Direcció Financera II

Chapter 2: Investment Decisions

Part (a): Investing in risk-free assets

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In this chapter…

- Part (a): Evaluate risk-free projects:
  - Decide whether to invest in a project:
  - Project selection
- Part (b): Adjusting for risk:
  - How to adjust the “discount rate”?

In part (a)…

- Compute…
  - Net present value (*valor actual net*)
  - Internal rate of return (*taxa de rendiment interna*)
  - Profitability index (*index de profitabilitat*)
  - Payback period (*periode de recuperació*)
- Decide whether to invest in a project:
  - Net present value rule
  - Internal rate of return rule
- Project selection:
  - Mutually exclusive projects
  - Scalable projects with limited resources

How to value the future?

- One euro today is worth more than one tomorrow!

- Why?
- Possible to earn interest! If interest is 10% a year…
  - Investing 10 million today gives 11 million in a year
  - The future value (in a year) of 10 million is 11 million
  - The present value of 11 million in a year is 10 million

Future and Present Values

- Future Value: Amount to which an investment will grow after earning interest

$$FV = C_0 \times (1+r)^t$$

  - For example, 10 million after two years will be

$$FV = 10m \times (1+0.1)^2 = 12.1m$$

- Present Value: Value today of a future (expected) cash flow

$$PV = \frac{1}{(1+r)^t} \times C_t$$

Discount factor

Discount rate or opportunity cost of capital

  - For example, 12.1 million in two years is

$$PV = \frac{1}{(1+0.1)^2} \times 12.1m = 10m$$

Net Present Value: an example

- Cash flows: immediate \$81.6 million “outflow” and an “inflow” of \$28 million per year for 4 years

Month:	0	1	2	3	4
Cash flow:	− \$81.60	+ \$28	+ \$28	+ \$28	+ \$28

- Therefore, if discount rate is *r = 0.10*, the NPV is:

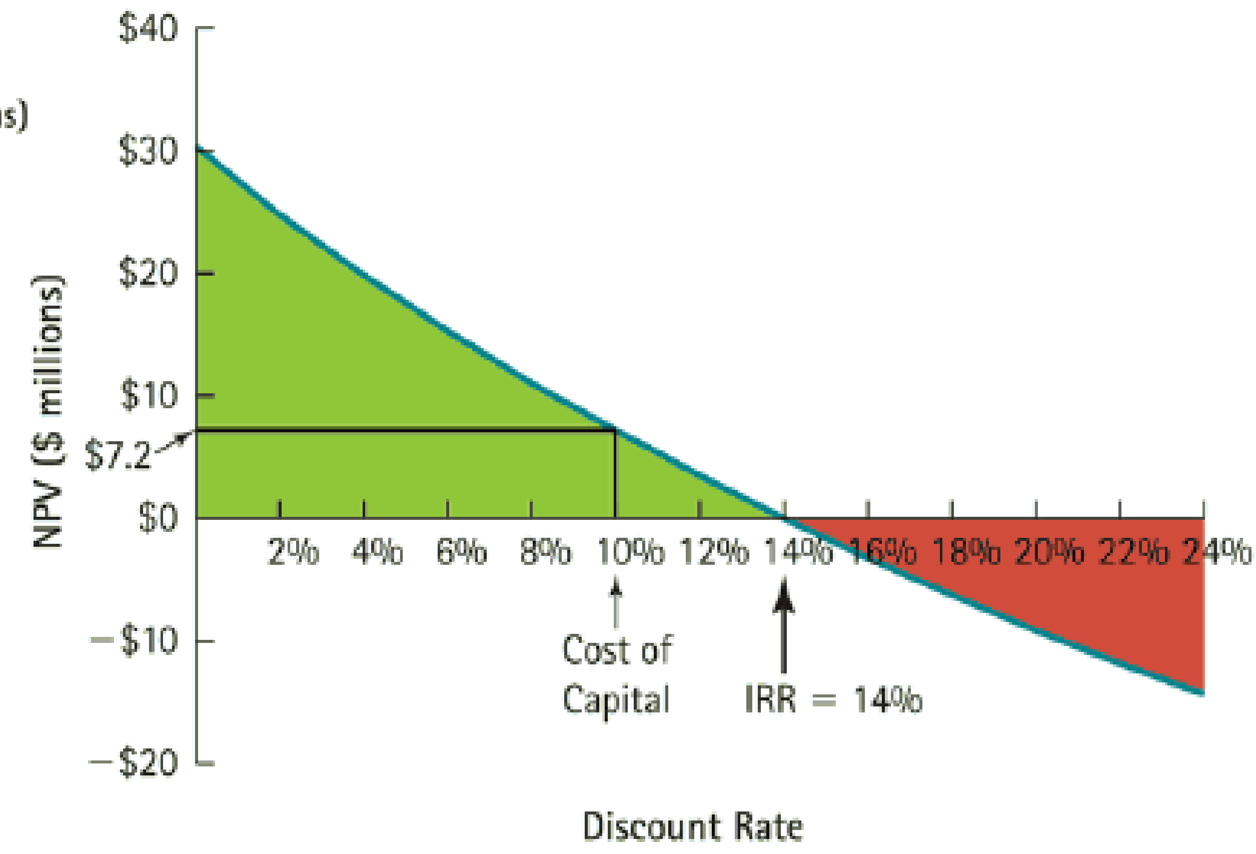
$$NPV = -81.6 + \frac{28}{(1+0.1)^1} + \frac{28}{(1+0.1)^2} + \frac{28}{(1+0.1)^3} + \frac{28}{(1+0.1)^4}$$

