Lecture 9 Risk, Cost of Capital, and Valuation

- Our previous work on NPV allowed us to value riskless cash flows precisely. That is, we discount by the riskless interest rate.

$$NPV = -C_0 + \sum_{i=1}^{T} \frac{C_i}{(1+r)^i}$$

However, because most real world cash flows in the future are risky, business demands a procedure for discounting risky cash flows.

- This chapter applies the concept of net present value to risky cash flows.

1 The Cost of Capital

Whenever a firm has extra cash, it can take one of two actions.

On the one hand, it can pay out the cash immediately as a dividend.

On the other hand, the firm can invest extra cash in a project, paying out the future cash flows of the project as dividends.

Which procedure would the stockholders prefer?

If a stockholder can reinvest the dividend in a financial asset (a stock or bond) with the same risk as that of the project, the stockholders would desire the one with the highest expected return.

In other words, the project would be undertaken only if its expected return is greater than that of a financial asset of comparable risk.

This is illustrated in the figure.

- **The discount rate of a project should be expected return on a financial asset of comparable risk.**（项目的折现率应等于同样风险水平的金融资产的期望收益率）。

- **The discount rate** is often called **the required return** on the project, meaning that the project should be accepted only if the project generates a return above what is required.
- Alternatively, the discount rate of the project is said to be its **cost of capital**, meaning that the project must earn enough to pay its suppliers of capital.

2 Estimating the Cost of Equity Capital with the CAPM

- Now imagine that all projects of the firm have the same risk. Then the discount rate is equal to the cost of capital for the firm as a whole.

- If the firm is all equity, the discount rate is also equal to the firm's cost of equity capital. The cost of equity capital is the required return on a stockholders' investment in the firm.

- Under the CAPM, the expected return on the stock is

$$E(R_i) = R_F + \beta_i \times (E(R_M) - R_F)$$

Example 1:

Suppose Alpha Air Freight is an all equity firm with a beta of 1.21. Further suppose the market risk premium is 9.5 percent, and the risk free rate is 5 percent.

We find that the expected return is

$$5\% + (1.21 \times 9.5\%) = 16.495\%$$

Further suppose Alpha is evaluating the following non mutually exclusive projects:

Project	Project's Beta	Project's Expected Cash Flows Next Year	Project's Internal Rate of Return	Project's NPV When Cash Flows Are Discounted at 16.495%	Accept or Reject
A	1.21	$140	40%	$20.2	?
B	1.21	120	20	3.0	?
C	1.21	110	10	-5.6	?

Two key assumptions were made in this example:

1 The beta risk of the new projects is the same as the risk of the firm.

2 The firm is all equity financed.

Given these assumptions, it follows that the cash flows of the new projects would be discounted at 16.495%.

- The diagonal line represents the relationship between the cost of equity capital and the firm’s beta.

- An all equity firm should accept a project whose internal rate of return is greater than the cost of equity capital, and would reject a project whose internal rate of return is less than the cost of equity capital.

3 Betas in Real World

3.1 Estimation of Beta

- It is easy to understand that the beta of a firm is likely to change if the firm changes its industry.

- Now let us ask the reverse question: Does the beta of a firm stay the same if its industry stays the same?

If we consider one company by itself, then most analysts argue that betas are generally stable for firms remaining in the same industry.

- However, this is not to say that, as long as a firm stays in the same industry, its beta will never change. Changes in product line, changes in technology, or changes in the market may affect a firm’s beta.

- It is frequently argued that we can better estimate a firm’s beta by involving the whole industry.

- Consider the following Table.

Table Betas for Firms in the Computer Software Industry

Company	Beta
Microsoft	**0.98**
Apple, Inc.	**0.94**
Automatic Data Processing	**0.86**
Oracle Corp.	**1.41**
Computer Sciences	**1.30**
CA, Inc.	**1.34**
Fiserv, Inc.	**1.03**
Accenture, Ltd.	**1.18**
Symantec Corp.	**0.91**
Paychex, Inc.	**0.89**
Equally weighted portfolio	**1.08**

Consider Computer Sciences.

Assuming a risk-free rate is 1 percent and a risk premium is 7 percent, Computer Sciences might estimate that its cost of equity capital is

$$1\% + 1.30 \times 7\% = 10.1\%$$

Because beta estimation is subject to large random variation in this volatile industry and the error in beta estimation on a single stock is much higher than the error for a portfolio of securities.

Thus the CFO of Computer Sciences may use the industry beta of 1.08 as the estimate of its own firm's beta. So

$$1\% + 1.08 \times 7\% = 8.56\%$$

In general, we have this guideline.

- If we believe that the operations of the firm are similar to the operations of the rest of the industry, we should use the industry beta simply to reduce estimation error.
- If we believe that the operations of the firm are fundamentally different from those in the rest of the industry, the firm's beta should be used.

3.2 Determinants of Beta

- Beta is determined by the characteristics of the firm.

- We consider three factors: the cyclical nature of revenues（收入的周期性）, operating leverage（经营杠杆）, and financial leverage（财务杠杆）.

