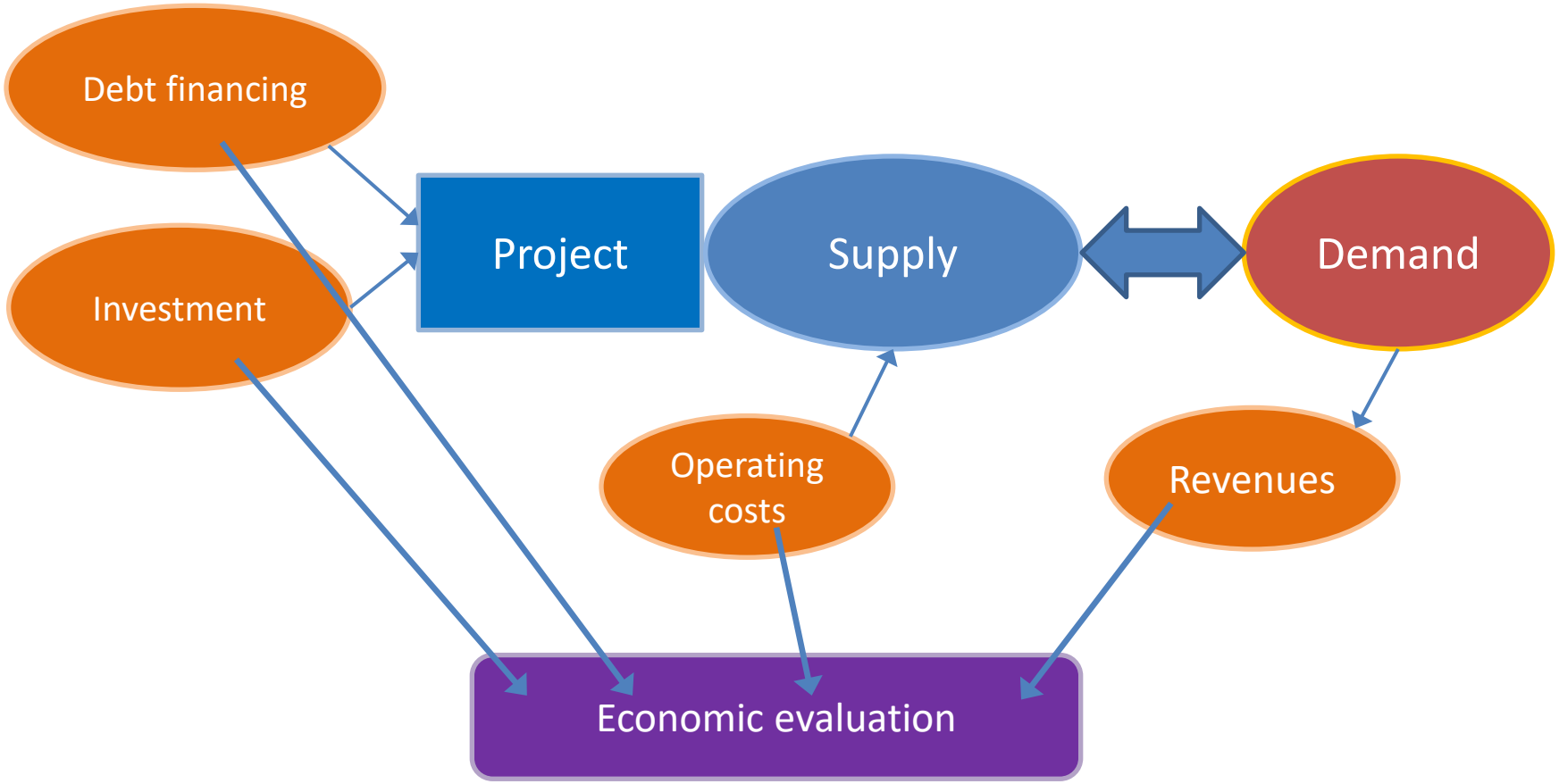
Economic evaluation: principles and methods

Economic evaluation of industrial projects

Economic evaluation: basic elements



Economic evaluation

- If all the factors involved (resources and effects) can be measured in monetary terms (e.g. Euro), they can be treated consistently.
- The properties of cardinal variables can be used.
- Economic evaluation methods are largely based on *neoclassical economic theory*.

Some basic aspects of the theory

- Resources are scarce $\Rightarrow$ choices
- A resource is *scarce* (limited) if the demand for that resource at a zero price exceeds its availability.
- Choices involve *trade-offs*.
- Typical choices:
  - *what to* produce
  - *how to* produce
  - *for whom to* produce.
- One activity (solution, product, service, etc.) is chosen at the expense of others that are given up.