- Discount rate depends on the riskiness of the cash flows
  - Higher risk implies greater discount and lower present value (more on that in part (b) of this chapter)

Panel (a)

Discount Rate	NPV ($ millions)
0%	$30.4
2%	$25.0
4%	$20.0
6%	$15.4
8%	$11.1
10%	$7.2
12%	$3.4
14%	$0.0
16%	−$3.3
18%	−$6.3
20%	−$9.1
22%	−$11.8
24%	−$14.3

Panel (b)



More generally…

- Cash flows:
  - Cash that a project generates over time
  - Inflow (+) or outflow (-)
  - Example: buying and selling a factory in the future, but also income from sales of products
- Net present value or “discounted cash flow”:

$$\text{NPV} = \text{C}_0 + \frac{C_1}{1+r_1} + \frac{C_2}{(1+r_2)^2} + \frac{C_3}{(1+r_3)^3} + \ldots + + \frac{C_T}{(1+r_3)^T}$$

Investment decision: the NPV rule

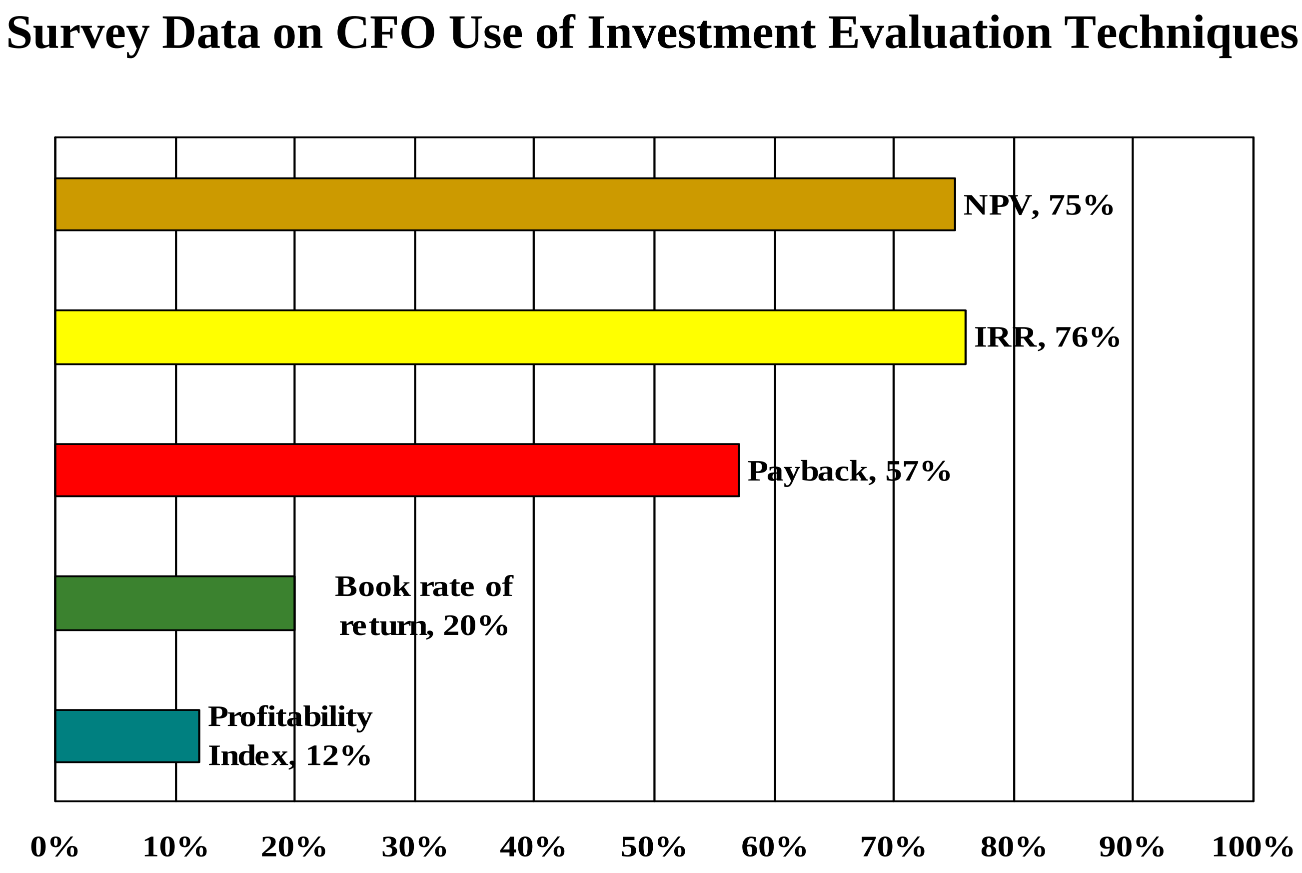
Step 1: Forecast future cash flows

Step 2: Estimate discount rate

Step 3: Discount future cash flows

Step 4: Go ahead if PV of payoff exceeds investment, i.e. if NPV > 0

But, are there other criteria?



SOURCE: Graham and Harvey, “The Theory and Practice of Finance: Evidence from the Field,” Journal of Financial Economics 61 (2001), pp. 187-243.

Rate of return: examples

1. Take an asset. Value in two subsequent periods:
   - C_0: 80m and C_1: 96.8m
   - Return: r = (96.8 – 80)/80 = 0.21 or 21%
2. Value in two non-subsequent periods:
   - C_0: 80m and C_2: 96.8m, return: ?
   - Numerical method: find *r* such that Net Present Value (NPV) = 0

