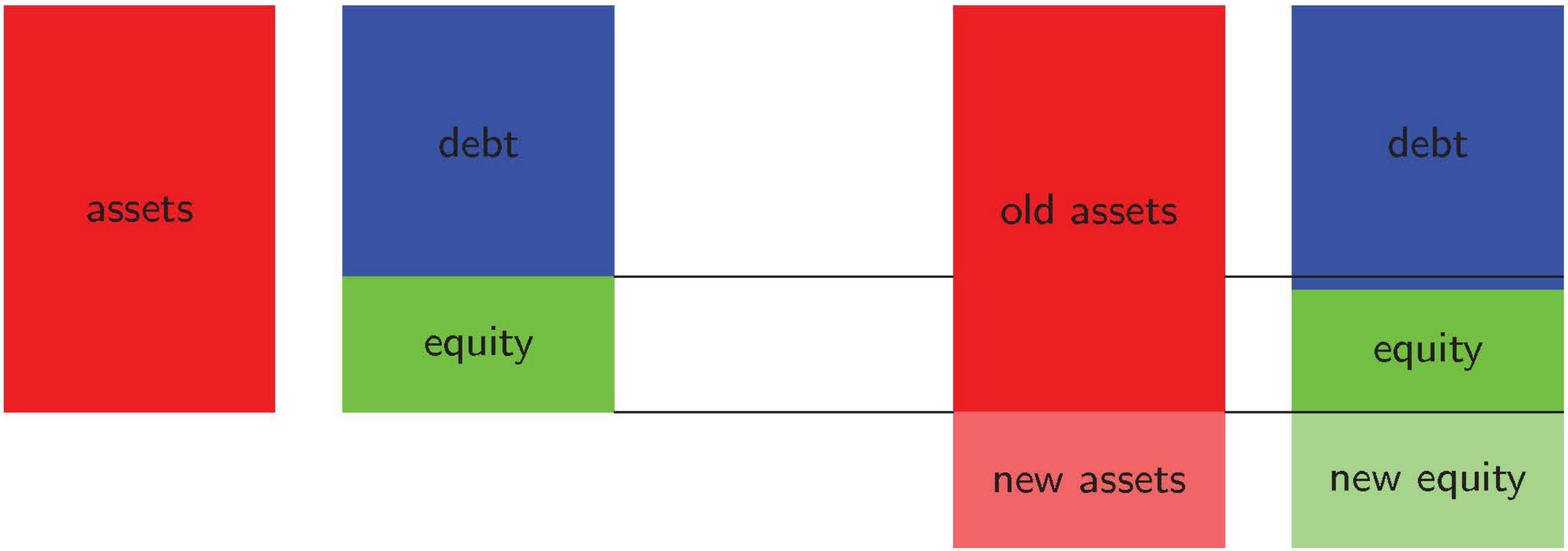
Debt overhang example

- Consider a corporation whose remaining cash flows are:



- Debt holders are owed $90M in final period
- A new project must be financed with equity, costs $10M to implement and generates $X for sure in the final period
- As a stand alone project, equity investors would require a 5% return from this investment
- But the project cannot be separated from the corporation
- How high must X be to justify investing into the new project?

Conventional debt overhang

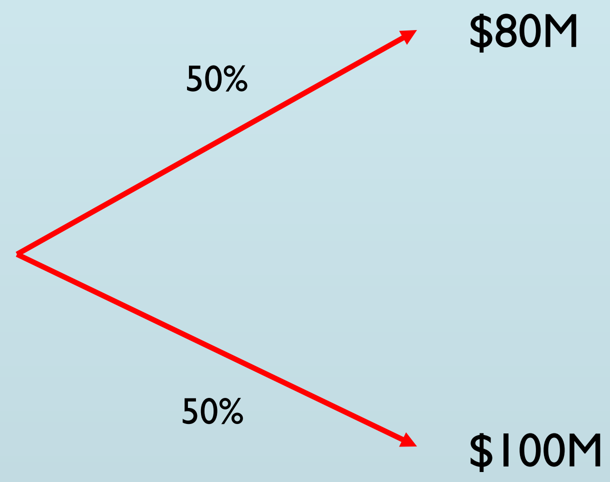


For shareholders to break even, the new assets must be purchased at a profit that exceeds the value transfer to creditors. (Myers, 1977)

Slide taken from Darell Duffie's Wisconsin talk on "Bank Debt Overhang and Financial Market Liquidity," hoping Darell won't mind

Gambling for resurrection

- Consider a corporation whose remaining cash flows are:

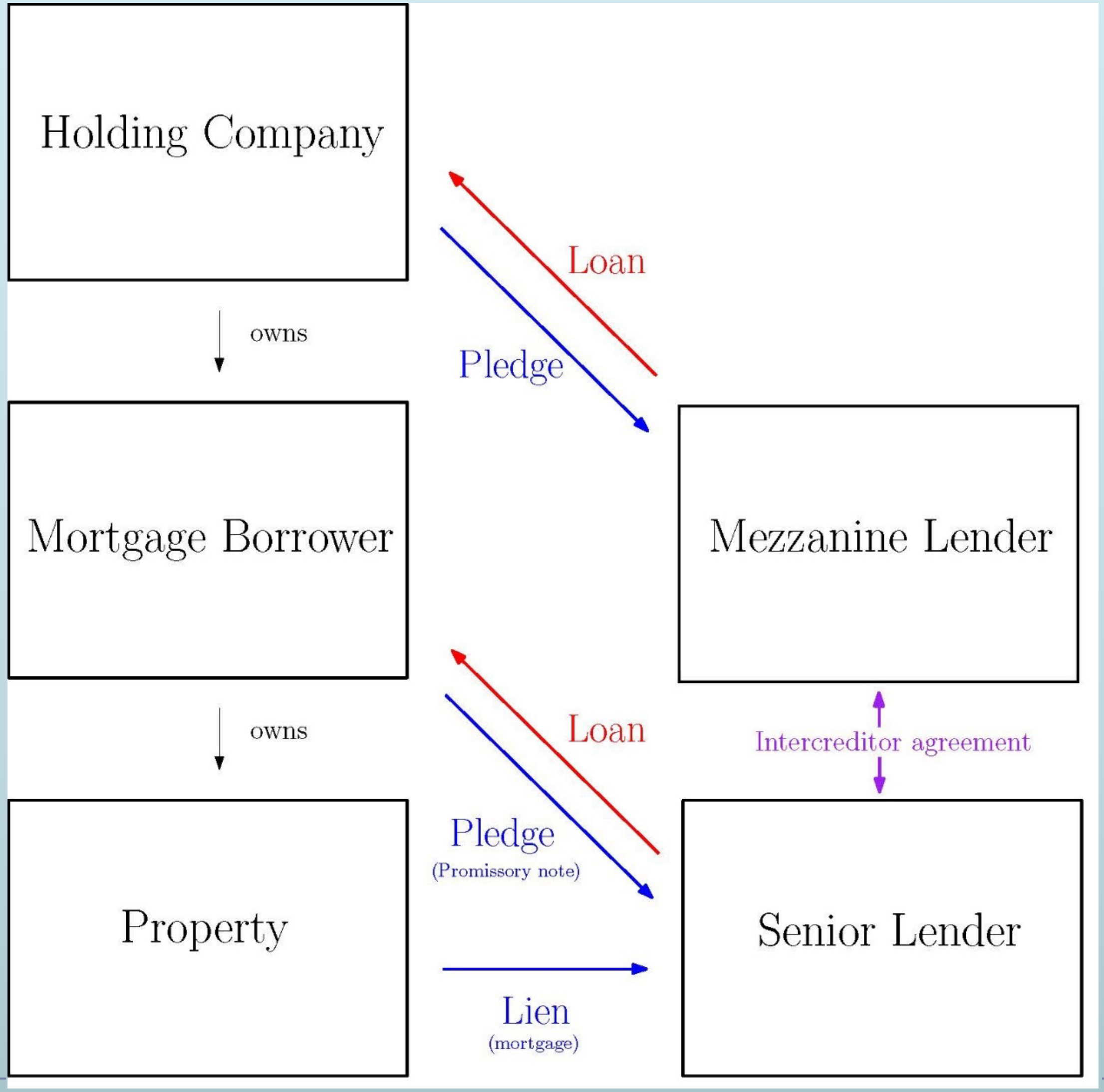


- Debt holders are owed $100M in final period
- A new project must be financed with equity, costs $0M to implement and generate $10 in the final period in the good state, but $-1,000,000,000M in the bad state
- This is a positive NPV project for incumbent equity holders

Other consequences of capital policy

- Debt reduces free cash flows hence moral hazard issues (Jensen, 1986)
- Debt is always there: low leverage means dry powder
- Secured vs unsecured debt: flexibility is valuable
- Debt holders bring skills to the table (monitoring, back-up operating skills…)

A back-up QB view of mezzanine finance



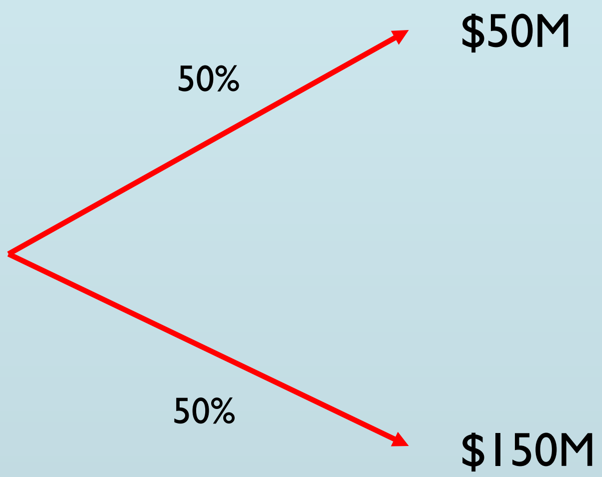
Pecking order (Myers and Majluf, 1984)

- According to this view, companies prefer raising funds in the following order:
  1. Internal funds
  2. Debt (safe, then risky, then hybrids)
  3. Equity

