# *Methods for financial analysis*

- *Financial analysis* takes the perspective of one specific actor or group of actors involved in the project, such as a company or an entrepreneur.
  *Economic analysis* is concerned with the costs and benefits to society as a whole.
- The structure of methods for financial analysis is also valid, with appropriate distinctions, for economic analysis.

- A project produces an output that generates effects over time; for example, a plant has a technical life of several years.
- However, *technical* life may be different from the *economic* life.
- The technical (physical) life of an *asset* is the operational life of the asset under standard design conditions.
- It is influenced by
  - the quality of components and workmanship
  - the utilisation rate
  - the applied maintenance
  - environmental factors.

- The *economic life* of an asset is the time during which it provides, with normal maintenance, the designed functions in an *economically* viable manner.
- It depends both on physical factors and on economic factors such as
  - the perception of value offered
  - competing alternative goods
  - the modification of users' habits.

- Technical life is generally longer than economic life.
- It constitutes the upper limit of the *useful life* that is assigned to an asset and used in the evaluation.
- For example, although the technical life of a building can exceed 50 years, the standards set its service life at 20 years.

# *Methods without discounting*

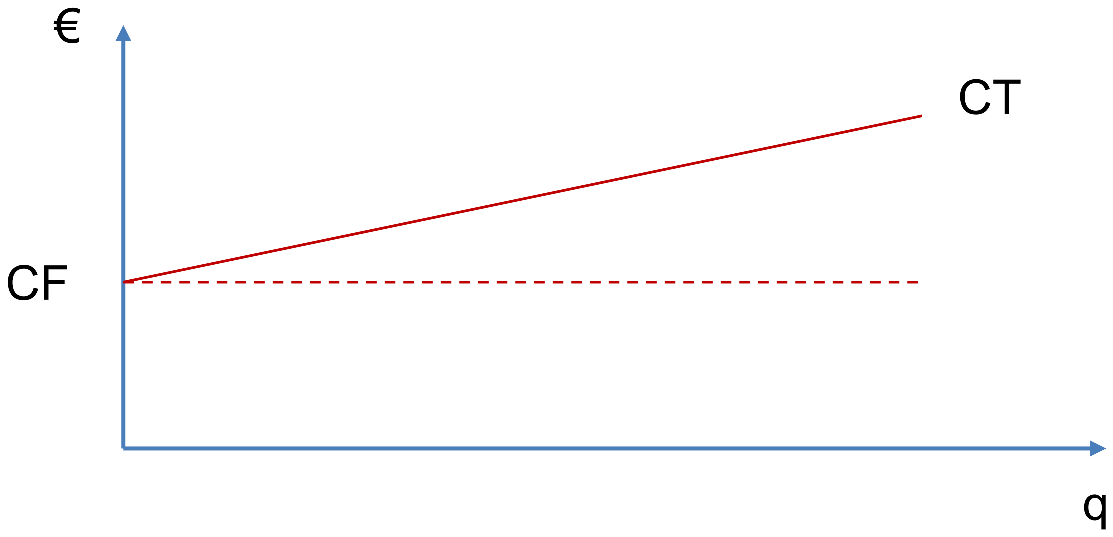
- In these methods, the different value of a unit of cash produced in different periods is not explicitly considered.
- We present two methods:
  - the *break-even point* method
  - the *payback* period method.

