TU Delft Delft University of Technology

Evaluating Investment Opportunities

MOT111A Financial Management: Lecture 2

Textbook: Chapters 3(3.1-3.4),4, 5 & 7

Dr.ir. Zenlin Roosenboom-Kwee
Email: Z.Roosenboom-Kwee@tudelft.nl

Lecture 2 Outline

- Valuing decisions
- The time value of money
- Present value and NPV (net present value) decision rule
- Internal rate of return (IRR)
- Interest rates (EAR and APR)
- Payback rule and profitability index (PI)

Valuing Decisions

- Decisions have consequences on costs and benefits
- Valuing principle: using competitive market prices to determine the value today of the costs (C) and benefits (B)
  - Competitive market: a market in which a good can be bought and sold at the same price
  - V(B) > V(C) → MV increases

Example: Valuing Decision
Which to choose?

OPTION 1: KEEP $50,000 TODAY

OPTION 2: EXCHANGE $50,000 TODAY WITH 2,500 SHARES OF T*SLA STOCK AND €10,000 TODAY

The current market price for T*sla stock is $14 per share and the current exchange rate is $1.12/€.

Solution

- The costs and benefits must be converted to their cash values. Assuming competitive market prices:

$$€10{,}000 \times \frac{\$1.12}{€} = \$11{,}200$$

$$2{,}500 \text{ shares} \times \frac{\$14}{\text{Share}} = \$35{,}000$$

The net value of the opportunity is \$35,000 + \$11,200 − \$50,000 = −\$3,800; → choose option 1.
This value depends only on the current market prices for T*sla and the euro. Our personal opinion about the future prospects of the euro and T*sla does not alter the value the decision today.

Valuing Decisions and The Law of One Price

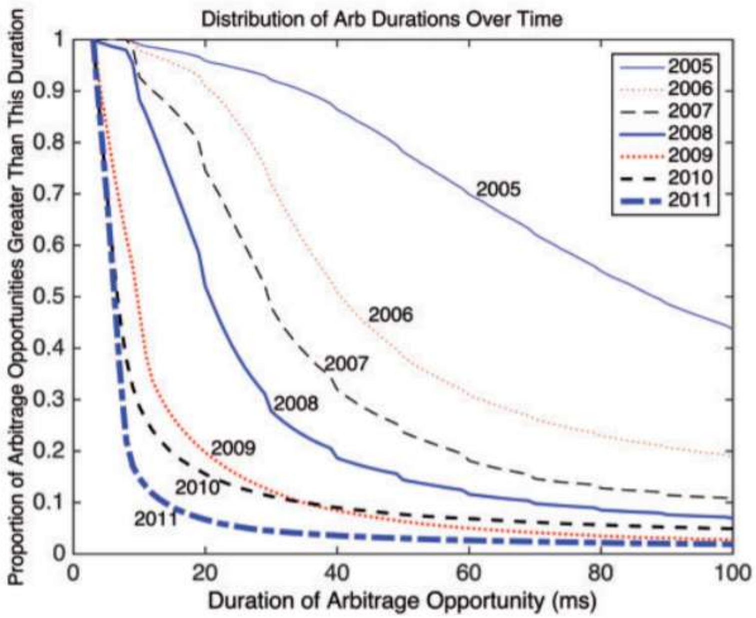
- The law of one price: If equivalent investment opportunities trade simultaneously in different competitive markets, then they must trade for the same price in all markets

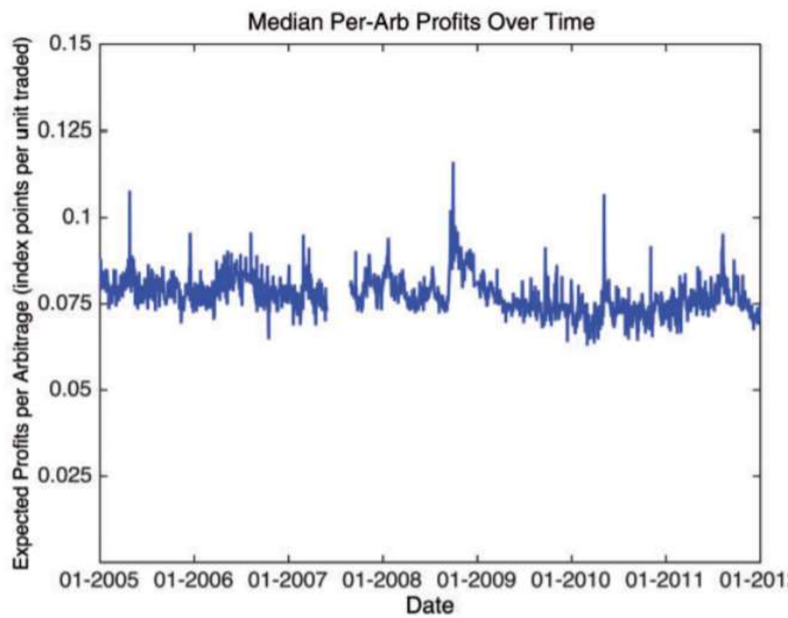
- **What if the same good trades for different prices in different markets?**

