Introduction into cost-benefit analysis
CONTENT

INTRODUCTION

- The concept of "investment"
- Management steps

BASICS OF DISCOUNTING

FINANCIAL EVALUATION METHODS

- Net present value method (NPV)
- Internal rate of return (IRR)
- Payback method

- Case -

Introduction into cost-benefit analysis
CONTENT

VALUE ANALYSIS

- Definition of objectives
- Weighting of objectives
- Quantification of values

- Case

CALCULATION OF ECONOMICS RATE OF RETURN

- Relevant costs
- Valuation of costs and benefits

- Case

Introduction into cost-benefit analysis
CONTENT

SENSITIVITY ANALYSIS

RELEVANCE OF CBA FOR AN AUDITOR

- Legal background
- List of typical type of projects
- What items can be verified ?
- Possible conclusions for the auditor

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INVESTMENT

DEFINITION

➧Investment:

the act of placing funds in other form capital

or

to place funds in non-financial assets in order to achieve financial or non-financial return

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INVESTMENT

- limited period of using investment
  - **technical life-time (economic life-time)**
- induced financial flows
  - **costs**
  - **revenues**
- uncertainty

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INVESTMENT

DECISION PROBLEM

1. Is an investment profitable ?
2. What is the most profitable alternative ?

MANAGEMENT STEPS

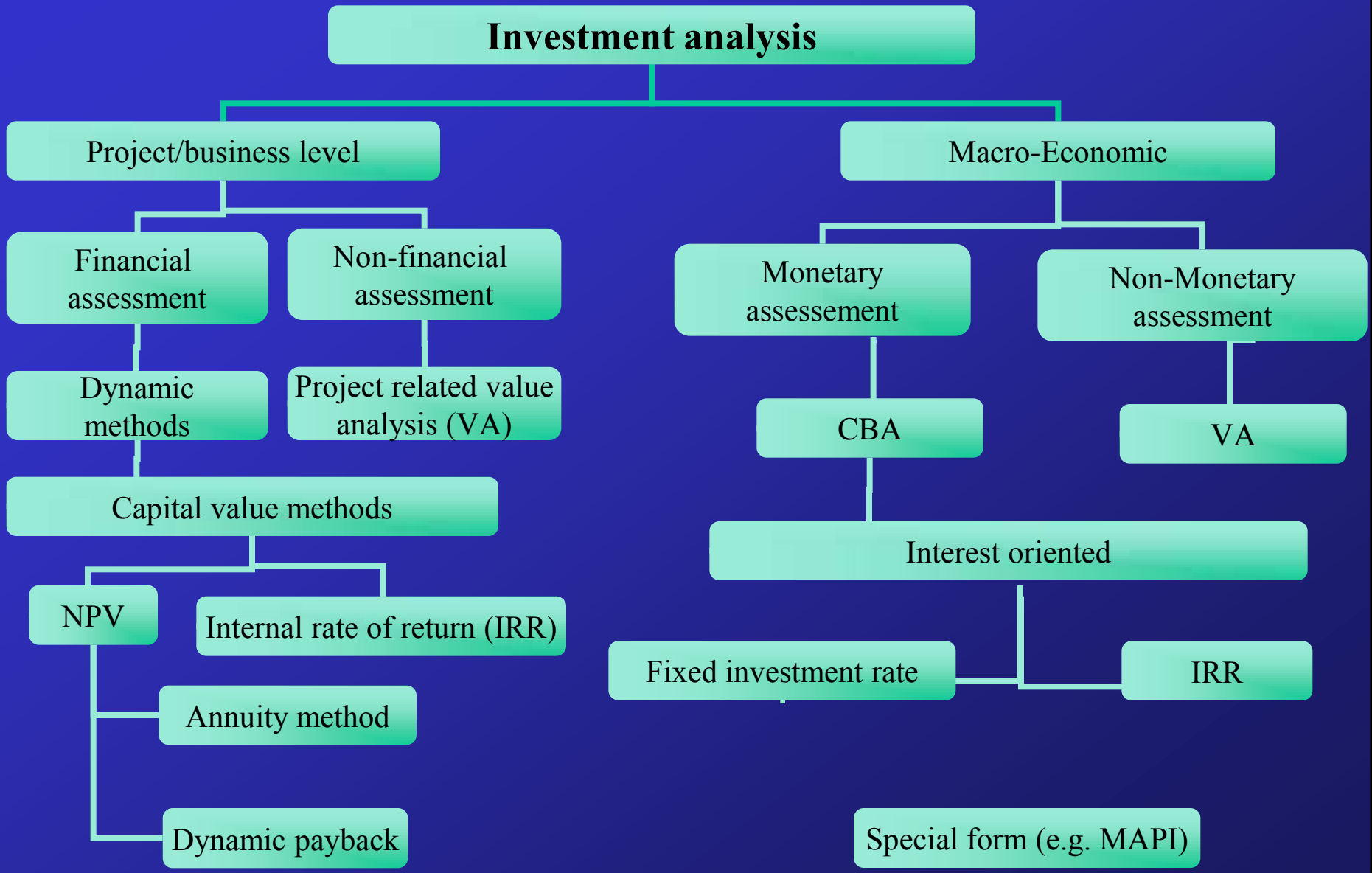
Step 1: Identification and description of the project