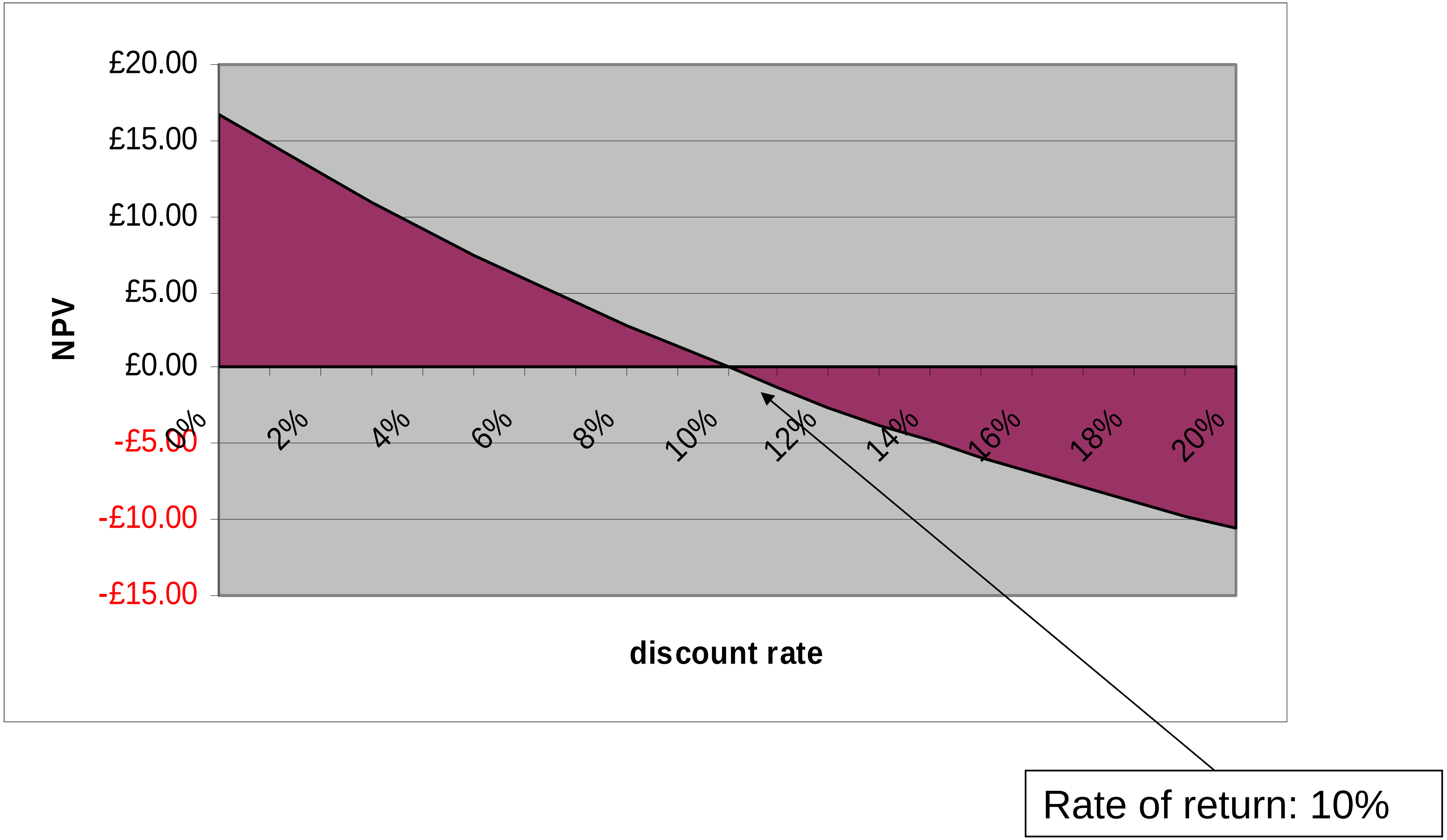
$$NPV = -80 + \frac{96.8}{(1+r)^2} = 0 \quad \text{or} \quad r = 0.10 = 10\%$$

   - In other words,

$$80(1+0.1)(1+0.1) = 96.8$$

   - What is the rate of return in the first example?

Example 2


£20.00
£15.00
£10.00
£5.00
£0.00
-£5.00
-£10.00
-£15.00
NPV
0%
2%
4%
6%
8%
10%
12%
14%
16%
18%
20%
discount rate
Rate of return: 10%