Arbitrage

- Arbitrage: the practice of buying and selling equivalent goods in different markets to take advantage of a price difference
- Arbitrage opportunity: a situation where making profit is possible without taking any risk or making any investment
- A competitive market (a normal market) is where there are no arbitrage opportunities

How long can arbitrage last and how much can one earn from arbitrage in markets?





Budish, E., Cramton, P., & Shim, J. (2015). The high-frequency trading arms race: Frequent batch auctions as a market design response. *The Quarterly Journal of Economics*, *130*(4), 1547-1621.

Valuing Principle & Discounted Cash Flow (DCF) Technique

- Recurring problem of valuation in financial statement analysis: backward looking
- Financial evaluation of investment proposals (capital budgeting) is *forward* looking
- Discounted cash flow (DCF) technique: when a company needs to analyze an action that may impact costs or benefits beyond the current year

Incorporating Time Value of Money

- An accurate figure of merit must reflect: a dollar (a euro) today is worth more than a dollar (a euro) in the future

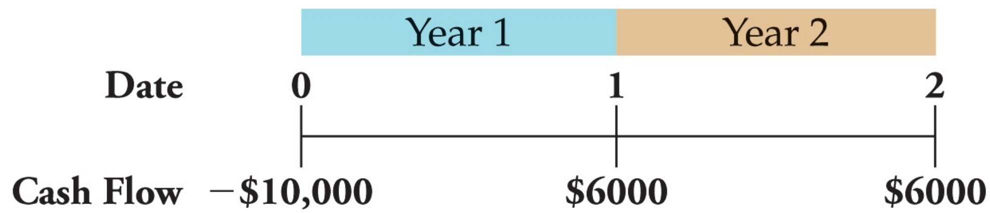
- Money has a time value because of:
  - an opportunity cost
  - inflation
  - risk

The Interest Rate: An Exchange Rate Across Time

- The rate at which we can exchange money today for money in the future is determined by the current **interest rate**.
  - Risk–Free Interest Rate (Discount Rate), r_f: The interest rate at which money can be borrowed or lent without risk.
    - Interest Rate Factor = $1 + r_f$
    - Discount Factor = $1 / (1 + r_f)$

The timeline & three rules of time travel

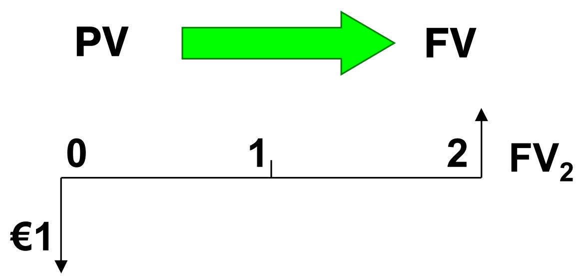
- To visualise the timing of cash flows, use/draw a timeline
  - Inflows /money received (+ or) are positive cash flows
  - Outflows / money paid (– or) are negative cash flows



Rule 1	Only values at the same point in time can be compared or combined.	
Rule 2	To move a cash flow forward in time, you must compound it.	Future Value of a Cash Flow $FV_n = C \times (1+r)^n$
Rule 3	To move a cash flow backward in time, you must discount it.	Present Value of a Cash Flow $PV = C \div (1+r)^n = \dfrac{C}{(1+r)^n}$