Step 2: Ex-ante evaluation

Step 3: Decision making process

Step 4: Realisation of the investment

Step 5: Ex-post evaluation


Investment analysis
Project/business level
Macro-Economic
Financial assessment
Non-financial assessment
Monetary assessement
Non-Monetary assessment
Dynamic methods
Project related value analysis (VA)
CBA
VA
Capital value methods
Interest oriented
NPV
Internal rate of return (IRR)
Fixed investment rate
IRR
Annuity method
Dynamic payback
Special form (e.g. MAPI)

Basic of discounting

Principle : 1 EURO spent in the future has less value today

OR 1 EURO spent today has higher value in the future

Definitions :

Co = capital (present) value at the beginning of an investment period

Cn = capital value at the end of an investment period

t = 1, 2, ..., n year (n = last year)

i = discount rate

a o = initial investment

Rn = residual value of an investment after n-years

A = annuity

Calculation examples

- I. Investment amount 1.000
- Interest rate 0,05 (=5%)
- duration 3 years

1. Year end: 1.000 + 1.000*0,05 = 1.050 or
   1.000 *(1 + 0,05) = 1.050
2. Year end: 1.050 + 1.050*0,05 = 1.102,5 or
   1.000*(1+0,05) *(1+0,05) =
   $1.000*(1*0,05)^2 = 1.102,5$
3. Year end 1.102,5 + 1.102,5 * 0,05 = 1.157,63 or
   1.000*(1+0,05)*(1+0,05)*(1+0,05)
   $1.000*(1 + 0,05)^3 = 1.157,63$