# *Break-even point method*

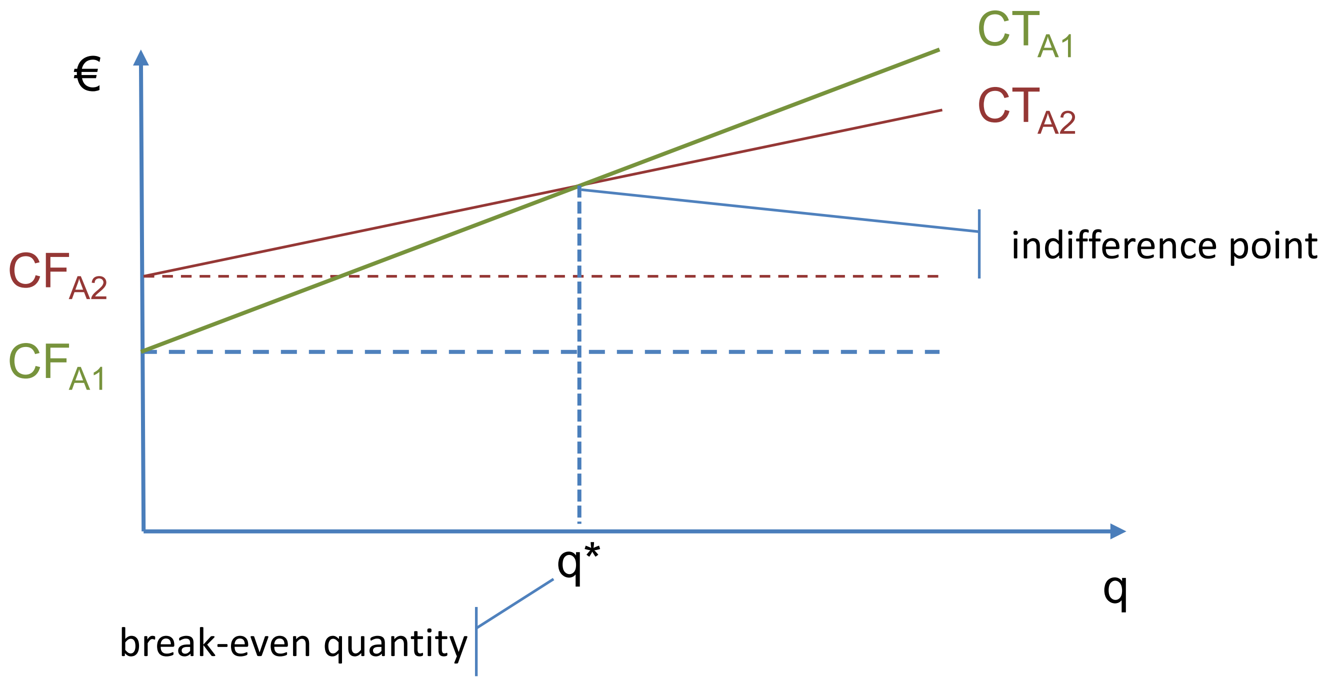
- A production asset has a production capacity Q (e.g. annual).
- Capacity is influenced:
  - by other plants/processes with which the asset is related
  - by the actual operating time of the asset.
- Two cost components can be identified:
  - *fixed costs* (CF), which do not change with the quantity produced
  - *variable costs* (CV), which change with the quantity produced.

- The sum of the two components gives the total costs (CT) for a certain quantity of production (q).
- The production function CT(q) can be assumed to be *linear* within an interval of variation of q:

$$CT(q) = CF + CV \cdot q$$



- Two alternative assets A1 and A2 can be compared when:
  - $CF_{A1} < CF_{A2}$ and $CV_{A1} > CV_{A2}$
  - or vice versa.



- The break-even quantity q* can be calculated as:

$$CT_{A1}(q^*) = CT_{A2}(q^*)$$

$$CF_{A1} + CV_{A1} \cdot q^* = CF_{A2} + CV_{A2} \cdot q^*$$

$$q^* = \frac{CF_{A2} - CF_{A1}}{CV_{A1} - CV_{A2}}$$

# Example (EMot)

- A manufacturing department must replace an electric motor which supplies a power of 18.5kW
- Two options are considered:
  - MIE1, standard IE1 class motor, efficiency $\eta$=89.5%
  - MIE2, high efficiency IE2 class motor, efficiency $\eta$=92%.
- The investment costs for the options are:
  - MIE1: 540€
  - MIE2: 710€
- The company adopts a 20% depreciation coefficient.
- The unit cost of electric energy is 0.24€/kWh

# Example (EMot)

- Variable cost is a function of the energy used in the hours of operation (per year):

$$CV = c_E \cdot Energy\ used = \frac{c_E \cdot P \cdot H}{\eta}$$

- where:
  - $c_E$ is the unit cost of electric energy (€/kWh)
  - P is the supplied power (kW)
  - H is the number of operation hours per year
  - $\eta$ is the efficiency of the motor.