E.g. Compounding & Discounting at interest rate 10%

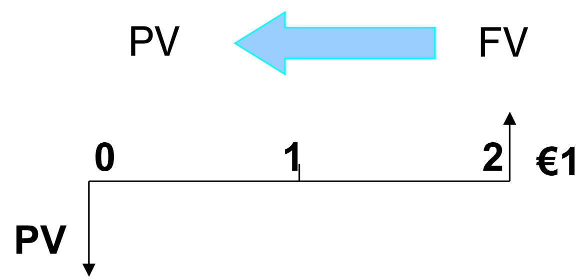
Compounding



$$FV_{(n=2)} = 1\ (1+.10)^2$$

$$= €1.21$$

Discounting



$$PV = €1\ (1/\ (1+.10)^2)$$

$$= €0.826$$

Present Value and NPV

- The **net present value (NPV)** of a project or investment is the difference between the present value of its benefits and the present value of its costs.
  - Net Present Value

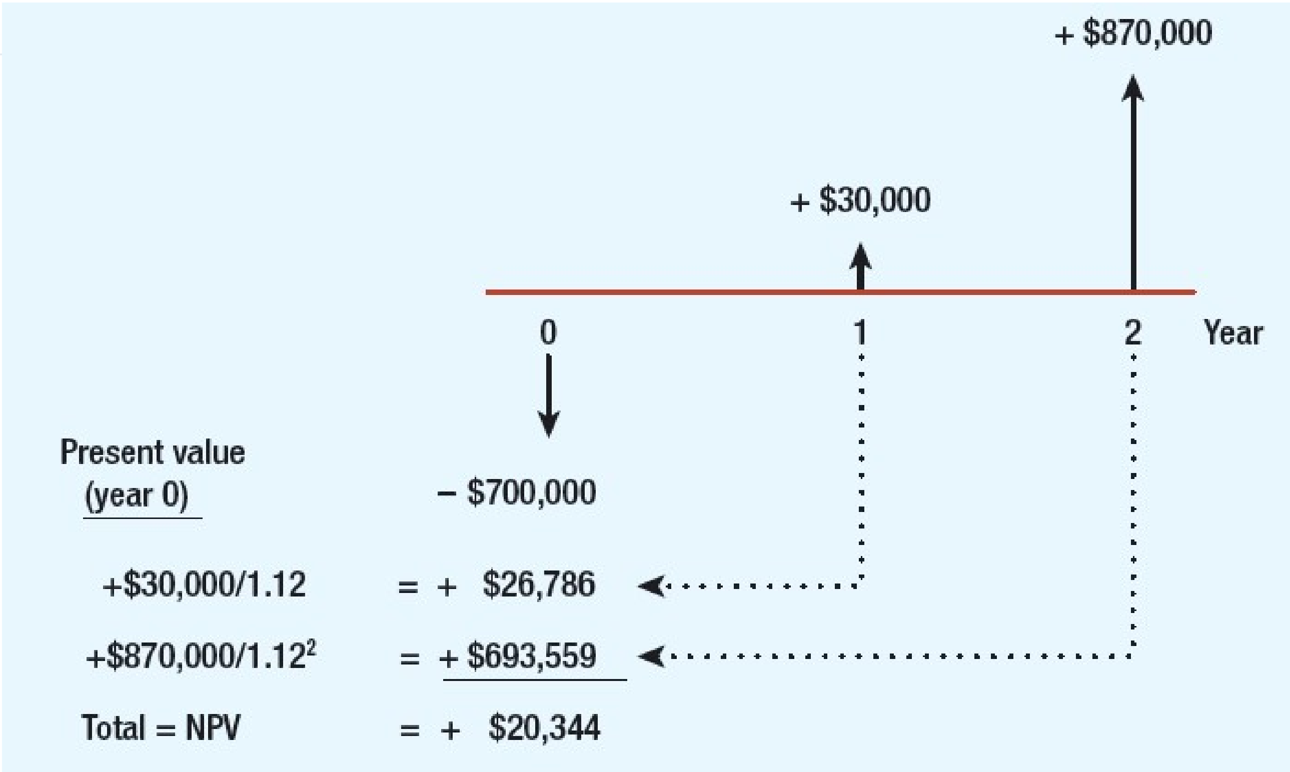
$$NPV = PV(\text{Benefits}) - PV(\text{Costs})$$

$$NPV = PV(\text{All project cash flows})$$

NPV as Investment Evaluation Tool

- NPV equals the difference between the PV of an investment's cash inflows and the PV of its outflows
- When can you accept an investment that can create value?
- NPV and an investment evaluation:
  - NPV > 0 → accept the investment
  - NPV < 0 → reject the investment
  - NPV = 0 → the investment is marginal
- NPV decision rule: choose the highest NPV

An Example of NPV



Perpetuities

- A perpetuity: When a constant cash flow will occur at regular intervals forever

$$PV(C \text{ in perpetuity}) = \frac{C}{r}$$

Example: PV Of perpetuities

- What is the present value of $1 billion every year, for eternity, if the perpetual discount rate is 10%?