Introducing revenues and costs

- No revenues:
  - AV_0: 80m and AV_2: 96.8m

$$NPV = -80 + \frac{96.8}{(1+r)^2} = 0 \quad \text{or} \quad r = 10\%$$

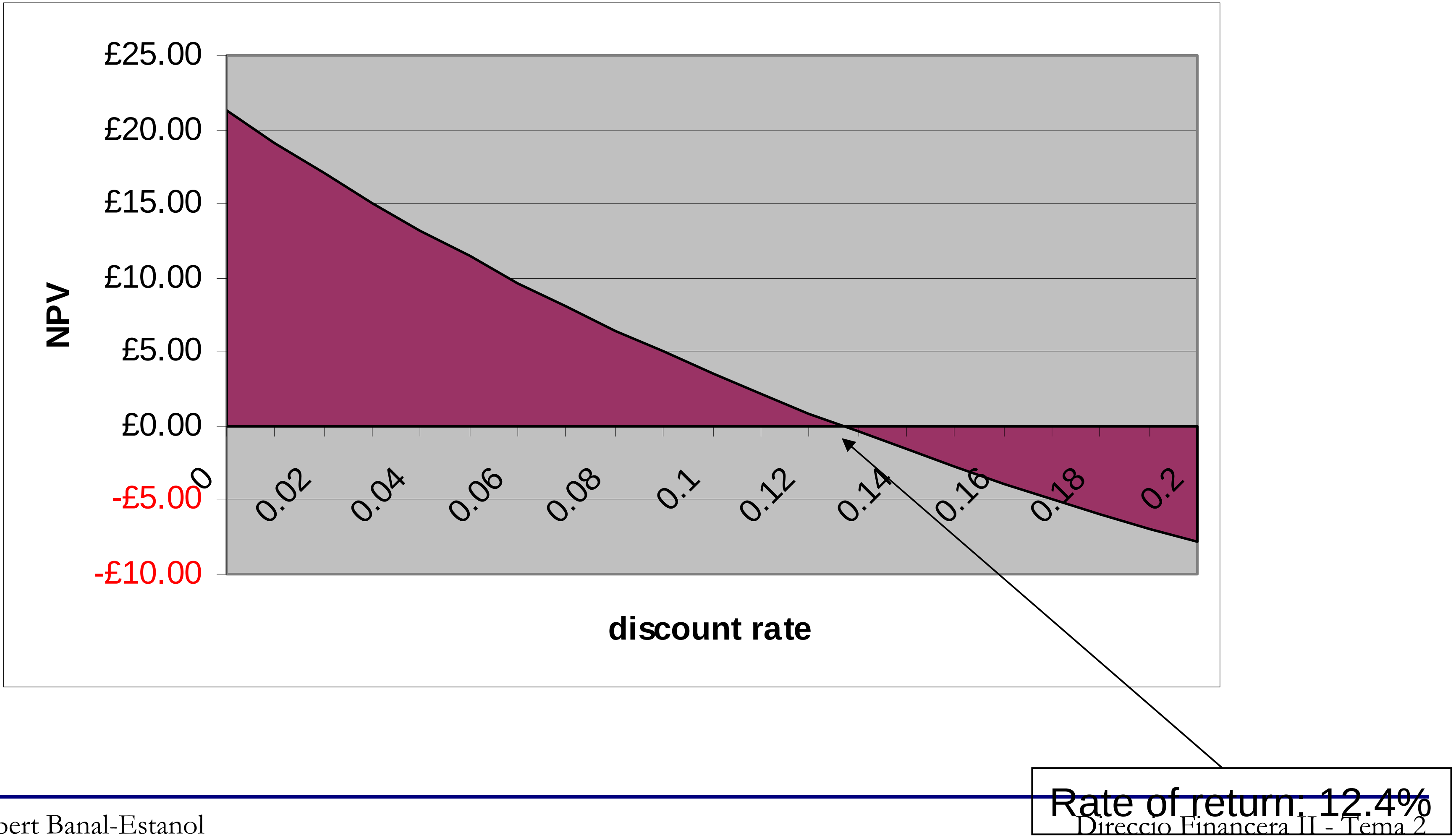
- With constant revenues:
  - AV_0: 80m, AV_2: 96.8m, R_1: 2m, R_2: 2m

$$NPV = -80 + \frac{2}{(1+r)^1} + \frac{2}{(1+r)^2} + \frac{96.8}{(1+r)^2} = 0 \quad \text{or} \quad r = 12.4\%$$