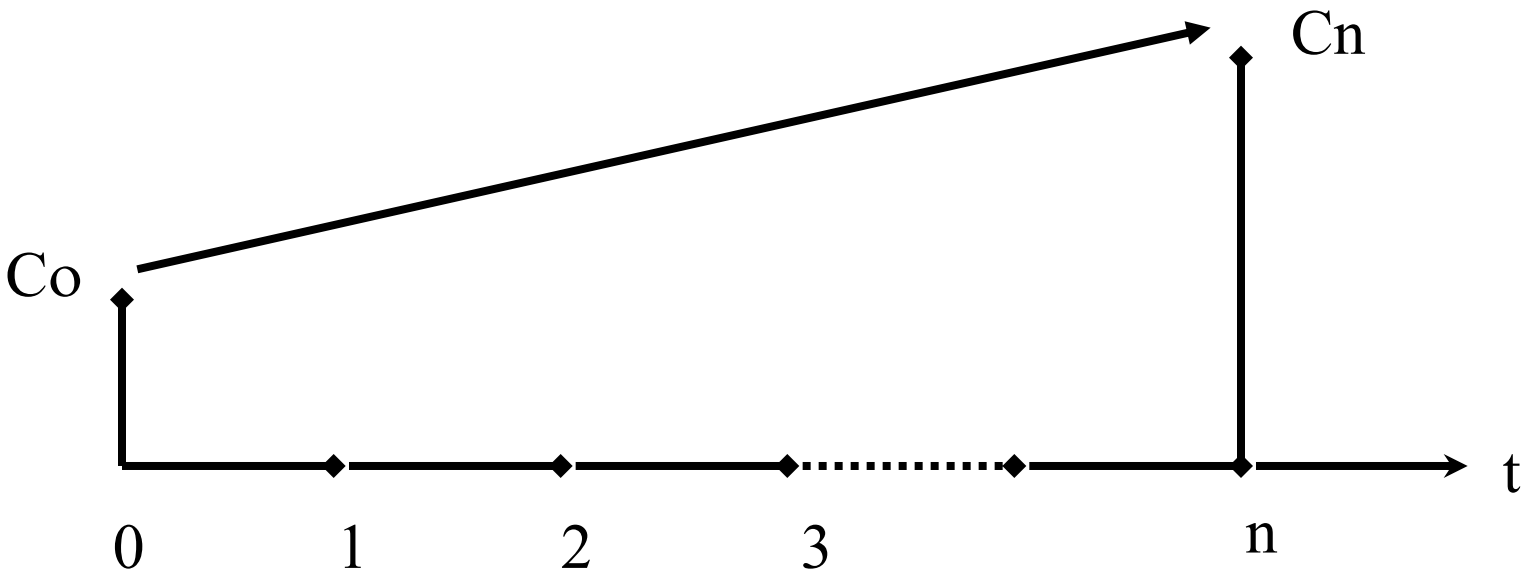
*Or 1.000 * 1/discount factor (t=3 I=5) = 1.000 *1/0,864= 1.157,4*

Interpretation of result

- The start capital of 1.000 is after 3 years 1.157,63 worth; the present value is increased in the future

- *Or* an value of 1.157,63 end of three years from the present would have a worth at present of 1.000; the future value is less worth at present

