



Corporate Finance Review

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Debt overhang / underinvestment problems

- Issuing equity / junior debt will be costly because funds put into the company will primarily increase the value to existing debtholders rather than investors putting funds in.
- Problem for companies whose debt is trading below par
- E.g. in financial distress and bankruptcy
Will make equity issues costly / dilutive

[Example. Q1]

- Consider a firm that has debt outstanding with a face value of \$80 and 10 shares of stock.
- There's a 50% chance the firm will be worth \$100, and a 50% chance the firm will be worth \$20.
- What will the debt and equity trade at (i.e., be worth)?

[Answer Q1]

- When the firm is worth \$100: the debt receives full value of \$80; the equity receives \$20.
- When the firm is worth \$20, the debt receives only \$20; the equity gets 0.
- The debt will trade at \$50 ($= 1/2 \times 80 + 1/2 \times 20$).
- The equity will trade at \$10 ($= 1/2 \times 20 + 1/2 \times 0$).
- Each share of stock will trade at \$1

[Example (cont) Q2]

- Firm has an investment that requires \$15 up front, but will pay off \$20 for sure. The firm wants to issue equity to finance the investment
- Under this situation, what will the debt and equity trade at (i.e., be worth)?

[Answer Q2]

- Once the investment is financed there is a 50% chance the firm will be worth \$120, and a 50% chance it will be worth \$40
 - When the firm is worth \$120: the debt receives full value of \$80; the equity receives \$40
 - When the firm is worth \$40, the debt receives only \$40; the equity gets 0
 - The debt will now trade at \$60 ($= 1/2 \times 80 + 1/2 \times 40$). It will increase in value by \$10
 - The equity will trade at \$20 ($= 1/2 \times 40 + 1/2 \times 0$)

[Answer Q2 (cont)]

- There are 10 old shares. The number of new shares equals the number that is necessary to raise \$15 to finance the investment.
- Because the total equity value is \$20, \$15 represents 75% of the total number of shares. The new shares must be 75% of the total or no one would buy the equity.
- The 10 old shares must control only 25% of the total or \$5. Each old share will trade at only \$0.50.
- By issuing equity to finance a positive NPV investment, this firm will succeed in cutting the value of its old shares in half!

When will an equity issue make sense?

- No debt overhang, i.e., debt trades close to par.
- Present value of the investment exceeds the transfer to the debt.
 - If the investment cost only \$10, the old shareholders would breakeven

[Risk Shifting]

- If company has significant debt, management has incentives to start play lotteries
 - Debtholders pay costs, since they suffer the most from downside
 - However, equityholders enjoy almost all benefits of upside. Debtholders cannot get more than face value!

[Example]

- Suppose a firm has two mutually exclusive projects A and B to choose from. Both cost \$40M today. Project A gives a sure CF of \$50M next year. Project B is more risky and gives \$80M with 50% chance and 0 with 50% chance. Assume the rate of discount to be zero for simplicity.

[Q1

- Suppose first the firm is all equity financed. Which project do we choose? What is the value of the company?

[Answer Q1]

- The NPV of the two projects are as follows:
 - $NPV(A) = -40 + 50 = 10$
 - $NPV(B) = -40 + 0.5*(80+0) = 0$
- Clearly project A (the safe one) is better since it provides a higher NPV. If the firm is all equity financed (there are no agency costs of debt since the firm is completely equity financed), then project A would be chosen. The firm value would be \$50 M.

[Q2]

- Now suppose the firm finances itself with \$30M in debt (before the project is chosen). Suppose debt holders (naively) think that project A will be taken so they agree to a 0 interest rate. What's the cash flow to equity in a year for the two projects? Which project do the equity holders choose? What's the (ex ante) value of the company, the debt, and the equity? Who bears the cost of the over-investment due to risk-shifting?

[Answer Q2]

- Since the debt holders believe that A will be chosen, they will accept a face value $F = \$30\text{m}$ so that they break even.
- $E = 50 - 30 = \mathbf{20}$, with certainty if project A is chosen
- If B is chosen then equity holders get \$50 (80-30) in the good state of the world while they get 0 in the bad state of the world.
- The equity will therefore be worth \$20M in A and $0.5 * 50 + 0.5 * 0 = \mathbf{25}$ in B
- \Rightarrow Shareholders prefer project B!
- $D = 0.5 * \min(80, 30) + 0.5 * \min(0, 30) = 15$
- Thus the debt holders (if they are naïve) lose $30 - 15 = \$15$!

[Q3]

- Now assume debt holders are not naïve!
What will their required face value F be for contributing \$30M today, realizing that project B will be taken?
- What is the (ex ante) value of debt, equity, and the company now?
- Who bears the cost of the over-investment now due to risk-shifting?

[Answer Q3]

- If debt holders are not naïve, they will anticipate that once the debt holders lend their money, the equity holders will always choose the risky project
- Therefore, the debt holders will anticipate that they can expect to get back the money only in the good state of the world
- Thus if F is the face value of the debt then debt holders expected payoff is $0.5 \cdot F$, and this should equal the \$30 M that they lend. To get $0.5 \cdot F = 30$, we need **$F = \$60M$**
- $E = 0.5 \cdot (80 - 60) + 0.5 \cdot 0 = 10$
- Which is 10 less than 20! So now it is the equity holders that pay the cost of the agency problem

[Q4

- How low would the leverage have to be to avoid the problem of risk shifting?