- With increasing revenues and costs:
  AV_0: 80m, AV_2: 96.8m, R_1: 2m, R_2: 2.5m, C_1: 1m, C_2: 1.2m

$$NPV = -80 + \frac{2}{(1+r)^1} + \frac{2.5}{(1+r)^2} + \frac{96.8}{(1+r)^2} = 0 \quad \text{or} \quad r = 12.7\%$$

Example with constant revenues



More generally

- The rate of return of a cash flow stream is the interest rate y that makes the NPV of a project equal to 0:

$$0 = C_0 + \frac{C_1}{1+y} + \frac{C_2}{(1+y)^2} + \frac{C_3}{(1+y)^3} + \ldots + + \frac{C_T}{(1+y)^T}$$

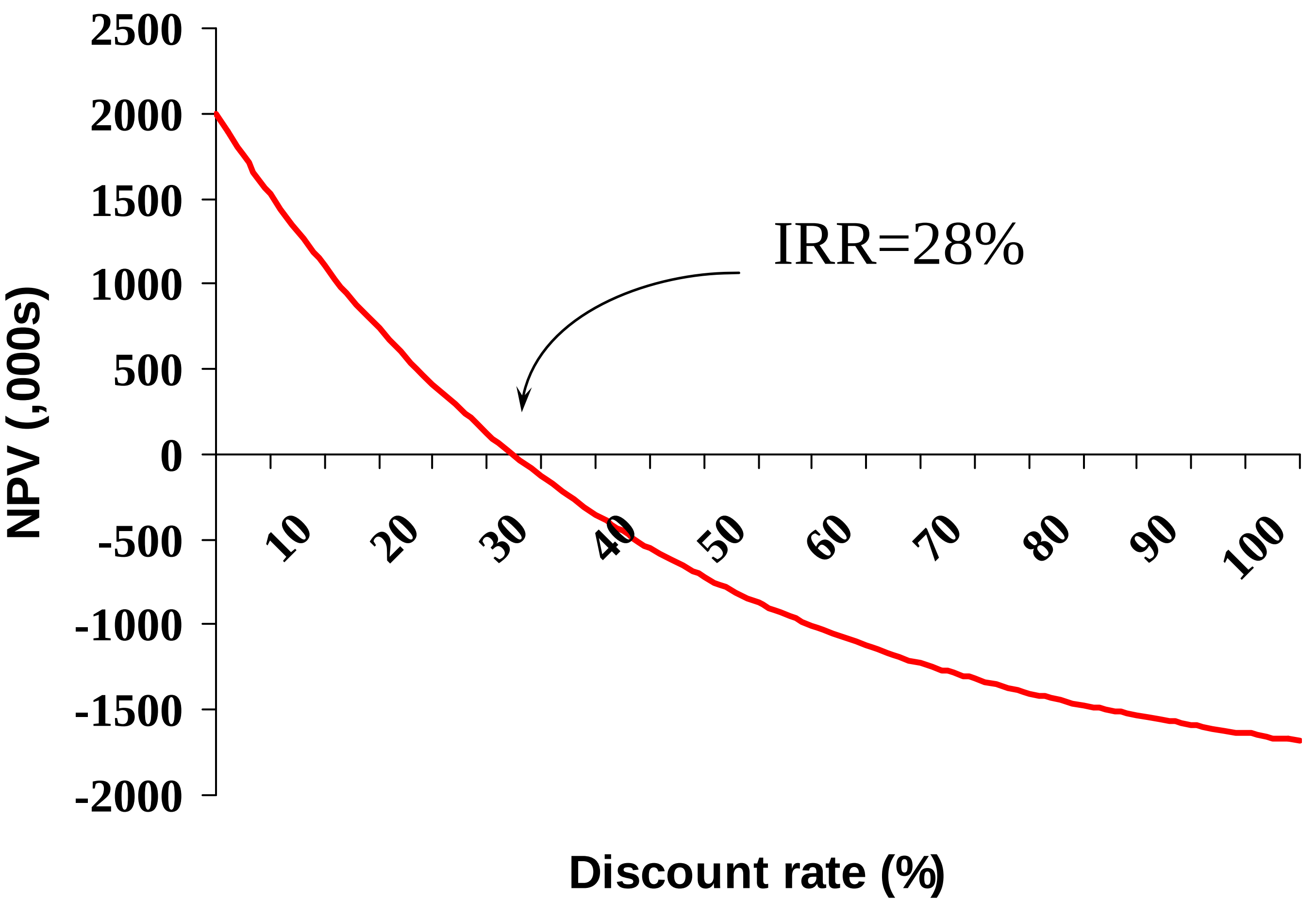
- ***Another example***

  You can purchase a turbo powered machine tool gadget for $4,000. The investment will generate $2,000 and $4,000 in cash flows for two years, respectively. What is the IRR on this investment?

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

$$IRR = 28.08\%$$

Internal Rate of Return



Rate of Return Rule

- Accept investments offering rates of return in excess of the appropriate discount rate (opportunity cost of capital)

Example

In the following project, the foregone investment opportunity is 12%. Should we do the project?

$$\text{Return} = \frac{\text{profit}}{\text{investment}} = \frac{420{,}000 - 370{,}000}{370{,}000} = .135 \text{ or } 13.5\%$$

Yes!!! We can do the same with previous examples

IRR and NPV

- Same criteria if NPV is decreasing wrt discount rate
- However, the IRR has some pitfalls:
  - If NPV increases (lending money instead of borrowing), we should ask for an IRR lower than opportunity cost of capital
  - There might be several IRRs or none
  - Ignores magnitude and cannot select among different projects
  - Even more problematic if we discount rates are not stable over time (with which one do we compare?)

Caution with NPV in practice

- Cash flow means pounds paid in (not earned!) less pounds paid out (not need to depreciate over time!)
- Compute them on after tax-basis
- Forget sunk costs
- Treat inflation consistently

Book Rate of Return

Book Rate of Return - Average income divided by average book value over project life. Also called *accounting rate of return*.