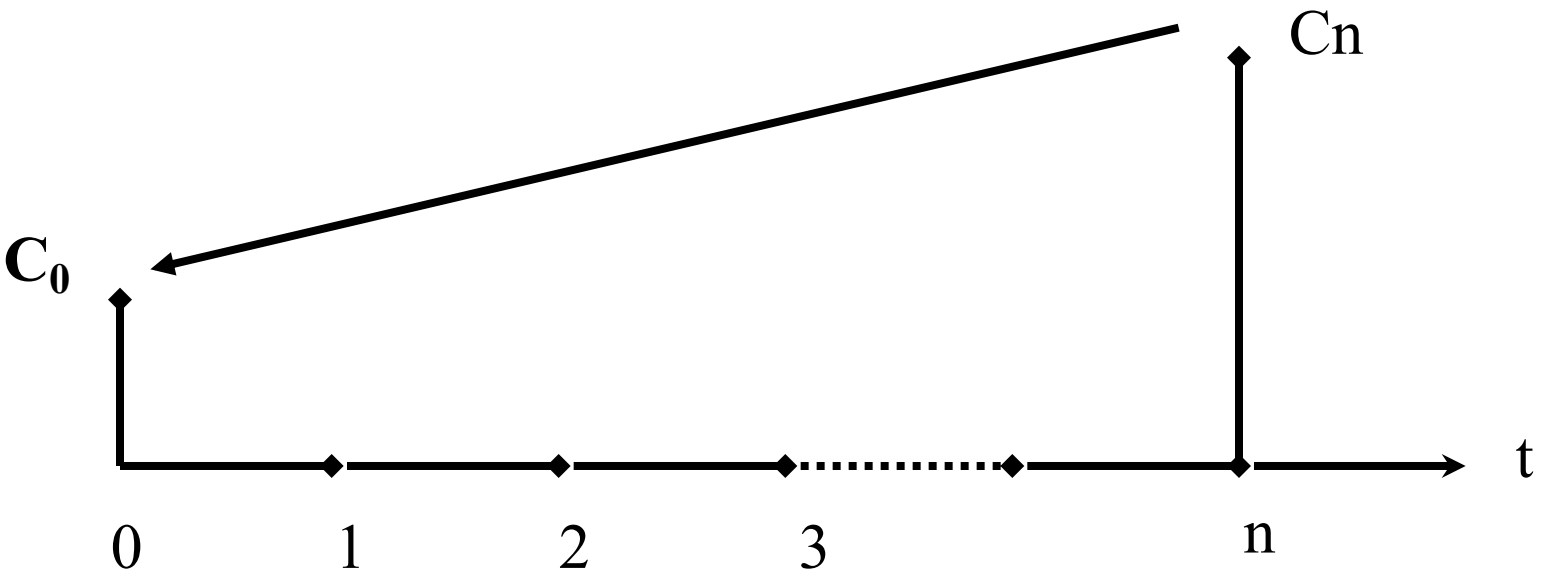
1. Calculation of the end-value Cn



Factor : $r^n = (1 + i)^n$

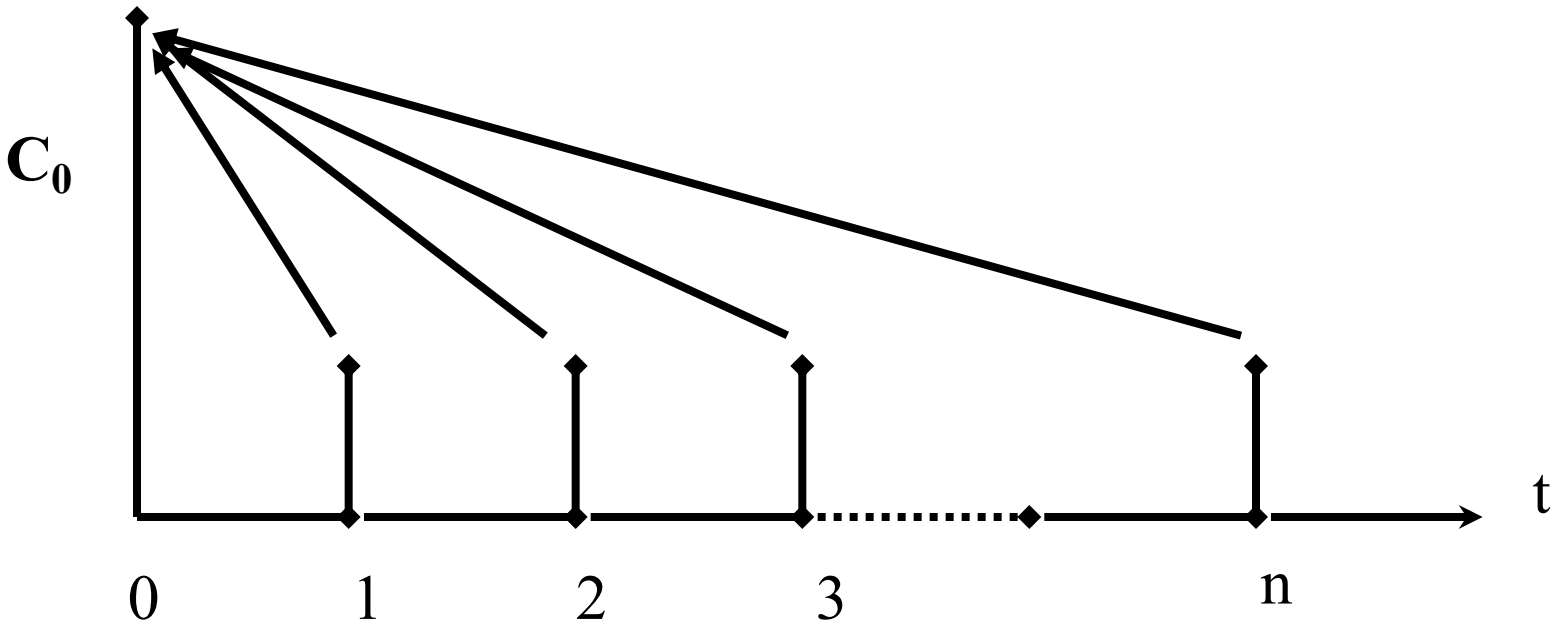
$C_n = C_0 \times r^n$

2. Net value C_0 calculated by discounting



