PRINCIPLES OF FINANCE

WEEK 2

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Last lecture

What we learned last week:

- How to calculate the value of a firm?
- How to decide whether to undertake an investment or not?

What you learned from the video:

- How to value a bond?
- What is the Gordon growth model for stock valuation?

Real-life example:

- Green bonds

Outline of today's lecture

This lecture is about:

- How to decide whether or not to undertake a project:
  - The Net Present Value (NPV) Rule
  - The Internal Rate of Return (IRR) rule
  - The payback period rule
- Financial statements: balance sheet and income statement

The video to watch is about capital budgeting with the NPV rule:

- How to derive free cash-flows from the income statement
- How these free cash-flows enter the NPV rule.

Real-life example: Apple.

The Net Present Value (NPV) rule
and
the Internal Rate of Return (IRR) rule

NPV

$$NPV = PV\ of\ cash\ inflow - PV\ of\ cash\ outflow$$

$$PV_0 = \sum_{t=1}^{T} \frac{CF_t}{(1+r)^t}$$

May not be known at time 0. In this case, use the **expected CF**.

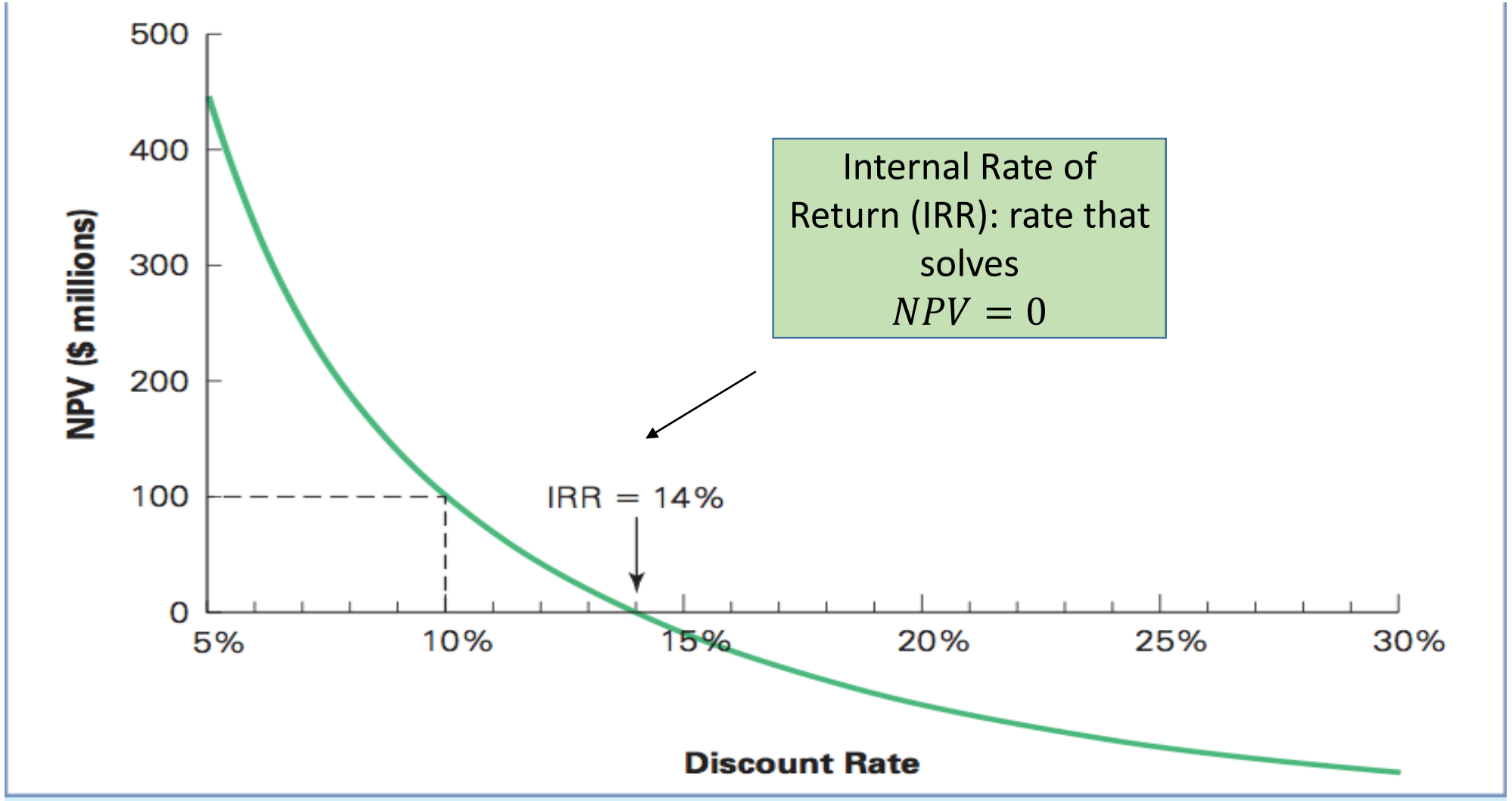
Keywords:
Opportunity cost = required rate of return = cost of capital

Rate of return that one would expect on an alternative investment of comparable risk. Reflects the compensation of delay in consumption

Often referred to as **opportunity cost**, since investing in the project prevents the investor from being able to invest in an alternative investment. Also called **required rate of return** or **cost of capital**.

Influenced, among others, by inflation, risk…
We will see in another lecture how to set it.

NPV and IRR


500
400
300
200
100
0
NPV ($ millions)
5%
10%
15%
20%
25%
30%
Discount Rate
IRR = 14%
Internal Rate of Return (IRR): rate that solves
$NPV = 0$

The NPV rule

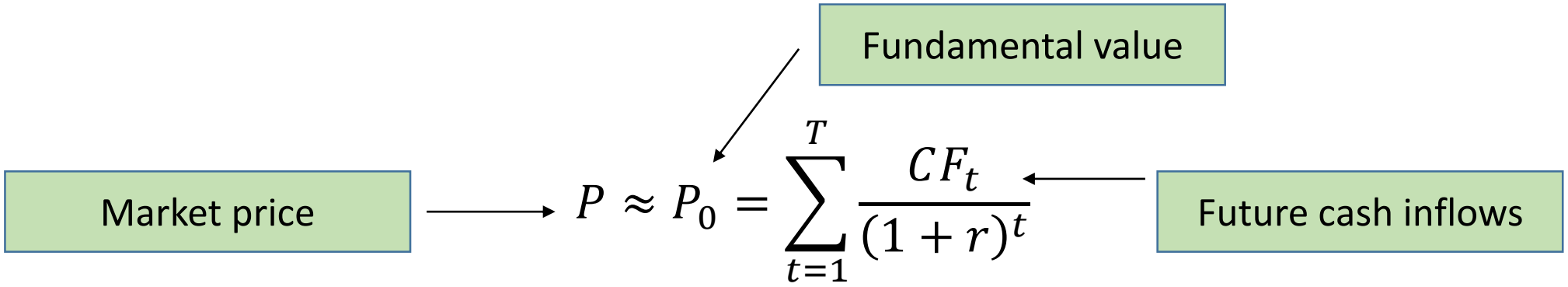
- **The NPV rule**: Accept a project if the NPV is greater than zero.

- Accepting a positive NPV project increases the value of the firm, as the project is going to earn a rate of return superior to what the firm can currently obtain in the market → It benefits shareholders.

- The value of the firm is the sum of the values of the different projects, divisions, or other entities within the firm: **value additivity**. The contribution of any project to a firm's value is simply the NPV of the project.

- In financial markets, we usually assume that the NPV of a transaction is zero. This is the same as saying that financial markets are **efficient** – the price is very close to its fundamental value.

Market price vs. fundamental price



- The fact that the NPV is zero does not mean that the investor made a bad deal! It just means that the investor will earn his/her required rate of return on his investment.
- Positive NPV opportunities are possible because entrepreneurs keep finding creative new ways of using existing physical assets.

Back to the NPV rule

- In reality, firms may have constraints on the amount of funds which can be raised and projects may be mutually exclusive.
- NPV Rule: Choose projects to maximize the sum of NPVs.
- If we have unlimited resources and the projects are not mutually exclusive, choose **all** projects with positive NPV.
- If we have limited resources and/or some of the projects are mutually exclusive, choose the projects that can be undertaken together and for which, the sum of initial investments is feasible and the sum of the NPVs is positive and maximal.