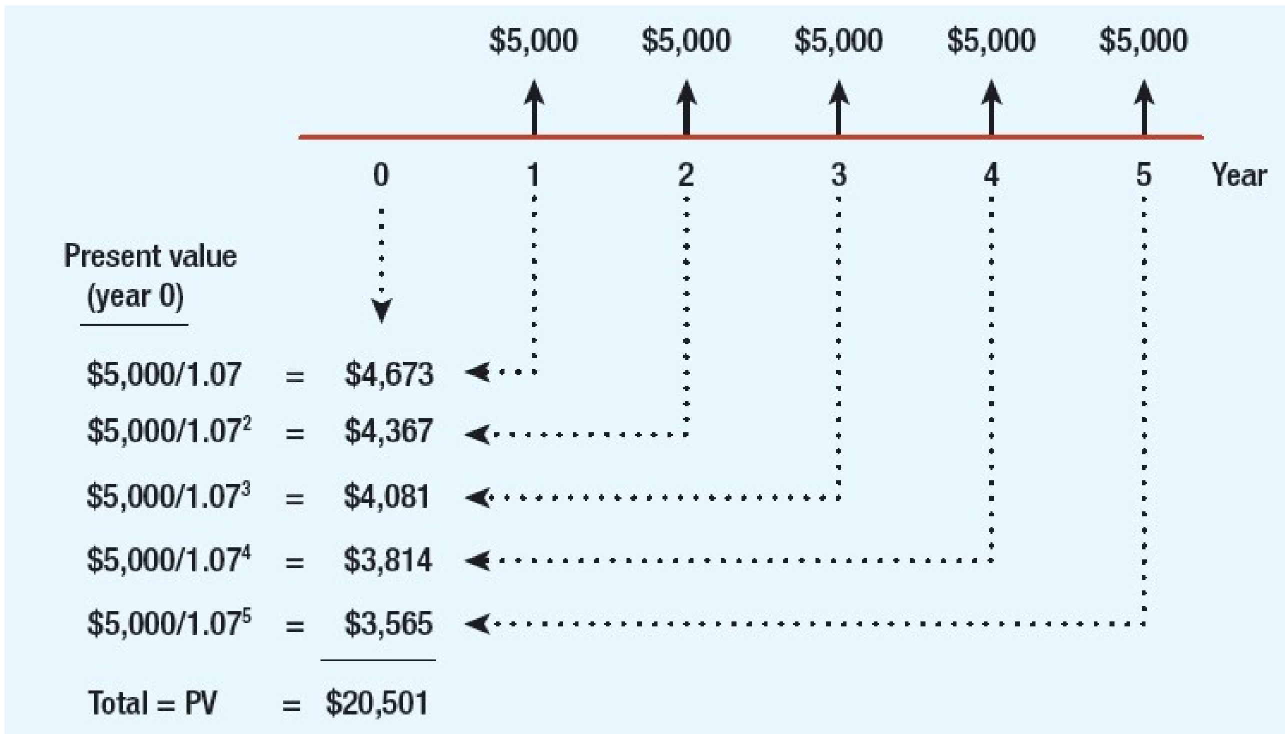
$$\boxed{PV = \frac{\$1\,\text{bil}}{0.10} = \$10\ \text{billion}}$$

- What if the investment does not start making money for 3 years?

$$\boxed{PV = \frac{\$1\,\text{bil}}{0.10} \times \left(\frac{1}{1.10^3}\right) = \$7.51\ \text{billion}}$$

Annuities

- An annuity: a constant cash flow will occur at regular intervals for a finite number of *N* periods



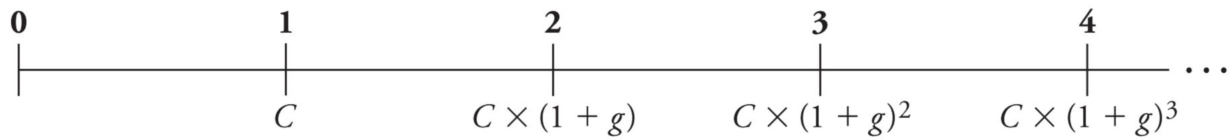
Calculating PV and FV from Annuities

$$\boxed{\text{PV of annuity} = C \times \frac{1}{r}\left(1 - \frac{1}{(1+r)^N}\right)}$$

$$\boxed{\text{FV of annuity} = C \times \frac{1}{r}\left((1+r)^N - 1\right)}$$

Growing perpetuity

- This formula can be used to value a perpetuity at any point in time



$$PV \text{ (growing perpetuity)} = \frac{C}{r - g}$$

g = the annual growth rate of the cash flow

- What is the present value of $1 billion paid at the end of every year in perpetuity, assuming a rate of return of 10% and constant growth rate of 4%?