Factor : $y^n = 1/r_n$ **$C_0 = C_n \times y^n$**

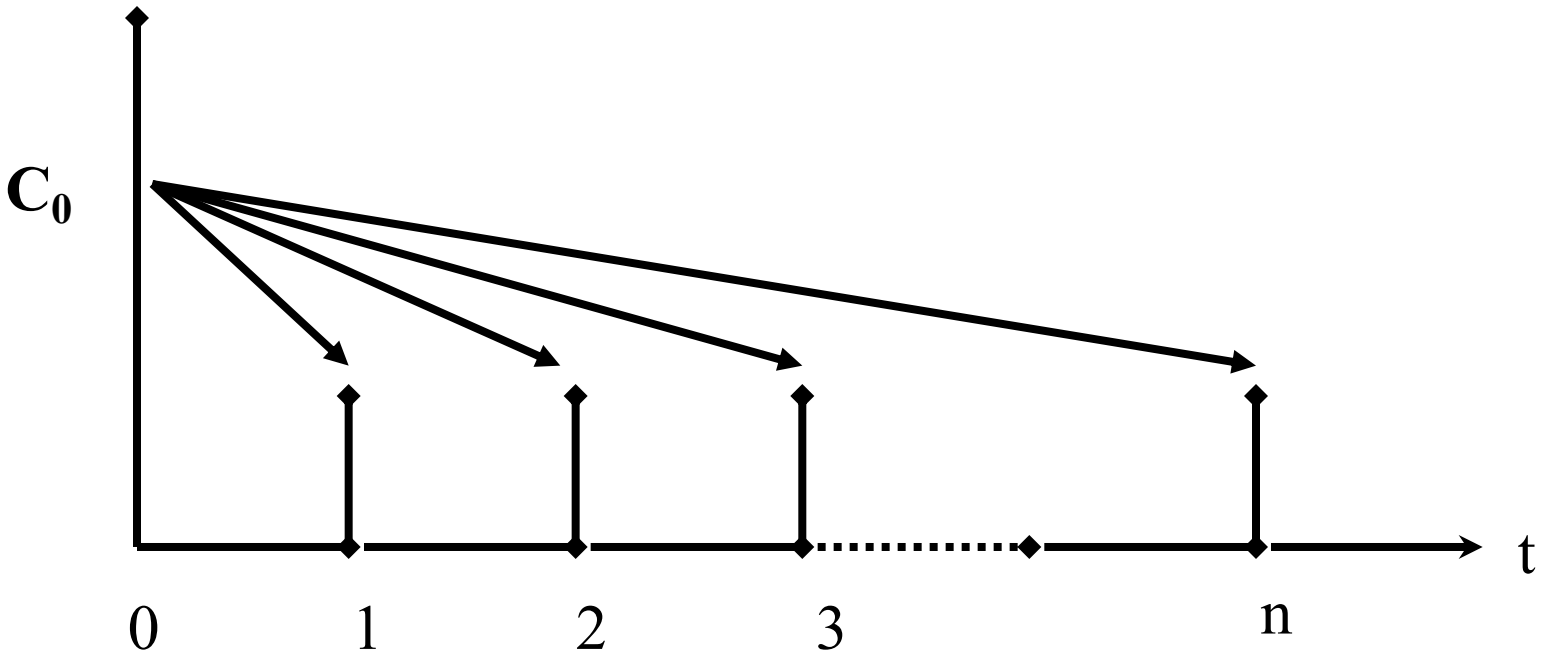
3. Net value of an annuity



Factor : $\dfrac{(1+i)^n - 1}{(1+i)^n \times i} = a_n$