# Example (EMot)

- Annual costs are reported in the table:

| | MIE1 | MIE2 |
|---|---|---|
| Depreciation (€) | 108.00 | 142.00 |
| Maintenance (€) | 60.00 | 60.00 |
| Total fixed (€) | 168.00 | 202.00 |
| Variable cost (€/h) | 4.96 | 4.83 |

- The indifference quantity (hours of operation) is:

$$q^* = \frac{CF_{\mathrm{MIE2}} - CF_{\mathrm{MIE1}}}{CV_{\mathrm{MIE1}} - CV_{\mathrm{MIE2}}} = \frac{202 - 168}{4.96 - 4.83} \cong 252$$

# Methods based on cash flows

- The break-even method does not explicitly consider the cash flows of the project.
- The time horizon of analysis comprises several elementary periods ($t$), e.g. years.
- For each year $t$, the difference between revenues and (monetary) costs can be obtained, i.e. the *cash flow* (or *cash balance*) for year $t$ of the project ($F_t$).

- For now, we will consider the components of cash flows at a level of detail sufficient to understand the structure of the methods.
- We will separate the two main cost components
  - investment costs
  - operating costs
- and the revenue component of a project
  - operating revenues.

- Financial structure of a *project* (*project financials*)

| Classes | for the year t |
|---|---|
| Operating revenues | $R_t$ |
| Cost of sales | $Cv_t$ |
| Management overheads etc. | $Cga_t$ |
| Profit before tax | $R_t - Cv_t - Cga_t$ |
| Depreciation | $Amm_t$ |
| Taxes (Alq rate) | $Alq(R_t - Cv_t - Cga_t - Amm\ )_t$ |
| Cash flow $(FC\ )_t$ | $(1\text{-}Alq)(R_t - Cv_t - Cga_t - Amm_t\ ) + Amm_t$ |
| Investments | $I\ _t$ |
| Free cash flow | $FC_t - I\ _t$ |

- In several cases we will not consider the “after-tax” cash flows.

# Asset life cycle

- We will see several examples of cash flow construction.
- If a project concerns an asset, several components can be identified.
- They can be grouped according to the stages of the asset’s life cycle.

- Acquisition
  - pre-acquisition and supply management
  - main facilities and equipment
  - facilities and support equipment
  - support services (e.g. electricity, fluids, etc.)
  - testing
  - operational infrastructure (e.g. logistics)
  - ICT systems
  - data acquisition and processing
  - storage, handling and transport of materials
  - initial staff training
  - *commissioning*.

- Operation
  - net personnel
  - net operating services
  - production and consumption materials
  - energy
  - personnel selection and training
  - operating documentation
  - ICT systems training
  - operation and management of infrastructure related to the asset.

- Maintenance
  - materials for routine maintenance
  - materials for breakdown maintenance
  - adjustments or planned revisions
  - planned expansions
  - maintenance personnel
  - training of maintenance personnel
  - maintenance documentation
  - external services for maintenance
  - spare parts.

- Support Services
  - operations management
  - *overheads*
  - insurance
  - security
  - human resources management
  - storage infrastructure (warehouses)
  - logistics services and order preparation.

- Decommissioning
  - plant shutdown
  - disassembly and removal of materials
  - recycling and material transfer
  - salvage value
  - divestment.

- Often, costs exceed revenues in the first years because of
  - the investment outlays
  - the start-up phase of the operation.