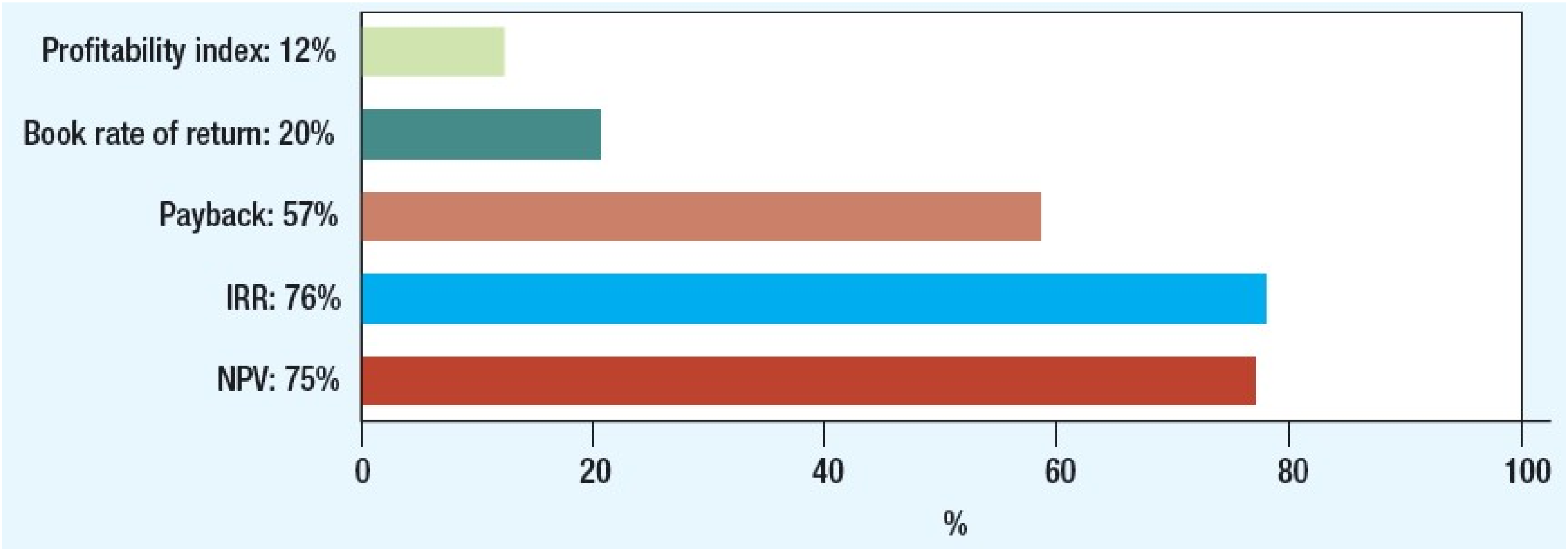
$$\boxed{\begin{aligned} PV_0 &= \frac{1}{.10 - .04} \\ &= \$16.667 \text{ billion} \end{aligned}}$$

Growing Annuity

- The present value of a growing annuity with the initial cash flow *c*, growth rate *g*, and interest rate *r* is defined as:
- Present Value of a Growing Annuity

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

Besides NPV, what are other decision tools for CFOs?