- The first two factors are **business risk.**

  It depends both on the responsiveness of the firm’s revenues to the business cycle and on the firm’s operating leverage.

3.2.1 Cyclicality of Revenues

- The revenues of some firms are quite cyclical. That is, these firms do well in the expansion phase of the business cycle and do poorly in the depression phase.

- Because beta measures the responsiveness of a security to the movement on the market, high cyclical stocks usually have high betas.

- Notice that cyclicality is not the same as variability.

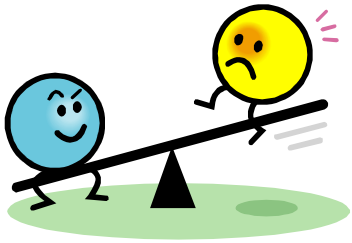
3.2.2 Operating Leverage

Operating leverage measures the percentage change in EBIT for a given percentage change in sales or revenues.

$$Operating\ leverage = \frac{change\ in\ EBIT}{EBIT} \times \frac{Sales}{change\ in\ sales}$$

EBIT is the earnings before interest and taxes.

The general view states that operating leverage increases as fixed costs rise and as variable costs fall.



Firms often face a trade-off between fixed and variable costs.

Firms with high fixed costs and low variable costs are generally said to have high operating leverage.

Operating leverage magnifies the effect of the cyclicality of a firm's revenues on beta. That is, a firm with a given sales cyclicality will increase its beta if fixed costs replace variable costs in its production process.

Example 2:

Consider a firm that can choose either technology A or technology B when making a particular product. The relevant differences between the two technologies are displayed below

Technology A	Technology B
Fixed costs: $1,000/year	Fixed cost: $2,000/year
Variable cost: $8/unit	Variable cost: $6/unit
Price: $10/unit	Price: $10/unit
Contribution margin: $2 ($10-$8)	Contribution margin: $4 ($10-$6)

- Because B has both lower variable costs and higher fixed costs, we say that B has higher operating leverage.

- The contribution margin is the difference between price and variable cost, which measures the incremental profit from one additional unit.

  Because the contribution margin in B is greater, its technology is riskier.

- The figure shows the change in EBIT for a given change in volume. The slope of B is greater, indicating that technology B is riskier.

  In general, high operating leverage stocks have high beta.

- Although the preceding discussion concerns firms, it also applies to projects as well.

  Those projects whose revenues appear strongly cyclical and whose operating leverage appears high are likely to have _____(high/low) betas. Conversely, weak cyclicality and low operating leverage implies _____(high/low) betas.

3.2.3 Financial Leverage

- A levered firm is a firm with some debt in its capital structure. Financial leverage is the extent to which a firm relies on debt.
- Operating leverage refers to the firm's fixed costs of production. Financial leverage refers to the firm's fixed costs of finance.

- The asset beta is the beta of the assets of the firm.

  The asset beta is the same as the equity beta if the firm had been financed only by equity.

Consider a firm with some debt and some equity in its capital structure. What is the beta of the portfolio of the firm's debt and equity?

The beta of this portfolio is a weighted average of the betas of the individual items in the portfolio.

$$\beta_{Asset} = \frac{Debt}{Debt + Equity} \times \beta_{Debt} + \frac{Equity}{Debt + Equity} \times \beta_{Equity}$$

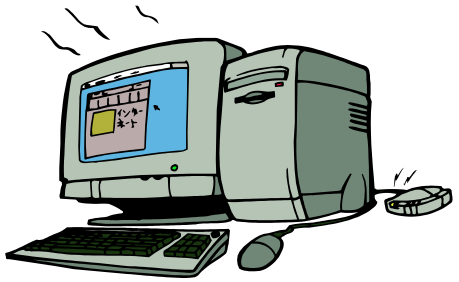
β_{Equity} is the beta of the stock (equity) of the levered firm.

- The asset beta can also be viewed as the beta of the common stock had the firm been all equity.

- β_{Asset} is the beta or systematic risk of all the firm's assets. It reflects the business risk of an enterprise. It is the risk inherent in a firm's operation.

- β_{equity} is the systematic risk of leveraged equity. It is the financial risk, the additional risk borne by stockholders in a levered firm.

- β_{debt} is the systematic risk of the firm's debt.



If we make an assumption that the beta of debt is zero, we have

$$\beta_{Asset} = \frac{Equity}{Debt + Equity} \times \beta_{Equity}$$

$$\Rightarrow \quad \beta_{Asset} < \beta_{Equity}$$

Rearranging this equation, we have

$$\beta_{equity} = \beta_{Asset}(1 + \frac{Debt}{Equity}) \qquad without\ tax$$

$$\beta_{equity} = \beta_{Asset}(1 + \frac{Debt}{Equity}(1 - T_C)) \qquad with\ tax$$

The equity beta is always greater than the asset beta with financial leverage.

Example 3:

Consider a tree-growing company, which is currently all equity and has a beta of 0.8. The firm has decided to move to a capital structure of one part debt to two parts equity.