Example:

Problem

A small commercial property is for sale near your university. Given its location, you believe a student-oriented business would be very successful there. You have researched several possibilities and come up with the following cash flow estimates (including the cost of purchasing the property). Which investment should you choose?

Project	Initial Investment	First-Year Cash Flow	Growth Rate	Cost of Capital
Book Store	$300,000	$63,000	3.0%	8%
Coffee Shop	$400,000	$80,000	3.0%	8%
Music Store	$400,000	$104,000	0.0%	8%
Electronics Store	$400,000	$100,000	3.0%	11%

Solution

Assuming each business lasts indefinitely, we can compute the present value of the cash flows from each as a constant growth perpetuity. The NPV of each project is

$$NPV(\text{Book Store}) = -300{,}000 + \frac{63{,}000}{8\% - 3\%} = \$960{,}000$$

$$NPV(\text{Coffee Shop}) = -400{,}000 + \frac{80{,}000}{8\% - 3\%} = \$1{,}200{,}000$$

$$NPV(\text{Music Store}) = -400{,}000 + \frac{104{,}000}{8\%} = \$900{,}000$$

$$NPV(\text{Electronics Store}) = -400{,}000 + \frac{100{,}000}{11\% - 3\%} = \$850{,}000$$

Thus, all of the alternatives have a positive NPV. But, because we can only choose one, the coffee shop is the best alternative.

Exercise

The Marx Brewing Company has 3 projects. Project B is an independent project (whose acceptance or rejection is independent of the acceptance and rejection of other projects), while A and C are mutually exclusive. The cash flows (in million $) as follows:

time	0	1	2	3
A	−65	30	30	25
B	−55	25	25	25
C	−50	30	30	0

The discount rate is 10%. The company can raise only $115 millions to invest. What is the most profitable strategy?

Exercise

Calculating the NPV yields

$$NPV_A = 5.85$$
$$NPV_B = 7.17$$
$$NPV_C = 2.07.$$

But investing in B and A requires investing \$120 millions > 115.

$$NPV_{A\&C} = 7.92$$
$$NPV_{B\&C} = 9.24$$

→ Invest in projects B and C.

Investments with different lives

Annuity:

$$PV = \frac{C}{r}\left(1 - \frac{1}{(1+r)^n}\right)$$

Example: A firm can choose between 2 designs for a new machine:

- The 1st design costs \$10m and lasts 5y.
- The 2nd design costs \$16m and lasts 10y.

In both cases, the machines produce revenues of \$3m a year. If the cost of capital is 10%, which design should the firm choose?

$$NPV_1 = \frac{3}{0.1}\left(1 - \frac{1}{1.1^5}\right) - 10 = \$1.37m$$

$$NPV_2 = \frac{3}{0.1}\left(1 - \frac{1}{1.1^{10}}\right) - 16 = \$2.43m$$

But does not account for what will happen in 5 years if machine 1 is chosen.

Investments with different lives

- If the machine is not replaced in 5 years: machine 2 should be chosen.
- If it is replaced with the same terms:

$$NPV_{1,with\ replacement} = 1.37 + \frac{1.37}{1.1^5} = \$2.2m$$

Machine 2 should still be chosen

- If machine 1 is replaced at better terms, with a cost of \$7m

$$NPV_{1,with\ improved\ replacement} = 1.37 + \frac{4.37}{1.1^5} = \$4.08m$$

Now machine 1 should be chosen.

Equivalent Annual Benefit (Cost) Method

- The **equivalent annual benefit (or annual cost)** is the constant annuity payment over the life of the project that is equivalent to receiving its NPV today.

$$EAB = \frac{PV.r}{\left(1 - \frac{1}{(1+r)^n}\right)}$$

Annuity:

$$PV = \frac{C}{r}\left(1 - \frac{1}{(1+r)^n}\right)$$

- Last example:

$$EAB_1 = \frac{1.37 \times 0.1}{\left(1 - \frac{1}{1.1^5}\right)} = \$0.361m$$

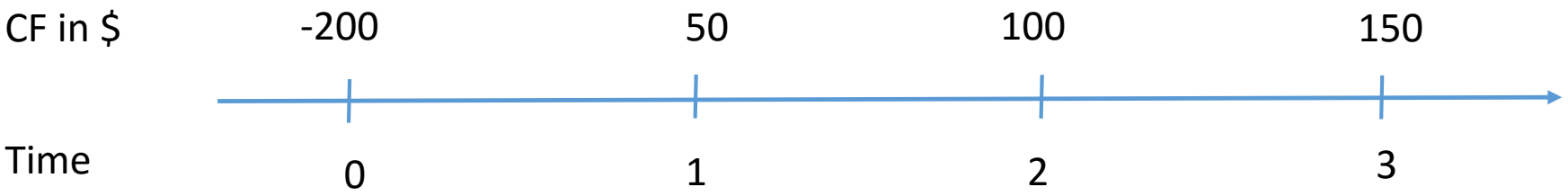
$$EAB_2 = \frac{2.43 \times 0.1}{\left(1 - \frac{1}{1.1^{10}}\right)} = \$0.395m$$

Often used in practice but beware of the assumption.

- Equivalent to assuming that we can replace the project at identical terms.

The IRR

- "What is the return from my investment?"
- The IRR (internal rate of return) is the rate that sets the NPV of investment to zero.
- Example: Consider the following project:



- $0 = -200 + \frac{50}{1+IRR} + \frac{100}{(1+IRR)^2} + \frac{150}{(1+IRR)^3}.$

Note: The IRR only depends on the CF.

The IRR

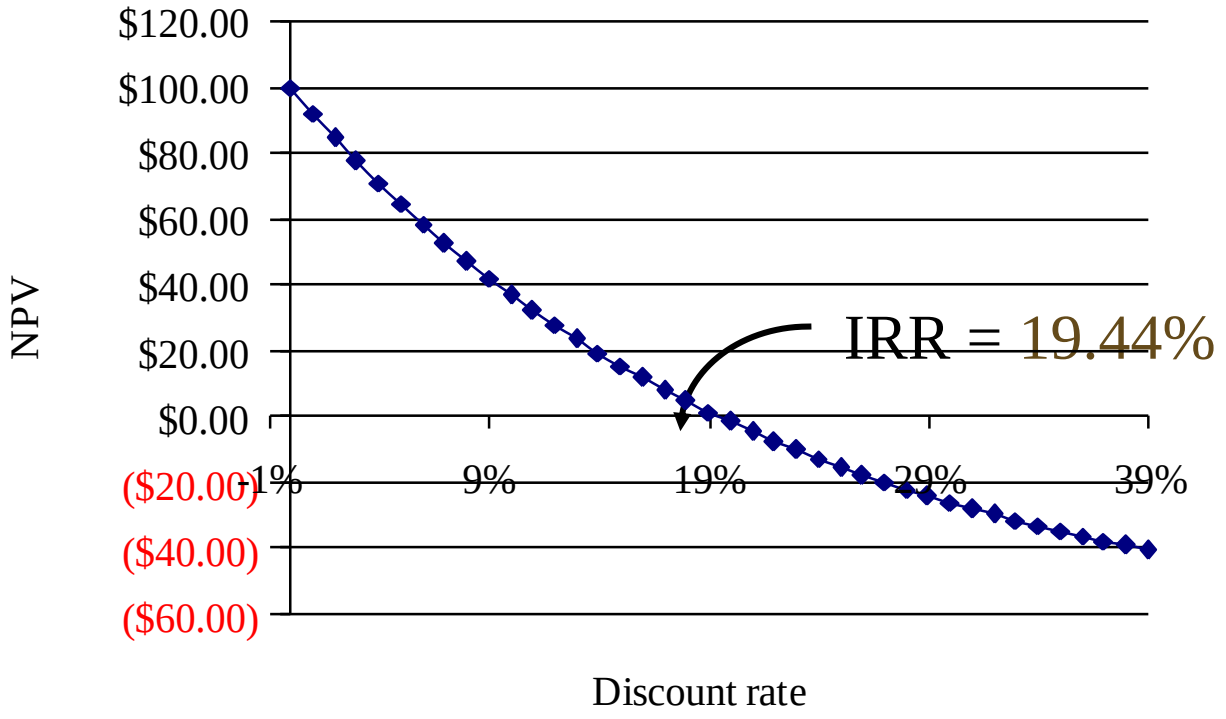
Basic IRR Rule:

- Accept a project if the IRR exceeds the required return.
- Reject a project if the IRR is less than the required return.
- Select the project with the highest IRR.