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

Internal Rate of Return (IRR)

- IRR is the discount rate at which an investment's NPV equals zero (break-even rate)
- Comparing IRR with the opportunity cost of capital (K)
  - IRR>K → accept the investment
  - IRR<K → reject the investment
  - IRR = K → the investment is marginal

Incremental IRR is the discount rate at which it becomes profitable to switch from one project to the other **(not part of the exam!)**

Example of IRR

- Tool A costs $4,000. Investment will generate $2,000 and $4,000 in cash flows for two years. What is IRR?

$$\boxed{NPV = -4{,}000 + \frac{2{,}000}{(1+IRR)^1} + \frac{4{,}000}{(1+IRR)^2} = 0}$$

$$\boxed{IRR = 28.08\%}$$

IRR rule vs. NPV rule

- The IRR rule will give the same answer as the NPV rule in many, but not all, situations.
- In general, the IRR rule works for a stand-alone project if all of the project's negative cash flows precede its positive cash flows.
- Situations where the IRR rule and NPV rule may be in conflict:
  - Delayed Investments
  - Multiple IRRs
  - Non-existent IRR

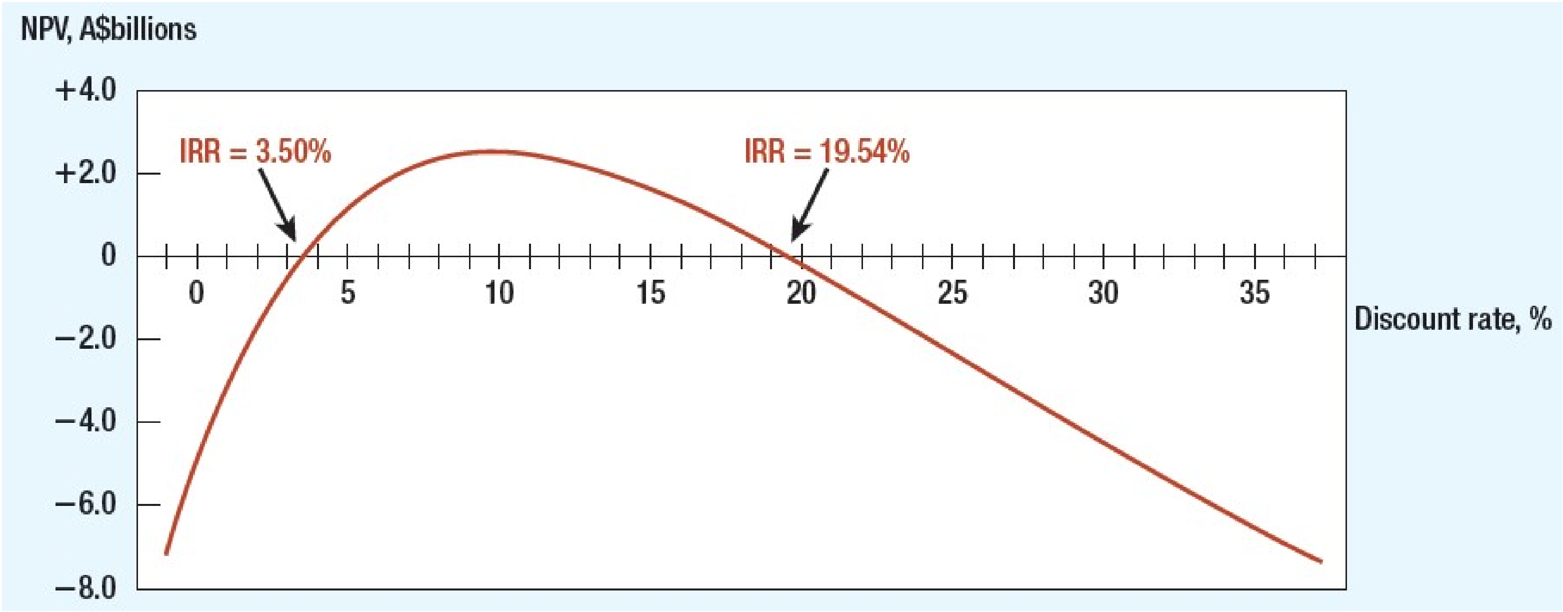
Pitfalls of IRR (1): Lending or Borrowing?