$$\text{Book rate of return} = \frac{\text{book income}}{\text{book assets}}$$

Managers rarely use this measurement to make decisions. The components reflect tax and accounting figures, not market values or cash flows.

Payback and payback rule

- The payback period is the number of periods (years) it takes before the cumulative forecasted cash flow equals the initial outlay
- The payback rule says only accept projects that “payback” in the desired time frame.
- This method is flawed, primarily because it ignores later year cash flows and the the present value of future cash flows.

Payback

Example

Examine the three projects and note the mistake we would make if we insisted on only taking projects with a payback period of 2 years or less.

Project	C_0	C_1	C_2	C_3	Payback Period	NPV@ 10%
A	- 2000	500	500	5000	3	+ 2,624
B	- 2000	500	1800	0	2	- 58
C	- 2000	1800	500	0	2	+ 50

Project Selection

- If only one from a set of positive NPV projects can be selected, we should select that with the largest NPV
- When resources are limited, the profitability index (PI) helps selecting among various project combinations and alternatives:
  - $PI = (NPV - C_0) / (-C_0) = PV / (-C_0)$
  - If resources are unlimited, we should select projects with PI>1. Why?
  - Limited resources and projects can yield various combinations
  - Example: Two scalable projects and Eur 10,000

Project	C_0	C_1	C_2	PV @10%	PI
A	-1	$+22$	-12.12		
B	-4	$+44$	-24.24		

Project Selection

- If only one from a set of positive NPV projects can be selected, we should select that with the largest NPV
- When resources are limited, the profitability index (PI) helps selecting among various project combinations and alternatives:
  - PI = (NPV - C_0) / (-C_0) = PV / (-C_0)
  - If resources are unlimited, we should select projects with PI>1
  - Limited resources and projects can yield various combinations
  - Example: Two scalable projects and Eur 10,000

Project	C_0	C_1	C_2	PV @10%	PI
A	-1	$+22$	-12.12	8	8
B	-4	$+44$	-24.24	16	4