IRR vs. NPV

If $C_0 < 0$, *and* $C_1, \ldots, C_T > 0$, then IRR > $r \Leftrightarrow$ NPV > 0. NPV gives dollar value, while IRR gives average rate of return.

Discount Rate	*NPV*
0%	$100.00
4%	$71.04
8%	$47.32
12%	$27.79
16%	$11.65
20%	($1.74)
24%	($12.88)
28%	($22.17)
32%	($29.93)
36%	($36.43)
40%	($41.86)



Strengths and weaknesses of the IRR rule

Advantages:

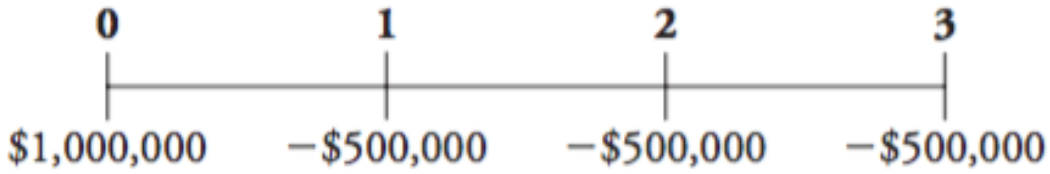
- Easy to understand and communicate.
- Summarizes the information about a project in a single rate of return.

Drawbacks

- For both independent and mutually exclusive projects:
  - Are we borrowing or lending?
  - Multiple IRRs.
- Specific to mutually exclusive projects:
  - The scale problem.
  - The timing problem.

Drawback 1: Are we borrowing or lending?

Example: Suppose the cost of capital equal to 10%.



$$NPV = 1{,}000{,}000 - \frac{500{,}000}{1+r} - \frac{500{,}000}{(1+r)^2} - \frac{500{,}000}{(1+r)^3}$$

Calculating the IRR yields 23.38%. What is your decision?

Now take a look at the NPV:

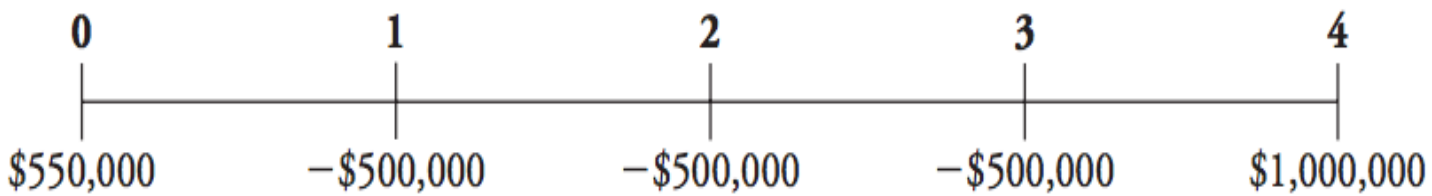
$$NPV = 1{,}000{,}000 - \frac{500{,}000}{1.1} - \frac{500{,}000}{1.1^2} - \frac{500{,}000}{1.1^3} = -\$243{,}426$$

Drawback 1: Are we borrowing or lending?

- When $C_0 > 0$ and $C_1 < 0$, you are borrowing (or financing).
- **Rule:** When IRR < Discount rate, NPV > 0 → accept the project.

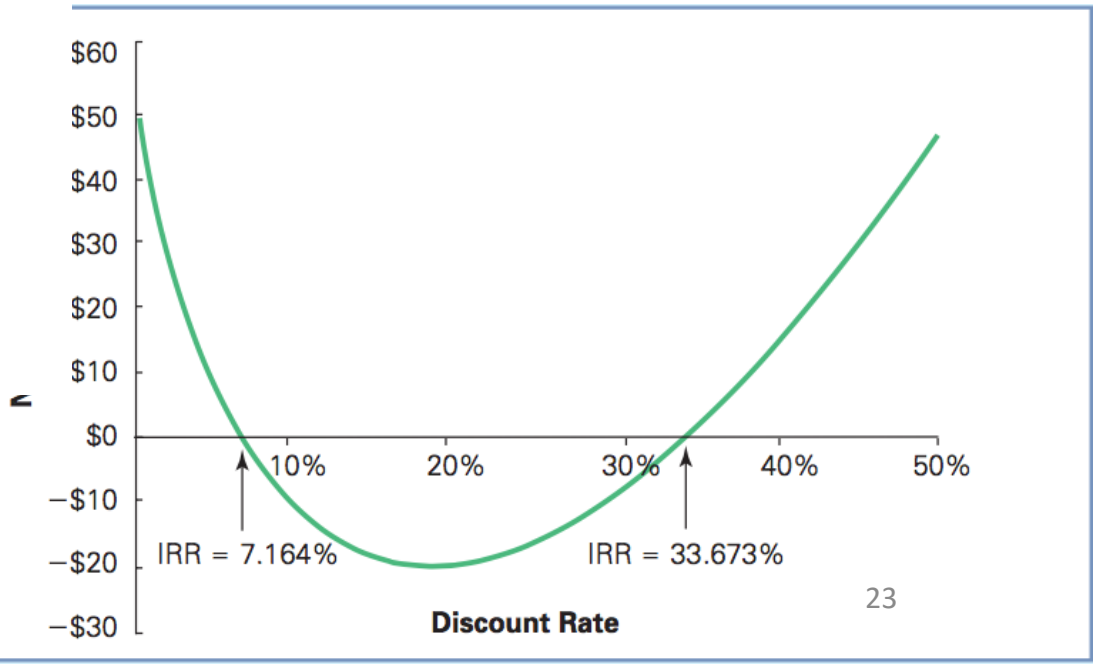
Drawback 2: Multiple IRRs

Example 1: Borrowing and then lending:



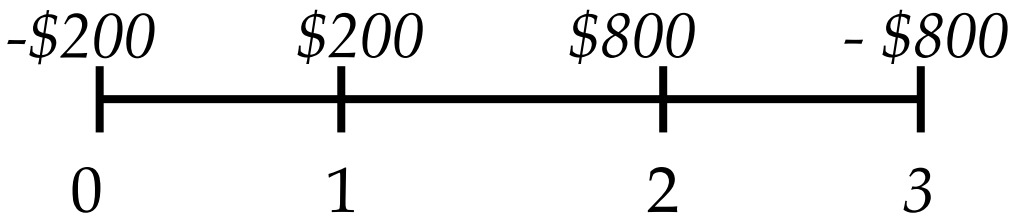
The NPV of Star's new offer is

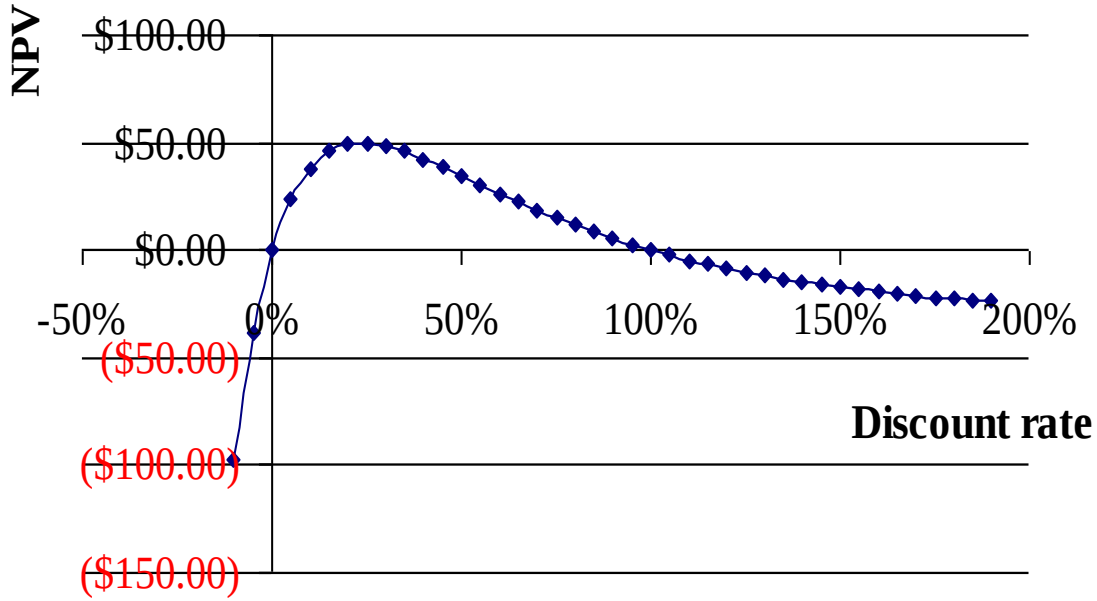
$$NPV = 550{,}000 - \frac{500{,}000}{1+r} - \frac{500{,}000}{(1+r)^2} - \frac{500{,}000}{(1+r)^3} + \frac{1{,}000{,}000}{(1+r)^4}$$