- IRR does not distinguish between investing and borrowing cashflows

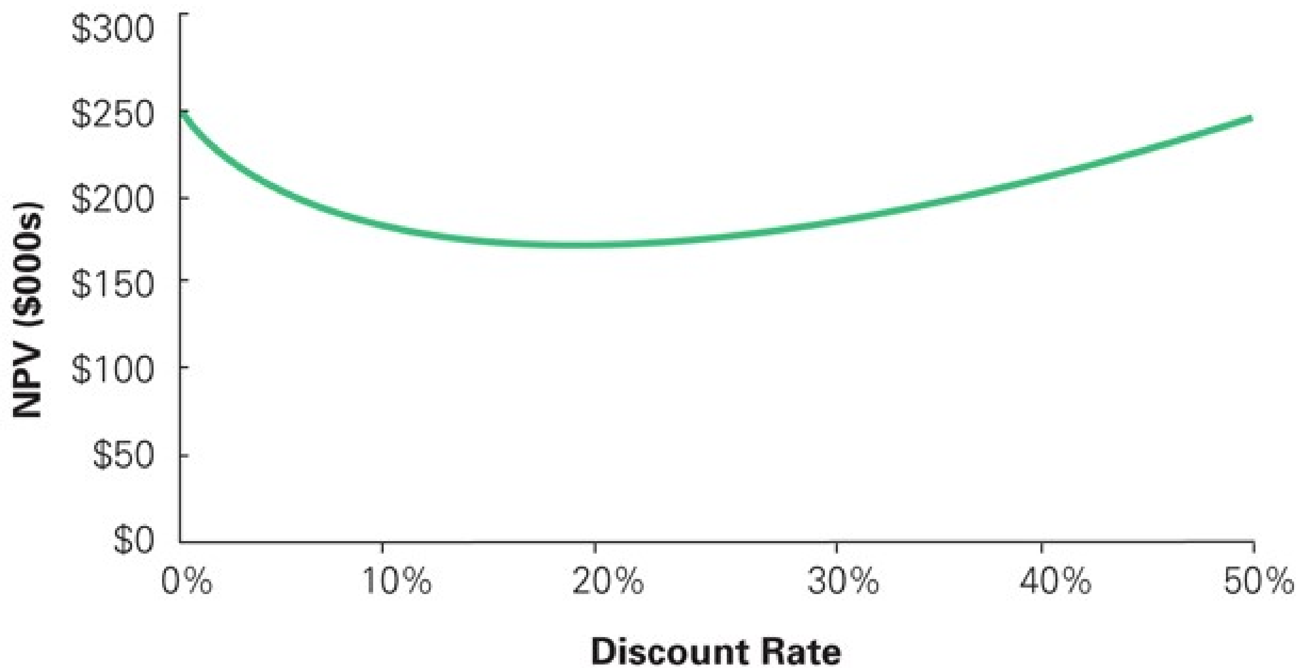
Cash Flows ($)				
Project	C_0	C_1	IRR	NPV at 10%
A	−1,000	+1,500	+50%	+364
B	+1,000	−1,500	+50%	−364

Pitfalls of IRR (2): Multiple IRRs

- Certain cash flows generate NPV = 0 at two different discount rates



Pitfalls of IRR (3): Nonexistent IRR



No IRR exists because the NPV is positive for all values of the discount rate. Thus, the IRR rule cannot be used.

Pitfalls of IRR (4): Ignoring magnitude of project

	Cash Flows, $			
Project	C_0	C_1	IRR (%)	NPV at 10%
D	−10,000	+20,000	100	+ 8,182
E	−20,000	+35,000	75	+11,818

Pitfalls of IRR (5): When there is more than one opportunity cost of capital

- Term Structure Assumption
  - Assume discount rates stable during term of project
    - Implies all funds reinvested at IRR
    - False assumption

$$\boxed{\text{NPV} = C_0 + \frac{C_1}{(1+r_1)^1} + \frac{C_2}{(1+r_2)^2} + \frac{C_3}{(1+r_3)^3}}$$

How Interest is Paid and Quoted

- Effective Annual Interest Rate (EAR)
  - Interest rate annualized using compound interest
- Annual Percentage Rate (APR)
  - Interest rate annualized using simple interest

$$1 + EAR = \left(1 + \frac{APR}{k}\right)^k$$

- Given a monthly rate of 1%, what is the EAR? What is the APR?

$$\text{EAR} = (1 + .01)^{12} - 1 = r$$

$$\text{EAR} = (1 + .01)^{12} - 1 = .1268, \quad \text{or } 12.68\%$$

$$\text{APR} = .01 \times 12 = .12, \quad \text{or } 12.00\%$$

Annual Percentage Rates (cont'd)

Effective Annual Rates for a 6% APR with Different Compounding Periods

Compounding Interval	Effective Annual Rate
Annual	$(1 + 0.06/1)^1 - 1 = 6\%$
Semiannual	$(1 + 0.06/2)^2 - 1 = 6.09\%$
Monthly	$(1 + 0.06/12)^{12} - 1 = 6.1678\%$
Daily	$(1 + 0.06/365)^{365} - 1 = 6.1831\%$

- A 6% APR with continuous compounding results in an EAR of approximately 6.1837%.