Because the firm is staying in the same industry, its asset beta should remain at 0.8. However, assuming a zero beta for its debt, its equity beta would be

$$\beta_{equity} = \beta_{Asset}(1 + \frac{Debt}{Equity})$$

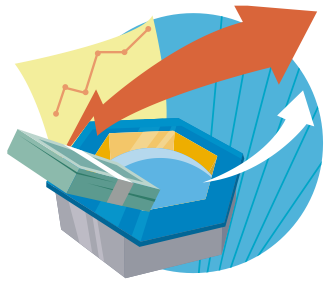
$$1.2 = 0.8 \times \ (1 + \frac{1}{2})$$

If the firm had one part debt to one part equity in its capital structure, its equity beta would be

$$1.6 = 0.8 \times (1 + 1)$$

However, as long as it stayed in the same industry, its asset beta would remain at 0.8.

The effect of leverage, then, is to increase the equity beta.



4 Extensions of the Basic Model

4.1 The Firm versus the Project

- We now assume that the risk of a project differs from that of the firm. Then the project should be discounted at the rate with respect to its own beta.

- Any project's cost of capital depends on the use to which the cash is being put. It depends on the risk of the project and not the risk of the company.

Example 4:

Suppose a company has a cost of capital based on the CAPM of 17%. The risk free rate is 4%, the market risk premium is 10% and the firm's beta is 1.3.

$$17\% = 4\% + 1.3 \times 10\%$$

This is the breakdown of the company's investment projects:

1/3 Automotive retailer $\beta = 2.0$

1/3 Computer Hard Drive $\beta = 1.3$

1/3 Electric Utility $\beta = 0.6$

The average beta of asset is 1.3.

When evaluating a new electrical generation investment, which cost of capital should be used?

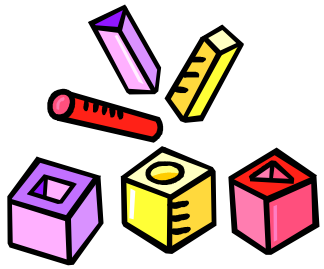
$$10\% = 4\% + 0.6 \times 10\%$$

10% reflects the opportunity cost of capital on an investment in electrical generation given the unique risk of the project.

Investment in hard driver or auto retailing should have _____(higher or lower) discount rate.

- Use of a firm's cost of capital in calculations may lead to incorrect capital-budgeting decision.

- Projects with high risk should be discounted at a high rate. By using the firm's cost of equity, the firm is likely to ____ (accept or reject) too many high risk projects.
- Projects with low risk should be discounted at a low rate. By using the firm's cost of capital, the firm is likely to ____ (accept or reject) too many low risk projects.



4.2 The Cost of Capital for a Levered Firm

We know how to choose the discount rate when a project is all equity financed. Now we consider the project, which is financed with both debt and equity.

Suppose a firm uses both debt and equity to finance its investments. If the firm pays r_B for its debt financing and r_S for its equity, what is the overall or average cost of its capital?

The firm uses both debt and equity. The cost of equity is r_S , and the cost of debt is the firm's borrowing rate r_B .

The cost of capital is a weighted average of each:

$$r_{WACC} = \frac{S}{S+B} \times r_S + \frac{B}{S+B} \times r_B$$

The weights are the proportion of total value represented by the equity and the proportion of total value represented by debt.

Notice that interest is tax deductible at the corporate level. If T_C is the corporation's tax rate, the cost of debt after tax is

$$r_B \times (1 - T_C)$$

The average cost of capital after tax for the firm is

$$r_{WACC} = \frac{S}{S+B} \times r_S + \frac{B}{S+B} \times r_B \times (1 - T_C)$$

Because the average cost of capital is a weighting of its cost of equity and its cost of debt, it is referred to as the weighted average cost of capital, r_{WACC} .

Example 5:

Suppose that a firm has both a current and a target debt-equity ratio of 0.6, a cost of debt of 15.15 percent, and a cost of equity of 20 percent. The corporate tax rate is 34 percent.

The firm is considering taking on a warehouse renovation costing $50 million that is expected to yield cost savings of $12 million a year for six years.

Should the firm take this investment?

Example 6:

A firm has a debt equity ratio of 2. The betas on the equity and the debt are 2.5 and 0.25 respectively. The risk free rate is 3% and the market risk premium is 12%.

The firm's managers are trying to decide whether to invest in a project with a one year lifespan that has the same riskiness as the overall firm. This project is expected to generate a 10% return , and there are no taxes.

A Calculate the weighted average cost of capital of the firm.

B Should they adopt the project?

C If the firm wants to change its debt equity ratio to 3, what is its new equity beta?

(Hint: The asset beta depends on the business risk of the firm assets, which does not change whichever the way the firm arranges the capital structure).

Please check the webpage for the third homework!

Due on Nov, 11th in lecture!

Less than one week late: one grade penalty

More than one week late: no accepted

(no excuse, no make-up)

You have to finish the homework individually!