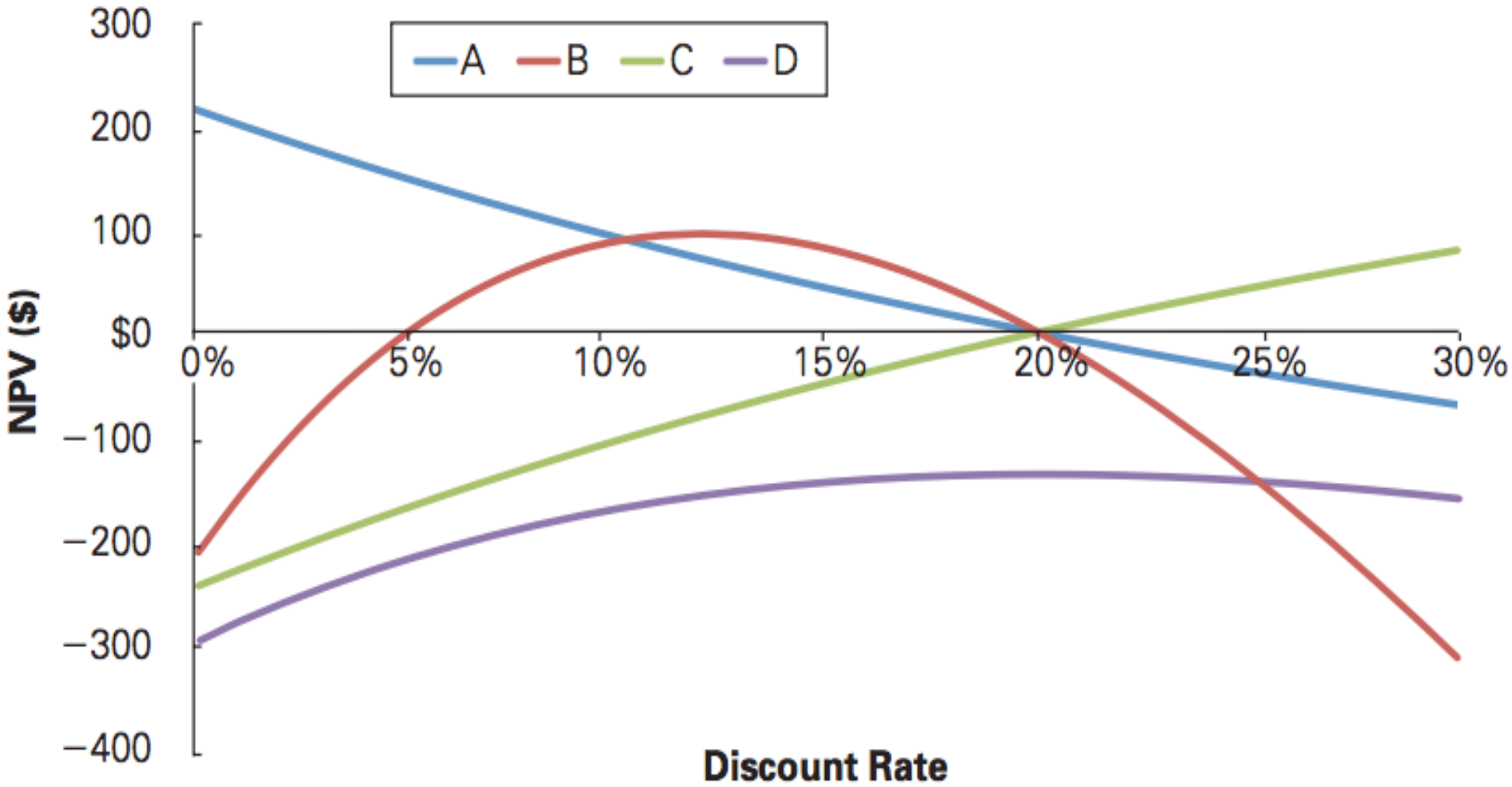
Drawback 2: Multiple IRRs

Example 2: Lending and then borrowing:



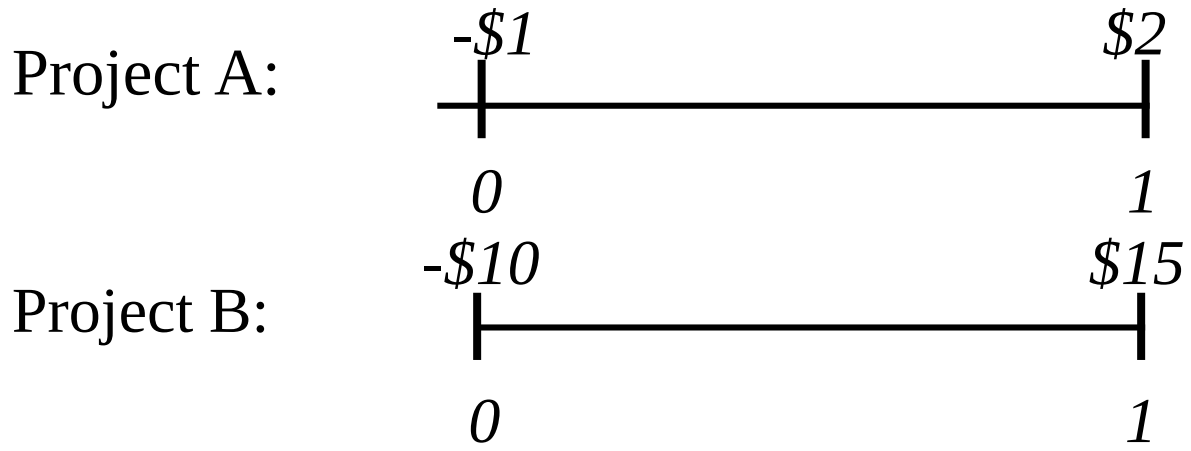


- A cash flow stream with *K* changes in sign can have up to *K* IRRs.
- When multiple IRRs exist, our only choice is to rely on the NPV rule.