- First aspect:
  I choose an activity based on the benefits I can derive from it.
- The *willingness to pay* (WTP) for an activity is the maximum amount of money the economic agent agrees to pay in order to perform it.
- Second aspect:
  if I choose an activity A:
  - I have to bear an *explicit* cost
  - I have to bear a cost because I give up other activities.
- *Opportunity cost* is defined as the value of the *best* alternative that the agent gives up.
- Both WTP and opportunity cost depend on the specific agent.

- Linked to the previous concepts is that of *utility*.
- Utility is a measure of the satisfaction of the economic agent.
- However, perceived utility is not directly observable, but it is possible to obtain a preference judgement between two different options.
- Utility can be regarded as a representation of a subject's ordinal preference.
- Utility can be linked to the concept of *value*.

- Value denotes the quantity of a certain good at which another good (or service) can be exchanged (*exchange value*).
- According to these principles, an economic agent will always choose the object (solution) that offers the highest value.
- The monetary measure of the same object (its value) depends on the agent and their specific situation.
- To sum up, an object has (economic) *value* when it is characterised by
  - utility
  - scarcity.

Investments and assets

- A project is carried out by *private*, *public* or mixed (public-private partnership) actors to meet a need (expressed by a *demand*).
- As already seen, resources are absorbed:
  - for the realisation of the project
  - to ensure the operability of the output.

- It is worth remarking that the term *asset* applies to:
  - fixed assets (property, plant and equipment)
  - current assets (e.g. inventory).
- We will focus our attention on tangible fixed assets, i.e. physical objects with multi-year value.
- Not all projects, however, realise a material output in the strict sense.

- Investors usually have several opportunities for using their (limited) financial resources (COpp).
- *Opportunity cost*: in the presence of limited resources, it is the cost incurred by foregoing *the best* alternative use of resources.
- For example, a company uses some capital for a project, giving up the best investment, which offers a return of 4%.

- As seen, a subject manifests a *willingness to pay* (WTP) for a product or service (activity).
- When the difference (WTP - COpp) for an activity is positive, the activity creates *value* for the economic agent.
- Economics analyses the *increase* (or *decrease*) in value resulting from a *specific* choice:
  this is called *marginal* analysis (valuation) .

Financial and economic evaluation

- Two types of project evaluation are outlined:
  - *financial* analysis and evaluation (private)
  - *economic* analysis and evaluation (public) .
- Of the project, the financial analysis aims to evaluate:
  - *profitability*
  - *sustainability*.

- A project has *positive profitability* if it generates sufficient revenue
  - to recover investment and operating costs
  - to produce profits

  regardless of funding policies.
- The profitability analysis should be conducted even if the service provided by the output is free of charge.
- The *financial sustainability* analysis takes into consideration all sources of funding involved in the project as well as the timing of receipts and payments.
- A project with negative profitability will be sustainable if, considering *all* sources of financing, it is able to repay investment and operating costs.

Types of economic comparison

- *A first* type of comparison is between
  - investment costs + operating costs
  - revenue (from sales of goods, services, etc.)
- A *second* type of comparison is between
  - situation *without* intervention
  - situation *with* intervention
- A *third* type of comparison concerns the possible *alternatives* for intervention.

Scenarios subject to evaluation

- The basic approach of any evaluation is to compare alternative scenarios.
- In decision making, two options are always possible:
  to implement or not implement the project.
- The decision to implement the project hinges on comparing the economic effects of these two options.

- Each project solution is assessed in comparison to the scenario where no project is implemented.
- This is often called a *reference* (or *base*) *solution*.
- Evaluation consists of measuring the *incremental* effects (costs and benefits) of a project compared to the “no project” scenario or other reference solution.

- Particularly important is the definition of the baseline scenario with respect to the project context.
- Sometimes this baseline is called “as-is” situation (or *scenario*).
- Examples:
  - the production system as it stands
  - the current mode of product/service delivery.
- But the concept is *dynamic*: how would the current system operate in the expected development of the reference scenario?
- Technically, this is referred to as a “*business-as-usual*” (BAU) scenario.

- While “as-is” focuses on analysing the current state to drive improvements, BAU emphasizes the option of maintaining smooth daily operations without major changes.
- In any case, the base scenario is not a *do-nothing* situation.
- Some investment outlays may be necessary (e.g. for the partial overhaul of an existing infrastructure).
- Instead, the base scenario is a “*do-minimum*” scenario.
- Defining the reference scenario as one in which no investment is made can be misleading.

- To sum up:
  - the *reference solution* generates costs and revenues
  - the *project solution* generates costs and revenues

  the differences in costs and revenues between the two scenarios should generally be considered.
- When analysing an individual project, the comparison may not be with an explicit reference solution.
- In practice, one operates as if the baseline scenario did not produce any costs and revenues, but what is actually evaluated is the *marginal* effect of the new project.