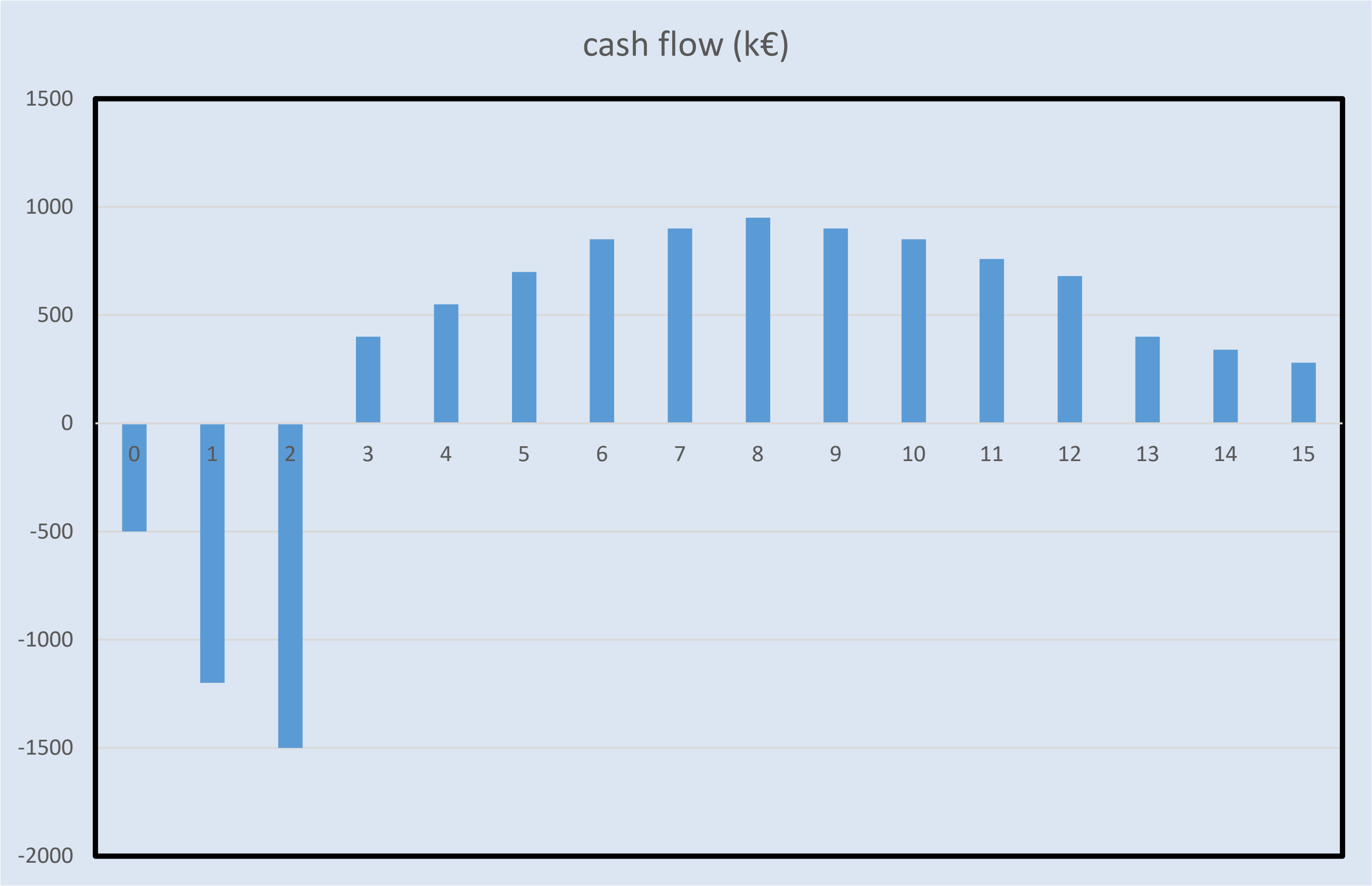
- If $I_t$ , $R_t$ , $C_t$ are respectively the investment outlay, the operating income and the operating cost at generic time t, flows are (useful life from period 0 to period *n*):

  - $I_t\ (and\ Rt = 0, Ct = 0)\ from\ 0\ to\ t'$
  - $C_t > R_t\ from\ (t' + 1)\ to\ t''$
  - $R_t > C_t\ from\ (t'' + 1) to\ n$

- In each year *t* : $F_t = R_t - C_t$

positive flows
(*cash inflows*)

negative flows
(*cash outflows*)



# Payback period

- Let $I_0$ be the initial outlay and Fm the *estimated average value* of the annual cash flow.
- The value $I_0$ can be broken down into PB periods of equal value Fm:

$$PB = \frac{I_0}{Fm}$$

- PB represents the number of periods required to recover the value of the initial investment.

- As Fm increases, PB decreases.
- This approach implies a preference for low PB values.
- It is believed that if PB is short
  - resources can be redeployed more quickly
  - the project is less risky.
- In any case, PB shall be shorter than the economic life of the project.

- If there is a salvage value (SV) at the end of the life of the asset, the capital to be recovered is the net capital:

$$PB = \frac{I_0 - SV}{Fm}$$

- In fact, SV is a cash inflow (if the asset is sold at its SV).

- When comparing an alternative ($A_1$) to the as-is situation ($A_0$), the average cash flow is the differential:
  - differential cash inflows with respect to $A_0$
  - differential cash outflows with respect to $A_0$.

- What happens if the operating revenues are the same in both situations?
- Alternative $A_1$ is expected to yield cost savings such that the related investment is recovered.

- If several alternatives are compared, the one with the shortest PB will be preferred.
- In any case, a “threshold value” for the payback (explicit or implicit) is adopted in the evaluation.