300
200
100
$0
−100
−200
−300
−400
NPV ($)
A
B
C
D
0%
5%
10%
15%
20%
25%
30%
Discount Rate

Drawback 3: The scale problem

Consider two mutually exclusive projects:



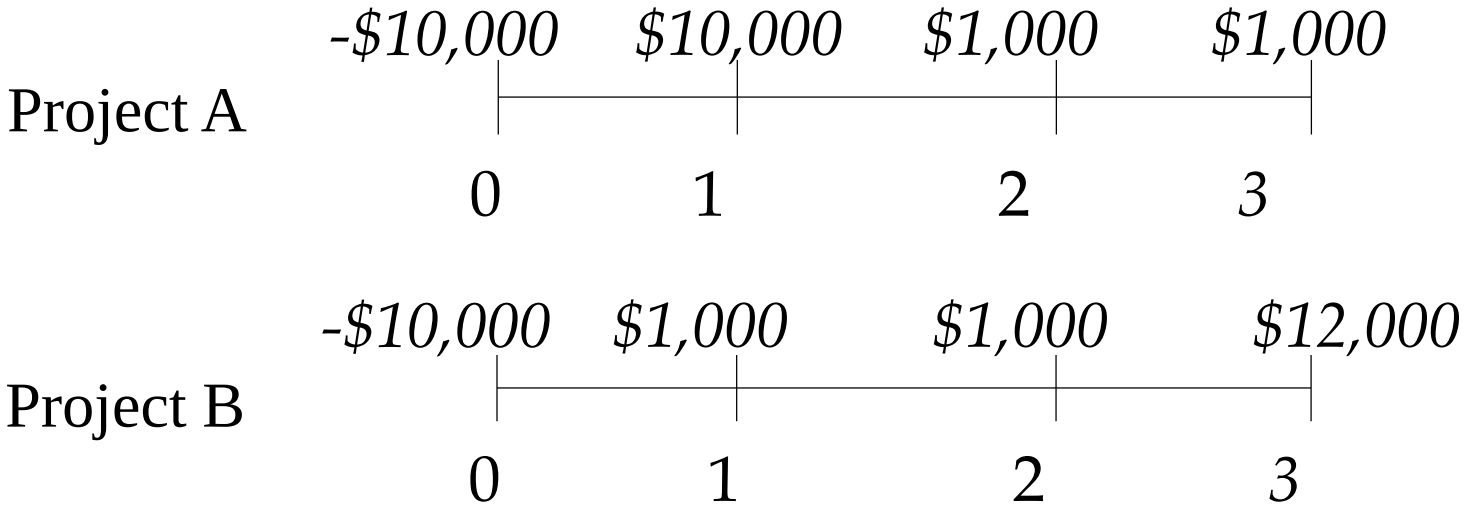
The required return is 10%.

The IRR of Project A is 100%. The IRR of Project B is 50%.

Suppose raising fund is not a problem, which project to choose?

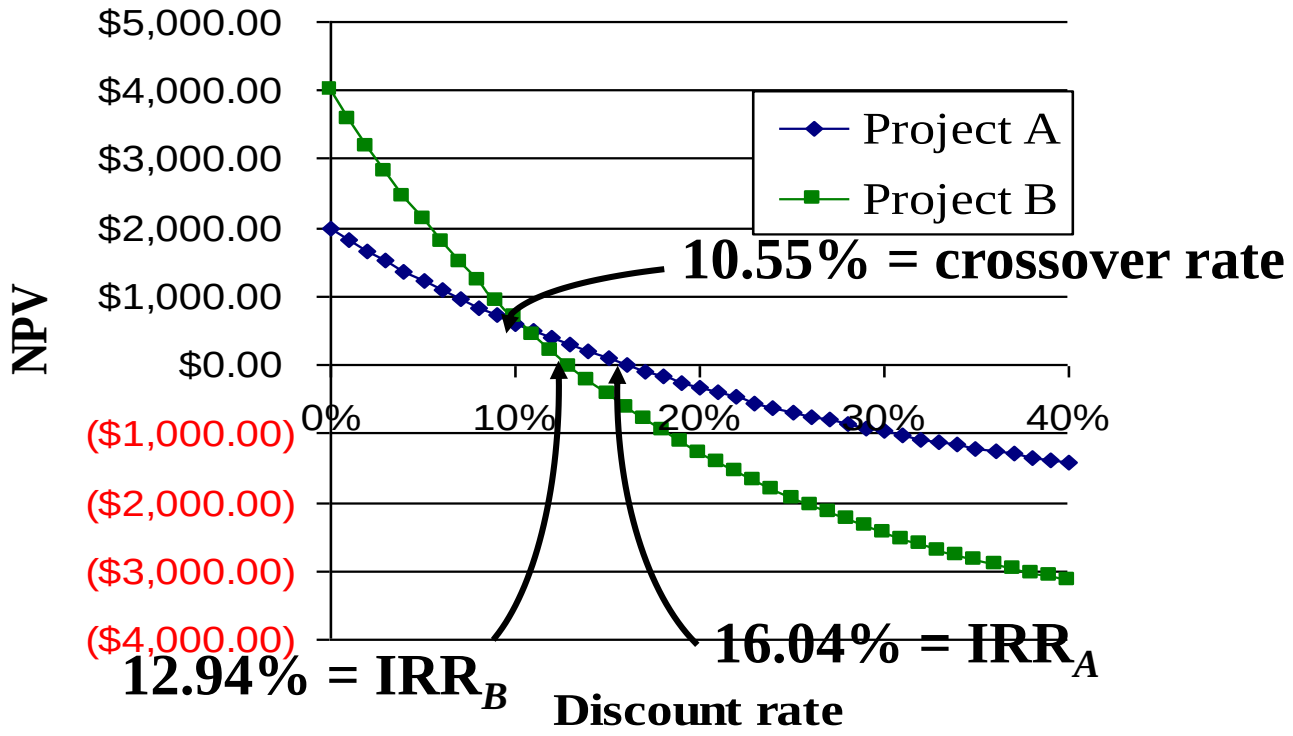
Drawback 4: The timing problem

Consider two mutually exclusive projects:



IRR_A=16.04%. IRR_B=12.94%. Should we prefer A to B?

Drawback 4: The timing problem



Problem: The IRR approach assumes that the cash inflow can be reinvested at the rate equal to IRR.

When can returns be compared?

We can only compare returns in the investments

1) Have the same scale
2) Have the same timing
3) Have the same risk.

How to solve scale and timing problems?

→ **Incremental IRR**

- IRR of the incremental cash flows that would result from replacing one project with the other.
- Tells us the rate at which it becomes profitable to switch from one project to the other.

How to solve scale and timing problems?

Problem

Your firm is considering overhauling its production plant. The engineering team has come up with two proposals, one for a minor overhaul and one for a major overhaul. The two options have the following cash flows (in millions of dollars):

Proposal	0	1	2	3
Minor Overhaul	−10	6	6	6
Major Overhaul	−50	25	25	25

What is the IRR of each proposal? What is the incremental IRR? If the cost of capital for both of these projects is 12%, what should your firm do?

Solution

We can compute the IRR of each proposal using the annuity calculator. For the minor overhaul, the IRR is 36.3%:

For the major overhaul, the IRR is 23.4%:

How to solve scale and timing problems?

Which project is best? Because the projects have different scales, we cannot compare their IRRs directly. To compute the incremental IRR of switching from the minor overhaul to the major overhaul, we first compute the incremental cash flows:

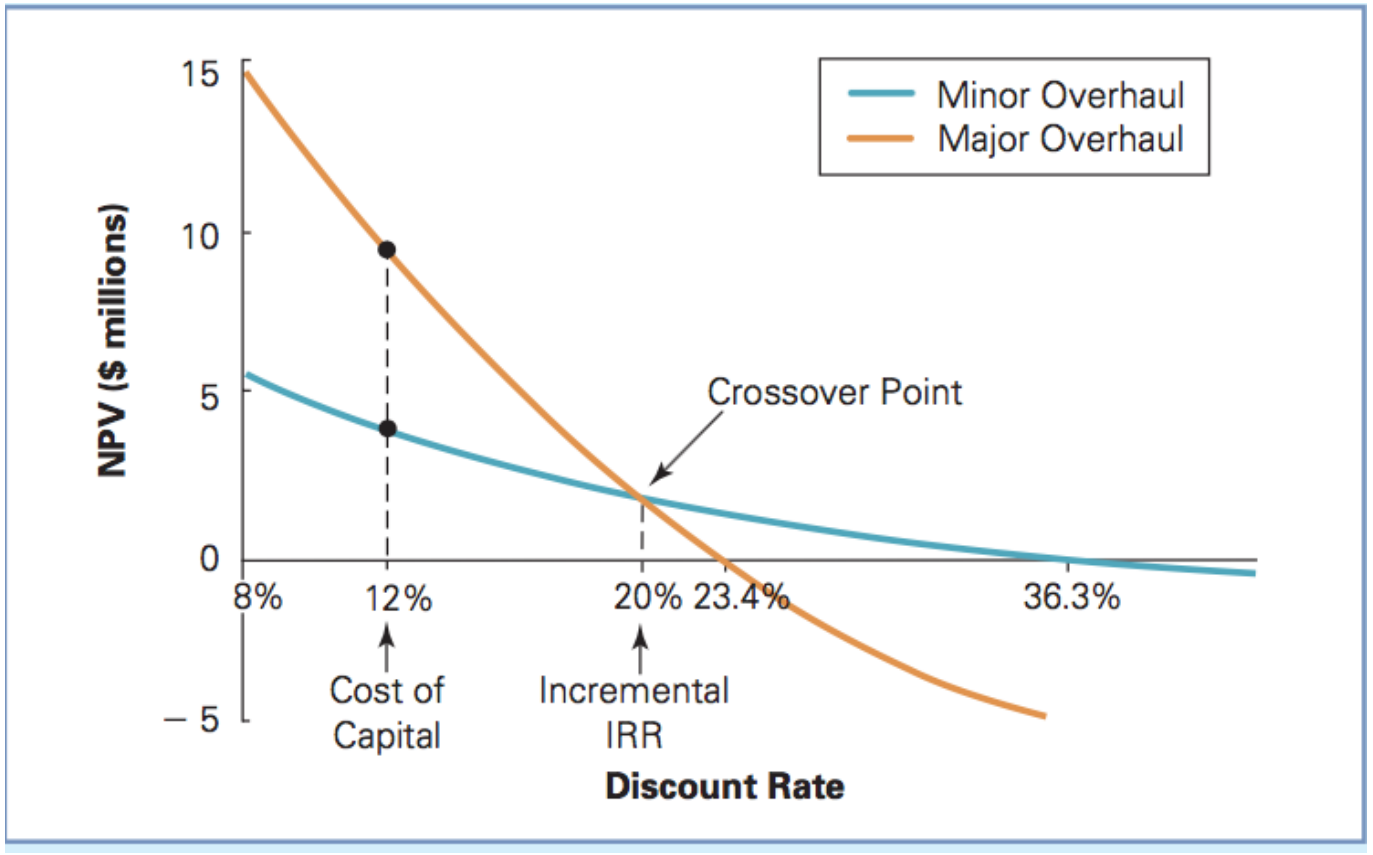
Proposal	0	1	2	3
Major Overhaul	−50	25	25	25
Less: Minor Overhaul	−(−10)	−6	−6	−6
Incremental Cash Flow	−40	19	19	19

These cash flows have an IRR of 20.0%:

Incremental IRR > Cost of capital (12%)

→ Switching to the major overhaul is attractive (its larger scale makes up for its lower IRR)

How to solve scale and timing problems?



The **crossover point** is the rate for which the best project choice switches from the major overhaul to the minor one.

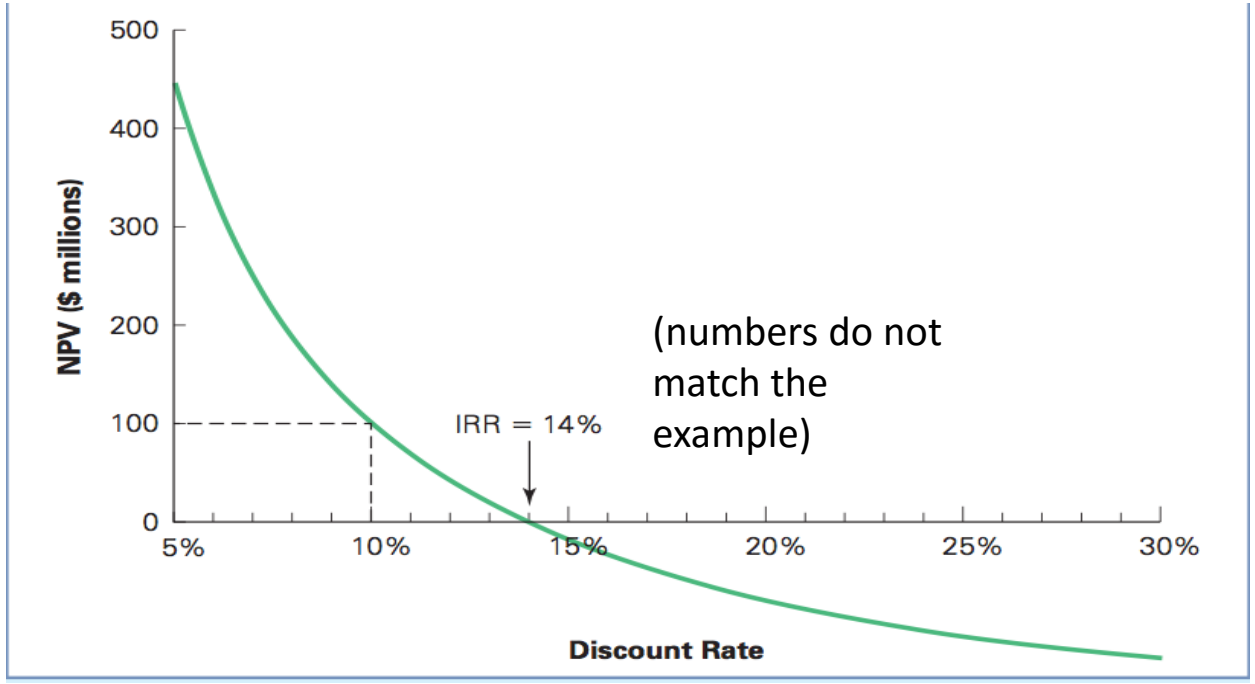
Does the order matter?

		0	1	2	3
	Major overhaul	-50	25	25	25
	Minor overhaul	-10	6	6	6
Incremental CF	**Major - Minor**	-40	19	19	19
	Minor - Major	40	-19	-19	-19
	IRR Major-Minor	20%		cost of capital	
	IRR Minor-Major	20%		12%	

- **The IRR is the same** whether you calculate incremental cash flows of the major overhaul relatively to the minor overhaul or vice versa. But…
- **Major minus minor:** the 1st cash flow is negative (standard case) and the other positive.
- **Minor minus major:** the 1st cash flow is positive and the other negative.
- When using the IRR rule one needs to remember one of its drawbacks: ‘’are we borrowing or lending’’. **The sign of cash flows matters.** Indeed, **the rule changes** depending on which holds.

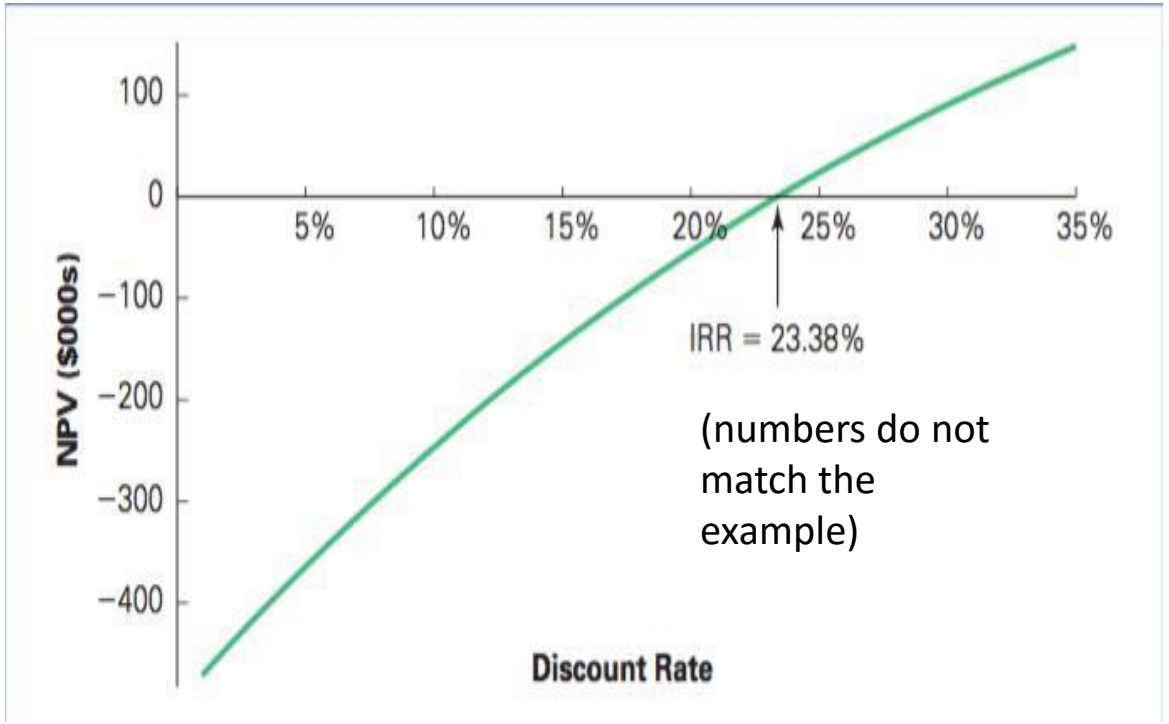
No if you are careful…

Case 1: 1st cash flow is negative, following cash flows are positive (standard case)