Role of demand

- We have seen that a project proposal stems from the existence (or prediction) of a need.
- Estimates of current demand and forecasts of its development provide the necessary input for the evaluation.
- In-depth demand analysis is usually elaborated in specific studies (e.g. market analysis).

- The estimate must be made for all scenarios considered:
  - solution without project
  - all project alternatives considered.
- The unit of measurement depends on the type of intervention:
  - quantity/day
  - kWh/year
  - machine hours etc.
- The evolution of demand should be estimated, independently and dependently upon the project.

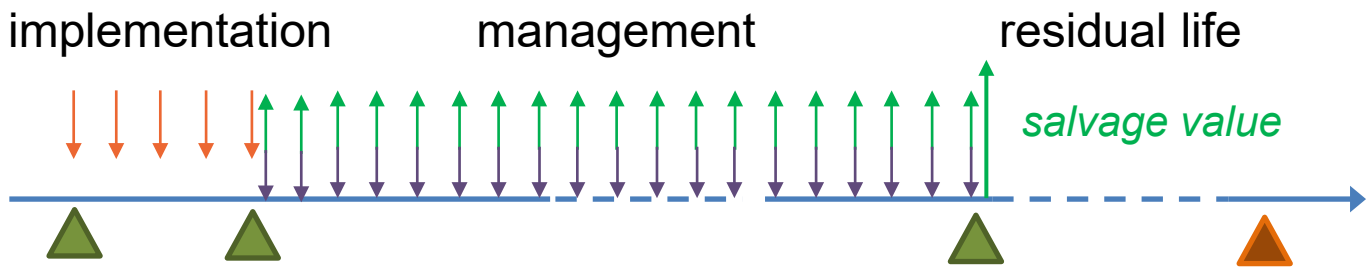
Analysing a project

- The *effect* of a project can be summarised in financial terms through the *cash flows* associated with it.
- Cash flows are derived from the costs and revenues determined by the project (and its outputs).
- They are realised over a time horizon in which the project is implemented and its outputs managed.

- In the case of industrial assets, the life cycle includes:
  - identification of the problem or opportunity
  - identification of the gap between the present state (as-is) and the desired state (to-be) and the requirements
  - the pre-feasibility study and pre-selection of solutions
  - the feasibility study of pre-selected alternatives
  - the final design and procurement (or in-house implementation)
  - the provision of materials, services, energy
  - operation and maintenance
  - decommissioning and divestment.

- The financial analysis must estimate the following periods of the project life:
  - starting year
  - years of implementation (from start to start of operation)
  - years of management (referring to the subject for which the analysis is carried out)
  - years of remaining useful life after the end of management.

- The *initial outlay* is the *investment cost* in the first years of the useful life.
- During operation, other costs (management and operating costs) will have to be incurred.
- Operating revenues will begin to show up after a certain year and may also be distributed.



- Civil works or installations of significant size (e.g. energy production plants, waste treatment plants) are developed in multi-year phases.
- For more limited technological interventions (e.g. installation of machine tools), the implementation phase is completed within one to two years (including design and supplier selection time).
- Moreover, the operational phase of the asset can be started gradually, so that revenues can start to be generated before the whole project is completed.

A general classification of costs and revenues

- *investment costs*
  - design
  - land acquisition
  - civil works
  - plant and machinery
  - overheads
  - contingencies
  - overhaul after some years of operation

- *operating costs*
  - energy costs
  - costs for materials
  - costs for services
  - personnel costs
  - management charges
  - routine maintenance.

- *operating income*
  - selling products
  - selling services
  - rentals or leases
  - savings (compared to the situation without investment)
- *salvage value* (at the end of the useful life).

- Two categories of costs considered in valuation methodologies:
  - *cash costs*: these are costs that generate actual monetary transactions (income or expenditure).
  - *non-cash costs* (accounting costs): these are costs that do not generate cash movements; a typical example is depreciation.
- In the evaluation of investments, the cash principle is adopted, according to which:
  - the “costs” of a year *t* are the actual monetary outflows in *t*
  - the “revenue” of year *t* is defined as the cash that is *actually* collected (inflow) in *t*.

- A different principle is adopted in accounting, where all administrative facts that contributed to the production of year *t* are defined as costs and revenues.
- This is irrespective of whether these facts gave rise to a cash transaction or not.
- For industrial assets:
  - in the case of the cash principle, the cost is charged for the purchase price at the time of actual payment
  - in accounting, the cost is allocated as annual expense over the useful life of the asset (*depreciation*).