- “Good” firms don’t want to give away upside
- Firms/managers are more likely to issue equity when it is overvalued
- Raising external funds is costly

Equity issuances signal bad news

- Consider a corporation whose value next period, absent new investments, is:



- The corporation is and will remain unlevered
- Investors are risk-neutral and do not discount the future
- A new project yields payoff $110M in the bad state and $120M in the good state
- It costs $100M to implement today and requires fresh equity
- Incumbent shareholders discover whether the state is good or bad prior to investing

No pooling equilibrium

- Assume an equilibrium exists under which the project is implemented no matter what incumbent shareholders learn
- Value of the corporation today:

$$\frac{1}{2}(150+120)+\frac{1}{2}(50+110)=215$$

- 100 has to be raised in new equity so incumbent's share is $\frac{215-100}{215}$
- But incumbents who learn that the news is good are better off not investing since

$$150 > \frac{215-100}{215}\times 270$$

- The only possible equilibrium is one in which only incumbents who receive bad new invest
- Intuition: incumbents with good news know that share is undervalued at investment time, dilution is too costly for them

Maturity management

- A key aspect of capital structure management is the choice of a maturity structure in order to manage:
  1. Duration risk
  2. Refinancing/rollover risk

- In practice:

1. ladders (no towers) are viewed as the prudent thing to do
2. Average maturity should match average maturity of long-term investments (unless maturity transformation is your core business)

Capital structure management in practice

- Corporations, in some way or other, select a cost of capital (=debt rating) happy place given:
  1. Current and future investment opportunities
  2. Industry benchmarks

- Ratings, in turn, are a fairly well understood function of:
  1. Business risk
  2. Financial risk

Financial risk management

Exhibit 1: Aggregate Metrics by Rating Category

	Aaa-Aa	A	Baa	Ba	B	Caa-C	Median IG	Median SG
Interest Coverage	16.0	8.6	5.4	3.7	1.9	0.7	6.5	2.1
Asset Coverage	3.7	2.4	2.3	2.0	1.3	1.0	2.4	1.4
Leverage	31.6%	41.7%	44.8%	49.8%	68.7%	92.2%	43.6%	66.8%
Cash Flow-to-Debt	52.4%	32.6%	25.8%	21.6%	12.1%	6.4%	28.4%	12.7%
Return on Assets	11.6%	7.5%	5.3%	4.4%	1.7%	-2.1%	6.3%	1.9%
Profit	11.8%	9.0%	6.7%	5.0%	2.0%	-2.6%	7.8%	2.1%
Liquidity	7.8%	4.7%	4.0%	4.3%	3.9%	3.3%	4.6%	3.9%
Revenue Stability	7.2	7.3	6.1	5.2	6.1	7.3	6.6	5.9

Source: Moody's ratings and financial database as of July 1, 2006

Appendix D Definition of Financial Metrics

- Interest Coverage:
  - (EBIT - Interest Capitalized + (1/3)*Rental Expense) / (Interest Expense + (1/3)*Rental Expense + Preferred Dividends/0.65)
- Asset Coverage:
  - (Total Assets - Goodwill - Intangibles) / Total Debt
- Leverage:
  - (Total Debt + 8*Rental Expense) / (Total Debt + 8*Rental Expense + Deferred Taxes + Minority Interest + Total Equity)
- Cash Flow/Debt:
  - (Net After-Tax Income Before X-Items + Depreciations - Dividends) / (Total Debt + 8*Rental Expense)
- Return on Assets:
  - Net After-Tax Income Before X-Items / 2 Year Average Assets
- Profit:
  - Net After-Tax Income Before X-Items / Net Sales
- Liquidity:
  - Cash & Market Securities / Total Assets
- Revenue Stability:
  - 5 Year Average Net Sales / 5 Year Standard Deviation Net Sales

Merton's distance to default model

- Merton models equity as a call option on the firm's assets (which it is given limited liability)

- Then (under strong assumptions) one shows "distance to default" to be

$$DD = \frac{\ln\left(\frac{V}{D}\right) + \left(r - \frac{\sigma^2}{2}\right) \times T}{\sigma \times \sqrt{T}}$$

where V is asset value, σ its volatility, T is debt maturity, r is the short-term interest rate

- Under even stronger assumptions, the probability of default is $N(-DD)$

Default probabilities implied by CDS spreads (1)

- Assume constant hazard rates λ, constant recovery rate R, and flat CDS spreads κ
- Then CDS spreads κ should solve:

$$\lambda = \frac{\kappa}{1 - R}$$

- Further, letting $P(0,t)$ be probability of default between now and time t:

$$P(0,t) = \int_0^t \big(1 - P(0,s)\big)\lambda ds$$

Default probabilities implied by CDS spreads (2)

- It follows that $\frac{dP(0,t)}{dt} = \left(1 - P(0,t)\right)\lambda$
- This is a first-order differential equation whose solution, given $P(0,0) = 0$ is:

$$P(0,t) = 1 - e^{-\lambda t}$$

- So, finally,

$$P(0,t) = 1 - e^{-\frac{\kappa t}{1-R}}$$