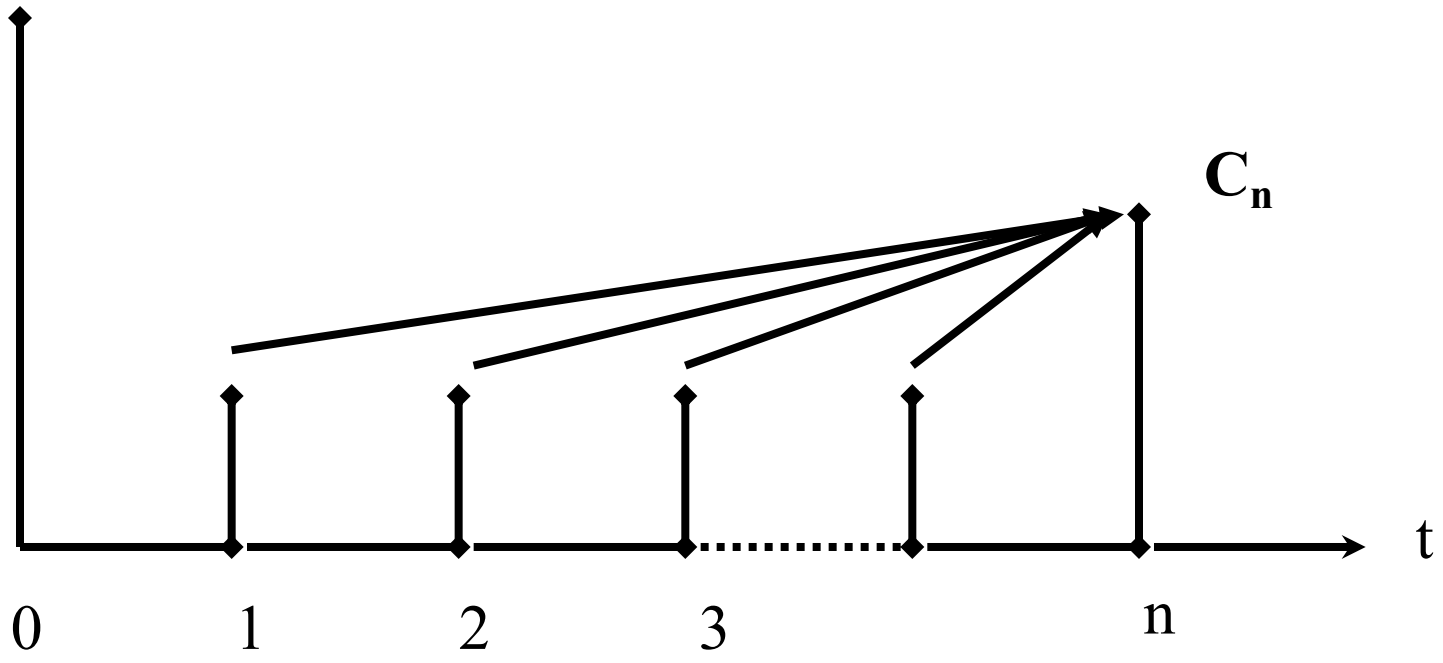
$C_0 = A_c \times a_n$

4. Annuity for interest of i and payback C_0



Recovery factor : $y^n = \frac{1}{a_n}$ $\quad A = C_0 \times \frac{1}{a_n} = C_0 \times RF$