$\text{NPV} > 0 \Leftrightarrow \text{IRR} > \text{discount factor}$

Case 2: 1st cash flow is positive, following cash flows are negative



$\text{NPV} > 0 \Leftrightarrow \text{IRR} < \text{discount factor}$

… and adjust the rule

		0	1	2	3
	Major overhaul	-50	25	25	25
	Minor overhaul	-10	6	6	6
Incremental CF	**Major - Minor**	-40	19	19	19
	Minor - Major	40	-19	-19	-19
	IRR Major-Minor	20%		cost of capital	
	IRR Minor-Major	20%		12%	

- Major-Minor overhaul: we are in case 1 with IRR > discount rate (cost of capital) ⇒ NPV>0 ⇒ **It is worth choosing the major overhaul relatively to the minor overhaul.**
- Minor-Major overhaul: we are in case 2 with IRR > discount rate ⇒ NPV<0 ⇒ **It is not worth choosing the minor overhaul relatively to the major overhaul.**
- → **It does not matter which approach you choose as long as you use the right rule!**

Remaining problems of the incremental IRR

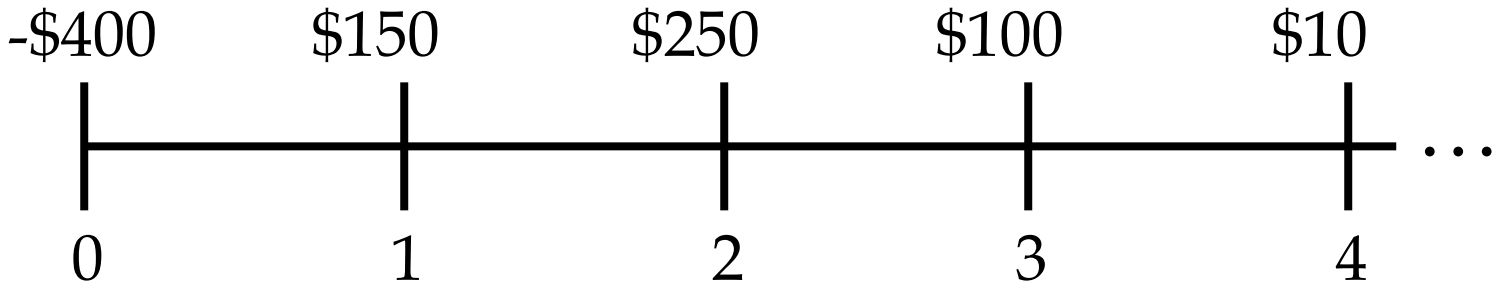
- Shares some of the problems of the IRR (may not be unique / exist).
- Can indicate whether it is profitable to switch from one project to another, but does not say whether either project has a positive NPV.
- In the case of projects with different costs of capital, not clear what the incremental IRR should be compared to.

→ The NPV is more flexible, hence a better decision tool.

The payback period rule

The payback period rule

- “In how much time will I be able to recover my investment?”
- Payback Period = number of years to recover initial costs
- **Rule**: A particular cutoff time is selected by management.
  - Accept a project if it has payback period less than or equal to the cutoff time.
  - Reject a project if it has payback period more than the cutoff time.
- Example: cutoff time = 2 years



Pros and cons

Disadvantages

- Ignores the time value of money
- Ignores cash flows after the payback period
- Biased against long-term projects
- Requires an arbitrary cutoff time
- A project accepted based on the payback rule may have negative NPV.

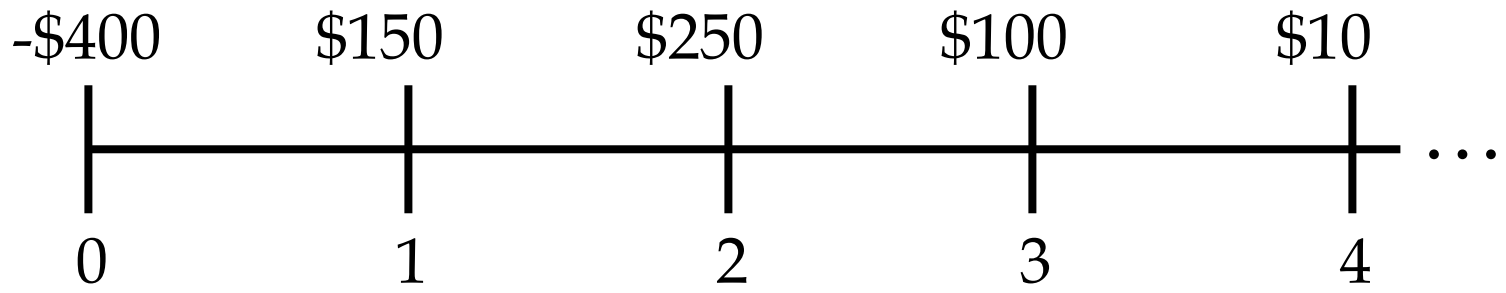
Advantages

- Easy to use (lower level management)
- Biased toward liquidity (Quick Cash Recovery)

Modified version: discounted payback

→ How long does it take for the project to “pay back” its initial investment with the discounted cash flow?

Example: Previous example with required return: 10%.



$$\frac{150}{1.1} + \frac{250}{1.1^2} = 342.98 \; ; \; \frac{150}{1.1} + \frac{250}{1.1^2} + \frac{100}{1.1^3} = 418.11 > 400.$$

What is used in practice?

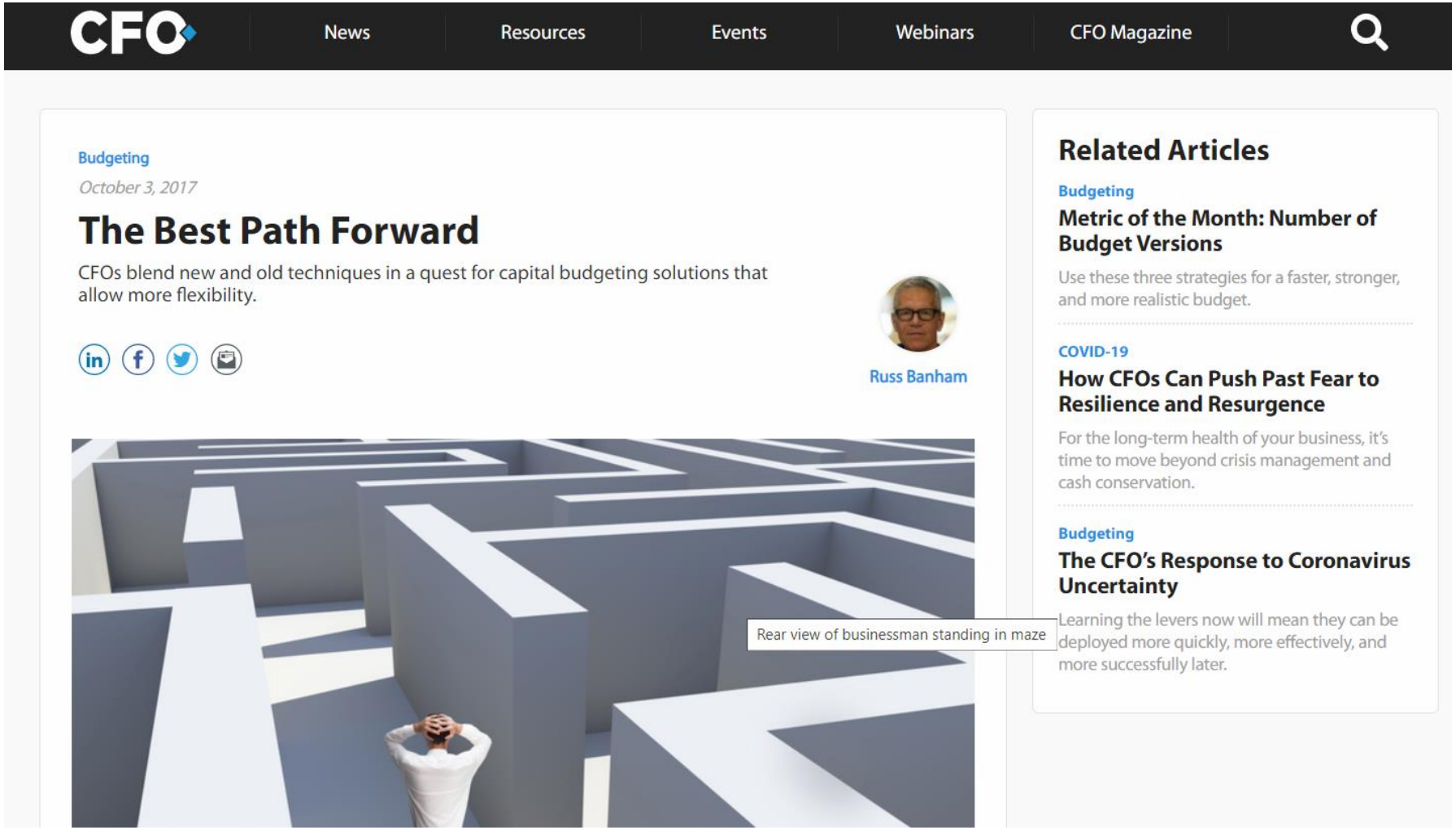
20y ago: *(Source: J.R.Graham,C.R.Harvey, 2001, The theory and practice of corporate finance: evidence from the field, Journal of Financial Economics 60 (2-3), 187-243)*