[Answer Q4]

- For the equity holders to choose A, the face value of debt must be such that equity holders prefer project A to project B. If F is the face value of the debt, then the payoff to equity holders with the two projects is given by
- $PV E(A) = 50 - F$
- $PV E(B) = 0.5 * (80 - F) + 0.5 * 0 = 40 - F/2$.
- Hence, we need $50 - F \geq 40 - F/2$ or **$F \leq 20M$**

[Asymmetric Information]

- Lemon problem
- Signaling
- Self selection

[Example]

- Consider an all-equity financed oil firm named “Screwon”. There is uncertainty about the quality of screwon’s management.
- The market believes that the management is of “good” quality with probability 0.5 , and of “bad” quality with probability 0.5 .
- The management itself however knows for sure whether it is good or not. Screwon currently is contemplating on investing in some new assets.
- The new assets require 100 million dollars in external financing. Assume that equity is the only source of financing available

[Example (cont)]

	“Good” Management	“Bad” Management
Market probability	0.5	0.5
Value of Old Assets	150	50
Value of New Assets	120	100
NPV of new project	$120 - 100 = 20$	$100 - 100 = 0$

[Q1]

- Assume that the market naively believes that the probability that the management is good is 0.5 no matter if the firm issues equity or not
- What will the market value of the firm be after it issues equity?
- What fraction of the firm will the new investors demand in return for their \$100m?
- What fraction will be left to the old shareholders?

[Answer Q1]

- If the firm raises new equity, the market will value the assets at:
- $V_m = 0.5 \cdot (150 + 120) + 0.5 \cdot (50 + 100) = 210$. Since the new investor will demand a share x of the company such that on average they are compensated for their outlay of \$100m.
- Given a zero discount rate, this translates into $x \cdot V_m = 100$ so the share they demand is $x = 100/V_m = 100/210 = 48\%$.
- The old shareholders will keep 52% of the firm.

[Q2]

- Assume now that the management knows that the firm is of "good" type
- What will the true total value of the firm be if it issues equity?
- What will the true total value of the firm be if it does not issue equity?
- What will the true value of the old and new shareholders' claim be if the firm does not issue equity?
- What if it issues equity?

[Answer Q2]

- Old assets are worth \$150m and the new assets \$120m. If the firm does not issue equity the true firm value is therefore **\$150m**. If it does issue equity the total true firm value will be $\$150 + \$120 =$ **\$270m**.
- Not issuing:
 - The old shareholders get 100% or **\$150m**
 - The new shareholders get 0
- Issuing
 - The old shareholders' claim will be $0.52 \cdot 270 =$ **\$140m**,
 - The new shareholders' claim will be worth $0.48 \cdot 270 =$ **\$130m**

[Q3

- Assuming that the management maximizes the wealth of the old shareholders, will it issue equity?

[Answer Q3]

- Since $\$140\text{m} < \150m , the firm will choose to not issue equity. *Thus it foregoes positive NPV project!*
- The reason is asymmetry of information. Management knows that the firm is good for sure, but the new investors only think it is good with probability 50%. To cough up the \$100m dollars, the new investor will therefore require compensation as if the firm was only good with probability 50%.
- Although the new project has an NPV of \$20m, the old shareholders have to give up $130 - 100 = \$30\text{m}$ to the new investors in order to realize the project. 30 is greater than $\text{NPV}=20$!

[Q4

- If the firm was known to the management to be of "bad" type, would it issue equity?

[Answer Q4]

- If the firm is of bad type, the old shareholders' equity is worth **\$50m** if the firm does not invest in the new project by issuing equity. If it issues equity, the firm's true value will be $50 + 100 = \$150\text{m}$.
- Old shareholders will keep 52% of the firm. The true value of their shares is therefore $0.52 \cdot 150 = \mathbf{\$78\text{m}}$
- This is bigger than \$50m so bad firms will issue equity.
- Now the new shareholders actually get *less* than they think, and so the old shareholders get a bigger than fair share of the firm's value.

[Q5]

- Given the answers in Q3 and Q4, is the market rational in believing that the firm is of good quality with probability 0.5 no matter if it issues equity or not? What would rational beliefs look like?

[Answer Q5]

- Since only bad firms will issue equity, the market belief is wrong. The rational conclusion is that if the firm issues equity, it is of "low" quality for certain.

[Q6]

- Assume that the market rationally assumes that a firm that issues equity is always of "bad" quality.
- What is the market value of the old shares of the firm before it makes its decision to issue equity or not (in other words, before the market knows if the firm is of good or bad type)?
- What will it be if decides to issue (thus revealing itself as having bad quality)?

[Answer Q6]

- The market value of the old shares will be the expected value of the old shares. If the firm is of good type, its old shares will be worth \$150m since they will not issue new equity. If the firm is of bad type, the old shares are worth \$50m.
- Before the decision to issue equity or not, the market value of the old shares is therefore $0.5 * \$150m + 0.5 * 50 = \$100m$.
- If the firm issues new equity it reveals itself to be bad and therefore the old shares will get a fair market value of \$50m. The price drops by \$50m because the firm is revealed to be of bad quality when it issues equity.