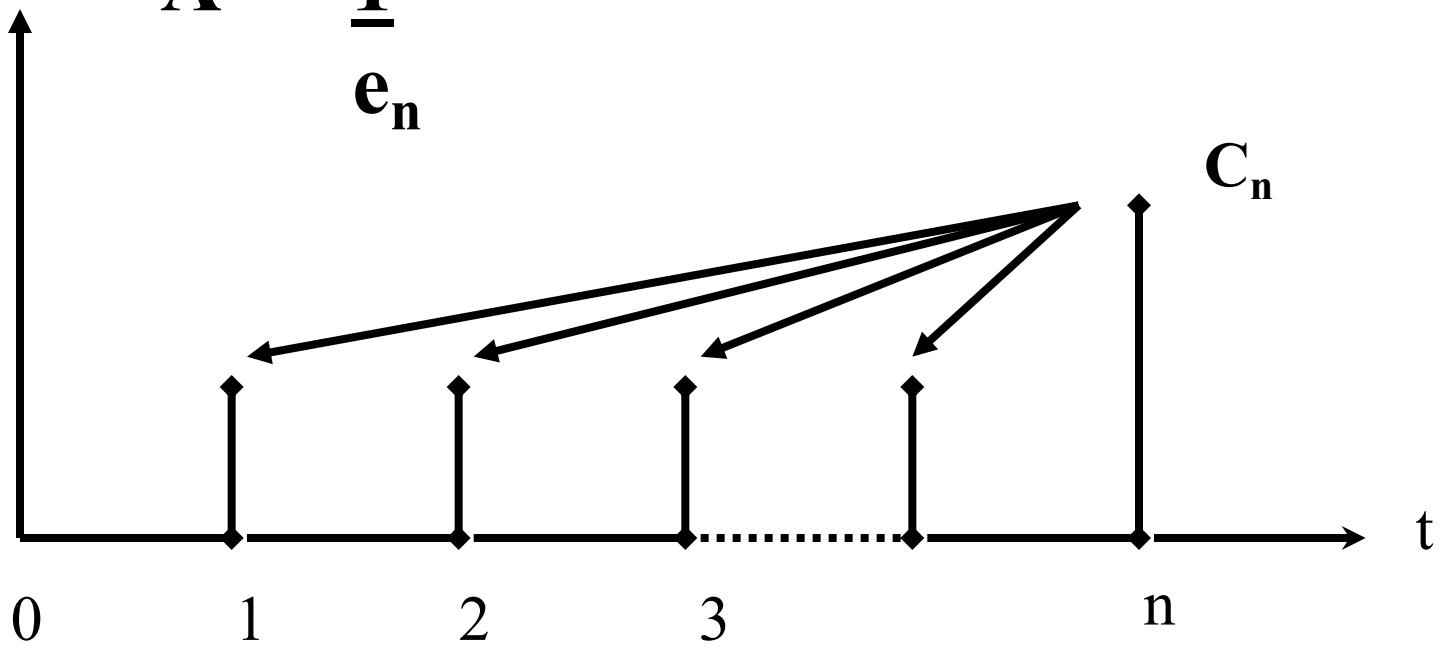
5. Final value of C_n with an annuity of A



$$e_r = \frac{(1+i)^n - 1}{i} = (r^n - 1) / i \qquad C_n = A \times e_n$$

6. Annuity A of a final value Cn

$$A = \frac{1}{e_n}$$



$$\text{Factor : } \frac{i}{(1+i)^n - 1} = \frac{i}{(r_n - 1)} = \frac{1}{e_n}$$

How to proceed with the NPV methode

- determine the available amount and the calculation rate (alternative rate for placing funds in the capital market)
- determine duration of the investment
- determine the expected cash flows (costs; revenues) and the residual value at the end of the periode
- Discount the flows to receive the NPV

Decision criteria for NPV

- **An investment is profitable if the NPV ≥ 0**
- **With alternatives the investment with the biggest NPV ≥ 0 is preferred**