1) IRR,
2) NPV,
3) Hurdle rate (Project accepted if $\frac{cash\ flows}{initial\ investment} > threshold$)
4) Payback period rule.

Main changes since: Capex less and less fixed (cloud operations)

1) Timing matters more (short-term vs. long-term)
2) New important elements: vendor's score, customers' tertimonials, reputation
3) IRR and NPV still widely used.

What is used in practice?



Investment Decision Rules: Conclusion

- Use the NPV criterion whenever possible
  - Always yields correct results
- Use other investment decision rules with care
  - See “pitfalls”
- The other investment decision rules could be a useful addition to the NPV criterion
  - For example, for two identical investment projects with the same NPV, we may prefer to choose the one with shorter payback period
  - Liquidity considerations

Capital budgeting

Capital budgeting: what is it about?

Keyword:
Capital budgeting

- The process through which firms analyse alternative projects and decide which ones to pursue
  - Essentially, this is an NPV calculation like we did before
  - However, there are some complications
- Two main challenges
  - Obtain a **cost of capital** that is specific to the project and reflects project's risk and type of financing (← debt, cash, or equity)
    - We will learn how to do that at a later point in the course
  - Obtain the **project cash-flows**
    - We will do this in this session

Capital budgeting

Identify Incremental Cash Flows of the project: General rules

- Cash flows matter — not accounting earning or income.
- Only cash-flows that are **incremental** (that occur as a direct consequence of accepting the project) are relevant.
- **Sunk costs** (any cash-flow that has already occurred) should not be considered.
- Any **opportunity costs** (opportunities forgone because the project is made) and/or **opportunity benefits** (opportunities that arise because the project is made) should be included

Capital budgeting

- Any **side effects** (impacts of the project in other areas of the firm) like synergy and erosion should be included
- Taxes matter: we want incremental after-tax cash flows.

Basics of accounting: financial statements

Every public company is required to produce 4 financial statements:

- **Balance sheet**: Financial statement that shows the value of the firm's assets and liabilities at a particular point in time.
- **Income statement**: Shows the profitability of a firm during a specific period of time (say the past year).
- **Statement of cash flows**: Provides information on how much cash has been generated and how the cash has been allocated
- **Statement of stockholders' equity** (financial managers use it infrequently)

Balance sheet

Characteristics:

- Snapshot of the firm's assets and liabilities.
- Some assets and liabilities are financial (i.e. tied to a financial contract), some are not.
  - For ex., a tax liability is not a financial liability since the government does not have a contractual right to the firm's future cash flows
- Assets and liabilities are organized in descending order of liquidity (how quickly I can sell the asset at current price) and maturity (how slowly I will have to reimburse claims on the firm).

Balance sheet

How the firm raises capital

Keywords: Assets, liabilities, book value of equity

How the firm uses its capital (investments)

Assets	=	**Liabilities and stockholders' equity**
Current assets		**Current liabilities**
Cash		Accounts payable
Accounts receivable		Notes payable / short-term debt
Inventories		Current maturities of long-term debt
Long-term assets		**Long-term liabilities**
Land		Long-term debt
Buildings		Capital lease obligations
Equipment		
Less accumulated depreciation		
Net property, plant and equipment		**Stockholders' equity**
Goodwill and intangible assets		
Total assets		**Total liabilities and stockholders' equity**

Book value of an asset = Acquisition cost – accumulated depreciation

e.g., lease of a building for the corporate headquarter

Patents, brand name,...

Measure of the firm's net worth. Also called the **book value of equity**.

Keywords:
Book value,
market value

Book Value vs. Market Value

- **Book value (Carry value)** is historical cost adjusted for depreciation.
- **Market value** is the price at which buyers and sellers trade the assets.

Example: Philippe Corporation bought a factory at price $2,000,000 at 2006. They use a 10-year straight line depreciation. Due to the financial crisis starting in 2008, the housing prices dropped quickly. In 2010, a similar factory in the market was only worth $800,000.

What's the book value and market value of the factory in 2010?

MV = $800,000 ; BV = 2,000,000 - (2,000,000 / 10) * 4 = $1,200,000

Income statement

- Summarizes the revenues generated and the expenses incurred
- Also called profit and loss (P&L) statement, earnings statement

- The accounting definition of income:
  - Income = Revenue – Expenses
  - Revenue = “Top line”; Income = “Bottom line”

Income statement

Keywords:
Gross profit, operating expenses, operating income

Gross profit = Revenues from sales – Costs of sales

Costs directly related to producing the goods and selling them (e.g., manufacturing costs). Does not include administrative expenses, R&D and interest expenses.

Operating expenses = Expenses that are not directly related to producing the goods or services being sold

→ Administrative expenses, marketing, R&R …

Also includes depreciation and amortization

Costs of wear and tear or obsolescence of the firm's assets.

Operating income = Gross profit – Operating expenses

Income statement

Earnings before interest and taxes (EBIT)

= Operating income + other income /expenses

Company's net income before income tax expense and interest expense have been deducted. Used to analyze the performance of a company's core operations without tax expenses and the costs of the capital structure influencing profit.

Sources of income or expenses that arise from activities that are not central to the company's business (e.g., income from financial investments)

Net income =

EBIT – taxes

– interest expense

Unlevered net income

Keywords: EBIT, net income, EPS

Earnings Per Share (EPS) =

Net income / Shares outstanding

Income statement

	Year	0	1	2	3	4	5
Incremental Earnings Forecast ($000s)							
1	Sales	—	26,000	26,000	26,000	26,000	—
2	Cost of Goods Sold	—	(11,000)	(11,000)	(11,000)	(11,000)	—
3	**Gross Profit**	—	15,000	15,000	15,000	15,000	—
4	Selling, General, and Administrative	—	(2,800)	(2,800)	(2,800)	(2,800)	—
5	Research and Development	(15,000)	—	—	—	—	
6	Depreciation	—	(1,500)	(1,500)	(1,500)	(1,500)	(1,500)
7	**EBIT**	(15,000)	10,700	10,700	10,700	10,700	(1,500)
8	Income Tax at 40%	6,000	(4,280)	(4,280)	(4,280)	(4,280)	600
9	**Unlevered Net Income**	**(9,000)**	**6,420**	**6,420**	**6,420**	**6,420**	**(900)**

For next week

You will learn in the video:

- How to use the information from the income statement to derive cash flows
- What free cash flows are, and the different methods to compute them.

Real-life example: Free cash flows of Apple.