# Example (SMT)

- A facility management company (SMT) evaluates a new service for monitoring and analysis of process temperature for industrial companies.
- To this end, SMT should purchase an integrated monitoring system for data acquisition and processing.

# Example (SMT)

- SMT estimated  a demand of 2400 paid hours of service per year; the unit revenue (net of personnel cost) of 8.00€/h was also estimated.
- The solutions offered by two suppliers (P1 and P2) have the following features:

| | P1 | P2 |
|---|---|---|
| System capital cost (€) | 42000.00 | 36000.00 |
| Consumables (€/h) | 1.80 | 2.03 |
| Material costs (€/yr) | 4320.00 | 4860.00 |
| SW licenses (€/yr) | 750.00 | 720.00 |
| Maintenance cost (€/yr) | 550.00 | 430.00 |
| Economic life (years) | 8 | 8 |
| SV (in its eighth year) | 8400.00 | 7200.00 |

# Example (SMT)

- Personnel and other operating costs would not vary with the alternative.
- Fm is the difference between annual revenues and costs.
- The following values of payback are obtained:

| | P1 | P2 |
|---|---|---|
| Fm | 13580.0 | 13190.0 |
| PB | 2.5 | 2.2 |

- Two questions should be addressed:
  - Is a PB > 2 years congruent with the decision maker's expectations?
  - Is the difference between the values obtained significant for the choice?

# Example (EMot)

- Suppose that a change from the as-is situation is not compulsory, i.e. the existing motor could be used if it was more convenient.
- The existing electric motor has an efficiency of 88%.
- If the motor operates for 1600 hours/year supplying a power of 18.5kW, the cost of used energy is 8072.7 €/yr.
- Using the new MIE2, the company could reduce energy consumption.

# Example (EMot)

| | | |
|---|---|---|
| New cost of energy (MIE2) | 7721.7 | (€/yr) |
| Cost saving (per year) | 351.0 | (€/yr) |

- Considering the investment cost for the new motor (710€), we can calculate the payback:

$$PB = \frac{I_0}{Fm} = \frac{710}{351} \simeq 2.02\,(years)$$

- This version of the payback considers *constant* average cash flow over the analysis horizon.
- When it is possible to estimate annual costs and revenues and they are variable, the payback can be determined in a more refined manner.
- This method of calculation is preferable when non-negligible variability of cash flows is expected.

- It is necessary to establish a year from which to evaluate the return on investment.
- The payback corresponds to the expected number of years for the recovering of the investment.
- It is obtained by summing up the cash flows year by year, starting from year 0, until the year in which the cumulative sum becomes greater than or equal to 0.
- Again, the value obtained is compared with a *threshold value* set by the investor and which may depend on the type of project.

- It can be used to compare different alternatives:

| | Project A | Project B |
|---|---|---|
| **Year** | **cash flow (k€)** | **cash flow (k€)** |
| 0 | -1200 | -1200 |
| 1 | 200 | 300 |
| 2 | 300 | 400 |
| 3 | 400 | **500** |
| 4 | **300** | 300 |
| 5 | 300 | 200 |
| 6 | 400 | 200 |
| | **4 years** | **3 years** |

- However, some interesting results deserve attention:

| | Project A | Project B |
|---|---|---|
| Year | cash flow (k€) | cash flow (k€) |
| 0 | -2500 | -2500 |
| 1 | 300 | 600 |
| 2 | 400 | 800 |
| 3 | 600 | 600 |
| 4 | 800 | 300 |
| 5 | **400** | **200** |
| 6 | 300 | 200 |
| 7 | 200 | 100 |
| 8 | 200 | 100 |

| | Project A | Project B |
|---|---|---|
| Year | cash flow (k€) | cash flow (k€) |
| 0 | -2500 | -2500 |
| 1 | 300 | 600 |
| 2 | 400 | 900 |
| 3 | 500 | 600 |
| 4 | 700 | **400** |
| 5 | **600** | 200 |
| 6 | 500 | 100 |
| 7 | 400 | 100 |
| 8 | 300 | 100 |

# Comments

- The *simple* payback period method does not consider the fact that cash flows occur in different years.
- The basic principles of financial transactions state that monetary values occurring at different times cannot be *directly* compared, added or subtracted:

*to compare them, they must be referred to the same time*.