How to proceed for calculating the IRR

- determine available capital, expected duration, estimate the cash flows over the time, estimate the residual value
- One wants to get the rentabiltiy of the investement
- The internal rate is the rate, for which the NPV becomes *0*.
- Solutions: a) interpolation
  b) graphical
  c) approximation

Decision criteria for IRR

- Profitable if the IRR of bigger than the calculation rate
- for alternatives : the biggest IRR is the most profitable project

Pay-Back period

- A project is profitable if the cumulated cash flow over the life-time exceeds the initial investment
- If various investment alternatives : the project with the shortest pay-back period will be referred

Case 1

- 4 alternative investments with following data:

  each has amount of 20.000 to invest

  constant annual **revenue (costs)** for alternative one 18.000.-(6.000), two 20.000.-(10.000), three 12.000.-(4.000), and four 10.000.-(4.000)

The alternatives have following life time in years: 3, 5, 7, 9

- The calculation rate is 0,08 (8%)
- Find the NPVs, IIRs and payback periodes.

Basics about Value Analysis

- **objective hierarchy**
- **utility function**
- **weighting of objectives**
- **transformation function**
- **nominale – ordinale – cardinale**

Basics about Value Analysis

- **Procedural steps:**
  - **definition of target criteria**
  - **weighting of target criteria**
  - **identification of subvalue/utility**
  - **Total value**
  - **Assessment of advantage**

Basics about Value Analysis

- **Road alternative 1 A1**
- **Road alternative 2 A 2**
  - **Time saving T weight g1 0,3**
  - **security S weight g2 0,4**
  - **location advantage L weight g3 0,3**

Assumptions in Value Analysis

- **Value independent target criteria**
- **value/utility is measurable (cardinal)**
- **only feasible alternatives are analysed (financial and economic upper and lower bounds are given)**

Links of capital value and benefit value

1. $C_0 \geq 0$ **and** $N \geq \underline{N}$
2. $C_0 \leq 0$ **and** $N < \underline{N}$
3. $C_0 < 0$ **and** $N > \underline{N}$
4. $C_0 > 0$ **and** $N < \underline{N}$

With C_0 : financial value of an investment

N : benefit (non-financial) value of an investment

$\underline{N}$: subjective minimum of value to be achieved

Preparatory steps for the financial analysis

- ✓ Determine the project alternatives
- ✓ Assess the price for the initial investment
- ✓ Estimation of life-time
- ✓ Estimation of the periodical costs
- ✓ Estimation of the periodical revenues
- ✓ Estimation of the residual value
- ✓ Determination of the calculation rate

Decision criteria for IRR

- Profitable if the IRR of bigger than the calculation rate
- for alternatives : the biggest IRR is the most profitable project

Steps to calculate the IRR

1. Classical approach

   - compute NPV_1 with one calculation rate r1
   - if the RPV_1 is negative (positive) take another rate r_2, r3, ... until the NPV_2 becomes positive (negative)
   - make a graphical interpolation to find the intersection of the IRR which makes the NPV = 0 the rate which leads to NPV = 0 is the IRR

2. Simplified approach

IRR = r1 – NPV1 (r2 – r1) / (NPV2 – NPV1)

Some assumptions

- Returned capital will be placed on the capital market on the calculation rate
- Unlimited credit for the calculation rate would be available all over the time

Some Aspects of E-CBA

- **shadow prices**
- **opportunity costs**
- **what are labour costs?**
- **where to get data?**

Checklist for audit - 1

- What type and at what stage do rules foresee CBA?
- Who did CBA?
- When was it done?
- Which methode?
- Which calculation rate and how justified?

Checklist for audit -2

- Justification for time horizon?
- Which costs taken into account?
- How was estimated revenue achieved?
- CBA well documented?
- All assumptions listed?
- CBA for economic and financial calculation?

Checklist for audit -3

- For economic CBA: are shadow prices and costs listed and which source were taken?
- Was a sensitivity analysis made? Which results?
- Were alternatives considered?
- Final decision corresponds to CBA result? If not why not?