The Determinants of Interest Rates

- Inflation and Real Versus Nominal Rates
  - **Nominal Interest Rate:** The rates quoted by financial institutions and used for discounting or compounding cash flows
  - **Real Interest Rate:** The rate of growth of your purchasing power, after adjusting for inflation

Incorporating Inflation (1)

Example

- Project produces real cash flows of -$100 in year zero and then $35, $50, and $30 in three following years. Nominal discount rate is 15% and inflation rate is 10%. What is NPV?

$$\text{Real discount rate} = \frac{1+\text{nominal discount rate}}{1+\text{inflation rate}} - 1$$

$$= \frac{1.15}{1.10} - 1 = .045$$

Incorporating Inflation (2)

- Nominal figures
- Real figures

Year	Cash Flow	PV @ 15%
0	-100	-100
1	$35 \times 1.10 = 38.5$	$\frac{38.5}{1.15} = 33.48$
2	$50 \times 1.10^2 = 60.5$	$\frac{60.5}{1.15^2} = 45.75$
3	$30 \times 1.10^3 = 39.9$	$\frac{39.9}{1.15^3} = 26.23$
		NPV = \$5.5

Year	Cash Flow	PV @ 4.50%
0	-100	-100
1	35	$\frac{35}{1.045} = -33.49$
2	50	$\frac{50}{1.045^2} = 45.79$
3	30	$\frac{30}{1.045^3} = 26.29$
		NPV = \$5.50

The Payback Rule

- The **payback period** is amount of time it takes to recover or pay back the initial investment.
- If the payback period is less than a pre-specified length of time, you accept the project.
- Otherwise, you reject the project.
- The payback rule is used by many companies because of its simplicity.

Example of payback rule

- **Problem**
  - Projects A, B, and C each have an expected life of 5 years.
  - **Given the initial cost and annual cash flow information below, what is the payback period for each project?**

	A	B	C
Cost	$80	$120	$150
Cash Flow	$25	$30	$35

Solution

Payback A: $80 ÷ $25 = 3.2 years

Project B: $120 ÷ $30 = 4.0 years

Project C: $150 ÷ $35 = 4.29 years

Pitfalls of Payback Rule

- Ignores the project's cost of capital and time value of money.

- Ignores cash flows after the payback period.

- Relies on an ad hoc decision criterion.

Profitability Index

- The **profitability index** can be used to identify the optimal combination of projects to undertake.

$$\text{Profitability Index} = \frac{\text{Value Created}}{\text{Resource Consumed}} = \frac{\text{NPV}}{\text{Resource Consumed}}$$

Example

Problem

- Suppose your firm has the following five positive NPV projects to choose from. However, there is not enough manufacturing space in your plant to select all of the projects. Use profitability index to choose among the projects, given that you only have 100,000 square feet of unused space.

Project	NPV	Square feet needed
Project 1	100,000	40,000
Project 2	88,000	30,000
Project 3	80,000	38,000
Project 4	50,000	24,000
Project 5	12,000	1,000
Total	330,000	133,000

Solution (1)

- Compute the PI for each project.

Project	NPV	Square feet needed	Profitability Index (NPV/Sq. Ft)
Project 1	100,000	40,000	2.5
Project 2	88,000	30,000	2.93
Project 3	80,000	38,000	2.10
Project 4	50,000	24,000	2.08
Project 5	12,000	1,000	12.0
Total	330,000	133,000	

Solution (2)

- Rank order them by PI and see how many projects you can have before you run out of space.

Project	NPV	Square feet needed	Profitability Index (NPV/Sq. Ft)	Cumulative total space used
Project 5	12,000	1,000	12.0	1,000
Project 2	88,000	30,000	2.93	31,000
Project 1	100,000	40,000	2.5	71,000
Project 3	80,000	38,000	2.10	
Project 4	50,000	24,000	2.08	

Shortcomings of the Profitability Index

- In some situations, the profitability Index does not give an accurate answer.
  - Suppose in Example 7.5 that NetIt has an additional small project with a NPV of only $120,000 ($0.12 million) that requires 3 engineers. The profitability index (per engineering headcount) in this case is 0.12/ 3 = 0.04, so this project would appear at the bottom of the ranking. However, 3 of the 190 employees are not being used after the first four projects are selected. As a result, it would make sense to take on this project even though it would be ranked last.
- With multiple resource constraints, the profitability index can break down completely.